9th BACSA INTERNATIONAL CONFERENCE

"Sericulture preservation and revival – problems and prospects"

"SERIVIVAL" 2019

Batumi, Georgia

April 7th –12th 2019

PROCEEDINGS

BATUMI

2019

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9TH BACSA International conference "Sericulture preservation and revival – problems and prospects" - "SERIVIVAL" 2019, was organized by the Georgian Academy of Agricultural Sciences (Tbilisi, Georgia) and the Ministry of Agriculture of Autonomous Republic of Adjara (Batumi, Georgia) in close cooperation with the Black, Caspian Seas and Central Asia Silk Association (BACSA).

We appreciated presenting contributions on the main Conference topic as well as country reports, science and technology papers in the field of mulberry and non-mulberry silkworms, cocoon and silk production, pathology, breeding and becology, using silkworm and mulberry for non-textile purposes, post-cocoon technologies, silk enterprise and trade.

The collection of abstracts and papers are printed by a decision of the Georgian Academy of Agricultural Sciences and the Ministry of Agriculture of Autonomous Republic of Adjara.

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Vice-president: Prof. Dr. Elgudja Shapakidze, Georgian Academy of Agricultural Sciences, Tbilisi, Georgia.
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PROGRAMME

Organizing committee:
President: Prof. Dr P. Tzenov, President of BACSA and Director of Scientific Center on Sericulture under the Bulgarian Agricultural Academy.
Vice-president: Prof. Dr. Elgudja Shapakidze, Georgian Academy of Agricultural Sciences, Tbilisi, Georgia

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Scientific committee:
Prof. Dr. E. Shapakidze;
Dr. S. Cappellozza;
Prof. Dr. S. Madyarov;
Prof. Dr. P. Tzenov

Venue and Dates:
INTURIST hotel, Batumi, Georgia

Programme:

- **5th, 6th and 7nd April, Friday, Saturday and Sunday**

Arrival of participants at the International airports of Batumi, Tbilisi or Kutaisi, their meeting by conference organizers, transfer to hotel INTURIST and registration.

- **8th April, Monday**

9:00 – 9:30 registration;

9:30 – 10:10 opening ceremony:
9:30 – 9:40 Opening by Prof. Dr. P. Tzenov, President of BACSA;
9:40 – 9:50 Welcoming speech by Mr. Tato Aroshidze, Minister, Ministry of Agriculture, Adjara Autonomous Republic, Georgia;
9:50 – 10:00 Welcoming speech by Prof. Dr. Guram Aleksidze, President of Georgian Academy of Agricultural Sciences, Tbilisi, Georgia;

10:00 – 12:00 Session 1 Sericulture preservation and revival – problems and prospects:
CHAIRPERSON: PROF. DR. ELGUDJA SHAPAKIDZE, Georgian Academy of Agricultural Sciences, Tbilisi, Georgia

LEAD PAPER: Problems and Prospects of Sericulture Preservation and Revival in Europe, Caucasus and Central Asia, by Prof. Dr. Panomir Tzenov, President of BACSA;

Role of ISC for the development of Sericulture & Silk Industry in the world, by Dileep Kumar R., Programme Coordinator, International Sericultural Commission;

The European Silk Road: from cultural diversity to unity of purpose. The study case of the project Serinnovation, by Silvia Cappellozza and Alessio Saviane;

Current state of sericulturein Georgia, rehabilitation-revival, strategy of development, by G. Nikoleishvili, E. Shapakidze and M. Turmanidze;

Sericulture in Azerbaijan, by Yusif Shukurlu, Guduret Bakirov, Mehman Yusibov, Zarintaj Shukurova;

Silk in Georgian Culture and Religion: Past and Present, by I. Bakhtadze;

INDIAN SERICULTURE INDUSTRY LEAPS AHEAD, by Rajit Ranjan Okhandiar, Secretary General, International Sericultural Commission, Bangalore, India;

SERICULTURE IN GUANGDONG PROVINCE, South China - A successful model for tropical and subtropical sericulture, by Liu Ji Ping;

12:00 – 12:30 visit the sericulture exhibition;
12:30 – 13:30 Lunch;
13:30 – 14:30 Sericulture preservation and revival – problems and prospects, Session 2:
CHAIRPERSON: DR. SILVIA CAPPELLOZZA, CREA – Research Centre for Agriculture and Environment, Padua, Italy

Sericultura in Turkey, by D. Yilmaz;

Sericulture in Georgia and The State Silk Museum, by Nino Kuprava;

New studies on sericulture in Poland, by Malgorzata Lochynska;

14:30 – 15:00 Coffee break
15.00 – 16:45 Scientific – technical reports session:

CHAIRPERSON: DR. MALGORZATA LOCHYNSKA, Institute of Natural Fibers and Medicinal Plants, Poznan, Poland

A Survey Possible Reasons of Non-Spinning Syndrome in Sericulture Industry and Its Incidence in Turkey, by Ümran Şahan, R. Levent Büyükuysal, Ardahan Erdemir;

Diffusion kinetics of the molecules of the dye fizetin at all stages of the process of dyeing silk fibroin, by Yusif Shukurlu, Zarintaj Shukurova;

Production of environmentally friendly solid biofuel from mulberry branches, by N. Stepanishvili, L. Tsigriashvili, M. Bachilava;

New technology of obtaining the grafted and hybrid saplings of a mulberry by the accelerated method, by N. Stepanishvili, L. Tsigriashvili, A. Tsverikmazashvili;

Association of leaf anatomical traits with Powdery mildew resistance in mulberry (Morus spp.) germplasm of The Queen Sirikit Sericulture Center (Sisaket), by CHUMCHUEN Sukunya;

Problems of Mechanization in Sericulture, by E. Shapakidze and G. Nikoleishvili;

Effects of temperature, relative humidity and rainfall on epidemiology of mulberry red rust, by Anchalee Phodee, Benjamat Kaewrat, Pattarakorn Tuntaruk, Mayuree Chompoopuen, Suchai Sirimart and Aurawan Dokkieng.
20:00 - Welcoming Dinner

- **9th April, Tuesday**
  9:00 – 10:30 Posters session, Chairperson: Prof. Dr.Sc. Dimitar Grekov;
  10:30 – 11:00 Coffee break
  11:00 – 13:00 BACSA Executive committee meeting

13:00 – 14:00 Lunch
14:00 – 16:00 Concluding round table discussion

Chairperson: Prof. Dr P. Tzenov

Facilitator: Prof. E. Shapakidze

Opening: Prof. Dr P. Tzenov

Topics of the discussion:

- **Present World raw silk prices, their trend and influence on the sericulture revival and development.**
- **Problems, issues and development strategies of sericulture to involve the industry in the silk production chain by investing in the agricultural process.**
- **Problems, issues and development strategies to redistribute the income of the final product at the different steps of the production chain.**
- **Coordination among the different BACSA countries: redesigning different roles according to different competencies and vocation; competition or collaboration? Might BACSA help an integration process?**
- **Problems, issues and development strategies of Global silkworm and mulberry germplasm preservation, conservation, utilization and exchange.**
- **Suggestions for conference decisions, recommendations and follow ups.**

20:00 Dinner

- **10th April, Wednesday**

9:30 – 13:30 Visit the Experimental farm of Agroservice Center of the Ministry of Agriculture of Adjara (Kobuleti, Gvara, The Autonomous Republic of Adjara, Georgia);
13:30 – 14:30 Lunch;
14:30 -19:30 Visit the Batumi Botanical Garden (The Autonomous Republic of Adjara, Georgia);
20:00 Dinner

- **11th April, Thursday**

9:30 – 13:30 Batumi City Tour: Old part of Batumi; Piazza square; Batumi Boulevard (old and new parts); State Museum of Adjara; Visit to Gonio- Apsaros Fortress;
13:30 – 14:30 Lunch
14:30 Visit Adjarian Wine House; Dandalo arch bridge (built in 12th century); Makhuntseti waterfall
20:00 - Farewell dinner.

- **12th April, Friday**

Closing the conference
Departure.

THE LIST OF PARTICIPANTS
OF THE 9th BACSA INTERNATIONAL CONFERENCE
"SERICULTURE PRESERVATION AND REVIVAL- PROBLEMS AND PROSPECTS"
"SERIVIVAL" 2019
BATUMI, GEORGIA
APRIL 7th-12th,2019

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OPENING SPEECH

By

PROF. DR. PANOMIR TZENOV, PRESIDENT, BLACK, CASPIAN SEAS AND CENTRAL ASIA SILK ASSOCIATION (BACSA)

9th BACSA international conference
"SERICULTURE PRESERVATION AND REVIVAL – PROBLEMS AND PROSPECTS"
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Dear colleagues, Ladies and Gentlemen,

I would like to take this opportunity to express a cordial welcome to all of you attending this conference. In order to be present here today, you all must have put aside other important work and daily tasks.

I believe, this conference will provide opportunities to discuss common issues, seek solutions, share experiences and information and conceive ideas for future directions, and exchange resources and technologies, while getting to know each other for future collaboration in research, production and trade chains of sericulture products.

Why this international conference topic is on the preservation and revival of sericulture?

In fact, the total global raw silk production is around 193 000 tons annually, but out of them 160 000 tons are produced by China and 30 000 tons by India, while all the other countries produce only about 3000 tons of raw silk. That means almost 99 % of the total world silk production is from only two countries - China and India.

On the other hand, even though about 40 countries in the World deal with sericulture now, more than 90 % of those countries only make efforts to preserve it and only few of them to revive the sericultural industries. Even in the countries, the biggest World cocoon and silk producers, now there are entire regions where the sericultural activities have been partly or even completely stopped and the sericulture may be lost.

In the countries, having comparatively high costs of production in order to survive in the present sericulture business, producers should not make cheap products with low quality to compete for the prices, but to produce more sophisticated products, natural and environmentally friendly which satisfy consumers even though they are more expensive.

So, why should we make efforts to preserve and revive the sericulture?

First of all the sericulture is a part of the human civilization, in many countries it is a culture and long tradition.

As the so called "Queen of textiles", the silk will never be available in large quantities and international supplies will no doubt remain limited in the future.

The silk has some unique and important characteristics, such as the ability to keep the wearer warm when it is cool, and cool when it is warm, the silk is a healthy fiber because it breathes easily and naturally keeps away moisture from the skin, it is actually soothing to the skin diseases and itches. The silk protects the skin from sun ultra-violet irradiation as well.

The silk is a green fiber because the silkworm is very sensitive to pesticides. Unlike cotton silk uses very little pesticides in its production.

The mulberry plantations reduce the run-off of surface soil and soil erosion.

The sericulture being a labour intensive industry can employ a lot of farmers so as to avoid them rushing into cities.

The sericulture requires comparatively low investment, but provides high returns. One crop needs only one month, so the farmers can get cash back quickly.

The sericultural industry transfers money from rich to poor because usually the silk production is in developing countries, but the consuming is more in developed countries. Silk is produced by the farmers, but consumed by the rich people.

There already exists a new industry of mulberry fruit for production of juice, wine, jam and food additives.

There is a recent trend in using the silkworm for non-textile purposes such as silkworm powder for antidiabetes, 1-deoxynojirimycin (DNJ), cordyceps, use silk protein in cosmetics, development of silk new bio-materials with anti-aging, eardrum and silk artificial bone, transgenic silkworms.

It has been proved that the proteins, extracted from the silkworm cocoon have a strong antimicrobial function.

Recently a bio-technology sericulture has been developing. For the first time in the world the legitimately rearing of genetically modified silkworms in conventional sericulture farms started in 2017 in Japan.

The functional silk is a promising material for medical applications. Using the methods of genetic engineering absolutely new silks that have unprecedented functions were developed. These are transgenic Spider silk, hyperfine silk for small diameter artificial blood vessels, fluorescent silk.

Silk regenerative medical materials like silk sponge, silk hernia mesh, wound dressing, silk surgical tape, hydrogel, films and 3D scaffolds for wound healing and tissue regeneration and reconstruction gels, powders, enzyme immobilization matrices were also created.

Transgenic sericin is used for several medical reagents, like blood test drugs, biomatrix for tissue engineering and cosmetics.

The sericulture had a glory past, difficult present and bright future.

Finally, I wish you all pleasant stay in Batumi, a successful participation in this conference to the end, and a safe trip back to your home countries, bringing with you some work plans and business ideas to be put into practice for further sericulture revival and development in your respective countries and for further progressive international collaboration.

I would like thank very much to Ministry of Agriculture of the Autonomous republic of Ajara and the Georgian Academy of Agricultural Sciences for the financial support and their tremendous efforts in organizing the present conference.

Thank you very much again for coming this far and for listening.

PROBLEMS AND PROSPECTS OF SERICULTURE PRESERVATION AND REVIVAL IN EUROPE, CAUCASUS AND CENTRAL ASIA

Prof. Dr. PANOMIR TZENOV
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ABSTRACT

In fact, the main problems of the most European, Caucasus and Central Asian BACSA member countries in the present days is how to preserve and revive the sericulture.All the sericultural activities in the BACSA region have declined for the last 30 years, which is evident from the major statistical figures. The fresh cocoon producing countries in the region decreased the total production from about 50000 t to 30000 t annually or 1.7 times, while in some countries the decrease was from 21 to 100 times, or they completely stopped the production. The total raw silk production dropped from about 5000 t in 1984 to only about 2000 t annually or 2.5 times, what means that nearly a half of the dry cocoons produced are exported to other countries.Even though the cocoon and raw silk production declined more than two times during the recent decade, the Black, Caspian seas and Central Asia region still remains the third world producer, having very high potential for increase the silk production in the near future. In Europe (Italy, Switzerland) the top World quality silk fabrics and garment producing industries are concentrated. They however work entirely with raw silk imported mostly from China and smaller quantity from Brazil. The European, Caucasus and Central Asia region countries could be divided roughly into 3 groups, namely: 1) countries mainly silk exporters 2) countries mainly silk importers and 3) countries which do not produce significant silk amount, but almost do not import any silk as well.The region possesses one of the richest silkworm and mulberry germplasm. The total number of mulberry accessions available in the region is about 900, originating from 22 countries and of silkworm accessions is about 600, originated from 20 countries.Almost all the commercial silkworm hybrids, produced in the region manifested comparatively high productivity, namely single cocoon weight 2.2 – 2.5 g, shell ratio 23-24 %, shell weight 0.500 – 0.600 g, filament length 1300 – 1500 m under laboratory conditions.The sericulture science and technology in the region countries is at a comparatively high world level. Major constraints for the regional sericulture preservation, revival and development are lack of sufficient financial support from the governments, too low raw silk quality produced,crop losses due to mulberry and silkworm diseases, the production technologies at the field level are still more relying on the traditional methods and management system, thus not to be commercially oriented operation, lack of polices for protection sericulture industry.As a main barrier in the European countries for the cocoon production increase is that due to their comparatively higher living standard the present raw silk prices at the international market can not stimulate the farmers to produce cocoons, even some additional support from the government or EU availability.In the Central Asian countries the quality of presently available silkworm eggs do not meet the international standard and their quantity can not satisfy the local needs, thus in the recent years Tajikistan imports about 90 % and Uzbekistan –about 60 % of the necessary silkworm eggs. The main

reasons for cocoon and raw silk production decline were that in the ex-communist countries in Eastern Europe and Central Asia the transitional period from centralized to market economic system lead to sudden stop of the governmental support to sericulture, breakage of the traditional economic relationships between the countries, thus the destroy of the already established system for sharing the different parts of sericultural production.In the silk carpet producing countriesthe difficulties on exportation of silk carpet and also smuggling very cheap silk yarn, selling cheap and low quality carpets especially coming from Far East with prevalence of traditional Persian designs could not be prevented. As the genius hand woven silk carpets didn't have a chance to compete with the others owing to their high prices, many companies left the market, expanded usage of machine-made or other synthetic rugs.In the Western European countries like Italy and Spain the cocoon production declined very much far before 1990 due mainly to the higher living standard of the producers, compared with the raw silk prices and the rapid urbanization due to heavy industrialization.The land re-distribution policy and crop re-structuring, especially in areas where sericulture was popular and active and mulberry plantations had a big share among crops.The gain of new crops, especially industrial ones, which provided higher incomes and lead to the replacement of the mulberry plantations.The strategies for regional sericulture preservation, revival and development include preserving the research institutions in sericulture and the valuable mulberry and silkworm genetic resources, making possible own production of mulberry saplings and hybrid silkworm eggs.The research centers in the region countries must deal not only with a pure research, but also to have production activities such as providing mulberry saplings, silkworm eggs and technical support to the farmers.Governmental and/or European union subsidies for the research entities and those dealing with production of silkworm eggs, mulberry saplings, silkworm rearing equipment etc. should be provided.It is also necessary to have grants for the physical persons and companies for planting mulberry plantations and building silkworm rearing houses and equipment, grants for training in sericulture, direct subsidies, based on kg of fresh cocoons produced and/or boxes of silkworm eggs reared. By the direct subsidies a fresh cocoon price balance should be maintained, which will keep the existing farmers to continue dealing with this activity and also the price to be so attractive that more people to become interested to take up sericulture. Unlike most of the other agricultural producers the sericulturists are not able neither to use their product at home nor to deal alone with the cocoon marketing. In fact without a guaranteed accepting and paying the fresh cocoons their production is a nonsense. Presently in the region the cocoon purchasing from the producers, their processing and marketing of the final products are almost entirely in the hands of the private business or some cooperatives like in Turkey and Greece, that is why it is very important how the private business can be convinced that the silk industry is a profitable business in order to deal with it.In the present world of raw silk prices, dictated by only one big country and also unstable, the subsidies could contribute in a great extent in making the silk business more reliable and profitable, thus more attractive for the business.It will be necessary a sericulture products diversification by development of new products such as use the mulberry and silkworm for non – textile purposes, production of very high quality uni-bivoltine silk with certain special characteristics, silk handcraft production for selling to the tourists at the local market and also for export. In the short-medium term future the silk industry in the region should be mostly oriented to export. If some of the countries in the BACSA region can meet the raw silk standard requirements there is a big raw silk market in Europe and Central Asia. In the sericulture preservation and revival

process some important trends in the World sericulture industries development should be considered**:** So far the subsidies for sericulture, even very generous in some countries succeeded to save it from complete disappearing, but only maintained the production at a low level and did not succeed to revive it to the previous high production levels. In nowadays there are two main cocoon producers – China and India, providing more than 97 % of the Global cocoon production. In both two countries the local silk market plays a very important role, especially in India, thus presently China exports more than 98 % of the raw silk in the world market. Therefore the fresh cocoon purchasing prices in all the other countries are determined depending on the Chinese raw silk price.Now the current raw silk prices are stable since a couple of months. Low quality 2A 3A, from frozen cocoon price is at around 50 US$/kg. Regular qualities for Europe, i.e. 4A 5A from not so famous mills, good for crepe and weft yarn, have a price bit below 60 US$/kg. Very good qualities still keep a price, around 75 US$/kg.The present expectations are the cocoon production in China in this year to reduce 10% – 15% or so. Due to this trend the raw silk prices soon or later will start again upward trend and might reach a next level of about 80-100 US$/kg. It may be take several years. In the meantime there are no sign of new sources for raw silk despite announcements.We believe that no more it will be possible to produce cheap silk like in 90's of 20th century and early 2000's andour vision about the sericulture long-term future is that it will gradually become a boutique-like industry, producing very high value product in restricted amount. This is valid also for the sericulture products use for non-textile purposes. That means the sericulture may change from an industry for the poorest farmers, to an agribusiness, requiring more investments and productional costs, but having high revenues by high market price of the products.The BACSA region countries should consider these World trends and expectations in their plans for sericulture preservation, revival and development.

Keywords: sericulture, silk, preservation, revival, development, strategy

1. Introduction

In present days the main problems of the most European, Caucasus and Central Asian BACSA member countries is how to preserve and revive the sericulture. On the other hand, even though more than 40 countries in the World deal with sericulture now, about 90 % of them only make efforts to preserve it, and only few of them to revive the sericultural industries. Even in the countries, the biggest World cocoon and silk producers now there are entire regions where the sericultural activities have been partly or even completely stopped and the sericulture may be lost. Therefore the sericulture preservation and revival is not only a BACSA countries local problem, but a Global problem as well.

2. The present situation

All the sericultural activities in the BACSA region have declined for the last 30 years, which is evident from the

2.1.major statistical figures:

- The total area under mulberry decreased from about 115000 ha to 82000 ha or 1.4 times;
- The number of mulberry trees decreased from about 430 million to 200 million or 2 times;
- The silkworm egg production dropped from about 2.5 million boxes to 0.8 million or 3 times and the decline was especially sharp after 1992;
- The number of sericultural households decreased from about one million to half million or 2 times;

- The fresh cocoon production decreased from about 50000 t to 30000 t annually or 1.7 times. In Eastern Europe and Central Asia countries like Azerbaijan, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Romania, Turkey and Ukraine decreased their fresh cocoon production from 21 to 100 times, or completely stopped the production, while in Tajikistan and Uzbekistan the fresh cocoon production decreased about 1.6 times only.
- Uzbekistan was and still remains the biggest cocoon producer in the region, followed by Iran and Tajikistan. However in the past (1984) the share of Uzbekistan in the total fresh cocoon production in the region was around 67 %, while presently this country produces more than 90 % of the cocoons. In the other countries the cocoon production has been completely stopped or the amounts produced are negligible.
- The raw silk production dropped from about 5000 t in 1984 to only about 2000 t annually or 2.5 times, what means that nearly a half of the dry cocoons produced are exported to other countries.
- Even though the cocoon/silk production declined about two times during the recent decade, the Black, Caspian seas and Central Asia region still remains the third world producer, having very high potential for increase the silk production in the near future.
- In Europe (Italy, Switzerland) there are concentrated the top World quality silk fabrics and garment producing industries which however work entirely with raw silk imported mostly from China and smaller quantity from Brazil.

2.2. Silk trade:

- The European, Caucasus and Central Asia region countries could be divided roughly into 3 groups, namely: 1) countries mainly silk exporters 2) countries mainly silk importers and 3) countries which do not produce significant silk amount, but do not import any silk as well.

2.3. Sericulture genetic resources and the level of science:

- The total number of mulberry accessions available in the region is about 900, originating from 22 countries and of silkworm accessions is about 600, originated from 20 countries. However these genetic resources are not distributed uniformly between the different countries.
- The countries, having the richest sericulture genetic resources in the region are Bulgaria, Italy, Georgia and Uzbekistan.
- The mulberry leaf yield in the accessions maintained varies from 5 to 13 t /ha under and appears to be lower than in other sericulturally advanced countries from the temperate belt like Japan, China and Korea. However this lower leaf yield could be more attributed to the comparatively dryer summer in this region rather than the genetic potential of the mulberry varieties. It could be concluded that the mulberry accessions preserved in the region possess a comparatively good genetic potential for high leaf yield and quality.
- The silkworm accessions preserved in the region manifested comparatively high variation of the main productive characters, such as cocoon weight from 1.6 g to 2.5 g, shell ratio from 12.00 % to 25.00 % and filament length from 700 m to 1600 m. Some of the silkworm accessions and pure lines maintained in the region manifest comparatively high productivity. There are also some hardy silkworm strains already available.

- About 500 different mulberry varieties and 300 silkworm breeds have been bred in the region. The biggest number of mulberry varieties and silkworm breeds were created in Azerbaijan, Uzbekistan, Italy, Bulgaria, Georgia, Ukraine and Romania.
- Some advanced methods in mulberry and silkworm selection such as polyploidy and mutation mulberry breeding, breeding sex limited for egg color, larval marking and cocoon color silkworm strains, breeding tolerant to adverse rearing conditions silkworm breeds, breeding parthenogenetic /androgenetic lines, control the sex-balance etc. have been developed in the region.
- Almost all the commercial silkworm hybrids, produced in the region manifested comparatively high productivity, namely single cocoon weight 2.2 – 2.5 g, shell ratio 23-24 %, shell weight 0.500 – 0.600 g, filament length 1300 – 1500 m under laboratory conditions.
- The level of sericultural science and technology in the region countries is at a comparatively high world level.

- **2.4. Major constraints for the regional sericulture preservation, revival and development:**

- lack of sufficient financial support from the governments;
- too low raw silk quality produced, resulting in fail to receive the standard price in the markets and to lose existing markets;
- some of the existing sericulture research institutes/stations have old and/or insufficient laboratory facilities and equipment to support the industry;
- there are some crop losses due to mulberry and silkworm diseases and agricultural pesticides;
- most of the silkworm rearing houses and equipment are unsuitable, leading to low cocoon yield per box and too high labour expenses which could result in high production cost. The production technologies at the field level are still more relying on the traditional methods and management system, thus not to be commercially oriented operation;
- weakness of producer organizations;
- lack of strong cooperation from international organizations;
- poor coordination between sericulture and other sectors such as forestry, health, environment in order to be additionally supported by the government, NGOs and private sector;
- lack of polices for protection sericulture industry.

The recent constraints, facing the sericulture industry development in the region may be divided as common for all the countries and specific for the European and Central Asian countries. The main common problems for all the region are too low raw silk quality produced presently, resulting in fail to receive the standard price in the markets and to loose existing markets and that the production technologies at the field level are still more relying on the traditional technology and management system thus not to be commercially oriented operation.

On the other hand as a main barrier in the European countries for the sericulture development is that due to their comparatively higher living standard the present raw silk prices at the international market can not stimulate the farmers to produce cocoons even the subsidies released from the government or EU.

By the same time in most of the Central Asian countries the quality of presently available silkworm eggs do not meet the international standard and their quantity can not satisfy the local needs. For example in the recent years Tajikistan imports about 90 % and Uzbekistan - 60 % of the necessary

silkworm eggs.

3. Reasons for the decline of cocoon and silk production in the BACSA region during theperiod 1990 - 2000.

The main reasons for cocoon/raw silk production decline were as follows:

- In the ex-communist countries in Eastern Europe and Central Asia the transitional period from centralized to market economic system which lead to sudden stop of the governmental support to sericulture, breakage of the traditional economic relationships between the countries thus the destroy of the already established system for sharing the different parts of sericultural production.
- In the Western European countries like Italy and Spain the cocoon production declined much before 1990 due mainly to the insufficient incomes from cocoons, compared with other agricultural crops, high labor cost and wide use of agricultural pesticides.
- The raw silk price at the international market has been and still is dictated by China and only few other low income countries could withstand the competition without state subsidies for the cocoon producers.
- The appearance of new, competitive with the silk synthetic fibres and their huge distribution in the international market.
- The instability of cocoon and silk prices particularly within the local markets.
- The rapid urbanization due to heavy industrialization, especially in Europe.
- The land re-distribution policy and crop re-structuring especially in areas where sericulture was popular and active and mulberry plantation had a big share among crops.
- The gain of new crops, especially industrial ones, which provided higher incomes and lead to the replacement of the mulberry plantations.
- For the ex-Soviet union countries loss the traditional silk markets in Russia and Baltic countries and difficulties in exploring new markets.
- In the silk carpet producing countries-the difficulties on exportation of silk carpet and also smuggling very cheap silk yarn.
- It was not possible to provide training opportunities for silk handicrafts and this caused a quality loss in workforce. To create new designs, patterns and conception suitable for nowadays is failed.
- Selling cheap and low quality carpets especially coming from Far East with prevalence of traditional Persian designs could not be prevented. As the genius hand woven silk carpets didn't have a chance to compete with the others owing to their high prices, many companies left the market, expanded usage of machine-made or other synthetic rugs.
- Comparatively low raw silk quality produced,due to lower cocoon quality and out of the date old silk reeling machines and technology.
- Reduction and/or limitation of international economic growth rate which encourages utilization of cheaper products.
- Absence of big natural silk local market in most of the region countries.

4. The preconditions/prospects for regional sericulture revivaland development

- Very long tradition and experience in sericulture: In the region countries the sericulture industry was adopted around 4000-1500 years ago through the so called "great silk road". These countries used to produce annually more than 50000 t of fresh cocoons and about 5000 t raw silk until the end of 1980's

what was approximately 10 % of the total world production. The main cocoon/silk producers in the region, such as Uzbekistan, Iran and Tajikistan are still one of the leading world cocoon producers, occupying the 3rd place after China and India.

- Availability of about 200 million low/middle/high cut mulberry trees in the region as valuable resources which are enough for an annual production of about 50000 ton of fresh cocoon/year.
- Favorable climatic conditions allowing to produce high quality uni-bivoltine cocoons.
- Still comparatively low farmer's incomes in some countries and regions.
- Since the production is done mostly by old persons, women and even children who do not participate in active agricultural production, thus idle workforce is made valuable, secret unemployment is prevented in rural areas, high income is provided in short time and agricultural income is distributed more balanced.
- Some of those countries are members or candidates for joining to EU, where some subsidies for stimulation of sericulture development are provided by the European commission.
- There are comparatively well developed sericulture science, such as comparatively rich mulberry and silkworm germplasm in some of the region countries.
- There is an increasing World demand for natural and biological products such as the silk. The economical standards of the European population permit the consumption of such products even at high prices.
- Some silk companies from the region already succeeded in finding new markets for their raw silk/silk allied products.
- In some of those countries foreign investors, having safe markets for their silk products have already been attracted.
- The region is a traditional producer of world famous silk handcraft items, such as silk carpets and rugs.
- The region is a part of the big European silk market and some region countries could be created as alternative suppliers of raw silk instead of China.
- There is a global trend for increase of silk price.

5. Importance of sericulture in Europe, Caucasus and Central Asia

- The sericulture is a common culture of this region for already several thousands of years. Nowadays, sericulture is tried to be kept alive since it is accepted as a cultural product as well as for its economic values. The sericulture is going on as an economic, cultural and traditional sub-branch of agriculture. The sericulture has potential as a source of income in the region because with proper support, about 2 million farmers could probably earn approximately 1000 Euros per crop/family and involves marginal sectors of the society, contributing to the improvement of its standard of life.

6. Strategies for regional sericulture preservation, revival and development.

6.1. Preserving the research institutions in sericulture.

- Convincing the government authorities that the sericulture is very valuable for the nation as a cultural product as well as for its economic values and with good potential for development, thus it is worthily

the state to support and preserve the research institutions dealing with sericulture,even though the cocoon and silk production in the country has been temporarily declined or even stopped.

- Preserving the silkworm and mulberry genetic resources available in the country. This measure is a direct result from the previous one because it is impossible to maintain the germplasm without having stable research institutions. In addition it is important to convince the government to release money especially for sericulture germplasm preservation.
- Development and utilization of sericulture germplasm by the selection – breeding work and making possible own production of mulberry saplings and hybrid silkworm eggs. When in certain country the sericulture is at a critical stage of almost disappearing the production of mulberry saplings and silkworm eggs should be done at the state research centers where the germplasms are maintained. By this way the government will guarantee the supply of sericulturists with the basic materials for their production. As a very specific agricultural activity the extension service of sericulture should also be conducted by the research center. That means the research centers in the region countries must deal not only with a pure research, but also to have production activities such as providing mulberry saplings, silkworm eggs and technical support to the farmers.

6.2. Governmental and/or European union subsidies for the sericulture.

These subsidies should be in the following directions:

- Full or partial support to the research entities and those dealing with production of silkworm eggs, mulberry saplings, silkworm rearing equipment etc.;
- Grants for the physical persons and companies for planting mulberry plantations and building silkworm rearing houses and equipment;
- Grants for training in sericulture;
- Direct subsidies, based on kg of fresh cocoons produced and/or boxes of silkworm eggs reared.

The direct subsidies should provide a fresh cocoon price level which will keep the existing farmers to deal with this activity and also the price to be so attractive that more people to become interested to take up sericulture.

6.3. Marketing the sericulture products.

The product of sericulture – cocoons and silk in our region countries are usually not used or utilized at home. That means if a producer is not able to sell the cocoons he can not use orprocess them at home, thus practically his labor and other costs will be lost. Besides, if the cocoon producer doesn't have a dryer there should be some cocoon purchasing center to buy the cocoons and quickly to stifle the pupae. Therefore unlike most of the other agricultural producers the sericulturists are not able neither to use their product at home nor to deal with the cocoon marketing. In fact without a guaranteed accepting and paying the fresh cocoons their production is a nonsense.

As now all the region countries have free market economy it is hardly possible the government or municipalities to establish state companies for cocoon purchasing and processing. Hence the cocoon purchasing from the producers, their processing and marketing of the final products are almost entirely in the hands of the private business or some cooperatives like in Turkey and Greece. So, the question is how the private business can be convinced that the silk industry is a profitable business in order to deal with it? Here is exactly the great role of direct subsidies which may allow a not very

profitable or not profitable business to become profitable enough thus attractive. In fact there is available a strong state support to sericulture in some of the region countries. The silkworm rearing activity within some of the European Union (EU) countries like Greece and Italy is considered as one of the protected and promoted agro-industry The European commission conducts a protective policy for sericulture development by providing a direct subsidy in amount of EUR 133 for each silkworm egg box reared. Direct financial support to the sericulture farmers in amount of about US$ 10/kg fresh cocoons is provided by the Turkish government. The government subsidizes also the mulberry saplings, silkworm eggs, disinfectants, plastic mountages and other materials supply to the farmers.

6.4. Sericulture products diversification.

6.4.1. The silk commodities, produced in the BACSA region.

The silk commodities, produced may be divided roughly in two groups, namely industrially produced silk commodities and silk handcrafts.

The industrially produced items are silk and blended with other fibers fabrics and garment. The main producers are Italy, Switzerland, Spain, GB, Turkey, Greece, Uzbekistan, Azerbaijan, Bulgaria and Romania.

Silk carpets and rugs are the most famous silk handcrafts in the BACSA region whose producers are Iran, Turkey, Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan and Azerbaijan.

Handloom woven silk fabrics, embroidery, knitted garment, souvenirs etc. are produced in small quantities in nearly all the region countries.

6.4.2. The silk commodities trade in BACSA region

As regards the silk trade, the BACSA region countries could be divided into 3 groups, namely: **1) countries mainly silk exporters;2) countries mainly silk importers** and **3) countries which do not produce significant silk amount, but do not import any significant silk quantities as well.**

As main silk exporters Italy and Switzerland (silk fabrics and garment), Uzbekistan, Iran and Turkey could be identified. The main silk importers are Italy, Switzerland, Germany, Spain, GB and Greece.

6.4.3. The solutions for future sericulture industries development

The BACSA region countries should use their unique advantages in sericulture development by means of product diversification. The main directions of the regional strategy for sericultural industries revival and development may be:

- Development of new sericultural products such as use the mulberry and silkworm for non – textile purposes. Utilization the rich germplasm and advanced science for development of new varieties, breeds and hybrids suitable for these aims;
- Production of very high quality bivoltine silk with certain special characteristics;
- Organic silk production;
- Silk handcraft production for selling to the tourists at the local market and also for export.

6.4.5. In the medium term future the export/import of silk products in the region countries could have the figures below:

№	Country	Export			Import		
		Dry cocoons and raw silk	Silk fabrics and garment	Silk carpets and rugs	Dry cocoons and raw silk	Silk fabrics and garment	Silk carpets and rugs
1	Albania	yes			yes	yes	yes
2	Armenia	yes	yes		yes	yes	
3	Azerbaijan		yes	yes	yes	yes	
4	Bulgaria	yes	yes		yes	yes	
5	Georgia	yes	yes		yes	yes	
6	Germany		yes		yes	yes	yes
7	Greece		yes		yes	yes	yes
8	Iran			yes	yes	yes	
9	Italy		yes		yes	yes	yes
10	Switzerland		yes		yes	yes	yes
11	Kazakhstan	yes			yes	yes	yes
12	Poland		yes		yes	yes	yes
13	Portugal		yes		yes	yes	yes
14	Romania	yes	yes		yes	yes	yes
15	Russia				yes	yes	yes
16	Spain		yes		yes	yes	yes
17	Tajikistan	yes		yes			
18	Turkey	yes	yes	yes	yes	yes	
19	Ukraine	yes	yes		yes	yes	yes
20	United Kingdom		yes		yes	yes	yes
21	Uzbekistan	yes	yes	yes		yes	

Silk products	Countries, possible exporters	Countries, possible consumers
Dry cocoon and raw silk	Albania, Armenia, Azerbaijan, Bulgaria, Georgia, Kazakhstan, Romania, Tajikistan, Turkey, Ukraine, Uzbekistan	All the region countries, excluding Uzbekistan and Tajikistan
Silk fabrics and garment	Armenia, Azerbaijan, Bulgaria, Georgia, Germany, Greece, Italy, Romania, Switzerland, Poland, Portugal, Spain, UK, Turkey, Ukraine, Uzbekistan	All the region countries, excluding Uzbekistan and Tajikistan

Silk carpets and rugs	Azerbaijan, Iran, Tajikistan, Turkey and Uzbekistan	Albania, Germany, Greece, Italy, Romania, Switzerland, Poland, Portugal, Russia, Spain, UK

Considering the above figures, it could be concluded that in the short-medium term future the silk industry in the region should be mostly oriented to export. Since Italy, Switzerland, UK, Germany, Greece, Spain, Portugal, Iran and Turkey can not produce enough raw silk or do not produce any raw silk to meet their local demands they import presently raw silk and silk yarn mostly from China. Even thought Uzbekistan is a big cocoon producer their raw silk quality is not good enough to export it at a good price or to meet the high standards for raw silk quality imported to Italy and some other silk fabric producing countries. In fact, if some of the countries in the BACSA region can meet the raw silk standard requirements there is still a big raw silk market in Europe and Central Asia.

7. Some important trends in the World sericulture industries development which should be considered.

Unlikeinthepastwhen the temperatecountriesused tobethemajorsilkproducers,thereisa paradigmshiftofsilkproductiontowardstropicalandsub-tropicalcountries, namelySouthChina,India,Vietnam,ThailandinAsiawhoarethemajorsilkproducers in nowadays.

Now the current raw silk prices are stable since a couple of months. Low quality 2A 3A, from frozen cocoons is at around 50 US$/kg. Regular qualities for Europe, i.e. 4A 5A from not so famous mills, good for crepe and weft yarn, have a price bit below 60 US$/kg. Very good qualities still keep a price, around 75 US$/kg.

The present expectations are the cocoon production in China in this year to reduce 10% – 15% or so. Due to this trend the raw silk prices soon or later will start again upward trend and might reach a next level of about 80-100 US$/kg. It may be take several years. In the meantime there are no sign of new sources for raw silk despite announcements.

What will be the situation in the medium and long term future? During the second half of 20th century and beginning of 21st century the sericulture had been supported by the different international organizations and national governments mostly as an agro based industry, having a high social impact – "let develop the sericulture to alleviate poverty and create job opportunity and income resources for the poorest parts of rural society". This concept is one of the reasons for the "moving" of sericulture from the industrialized to developing regions and countries: the examples with Italian, Japanese and South Korean sericulture, moving the cocoon production in China from eastern part to south-western part etc.. The subsidies for sericulture, even very generous in some countries succeeded to save it from complete disappearing, but only maintained the production at a low level and did not succeed to revive it to the previous high production levels.

The silk produced was comparatively cheap, providing income resources to many poor farmers from the developing countries. In nowadays there are two main cocoon producers – China and India, providing more than 97 % of the Global cocoon production. In both two countries the local silk market plays a very important role, especially in India, thus presently China exports more than 98 % of the raw silk in the world market. Therefore the fresh cocoon purchasing prices in all the other countries

are considered with the Chinese raw silk price. The fresh cocoon purchasing prices in China and India have increased almost triple during the last 10 years, reaching around 7 – 10 US$/kg now. In fact, judging from the previous experience, there is no any chance these prices to go down back, on the contrary they increase year by year so far. Here we are not going to discuss the reasons of raw silk prices increase, but this situation will lead in a medium – term future to higher cocoon and raw silk prices. We believe that it will no more be possible to produce cheap silk like in 90's of 20th century and early 2000's.

Then the question is whether the more expensive silk and other sericulture products may be sold at the similar quantities like now?

It seems that at too high final products prices there will not be possible anymore to produce so comparatively big amount of cocoons and raw silk as now, so our vision about the sericulture long-term future is that it will gradually become a boutique-like industry, producing very high value product in restricted amount. This is valid also for the sericulture products use for non-textile purposes.

In the long-term future may be there will be a much smaller than now sericulture products market, but of high value products.

That means the sericulture may change from an industry for the poorest farmers, to an agribusiness, requiring more investments and productional costs, but having high revenues by high market price of the products.

The BACSA region countries should consider these World trends and expectations in their plans for sericulture preservation, revival and development.

8. Conclusions

- In present days the main problems of the most European, Caucasus and Central Asian BACSA member countries is how to preserve and revive the sericulture. All the sericultural activities in the BACSA region have declined for the last 30 years.
- The fresh cocoon producing countries in the region decreased the total production from about 50 000 t to 30 000 t annually or 1.7 times, while in some countries the decrease was from 21 to 100 times, or they completely stopped the production.
- Even though the cocoon and silk production declined about two times during the recent decade, the Black, Caspian seas and Central Asia region still remains the third world producer, having potential for increase the silk production in the near future.
- In Europe (Italy, Switzerland) the top World quality silk fabrics and garment producing industries are concentrated. They however work entirely with raw silk imported mostly from China and smaller quantity from Brazil.
- The region possess one of the richest silkworm and mulberry germplasm. Some of the commercial silkworm hybrids, produced in the region manifest comparatively high productivity, namely single cocoon weight 2.2 – 2.5 g, shell ratio 23-24 %, shell weight 0.500 – 0.600 g, filament length 1300 – 1500 m under laboratory conditions.The level of sericultural science and technology in the region countries is at a comparatively high world level.
- The main reasons for cocoon and raw silk production decline were that in the ex-communist countries in Eastern Europe and Central Asia the transitional period from centralized to market economic system lead to sudden stop of the governmental support to sericulture, breakage of

the traditional economic relationships between the countries, thus the destroy of already established system for sharing the different parts of sericultural production.

- In the silk carpet producing countries-the difficulties on exportation of silk carpet and also smuggling very cheap silk yarn, selling cheap and low quality carpets especially coming from Far East with prevalence of traditional Persian designs could not be prevented. As the genius hand woven silk carpets didn't have a chance to compete with the others owing to their high prices, many companies left the market, expanded usage of machine-made or other synthetic rugs.
- In the Western European countries like Italy and Spain the cocoon production declined much before 1990 due mainly to the insufficient incomes from cocoons, compared with other agricultural crops, high labor cost and wide use of agricultural pesticides, rapid urbanization due to heavy industrialization, the gain of new crops, especially industrial ones, which provided higher incomes and lead to the replacement of the mulberry plantations.
- Major constraints for the regional sericulture preservation, revival and development are lack of sufficient financial support from the governments, too low raw silk quality produced,crop losses due to mulberry and silkworm diseases and pesticides, the production technologies at the field level are still more relying on the traditional methods and management system, thus not to be commercially oriented operation, lack of polices for protection sericulture industry.
- As a main barrier in the region countries for the cocoon production increase is that the present raw silk prices at the international market still are not able to stimulate enough the farmers to produce cocoons without sufficientadditional support from the government or EU.
- The strategies for regional sericulture preservation, revival and development include preserving the research institutions in sericulture and the valuable mulberry and silkworm genetic resources, making possible own production of mulberry saplings and hybrid silkworm eggs.
- The research centers in the region countries must deal not only with a pure research, but also to have production activities such as providing mulberry saplings, silkworm eggs and technical support to the farmers.
- Governmental and/or European union subsidies release for the research entities and those dealing with production of silkworm eggs, mulberry saplings, silkworm rearing equipment etc. should be provided.
- It is also necessary to have grants for the physical persons and companies for planting mulberry plantations and building silkworm rearing houses and equipment, grants for training in sericulture, direct subsidies, based on kg of fresh cocoons produced and/or boxes of silkworm eggs reared.
- The direct subsidies should provide a fresh cocoon price level which will keep the existing farmers to continue dealing with this activity and also the price to be so attractive that more people to become interested to take up sericulture.
- Unlike most of the other agricultural producers the sericulturists are not able neither to use their product at home nor to deal with the cocoon marketing. In fact without a guaranteed accepting and paying the fresh cocoons their production is a nonsense.

- Presently in the region the cocoon purchasing from the producers, their processing and marketing of the final products are almost entirely in the hands of the private business or some cooperatives like in Turkey and Greece, that is why it is very important how the private business can be convinced that the silk industry is a profitable business in order to deal with it.
- In the present world of raw silk prices, dictated by only one big country and also unstable, the subsidies could contribute in a great extent in making the silk business more reliable and profitable, thus more attractive for the business.
- It will be necessary a sericulture products diversification by development of new products such as use the mulberry and silkworm for non – textile purposes, production of very high quality uni-bivoltine silk with certain special characteristics, organic silk, silk handcraft production for selling to the tourists at the local market and also for export.
- In the short-medium term future the silk industry in the region should be mostly oriented to export. If some of the countries in the BACSA region can meet the raw silk standard requirements there is a big raw silk market in Europe and Central Asia.
- In the sericulture preservation and revival process some important trends in the World sericulture industries development should be considered.
- So far the subsidies for sericulture, even very generous in some countries succeeded to save it from complete disappearing, but only maintained the production at a low level and did not succeed to revive it to the previous high production levels.
- In nowadays there are two main cocoon producers – China and India, providing more than 97 % of the Global cocoon production. In both two countries the local silk market plays a very important role, especially in India, thus presently China exports more than 98 % of the raw silk in the world market. Therefore the fresh cocoon purchasing prices in all the other countries are determined depending on the Chinese raw silk price.
- Now the current raw silk prices are stable since a couple of months. Low quality 2A 3A, from frozen cocoon price is at around 50 US$/kg. Regular qualities for Europe, i.e. 4A 5A from not so famous mills, good for crepe and weft yarn, have a price bit below 60 US$/kg. Very good qualities still keep a price, around 75 US$/kg.
- The present expectations are the cocoon production in China in this year to reduce 10% – 15% or so. Due to this trend the raw silk prices soon or later will start again upward trend and might reach a next level of about 80-100 US$/kg. It may be take several years. In the meantime there are no sign of new sources for raw silk despite announcements.
- We believe that it will no more be possible to produce cheap silk like in 90's of 20th century and early 2000's and our vision about the sericulture long-term future is that it will gradually become a boutique-like industry, producing very high value product in restricted amount. This is valid also for the sericulture products use for non-textile purposes.
- That means the sericulture may change from an industry for the poorest farmers, to an agribusiness, requiring more investments and productional costs, but having high revenues by high market price of the products. The BACSA region countries should consider these World trends and expectations in their plans for sericulture preservation, revival and development.

GEORGIAN SERICULTURE – PROBLEMS AND PERSPECTIVES

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Sericulture in Georgia has twelve- century history and it has always been a branch of agriculture and industry which increase family and country's income, and rationally uses labor forces. Georgian high quality silk was always appreciated on the world market, and historical trade route, so called *Silk Route* used to pass through Georgia. In the medieval centuries, Georgians used to pay a tribute to foreign invaders with silk; but the aggressors would cut down vine and mulberry trees to weaken country's economic potential.

Georgian silk fabric received particular attention and was awarded with gold medals in 1850, Turin, and in 1862, at London international exhibitions.

In 1998, fabric produced from thread obtained from Georgian silkworm species, "Mziuri 1," and "Mziuri 2" was awarded with *Platinum Star*.

Besides favorite climate conditions, development of sericulture in Georgia was determined by some important factors, such as, limited farmlands and high level of unemployment in the countryside, therefore, sericulture became a source of income. In the 1960s, about 120 thousand households were involved in cocoon production and silkworm rearing, and 5-6 thousand people were employed in silk production. During that period 4,0 – 4,4 thousand tons of cocoon was produced, and profit gained from silk production equaled to 15,5 – 16,5 million roubles.

Considerable intellectual and material resources were invested into development of the branch which resulted in substantial increase of profit as a direct consequence of implementation of purposeful governmental policies.

Sericulture and silk industry has wide range of economic profitability in case its product, silkworm egg, cocoon, silk thread and silk material are turned into export product.

It is hard to recognize that today the field of sericulture is totally destroyed, and only a small number of sericulture specialists, scientists and practitioners feel optimistic about its future. The basis of optimism is a century-old tradition and silkworm rearing skills which still exist among senior population of Georgia.

The government support will create solid basis for the revival of the branch and it will again become part of Georgian economy.

Critical situation of the branch in Georgia today is determined by mulberry tree diseases spread in 1960s which perished 15 million mulberry trees in Georgia. In the following years when Georgia became independent and agricultural lands were privatized, the feed base sharply decreased and the farmers could not overcome the problems existed in the field. The losses from sericulture industry increased and led to total disruption of silkworm egg, cocoon and silk production. Also, scientific

institutes, faculty of sericulture at Georgian Agrarian University stopped functioning. Nowadays, only Tbilisi Silk Museum and a scientific library are functioning successfully.

The government approach to the problem was based on incorrect assumption: Georgian sericulture will not be able to withstand world market competition and collapse; therefore it will be economically non-profitable. According to some businessmen, the government should be one of the main supporters of the branch and subsidize it. We agree with this assumption, but in our opinion, the government subsides will be needed only at the initial stage, later, sericulture will become a self-sustainable and profitable field. According to 1975 data, sericulture was developed in 45 administrative regions, in 670 collective farms, and 201 farms. Long time will pass till Georgia reaches that level of development, but this process should start immediately, fortunately, some positive steps in this direction has been already made.

Georgian Academy of Agricultural Sciences has worked out the plan for revival of the branch and the results of the study are published under the title: "Policy of Development of Sericulture in 2012-2025" with subsequent recommendations and investment projects attached. In 2019, the Academy published basic research in the field "Georgian Sericulture – Problems and Strategy of its Revival", in Georgian and English languages, which was dedicated to the 9th BACSA International Conference. With the initiative of the Academy, in 2018, in Ajara, testing feeding of silkworm took place with the help of small scale machinery. Also, some training sessions were organized in sericulture for those who showed interest and wanted to raise awareness in the filed. A good initiative was also donation of a loom by businessman Jimsher Chkhaidze for silk thread weaving and the first experiments took place in Ajara.

The 9th International Conference of BACSA was organized by Georgian Academy of Agricultural Sciences and Ajara Ministry of Agriculture. Researchers and specialists from Europe, Asia, Black and Caspian Seas and Central Asian countries participate in the Conference, therefore, we hope that they will also discuss the perspectives of revival of Georgian sericulture among other problems. Moreover, market economy is now more developed in Georgia and revival of sericulture is now considered by the government.

Proceeded what has been said above, it can be assumed that Georgian silk production will be both sustainable and profitable. The Academy is ready to continue working on preparing theoretical basis and working out strategic plans for revival of sericulture and silk production in Georgia. There is a hope that they will be considered by government, and investors.

ROLE OF ISC FOR THE DEVELOPMENT OF SERICULTURE & SILK INDUSTRY IN THE WORLD

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1. Introduction

Sericulture and Silk Industry has emerged as an ideal rural avocation for poverty alleviation and employment generation in many developing countries. Its activities are aligning with the Sustainable Development Goals (SDG) set by United Nations. The industry that has been successfully developed as a commercially viable economic model for rural development can be developed/introduced in many countries in the world as an ideal occupation for poverty alleviation. The International Sericultural Commission (ISC) has initiated many innovative programmes for the development and popularisation of silk industry across the globe. The ISC has been focussing mainly to converge programmes and assistance available from different agencies like; Government Departments, International Organizations, private entrepreneurs, etc., for bringing the much needed global synergy for transforming the silk industry as an effective tool for inclusive development and poverty alleviation. Specific strategic plans have been devised for the sustained development of the industry in potential countries of the world.

2. About ISC

International Sericultural Commission (ISC) is a UN registered inter-governmental organization engaged in the development of sericulture and silk industry across the globe. The ISC, which was institutionalised on 8th August, 1960 was functioning from Lyon, France till 2012. The Head Quarters of ISC started functioning from India with effect from 1st January 2013, consequent upon the election of an Indian nominee as the Secretary General. The shifting of ISC HQs has heralded with a number of innovative activities, which are now immensely benefiting the ISC member countries.

2.1. Structure of ISC

The ISC is governed by an international treaty signed by the participating Countries which was later adopted as its statute. At present, there are 20 Member Countries and 35 Associate Members in ISC. The 17 Member Countries are Afghanistan, Bangladesh, Brazil, DPR Korea, Egypt, France, Ghana, Greece, Indonesia, India, Iran, Japan, Kenya, Madagascar, Nepal, Romania, Syria, Thailand, Tunisia and Uzbekistan. The Governing Council bodies are “the Conference” and “the Executive Committee”. The Aims and Objectives enshrined in ISC Statues are being implemented through a Secretariat headed by the Secretary General. The Secretary General is the Chief Executive Officer of ISC, who is elected by the Member Countries on a three year term.

2.2. Aim and Objectives

The chief aim of ISC is to encourage and promote the development of sericulture and silk industry across the globe. To achieve this, the following Objectives are laid out:

a) To act as the Global Agency on all matters related to sericulture and silk industry,

b) Facilitate carrying-out enduring research and investigations on sericulture science,
c) Collaboration with other international organizations,
d) Undertaking frontier areas of research using silkworm or other sericigenous insects as "biological model" and silk as a material,
e) Exchange of knowledge and genetic materials,
f) Capacity building,
g) Exchange of scientific information through sericultural documentation centre,
h) Publication of the scientific journal "Sericologia", and specialized publications, etc., and
i) Organization of international scientific and technical meetings.

2.3. The activities

Ever since the HQs of ISC shifted to India, many innovative activities were conceived with the aim of introducing / developing sericulture as an effective tool for poverty alleviation and employment generation among the rural population. The major activities being undertaken by ISC are briefly narrated below:

2.3.1. Global leadership on silk industry

Being the only inter-governmental organization on silk industry, ISC has been protecting the interest of sericulture and silk industry at global forum. ISC is acting as a referral agency for vetting sericulture developmental projects which are being funded from international donor agencies. ISC has also been extending technical support to countries for the preparation of sericulture developmental projects, its implementation and later sourcing financial assistance from multilateral agencies. The mandate also includes global review of silk and silk products on a regular basis aiding various stakeholders to frame policy options for the sustained growth of the industry.

2.3.2. Promoting research and investigations on sericulture science

The ISC is proud to carry forward the rich legacy of advanced research on sericulture science initiated by Sir Louis Pasteur during 1860s. These efforts of many renowned scientists, including Sir Louis Pasteur, culminated in convening the 1st International Congress on Sericulture Science at Italy during 1870. Decisions taken in one of these Global meetings held during 1948 led to the formulation of a permanent inter-governmental body christened as "International Sericultural Commission". Subsequently, the ISC was officially institutionalised on 8th August, 1960.

It has been acknowledged worldwide that since the publication of the text instituting the ISC Convention, fundamental research work using silkworm as a biological model multiplied the world over. Due to the collaboration and cooperation through these works, significant and useful outputs were generated in different parts of the world thereby benefitted the industrial, pharmaceutical and cosmetic sectors. There are numerous possibilities still exist for the usage of silkworm in the areas of molecular biology, genetics and biotechnology which are being now explored. The genome sequence of *Bombyxmori* was completed in 2004 by Japanese and Chinese teams with the active association of ISC. Thus the ISC has been facilitating promotion of R&D activities among the countries and institutions to enhance the productivity and quality of silk. This type of collaboration is currently underway among Japan, India, Uzbekistan, Bulgaria, Australia, China, Romania, Bangladesh, etc.

ISC is also recognizing reputed R&D institutions as "Global Centres of Excellence" facilitating the countries to availing services on critical areas of research and development. Recently a R&D institution from Romania; Research Centre for Advanced Research in Sericulture and Promotion of Silk Production (RCARS-PSP) has been recognized as a "Global Centre of Excellence for Advanced Research in Sericulture and Promotion of Silk Production" (GCEARS-PSP).

2.3.3. Collaboration with international organizations

ISC has established collaboration with leading international organizations like FAO, IFAD, World Bank, UNDP, JICA, UNICEF, ITC, ESCAP, etc. on issues related to development of sericulture and silk industry**.** These collaborations have culminated in implementing various sericulture development programmes, enhanced the quality of research and technical manpower on sericulture science and silk industry, improved income generation in sericulture by enhancing the productivity and quality of silk, extensive infrastructure investments in sericulture industry and transforming sericulture practice as an economically viable occupation for employment generation and poverty alleviation.

While the above organizations have reiterated their intent for collaborating with ISC to support the countries under the Technical Cooperation Programme (TCP), recently ISC has also established tie-up with African Asian Rural Development Organization (AARDO) and South Asian Association of Regional Cooperation (SAARC). The developmental assistance from all these international organizations are providing the much needed synergy for accelerating the growth of sericulture across the nations.

2.3.4. Volunteer Expert Programme (VEP)

Sericulture is now being introduced in many developing countries where the expertise on implementing sericulture programme is very limited. The financial resources available under the project/programme may also be not sufficient to hire expert services from sericulturally advanced countries. In order to extend a helping hand to such countries, ISC has introduced a new programme called "Volunteer Expert Programme" wherein the countries may avail the services of about 55 sericulture experts from a list of Volunteers pooled by the ISC. The terms and conditions of the programme are given below:

1. The recipient country may avail the services of the expert without paying any consultancy charges,
2. The travelling, boarding, lodging and other expenses shall be met by the recipient country, and
3. The expert shall, after completion of the consultancy period, submit a report to recipient country, in the areas where the expert service has been sourced.

2.3.5. Exchange of knowledge and genetic materials

The last two decades witnessed significant progress in developing innovations and practices on sericulture and silk industry. Since the silk industry provides gainful employment to large sections of marginalized people across the continents, many countries are ready to share their knowledge for the orderly development of the industry. For example, the Indian Government has committed to support the countries for replicating the successful model of commercial sericulture practise

developed in the country. Thus, ISC is making all out efforts to facilitate free flow of information, technologies and practices among the countries.

Large quantity of genetic materials on silkworm and mulberry are dispersed around the world un-utilized, under-utilized, untapped or untouched. It is extremely important for the countries concerned to share these materials for research purpose thereby facilitating aggregation of potential traits for enhancing production, productivity and quality. All the years of hard work would be wasted if sericulture researchers do not utilize these genetic materials for the benefit of the poor farmers.

Keeping these facts into consideration, ISC has been encouraging Member Countries to share permissible varieties of genetic resources through the ISC platform for research purpose.The R&D institutes or agencies located in other countries can also exchange genetic materials through ISC on reciprocal basis. Many countries have already initiated steps for sharing of genetic materials.

2.3.6. Capacity Building

Under the Capacity Building Programme, different types of activities are organised by ISC either through its own funds or sourcing support from international and regional agencies and the Governments of the Member Countries. The details are given below:

a) **Training Programmes of ISC**

The ISC organizes training to the persons nominated by the Government of the Member Countries. Such nominated candidates should be associated in the sericulture developmental programmes implemented in their respective countries and should have adequate qualification and knowledge of English to undergo training in a foreign country. The training shall be arranged in sericulturally developing countries like India, Japan, or Thailand. While the host country will arrange for the training facilities, accommodation and other expenses, the recipient country would meet the international travel expenses of the trainees.

b) **Training programmes under Indian Technical Economic Cooperation (ITEC) of Ministry of External Affairs, Govt. of India**

ISC organises a special training on sericulture and silk industry for the candidates nominated from its Member Countries at Central Sericultural Research & Training Institute, Mysore. This programme is sponsored by the Ministry of External Affairs, Govt. of India under the Indian Technical Economic Cooperation (ITEC).

Under the programme, the sponsored candidate shall be provided with return air journey in economy/excursion class, living allowance, accommodation in the place of training in Hotel/Hostel, project allowance, study tour, etc. The cost of organizing the training shall also be met under the programme. The training programme proposed for the year April 2019 to March 2020 are given below:

Sl.No.	Name of the course	Period	No. of trainees
1	Training on Sericulture and Silk Industry at Central Sericulture Research and Training Institute, Mysore, India	2nd to 29th September 2019	30
2	Training on Post Cocoon Technology at Central Silk Technological Research Institute, Bangalore, India	6th January to 2nd February 2020	20
3	Training on Mulberry Silkworm Seed Production Technology	7th to 20th October 2019	20

c) **Scholarship Programme**

This programme aims to inspire the youngsters in sericulturally developing ISC Member Countries to take up research on sericulture and related fields or specialised studies/assignments by providing them opportunity to further their interest on sericulture science. The programme details are**:**

- ☞ The countries hosting the scholarship study shall be Japan and India,
- ☞ The host countries meet the maintenance expenditure covering facilities like guide support, laboratory, accommodation, etc.,
- ☞ ISC shall provide the international travel expenses and appropriate living allowance for the stay of the candidates,
- ☞ The duration of scholarship shall be a maximum of one month.
- ☞ The candidates deputed by the Government of the Member Countries shall possess adequate qualification and knowledge of English to live in a foreign country.

2.3.7. Organizing international scientific and technical meetings

One of the main activities of ISC has been to organize Global Meetings on sericulture and silk industry. These Meetings offers an exclusive opportunity for policy planners, technocrats, international scientists, universities, faculty & students of Institutions of research, including those in silk and silk related businesses to interact, share and exchange the most recent advancements in their fields. The recommendations evolved in these meetings have paved the way for adopting technologies and innovations, taking up developmental programmes, policy changes for the organized development of silk industry, furthering research and technical activities, etc. The following are the different types of Meetings organized by ISC:

a) International Congresses on Sericulture and Silk Industry. The 1st Congress was held at Italy during 1870 and the recent one at Bangalore during November 2014.
b) Regional Consultative Meetings based on the specific needs of Regional international agencies like SAARC, ESCAP, etc.
c) International Workshops to enlighten the country delegates on various advantages on sericulture and silk industry.
d) Technical Meetings and exposure visits as per specific needs of countries, agencies and institutions.

2.3.8. Publication of "Sericologia", and specialized publications

SERICOLOGIA is a reputed quarterly journal dedicated to the science of sericulture published by International Sericultural Commission. The journal started publication in the year 1948 from France with the title 'Journal of Silkworms' which later renamed as "Sericologia". The journal serves as the most effective medium to disseminate technical and scientific knowledge even to the farthest corners of sericultural areas across the globe.

ISC has also been involved in the publication of many books and magazines on sericulture and silk industry like; Proceedings of ISC Congress, Regional Consultative Meetings, International Workshops and other Technical Meetings.

2.3.9. Louis Pasteur Award

ISC instituted the only International Award on Sericulture and Silk Industry, known as "Louis Pasteur Award", which is considered as the Nobel Prize in Sericulture and Silk Industry. Persons who have contributed outstandingly for the development of sericulture and silk industry are selected for the Louis Pasteur Award. The award consists of a Citation, Medal and a Certificate. The award is given away during the ISC Congress held once in three years. The award is given to a maximum of three persons during the occasion. The awardees are elected by an Expert Committee constituted for the purpose and later approved by the Executive Committee of the ISC. So far 35 renowned scientists from different parts of the world have been awarded with this prestigious prize.

2.3.10. Award on Excellence on Sericulture Science

ISC has instituted instituted four new awards in four catagories of sericulture and silk industry namely: Silkworm Host Plant Development , Silkworm Development, Post cocoon and Post yarn Technology , and Silkworm and Silk in Non-Textile Industry. The award shall be given to scientists, professionals and other stakeholders associated with activities related to silkworm host plant andall silkworms and all silks including mulberry, non-mulberry, spiders, bees, hornets, and the other silk insects. Only individual persons shall be considered for the award. Any specific invention, research, action or any other efforts of the persons/group resulted/which can result significant impact to the specified areas of silk and related industries shall be considered for the award. The contribution shall have field applicability and contribute to the welfare of the silk industry in any manner.

The first batch of awardees shall be declared for the year 2019 and same would be presented during the ISC Congress scheduled at Tsukuba, Japan during 18-22 November 2019.

3. Global Eco-system for silk

Sericulture and silk industry can be introduced as an ideal avocation for rural development which eventually leads to inclusive development in many developing countries of Africa and Asia. The present global eco-system is favourable to adopt silk industry as an economically viable occupation for poverty alleviation. Some of these favourable conditions are listed below:

3.1. Increasing Global demand for silk

The global silk consumption for the last five years witnessed a robust growth of 12%. The major consumers are India, USA, Europe and Japan. It is expected that this trend may continue in the

coming years also subject to any economic recessions witnessed around the world. This situation provide greater demand for silk in the market to full-fill the increased requirement.

On the other hand, the reports emanating from different sources indicates that there may be sharp decline in Chinese silk production due to high labour cost, rapid industrialization and urbanization. As mandated in WTO rules and regulations, China may have to phase farm based subsidies by the end of 2019, which includes sericulture also. This effectively increase the cost of production and resultantly the silk production may come down significantly. With this hovering demand pull, the sericulture would become more remunerative thereby enhance the income generation of the primary cocoon producers.

3.2. Domestic demand for silk in potential countries

A recent study undertaken by ISC found that sericulture can be developed as a major employment generator in many developing countries of the world. The Balance of Trade (BoT) on silk in all these countries are on the negative trajectory. This means that these countries are increasingly depending on imported silk for their domestic requirement. So there is a stable domestic demand for silk in these countries. Many countries are traditional silk producers, albeit on a very limited scale. So there is a great potential to develop sericulture industry, which not only save foreign exchange but also generate gainful employment among the rural population.

3.3. Favourable socio-economic and climatic conditions

The Labour Force Participation Rate (LFPR) in sericulture is highest in comparison to other rural avocations. It provides employment to a massive 8.5 million persons alone in India. It is a family oriented enterprise where the women participation is about 60%. In short, 1 Hectare of mulberry plantation can provide employment to about 15 persons throughout the year from plantation to final product. The industry also require special skill in each phases of its production process that could be sourced among the families and rural artisans. These features of the industry readily align with the socio-economic conditions prevailing in many developing countries of the world.

The tropical climatic conditions of Asia, Africa and Latin American region are best suited to sericulture. The favourable conditions are; plenty of sunlight to yield maximum leaf production, fertile land, opportunity for regular crop cycles to earn stable income, reducedsusceptibility to diseases and pests, the incredible inclination of the rural people to adopt skilled work in the field of animal husbandry and artisanry jobs, availability of local materials for equipments and tool, etc.

3.4. Indian Sericulture Industry; a “Successful Enterprise Model” for replication

Sericulture and silk industry in India has emerged as an economically viable commercial enterprise model for providing employment to about 8.2 million persons. Although the grassroots level stakeholders are distributed on a highly fragmented production base, the programmes of the government could federate them thereby synchronize the production process resulting better production. This effort not only facilitated in disseminating technologies and innovation in an orderly manner but also enhanced the production, productivity and quality of silk matching international standards. The government has also played a major part in developing innovations and technologies and later effectively disseminating the same among the farmers by incentivizing additional investments required for the purpose.

This model developed in India can be easily replicated in many countries as the socio-economic and climatic conditions in all these countries are similar. This apart, the Indian Government is ready to help the developing countries to replicate the model by sharing the technologies and innovations. The government can also extend facilities like capacity building, sharing experts and resources, supply of materials, establish research collaborations, etc.

3.5. Enabling convergence of assistance

The above paragraphs gave a brief description about the support services available for the development of silk industry through various agencies and the prevailing favourable situations for developing the industry in different countries. Now the onus is lying with International Sericultural Commission, respective Countries and other agencies to converge these facilities and conditions on a single platform to provide the much needed impetus for the developmental agenda. As a prelude to these efforts, the ISC is ready to collaborate with countries and agencies with the following objectives:

a) To facilitate exchange of information, experiences, views, and experts on sericulture and silk industry.
b) To take up studies as well as action research projects, generate information and documentation in related fields.
c) To organise exposure visits and training programmes in the field of sericulture and other areas of mutual interests.
d) To take up projects jointly.
e) To conduct joint international seminars, symposia and workshops on the themes relevant to both the Parties.

4. The Path Ahead – Strategic Plan

The International Sericultural Commission is glad to inform the representatives of various countries that we have conceived a strategic Plan of Action for the introduction/development of sericulture and silk industry in potential areas of the world. The following are the perspective plans proposed by ISC:

1) ISC would collaborate with Countries to undertake an evaluation study on sericulture and silk industry in potential areas of the world. Experts can be sourced from ISC for undertaking the study under the "Volunteer Expert Programme".
2) Based on the evaluation study, comprehensive Silk Developmental Projects either for individual Countries or as Joint Projects for a Group of Countries can be conceived. International Sericultural Commission can provide technical support to the countries for the preparation of Projects by providing expert services.
3) ISC would support the countries to source financial support from multilateral agencies for taking up sericulture developmental Projects,
4) The Projects shall be implemented under the framework of an "Apex Advisory Committee" constituted by ISC and representatives of the concerned countries.
5) ISC would facilitate the support of Government of India for extending technical support, capacity building, sharing of knowledge and materials, supply of seed, equipments and machineries during the initial period or till such facilities are established in the respective countries.

6) Simultaneously, the Countries may avail the various facilities available in ISC for strengthening the manpower and expertise in the respective countries.
7) The countries may enroll as Members of ISC to participate in the above programme.

THE EUROPEAN SILK ROUTE: FROM CULTURAL DIVERSITY TO UNITY OF PURPOSE. THE STUDY CASE OF THE PROJECT "SERINNOVATION"

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ABSTRACT

The Silk Route was a historic trade itinerary that begun to be approached in the 2nd century BC and continued to exist until the 14th century AD; it stretched from China to the Mediterranean. Its name comes from silk trading during the time. It is important that the Silk Route served as a means for exchanging goods but also cultures. Both travellers of the road and the residents of the cities along it benefited from learning about each other's language, religion and ideas. They also took advantage from the increased material wealth that their trade generated. These interactions, in turn, improved the development of science, technology, literature, the arts and other fields of study. Then, from the 14th century AD, Europe begun to produce silk by itself and the Route lost its importance. Nowadays it is imperative to come back to the concept of exchange and collaboration in this sector among European countries. The Council of Europe launched the idea of a new cultural-touristic itinerary along the Silk Route, from the extreme boundaries of Europe to the Mediterranean. Countries with sericultural traditions should take profit of this initiative to come back to a strict collaboration among them. Sericulture is not a usual agricultural activity; it involves more than simple production: it means know-how, tradition, art, and culture. There is not one only winning strategy of revival and re-launch of this activity, but probably there are several models, apt to the various social and economic conditions of the different European countries.

Therefore, we should not give advices or impose a pre-packaged idea on how to revive sericulture. We should consider some study-cases, which are being successful in some countries, to adapt them to local conditions in Europe. This presentation will consider which problems should be faced in countries willing to revitalize this sector and possible actions to take.

In particular, the Italian case will be examined in-depth and the use of European Rural Development Funds (RDF) in the project Serinnovation.

Keywords: Council of Europe, Silk Route, sericulture, revival, Rural Development Funds, Serinnovation project

Introduction

The Silk Route was a historic trade itinerary that begun to be approached in the 2nd century BC and continued to exist until the 14th century AD; it stretched from China to the Mediterranean. Its name comes from silk trading during the time. It is important that the Silk Route served as a means for exchanging goods but also cultures. Both travellers of the road and the residents of the cities along it benefited from learning about each other's language, religion and ideas. They also took advantage from the increased material wealth that their trade generated. These interactions, in turn, improved the development of science, technology, literature, the arts and other fields of study. Then, from the 14th century AD Europe begun to produce silk by itself and the Route lost its importance.

Recently the Council of Europe launched the idea of a new cultural-touristic itinerary along the Silk Route, from the extreme boundaries of Europe to the Mediterranean.Set up in 1949, The Council of Europe is the oldest international organization in Europe and covers the whole continent. Its 47 member states have come together for the purpose of "safeguarding and realizing the ideals and principles which are their common heritage and facilitating their economic and social progress" (1949 Statute).
The Council of Europe defines the policies to be implemented by the programme of the Cultural Routes. The Enlarged Partial Agreement (EPA) on Cultural Routes established in 2010 follows the Council of Europe's policy guidelines, decides the programme strategy and awards the "Council of Europe Cultural Route" certification. It is open to Member and non-Member states of the Council of Europe aiming at providing political support for national, regional and local initiatives to promote culture and tourism.Joint programmes between the Council of Europe and the European Union establish cooperation between the EPA on Cultural Routes and the European Commissions for the establishment of sustainable projects favouring cultural, social and environmental development in Europe.
The European Institute of Cultural Routes (EICR), located in Neumünster Abbey in Luxembourg, is the technical agency set up in 1998 under an agreement between theCouncil of Europe and the government of the Grand Duchyof Luxembourg. The Institute advises Cultural Routes alreadycertified, provides assistance to new projects, organizes training and visibility activities for route managers and coordinates a university network.
As of September 2018, there are 34 certified Cultural Routes of the Council of Europe, covering varied themes of European memory, history and heritage (Table. 1).

Cultural Routes of the Council of Europe

Table 1.

1) Santiago de Compostela	**14) Routes of the Olive Trees (2005)**	**26) Rèseau Art Noveau network (2014)**
2) PilgrimRoutes (1987)		
3) The Hansa (1991)	**15) Transromanica (2007)**	**27) Via Habsburg (2014)**
4) Viking Routes (1993)	**16) Iter VitisRoute (2009)**	**28) Roman emperors and Danube Wine Route (2015)**

5) Via Francigena (1994)	**17) European Route of Cistercian abbeys (2010)**	**29) European Routes of Emperor Charles V (2015)**
6) Routes of El legadoandalusi (1997)	**18) European Cemeteries Route (2010)**	**30) Destination Napoleon (2015)**
7)Phoenicians' Route (2003)	**19) Prehistoric Rock Art Trails (2010)**	**31) In the Footsteps of Robert Louis Stevenson (2015)**
8) Pyrenean Iron Route (2004)	**20) European Route of Historic Thermal Towns (2010)**	**32) Fortified towns of the Grande Region (2016)**
9) European Mozart Ways (2004)	**21) Route of Saint Olav Ways (2010)**	**33) Impressionisms Routes (2018)**
10) European Route of Jewish Heritage (2004)	**22) European Route of ceramics (2012)**	**34) Via Charlemagne (2018)**
11) Saint Martin of Tours Route (2005)	**23) European Route of Megalithic Culture (2013)**	
12) Cluniac Sites in Europe (2005)	**24) Huguenot and Waldensian trail (2013)**	
13) Via Regia (2005)	**25) Atrium (2014)**	

On the other hand, 32 are the Member states of the Enlarged partial Accessions, which are shown in Table 2, with the year of accession in brackets.

Member states of the Council of Europe

Table 2.

1) Andorra (2012)	**14) Holy Spirit (2018)**	**28) Slovak Republik (2014)**
2) Armenia (2015	**15) Hungary (2013)**	**29) Slovenja (2011)**
3) Austria (2011)	**16) Italy (2011)**	**30) Spain (2011)**
4) Azerbaijan	**17) Lithuania (2012)**	**31) Switzerland (2013)**
5) Bosnia and Herzegovina (2016)	**18) Luxembourg (2011)**	**32) Turkey (2018)**
6) Bulgaria (2011)	**19) Monaco (2013)**	
7) Croatia (2016)	**20) Montenegro (2011)**	
8) Cyprus (2011)	**21) Norway (2011)**	
9) Finland (2018)	**22) Poland (2017)**	
10) France (2011)	**23) Portugal (2011)**	
11) Georgia (2016)	**24) Romania (2013)**	
12) Germany (2013)	**25) Russian federation (2011)**	
13) Greece (2011)	**26) San Marino (2017)**	
	27) Serbia (2012)	

Cultural routes can be grouped into three main categories: linear routes (e.g. Via Francigena), territorial routes (e.g. IterVitis Route) and virtual routes (e.g. European Mozart Ways).
A membership fee agreed by the members is required and the association must also have legal capacity. Nonetheless, the project's European dimension simplifies obtaining European funds.
The European Institute of Cultural Routes uses three different certification criteria: theme, field of action and network.
The deadline for the call for applications is 30 September and certification will be issued only eight months later. In cases in which the cultural route is certified, certification is re-evaluated every three years.
The Council of Europe launched the idea of a new cultural-touristic itinerary along the Silk Route, from the extreme boundaries of Europe to the Mediterranean.

The European Silk Route

By enhancing knowledge of a shared European heritage, the European Silk Route aims to contribute to the development of participatory and sustainable cultural tourism and to become a platform of good practices at the international level for all cities and institutions involved.
The "European silk route" aims to be a local cultural network and infrastructure linking cities, regions, sites, museums and universities in order to enhance knowledge of a shared European cultural heritage, both tangible and intangible, and to promote new relationships within Europe and between Europe and the East through sharing of best practices and cultural tourism activities.
The route would ideally be based on Marco Polo's travels eastward and include silk production and trade itineraries in Europe in the following centuries.

The aims of the European Silk Route are detailed as follows:

– Highlight the tangible and intangible heritage of silk: knowledge, traditions and production techniques that influenced the economic development and social history of the areas involved and contributed to the creation of a strong identity and various communities.
– Enhance the intrinsic link between silk production and sale and trade network between Europe and the East, reflecting a shared heritage.
– Highlight the role of silk as a reflection of changes to artisanal and industrial work and trade, as well as of changes to traditions, customs and tastes in every era.
– Contribute to the development of participatory and sustainable cultural tourism.
– Foster links and shared activities between European cities and regions that have been, and in some cases continue to be, centres of silk production and trade; between museums and research centresas regards the history, safeguarding and modern applications of silk.

The establishment of a European Silk Route can be an important chance for European sericulture. The most important reasons why all the countries involved in sericulture should work for its establishment are described below:

1) it would permit grouping of all the European sericultural countries under one umbrella only and persuading EC to focus on this matter that is a common heritage.
2) it could attract funds and resources for tourism and cultural initiatives that, on turn, could support local development of the sericultural industry
3) it is probably the only way to start again with sericulture, as the most important textile industries do not appear so much interested in supporting any developmental activity, especially in agriculture, but are looking for an already-created silk chain

4) it would give place to a small-scale, eco-compatible and niche activity of high added value

Why a small-scale development for a niche-market could be the correct way to develop again sericulture in Europe: the study-case of the project Serinnovation

In Italy a new development of sericulture has begun although it has been only timidly announcing itself.

The premises were:

- From 1990 to 2010 the cocoon production was destroyed by the use of an insecticide (the Insect Growth Regulator Fenoxycarb)
- Almost all the cocoon farmers have disappeared
- The textile industry was no more interested in producing in Italy (or Europe) but it was looking for a foreign country alternative to China
- Very few specialized mulberry fields remained
-

Since 2011-2012 CREA tried to collaborate with farmers and companies to re-establish a production chain with the first "laboratory" in the Venetian Region. Since the scale of its action was restricted it has been possible to take care of all the most relevant aspects: 1) Assistance to companies to develop new products; 2) Technical assistance to farmers and distribution of experimental polyhybrid eggs; 3) Training of farmers and new technicians; 4) Public/private stakeholders sensibilization/information. All these actions ranged from research to transfer of technical innovations and were coordinated by CREA. The existence of one direction only was one of the most important element for the success of the initiative.

This led to the formation of an Operational Group in the framework of the Program of Rural Development 2014-2020. The group was named "Serinnovation" and its focus is on "innovation, quality, traceability in sericulture, to develop supplementary income sources for farms".

It is a demonstration project born thanks to cooperation among farmers and other Venetian partnerscommitted to re-starting of a 100% Made-in-Italy sericultural chain.

Its objectives are: 1) 100% MADE IN ITALY**:** quality products from a traced and certified supply chain 2) AGRICULTURAL COMPETITIVENESS:A production process economically sustainable with a high added value. 3) CROP DIVERSIFICATION: Competence increase for a valuable integration of the farm income. 4)ENVIRONMENTAL SUSTAINABILITY: Where silkworm is reared the environment is protected and a circular economy is created.

The foreseen activities are: 1) FIELD DEMONSTRATION with automation to reduce/replace man labour; 2) LABORATORY DEMONSTRATIONwith healthy silkworm egg production; 3) SILKWORM REARING with high quality cocoon production; 4) CERTIFIED CHAINthrough production standard and traceability procedures; 5) TRAININGthrough professional courses dedicated to future silkworm rearers; 6) REPLICABILITYthanks to the definition of a competitive and remunerative model.

The partnership is composed of 5 farms and public and private institutions (CREA, University of Padua, CIPAT, which is a vocational training centre of the Venetian Region, ICEA, which is the

Institution for the Ethical and Environmental Certification – Bologna, Veneto marketing, which is the Innovation Broker of the project and Agridinamica, which is a consultancy agronomic company.

This project is in its second year of activity and the interest from farmers and industries concerning it is really huge.

The impact of the project comes mostly from the fact that sericulture stakeholders are working as a group and finally the project was developed with the perspective of recreating an activity respectful of man and environment.

Companies joined together and negotiate the cocoon price with farmers; they establish the cocoon price on a multi-year basis to accomplish social, individual and companydevelopment. Multipurpose use of the cocoons was developed according to their quality. The production is fair: companies engage themselves to respect the man work labour in the/out of the companies. High added-value and technical skills are necessary for excellent quality products: therefore, positions for young people and employment opportunities and new start-ups can grow. Research opportunities in the short and medium term in the field of automation, fashion, new materials, novel food, animal feeds can be created. As it is a "Made in Italy production" there are opportunities of growth for Italy and Italian companies.

Conclusions

The success (in term of impact on public opinion/industry/farmers) of the just-started project Serinnovation demonstrates that we need new approaches and new ways of re-thinking the sericultural process and its practice atan European level.

The general lesson that is possible to learn from this experience is: do not wait for the intervention of the textile industry to develop sericulture, but work in collaboration with this sector, and even with other innovative industries and different industrial sectors. When possible, look for several alternatives and a small-scale market with a high-added value.

- Try to innovate.
- Try to have new ideas.
- Try to make a group.
- Try to work with farmers and to listen to their needs.
- Do not expect policies from EC, but use the tools you have: for example, consider plans for Rural Development and take profit of the connections between tourism, cultural heritage, agricultural tradition.
- Try to go towards a sustainable agriculture and silk industrial production: we are facing an ecological planet emergency!!!

INDIAN SERICULTURE INDUSTRY LEAPS AHEAD

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Introduction

India is the largest producer of raw silk after China and the biggest consumer of raw silk and silk fabrics in the world. India has a long history and tradition of production, consumption and trade of silk by developing its own weave and texture, which are very popular all over the world. On account of existence of diverse agro-climatic conditions, a vast variety of flora and fauna facilitating seri-biodiversity, abundant availability of weaving and designing skills and low production cost, India has a vibrant silk industry. India also has the unique distinction of being the only country in the world, which produces all the five known commercial varieties of silk namely, mulberry, tasar, oak tasar, eri and muga.

Silk Production

The total production of raw silk was 31,906 MT in India during 2017-18, in which mulberry raw silk output aggregated to 22,066 MT followed by eri (6,661 MT), tasar (2,988 MT) and muga (192 MT) silks (Table 1). Silk production is wide spread across the states throughout the country. While mulberry sericulture is mainly practised in southern and north-western states, the forest based tasar silk is prominently produced in central and eastern India. The north-eastern states are known for the production of eri and muga silks.

The silk production in the country grew at an annual compound growth rate of 4.75% from 23,060 MT in 2011-12 to 31,906 MT in 2017-18. Among the four varieties of silks, mulberry silk accounted for 79% of the total silk production in the country during 2011-12. The *Vanya* silk production (tasar, eri and muga) grew at a comparatively higher rate than mulberry silk during 2011-12 to 2017-18. Therefore, the share of mulberry silk in the total silk production reduced to 69% in 2017-18.

Raw Silk Production in India during 2011-12 to 2017-18

Table 1.

Year	Raw silk production (MT)				
	Mulberry	Tasar	Eri	Muga	Total
2011-12	18272	1590	3072	126	23060
2012-13	18715	1729	3116	119	23679
2013-14	19476	2619	4237	148	26480
2014-15	21390	2434	4726	158	28708
2015-16	20478	2819	5060	166	28523
2016-17	21273	3268	5637	170	30348
2017-18	22066	2988	6661	192	31906
CAGR* (%)	2.73	9.43	11.69	6.16	4.75

Note: CAGR- Compound Annual Growth Rate

Bivoltine Silk Production

The Government has been giving thrust for improving the production of quality silk by promoting bivoltine silk production in the country. Various measures such as improving the bivoltine hybrids and technologies through R&D, strengthening the infrastructure with the seed producers, Chawki rearing Centres (CRCs) and farmers, organizing bivoltine clusters and establishing automatic reeling machines have been taken by Central as well as State governments for improving the production of bivoltine silk in the country, which have yielded desirable results. The bivoltine silk production in the country increased from 1685 MT in the country in 2011-12 to 5874 MT in 2017-18 at a growth rate of 19.53% per annum. Currently, the bivoltine silk accounts for about 27% of the total mulberry silk produced in the country.

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Bivoltine Raw Silk Production in India during 2011-12 to 2017-18

Table 2.

Year	Raw silk production (MT)		% share of bivoltine silk in total mulberry silk
	Bivoltine silk	Total mulberry silk	
2011-12	1685	18272	9.22
2012-13	1984	18715	10.60
2013-14	2559	19476	13.14
2014-15	3870	21390	18.09
2015-16	4613	20478	22.53
2016-17	5266	21273	24.76
2017-18	5874	22066	26.62
CAGR (%)	19.53	2.73	

Note: CAGR- Compound Annual Growth Rate

Demand-Supply Gap

As the domestic production of silk in India is not commensurate with the actual requirement of the silk industry, India imports raw silk to fill the demand-supply gap. The requirement of raw silk in India was around 35,618 MT of raw silk during 2017-18, of which 31,906 MT (90%) was domestically produced and the remaining 3,712 MT (10%) was imported primarily from China. The demand-supply gap has been narrowing down over the years due to increase in domestic silk production especially import substitute bivoltine silk production. It is expected that the country would become self-sufficient in raw silk production by 2022.

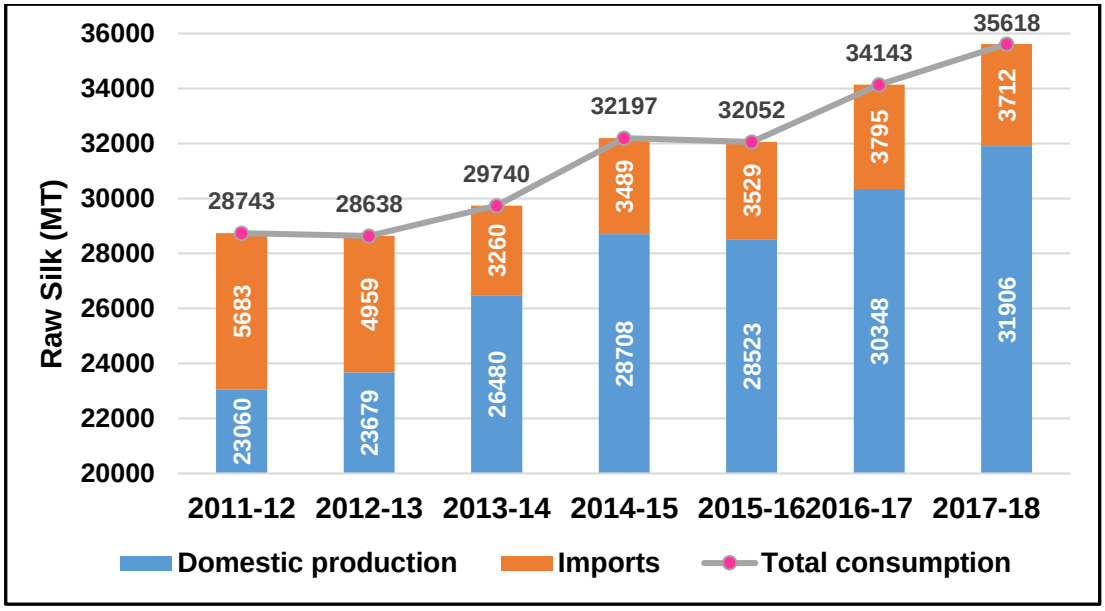

Fig. 1. Domestic production and import of raw silk

Silk Exports

As India has a large domestic market for silk goods, about 85 % of silk goods produced are sold in the domestic market. However, India is one of the leading players in silk global trade especially for finished/value added products. India earned a foreign exchange revenue of US$ 255.93 million through export of silk goods in 2017-18. The export of Indian silk products consists of finished goods like fabrics, made-ups, ready-made garments, furnishing materials like curtains, carpets, bed spreads, cushion covers etc. and silk waste. Among these goods, silk fabrics, made-ups and readymade garments account for about 92% of the total value of exports.

The traditional major markets for Indian silk goods are the UAE, the USA, European countries, Saudi Arabia, Hong Kong and Singapore. Besides, the exports to countries such as Afghanistan, Sudan, Malaysia, Tanzania, etc., have been increasing significantly in the recent years.

Potentiality of the Indian sericulture industry

Seri bio-diversity: India is considered as the hot spot of agro-biodiversity. Among 34 mega biodiversity countries in the world, India is home to many species of silk producing insects with a diverse fauna and flora. India is home for about 70 species of silk moths belonging to Bombycidae and Saturniidae families. Therefore, there is a wide scope for commercially exploiting the wild silks without affecting the ecological balance.

Livelihood security: In India, sericulture related activities ensure the livelihood security for over 1.2 million families spread over in about 75,350 villages across the country.

Women empowerment: The women participation in different activities of sericulture is about 55%.Many studies undertaken in China, Thailand and India proved that the sericulture industry is an ideal tool for women empowerment and gender equality.

Employment generation: The sericulture and silk industry *per se* is highly labour intensive and gives employment to mostly the tribal and the extremely backward rural people. Therefore, sericulture is the most appropriate tool to provide gainful employment to the poorer sections of the society.

Sericulture can generate employment @ 11 man-days per kg of mulberry raw silk production (in on-farm and off-farm activities) throughout the year.

Sustainable economic growth: The industry provides regular dependable income on a consistent basis. Most of the activities can be taken up indoor thereby making it as a decent occupation for a wide range of age groups and social stratum. The economic returns of the occupation directly benefit the family requirement as the family members are deeply associated in its various activities.

Value addition and product diversification: It is imperative thatadequate thrust on non-traditional uses of silk could create a positive pressure in the sector toconcentrate on high quality raw material for high value addition leading to a quantum leap forward. Products with high commercial value can be produced from by-products of sericulture industry (sericin, pupae, moths, silkworm excreta, silk fiber waste and mulberry leaves, fruits and roots)for therapeutic use (anti diabetic, antiviral, hypoglycaemic, antibacterial and antivirus products), as cosmetics (skin and hair products), animal food (feed for cattle, poultry, fishesetc.,) and foodstuff for human consumption (oil, juice, marmalade, wine, fruit distillate, vinegar, dried fruit powder and natural colouring).

Future Prospects

Indian silk industry has registered an impressive growth, both horizontallyand vertically. As there is a strong and expanding demand for silk in the country, India still needs to depend on the imported silk for fulfilling its requirements. However, the gap between the actual requirement and domestic production has been shrinking over the years due to expansion in quality silk production. It is expected to reach self-reliance in silk production in near future.

With a wide seri-biodiversity, there is a lot of scope for increasing the production of *Vanya* silks in the country. Vanya silk is primarily produced by the tribals in and around forest areas. The challenge is to optimally harnessthe abundant natural and human resources to bring about a balanced development without disturbing the forest ecology, traditional culture, ethnic value and the ways of life of the primary producers.

Another prospective area in sericulture industry is effective utilization of by-products for value addition and commercial exploitation. By-product utilization for non-textile purposes not only generates extra income to the farmers but also reduces the cost of production thereby increasing the profit margins.

CURRENT STATE OF SERICULTURE IN GEORGIA, REHABILITATION-REVIVAL, STRATEGY OF DEVELOPMENT

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1. Current status of sericulture, spreading of mulberry disease "leaf curl" and possibilities of rehabilitation-revival of sericulture

Thanks to its nature, almost all climatic-geographical peculiarities of the world are presented in Georgia, which enable us to manufacture diverse farm products. "Georgia and the Georgian nation possess some exquisite phenomena (miracles) – a book "Deda Ena" (Natural Language), traditions, songs, dance, grape wine and wine made in clay vessels (qvevri), wheat. Georgian silk and bee belong to such phenomena.

Image of economy, for the whole history, alongside with other traditional branches was defined and distinguished by sericulture. Georgia was praised for its silk in the neighbor and far countries and the Great Silk Road was connected with it too. For centuries rich national traditions were established in this branch which should be protected and preserved.

Historical sources prove that production of silk cocoon, its treatment and knitting were considered the prestigious activity; simultaneously silk played cult functions. With this in view, it was (and is) the acknowledged form of material wealth that contributes to closer relations between religions. Tendencies of silk production in Georgia should be explained by its favorable geo-economical location. One section of historically known "The Great Silk Road" used to cross territory of Georgia. Today, in the 21st century, one stream of the process of implementation of modernized project of the "The Silk Road" passes through territory of Georgia. In reality Georgia has become the buffer space contributing to proximity of economic interests of countries of Europe and Asia. This is the geo-economical advantage, which, alongside with many other benefits will give necessary impetus to development of sericulture.

Favorable geographical location for sericulture development, perfect natural conditions, ancient history of silk, high quality of product, silk brilliance, awards gained at the world expositions (in the heaviest period for the branch, in 1998, fabric made of thread of Georgian silkworm breeds (Mziuri-1 and Mziuri-2) at the international exhibition (Madrid) was granted the highest award "Platinum Star" by European Quality Committee. Scarcity of land, abundance of unemployed people and other factors, for example the fact that the population still keeps great love to this branch, the possibility to revive swiftly feed base, scientific potential, experienced practitioners who worked in sericulture and the enthusiasts interested in the revival of the branch - create favorable conditions for attraction of investments.

In the 60s of the last century annually Georgia produced 4.0-4.2 thousand ton live cocoon, 4.5-5.0 ton grain, 450-500 ton natural raw silk thread, 4.5-5.0 million linear meter natural fabric and other products and income gained from realization of the listed products successfully filled in all level budget of the country.

Population of villages, by realization of only live cocoon used to get annually 16-17 million rouble, and 100-120 thousand families were employed in the branch (14.5-15.0 thousand work places), silk industry used to occupy 5-6 thousand persons and in the managerial system of sericulture – united a big army of qualified specialists. Unfortunately, at that stage (1964) mulberry leaf disease "curl" was spread in Georgia and more than 15 million quality mulberry trees were destructed and it was added by the problems connected with establishing market economy, which resulted in final decline of the branch.

Currently the branch is destructed, still somehow preserved mulberry plantations are abandoned and are cut down, while in case of target-oriented development of the branch, thousands of inhabitants of our villages would manage to fill in the deficit of minimum of subsistence by their own labor and ecological environment would becomepurer .. "You must not

teach a man to eat fish, you must better teach him how to catch fish and it would be better to earn money by his own labor" (There is such a saying).

According to our computations, rural population failed to compensate the losses caused by decrease of cocoon manufacture at the expance of realization of product obtained by other branches and will not compensate it in future too. Thus, for example, silkworm breeders of Lagodekhi region before spreading of the above stated disease used to get more than 325 ton live silk cocoon and used to earn more than 4.0 million ruble. Unfortunately it was in the past, and today cocoon is no more produced in the region, and it becomes apparent when you look at the village, where 7500 socially vulnerable families are registered.

2. Mulberry and mulberry silkworm genofond, selection, anatomy, results

In Georgia enormous work had been implemented for creation and preservation of mulberry plant and mulberry silkworm genofond by the Caucasus Sericulture Station (found in 1887) and by its successor – Educational-Research Institute of Sericulture.

Up to 2010, mulberry genofond was presented by the verieties: Morus alba linn (2n, 3n, 4n), Morus bombycis (2n), Morus Kagayamae Koidz (2n), Morus nigra Linn (2n); by local induced breeds and endemic varieties Morus multicaulis Perr (2n).

In Georgia, selection activity in moriculture was (and is) directed towards obtaining of highly productive varieties, resistant of the mulberry leaf disease "Curl". With this in view, at the experimental bases of Educational-Research Institute of Moriculture (Tbilisi, Kutaisi) 290 breeds, forms and hydride combinations were presented. Among them were 146 mulberry species, 51 forms and 78 hybrid combinations.

Unfortunately only some breeds are preservedfrom the above listed ones and if we don't take measures timely, they will be destructed too. Deep scientific studies of genetic resources of mulberry plant were carried out at the Institute and we managed to make important conclusions of theoretical and practical significance.

On the base of works implemented in recent years in connection with the above problem the work (T.Dalalishvili, D.Shalamberidze, K.Mchedlishvili) was compiled in Georgian and English languages, which offers up to 100 photoesof various bodies of the plant.

For the first time in reality of moriculture, we are offered detailed study of anatomy, structure et al of various mulberry varieties and breeds such as leaf mesophile, central and side vein of butts, shoots and inter-cranks, which is successfully used for scientific research and educational purposes.

On the base of preliminary diagnostic of mulberry disease – leaf curl, as a result of selection works carried out in 1945-2016, dozens of varieties were obtained and more than 25 of those varieties were inculcated in industry. Currently some mulberry varieties are ready for their registration.

Genetic resources of mulberry silkworm conist of two parts:

1. Old/depreciated breeds removed from industry (there were up to 170, and only 73 have remained), which were shifted from Kutaisi Sericulture Station to Tbilisi Agrarian University.
2. Protection-preservation of just zoned perspective breeds are kept (till activation of industry) againin the system of Ministry of Environment Protection and Agriculture.

Today some perspective breeds (Mziuri and Dighmuri groups) and earlier zoned breed (Mziuri-1, Mziuri-2) are functioning, which are preserved in normal conditions.

Generally, the problem of preservation of genetic heritage and that of selection activity were especially sharply observed when those breeds were handed over for private holding of the Institute of Sericulture (2010) and if nothing is changed, the result will be still more sad.

3. Rehabilitation-revival of sericulture and strategy of its development

Strengthening of market economy in Georgia turned out very sensitive for the branch. Unfortunately neither the managerial system nor the society system turned was prepared for it. Thus, this traditional branch of economy is ruined and is to be established anew. The present-day power is willing and it has possibilities to revive this branch – in the program of governing party revival of the branch is considered in the state interests, but almost nothing has been done yet. The thing is that any person, proficient in the branch or not competent in it, local or alien, thinks his ideas are perfect and true and in the common chaos we lose the branch as shagreen.

In the created situation, Georgian Academy of Agricultural Sciences managed to evaluate objectively the heaviest chaotic state created in the branch, to develop adequate system of rehabilitation-revival, which played organizing role in preservation of the branch life for its further development, which really is a great national deed.

Georgian Academy of Agricultural Sciences published in the last decade: "Conception of Sericulture in Georgia for 2012-2025", more than dozen vital recommendations dedicated to the branch (in Georgian and English languages), projects for sericulture development for Khoni and Vani regions, 4 monographs and others; The Academy developed the issues of mechanization of laborious technological processes, a number of technical means, which were successfully tested in Adjara Autonomous Republic (Georgia) in the process of mulberry silkworm experimental feeding in 2018.

Thus the Academy successfully "reflected" the "grand attack of warriors" directed to sericulture and the rehabilitation-revival period of the branch commenced, which should be implemented at the support of the government.

At the current stage, revival of feed base and the branch requires a novel approach. This is why, taking into account the current reality we have to define directions of strengthening of feed base as well as production-treatment of cocoon; especially urgent are possibilities of multi-purpose application of unique properties of mulberry plant. It is pursued to produce saplings of recommended mulberry breeds in farm economies and to produce scion-rooted planting stock on small size (from 100 to 1000 km^2) thermal grounds based of natural warm waters.

At the first stage, annually we can produce 180-200 thousand scion rooted saplings and hybrid saplings, while at the second stage – 140-150 thousand plants.

In 2030 total mulberry plantation will reach 8-10 million plants, which will enable us to feed 50-55 thousand box silkworm grain and to produce 2.5-3.0 thousand ton cocoon; later, in the next period we can reach 4.0-4.2 thousand tons (the level of 1964), which will be a success. Grain produced at the first stage, raw thread, handicraft items will be designed mainly for local consumer market, but later it will occupy relevant segment of international market.

Strategic directions of development of sericulture will be determined by the principle of rational coexistencewith highly competitive, core branches. Besides, simultaneously with mobilization of local resources of the country it is necessary to attract foreign investments and to achieve integration between BACSA countries, first of all in the sphere of grain production.

Currently the conception dealing with the branch progress, recommendations and necessary materials have been elaborated thoroughly, scientifically in Georgia, which reflect the major aspects of the branch development and the main characteristics of economic efficacy.

The main idea of the program is:

- Restoration of rich traditions of sericulture manufacture, starting its rehabilitation-revival, economic strengthening of villages, improvement of ecologic conditions, revival of the old fame of the branch, perfection of infrastructure et al;
- By attraction and rational application of still preserved feed base, industrial means, intellectual resources, feeding of silkworm, preparation-winding of cocoon, realization of raw thread, fabric, and development of cottage craft will be started from 2020 by intensified speed, according to stages, and according to the populated zones.

4. Humble contribution of Georgian sericulture to the BACSA system

Sericulture of Georgia has always been model branch in the whole (later, in the Soviet Union) space, but compared to the advanced states, it was still referred to as of the "low level" one. Irrespective of problems existing in the branch Georgia managed to introduce its humble share in the world sericulture, but now we'll ponder on only three problems:

- With respect to the elevation of economic-cultural level of the society, by calculation per person, consumption of some vital products (grain…) is characterized by decrease, while systemic growth of natural silk product is a general regularity, which refers to the necessity of further progress of the branch (I.Jashi "Scientific materials of researchers and workers of sericulture of Georgian SSR" (materials), Tbilisi, 1962, p 82-95)
- In the second half of the 19th century, considering the interest to the revival of sericulture (Nestor Tsereteli, Kutaisi, 1895) integrated cooperative enterprise (farm sericulture+grainage factory+thread winding, knitting…) was created, which connected the economic interest of sericulture to distribution of incomes gained as a result of realization of grain, live cocoon, raw thread, fabric and other products. This problem should be consideredby analogous approach used in other branches of agriculture too and issue of subsidies should be set in other light (see: Recommendation "Economic efficacy of sericulture integration and recommendations for its rehabilitation-revival" Tbilisi, 2016, in Georgian and English languages, 15 pages).
- Rooting of mulberry varieties resistant to leaf curl disease by the wintered scion in open warm ground on the base of natural warm water (Georgiam Vani, vil. Amaghleba) is a measure worthy of international recognition. By the use of this method time of growth of sapling is shorter by 2 years than the time needed for sapling growth, self-cost decreases 2.0-2.5 times, while profitableness varies within 150-180%. (Recommendation "Wintered scion rooting of varieties resistant to mulberry disease - leaf curl, in substrate warmed with natural warm water and economic efficacy" Tbilisi, 2014, 16 pages, in Georgian and English languages).

Offers

On the base of analysis of available materials we have prepared the offers for relevant organizations:

1. To set the problem before the government of Georgia:

- To create the governmental commission by participation of representatives of relevant ministries, departments, scientific and financial structures, non-governmental organizations and other concerned persons/entities (companies, firms). To ask the commission to elaborate state program for revival-

development of the branch in the country for 2020-2030 years on the base of analysis of current situation in sericulture and existing materials. Besides, to declare sericulture as the priority branch.

- To remove arrest from Khoni moriculture economy which should become the center for revival of sericulture.
- Not to subject to sale 5-6 ha experimental plantation and part of buildings and constructions still preserved in the territory of the former Kutaisi sericulture experimental station of Georgian Agrarian University at least before itsshifting.
- To strengthen scientific-research works in sericulture, especially selection activity, by funding experienced specialists from the resources of budget.

2. To set the problem before BACSA's executive committee:

- Georgian delegation supports the idea of Prof. Panomir Tsenov about cooperation-integration between BACSA countries and succession of implementation of practical issues.
- To create a commission, which will study expediency of integration in the branch of sericulture between BACSA states, will study directions and will submit recommendations (offers) to be considered at expanded conference of executive committee and will be dispatched to relevant bodies of participating countries.
- To renew former rule of approved testing of mulberry silkworm breeds in BACSA's countries according to regions, and to start production of grain of the best recognized breeds in the newly created integrated grainage factories.
- The primary task is resolution of the problem of integration of grain production in BACSA countries, development of relevant normative and dissemination of grain on the base of selected breeds referred to above.
- Scientists of Georgia consider integration (according to regions) of grain production in Georgia expedient in Chokhatauri region (west Georgia, Guria region) on the base of grainage enterprise, while rooting of wintered scions of mulberry varieties resistant (relatively resistant) to mulberry leaf disease – curl in the open warm ground – is considered expedient in Vani region (west Georgia, Imereti region) on the base of warm waters.

ШЕЛКОВОДСТВО ГРУЗИИ – СУЩЕСТВУЮЩЕЕ ПОЛОЖЕНИЕ, РЕАБИЛИТАЦИЯ-ВОЗРОЖДЕНИЕ, СТРАТЕГИЯ РАЗВИТИЯ

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1. Существующее положение в шелководстве, распространение болезни шелковицы - курчавая мелколистность и возможности реабилитации-возрождения

Благодаря природе, в Грузии представлены почти все климатическо-географические особенности Земного шара, что дает нам возможность производить многообразную сельскохозяйственную продукцию. «Грузия и грузинская нация имеют несколько отличающих феноменов (чудес) – родную речь, обычаи, песню, танцы, лозу, вино квеври, пшеницу. К ним причисляются также грузинская пчела и грузинский шелк.

Имидж хозяйства, за всю историю, вместе с другими традиционными отраслями определял и представлял шелководство. Своим шелком Грузия ценилась, как среди соседних, так же и среди дальних стран. С ним связан и большой шелковый путь. В развитии данной отрасли обосновались большие национальные традиции, что требует охрану и сохранение.

Исторические источники подтверждают, что производство и переработка шелкового кокона, а также изготовление шелкового материала являлось престижным делом, одновременно шелк выполнял и культовую функцию. С этой точки зрения, шелк является признанной формой материального благополучия сближающая религий. Тенденции производства шелка в Грузии объясняются благополучным геоэкономическим положением страны. Один отрезок исторически известного «большого шелкового пути» проходил через территорию Грузии. В настоящее время, в XXI веке, осуществление одного потока модернизированного проекта «шелкового пути» проходит и по территории Грузии. Грузия реально превратилась благоприятствующим буферным пространством приближения экономических интересов Азиатских и Европейских стран. Это геоэкономическое преимущество, вместе с многим другим добром даст должный толчок развитию шелководства.

Существующее Благоприятное географическое расположение, хорошие природные условия, старейшая история шелководства, высокое качество продукции, луч шелка, на мировых выставках полученные награды (так например в тяжелейших условиях для отрасли – в 1998 году ткань изготовленная из нитей данных грузинскими породами шелкопряда Мзиури-1 и Мзиури-2 на международной выставке проводимой в Мадриде заслужила высшую награду от европейского комитета качества «Платиновую звезду»), малоземелье, свободная рабочая сила и т. д. создают благоприятные условия для развития шелководства и привлечения инвестиции. Наряду с этим в населении пока еще остается большая любовь к отрасли. Научный потенциал страны, опытные шелководы-практики и энтузиасты заинтересованы скорой реабилитации кормовой базы и восстановлением отрасли.

В 60-ых годах прошлого столетия в Грузии ежегодно производили 4,0-4,2 тыс. тонн живого кокона, 4,5-5,0 тонн грены, 450-500 тонн натуральной-необработанной шелковой

нити, 4,5-5,0 млн. метров натуральной ткани и др. продукцию, после реализации которых полученная прибыль успешно заполняла бюджет страны.

Сельское население, только от реализации живого кокона ежегодно получало 16-17 млн. рублей, вместе с тем в отрасли были заняты 100-120 тыс. семей (14,5-15,0 тыс. рабочих мест), в шелковой промышленности 5-6 тыс. человек и в системе управления шелководством – большая армия квалифицированных специалистов. К сожалению на этом этапе (1964 год) распространилась болезнь «курчавая мелколистность», которая уничтожила более 15 млн. деревьев шелковицы лучших сортов, этому добавились трудности связанные с установлением рыночной экономики, что вызвала окончательный урон отрасли.

На сегодняшний день отрасль уничтожена, сохранившиеся шелковицы оставлены без присмотра и вырубаются, тогда как при целевой развитии отрасли, тысячи жителей наших сел собственным трудом смогли бы заполнить недостаток прожиточного минимума и окружающая среда была бы чище. «Человека должны научить как ловить рыбу, а не как ее есть и будет лучше если он своим трудом заработает деньги.»

Нашими подсчетами, убыток полученный населением сел от сокращения производства коконов был настолько велик, что они не смогли возместить потери от реализации других продуктов с/х производства и не сможет возместить даже на будущее. Так, например шелководы Лагодехского района до распространения болезни в среднем производили более 325 тонн живого кокона и зарабатывали более 4,0 млн. рублей. К сожалению это было в прошлом. В настоящее время в районе коконов вообще не производится, что явно отразилось на селах, где на учет взяты более 7500 социально не защищенных семей.

2. Генофонд шелковицы и тутового шелкопряда, селекция, анатомия, результаты

В Грузии по направлении создания и сохранения генофонда шелковицы и тутового шелкопряда были проведены огромные работы кавказской станцией шелководства (был основан в 1887 г.) и ее сонаследником учебно-исследовательским институтом шелководства.

Генофонд шелковицы до 2010 года был представлен видамиMorusalbalinn (2n, 3n, 4n) Morusbombycis (2n), MorusKagaymaeKoidz (2n), MorusnigraLinn (2n). А также местными, интродуцированными сортами и эндемными видами MorusmulticaulisPerr (2n).

В Грузии по линии тутоводства селекционные работы в основном были (и по сей день) проведены для получения высокопродуктивных и резистентных сортов к курчавой мелколистности. С этой целью в экспериментальных базах учебно-исследовательского института шелководства (Тбилиси, Кутаиси) были представлены 290 сортов, форм и гибридных комбинации. Среди них были 146 сортов шелковицы, 51 форм, 78 гибридных комбинации.

К сожалению, на сегодняшний день из указанного количества сохранены лишь несколько сортов и без соответствующего ухода в скором будущем и они могут исчезнуть. В институте проводилось научное изучение генетических ресурсов шелковицы, на основе

которого были сделаны заключения имеющие огромное теоретическое и практическое значение.

В связи указанной проблемой, на основе исследовании проведенных за последние годы, на грузинском и английском языках представлена работа (Т. Далалишвили, Д. Шаламберидзе, К. Мчедлидзе), где приведены около 100 фотографии различных органов растении.

В первые в тутоводческой действительности детально изучены анатомия и структура мезофилла листьев, основного и бокового жилка плодоножки, побегов и междоузлиев и т. д. различных видов и сортов, что успешно используется в научно исследовательских и учебных целях.

На основе предварительной диагностики болезни курчавая мелколистность - в Грузии в результате селекционных работ в 1945-2016 годах выведены десятки сортов, из которых в производстве внедрены более 25. В настоящее время для регистрации подготовлены несколько сортов шелковицы.

Генетические ресурсы тутового шелкопряда состоят из двух частей:

1. Устаревшие, из производства изъятые сорта (было до 170, остались лишь -73), которые из кутаисской станции шелководства перенесли в Тбилиси – аграрный университет.
2. Охрана и сохранение новорайонированных перспективных сортов. На сегодняшний день (до начала производства) они охраняются опять-таки в системе министерства охраны окружающей среды и сельского хозяйства.

В настоящее время функционируют несколько перспективных сортов (группа Мзиури и Дигмури) и ранее районированная группа (Мзиури-1, Мзиури-2, Дигмури-1, Дигмури-2), сохранение которых производится в нормальных условиях.

Вообще, проблемы сохранения генетического наследия и селекционной работы, особенно проявились при переходе института шелководства в частное владение (2010 г.) и если ничего не изменится, результаты будут еще плачевными.

3. Реабилитация-возрождение шелководства и стратегия развития

Укрепление рыночной экономики в Грузии для отрасли стало очень чувствительным. К сожалению для этого не была готова ни система управления, ни общество. Так, что данная традиционная отрасль национального хозяйства уничтожена, поэтому требуется заново ее формировать. Нынешняя власть имеет добру волю и возможность возродить данную отрасль, но пока ни так много сделано. Дело в том, что кто бы ни был профессионал или дилетант, местный или чужестранец все считают свои доводы правильными и в общем хаосе отрасль стала исчезать как «шагреневая кожа».

В созданном положении, Академия сельскохозяйственных наук Грузии смогла объективно оценить созданное в отрасли наитяжелейшее хаотическое состояние, разработать четкую систему реабилитации-возрождения, что сыграла организационную роль для сохранения функционирования отрасли и ее дальнейшего развития. Все это является делом национальной важности.

За последнее десятилетие академия сельскохозяйственных наук Грузии издала: «Концепцию шелководства в Грузии в 2012-2025 годах», где даны более десяти рекомендации (на грузинском и английском языках), проект развития шелководства в Хонском и Ванском районах, 4 монографии и т.д. В академии разработаны также вопросы механизации трудоемких технологических процессов шелководства, технические средства нескольких видов, которые успешно прошли испытание в Аджарской автономной республике (Грузия) во время контрольного кормления тутового шелкопряда.

После того, как академия успешно «отразила» «большую атаку борцов» за развития отечественного шелководства, настал период реабилитации-возрождения отрасли, что должно осуществиться правительственной поддержкой.

На данном этапе восстановление кормовой базы и возрождение отрасли требует нового подхода. Поэтому учитывая существующую реальность необходимо определить направления как по укреплению кормовой базы, так и по производству и переработке коконов. Особого внимания требует возможность многоцелевого использования уникальных свойств шелковицы. Определены: производство саженцев рекомендованных сортов шелковицы в фермерских хозяйствах, а также производство собственнокорневых саженцев, на малоразмерных термических площадках, существующих на базе природных теплых вод.

На первом этапе ежегодно возможно производить 180-200 тыс. прививочных (собственнокорневых) и гибридных саженцев, а на втором этапе 140-1509 тысяч.

В 2030 году общее количество посадочного материаладостигнет 8-10 млн. шт. что даст возможность откормить 50-55 тыс. коробокчервей и получить 2,5-3,0 тыс. тонн коконов, а в последующем периоде можно увеличить указанное количество до 4,0-4,2 тонны (уровень 1964 года), что будет иметь большой успех. На первом этапу производимые грена, сырая шелковая нить, кустарные изделия в основном будут предназначеныдля внутреннего потребительского рынка, а позже займет соответствующий сегмент на международном рынке. Стратегические направления развития шелководства определяются по принципу рационального соподчинения с высокорентабельными, профилирующими отраслями. Вместе с тем, параллельно с мобилизацией внутренних ресурсов страны, необходимо привлечение иностранных инвесторов и интегрирование среди стран BACSA, в первую очередь в сфере производства грены.

В настоящее время в Грузии на высоком научном уровне разработаны концепция развития отрасли, рекомендации и необходимые материалы, где отражены основные аспекты развития отрасли и основные показатели экономической эффективности.

Основная идея программы:

- Восстановить богатую традицию производства шелка, начать реабилитацию-восстановление, усилить экономику села, улучшить экологические условия, восстановить прошлую славу отрасли, усовершенствовать инфраструктуру и т. д.

- В заселенных пунктах на оставшихся кормовых базах привлечением интеллектуальной силы и рациональным использованием базы, с 2020 года нарастающими темпами начнется выкормка тутового шелкопряда, производство коконов и извлечение из нее шелковой пряжи, реализация сырой шелковой нити и материала, а также поэтапное развитие кустарного производства.

4. Скромная доля грузинского шелководства в системе BACSA

Грузинское шелководство всегда было примерным (за весь период российской империи, в советское время), однако по сравнению с передовыми странами, считалось что оно низкого уровня. Не смотря на трудности существующие в отрасли, Грузия все же сумела внести свой скромный вклад в мировом шелководстве. Мы остановимся лишь на трех проблемах:

- В связи с повышением культурно-экономического уровня общества, в перерасчете на душу населения, употребление некоторых жизненно важных продуктов (зерновые) характеризуется тенденцией уменьшения, а систематический рост требования на натуральный шелк является общей закономерностью, что указывает на необходимость дальнейшего развития отрасли (И. Джаши « Материалы научной конференции ученых шелководов и работников производства Грузинской ССР», г. Тбилиси, 1962 г. ст. 82-95).
- Во второй половине XIX века, исходя из интересов возрождения шелководства (Нестор Церетели, Кутаиси, 1895 г.) было создано интегрированное кооперативное предприятие (приусадебное шелководство+гренажный завод+извлечение нити из коконов, ткачение), из-за чего произошло прикрепление экономических интересов на раздел доходов от реализации грены, живых коконов, необработанной нити, ткани и другой продукции. Данная проблема, аналогичным правилом должно определиться и в других отраслях сельского хозяйства и тогда вопрос субсидирования будет поставлен по другому (см, рекомендацию «Экономическая эффективность интеграции шелководства и рекомендации по реабилитации- возрождения», Тбилиси, 2016 г., на грузинском и английском языках, 15 страниц).

Предложения:

На основе анализа существующих материалов, ограничимся постановкой вопросов лишь перед соответствующими организациями.

1. **Поставить вопрос перед правительством Грузии:**
   - Создать правительственную комиссию с участием соответствующих министерств, ведомств, научных, финансовых структур, представителей неправительственных организации и заинтересованных лиц (компании, фирмы). Комиссия на основе созданного положения в шелководстве и анализа существующих материалов должна разработать государственную программу восстановления-развития отрасли в период

2020-2030 годов. Вместе с тем шелководство должно быть объявлено как приоритетная отрасль.

- снять запрет на имущество Хонского шелководческого хозяйства, которая должна стать центром возрождения шелководства.
- На территории кутаисской бывшей опытной станции шелководства аграрного университета Грузии по сей день числится часть опытных посадочных деревьев и здании-построек, которые не должны подлежать продаже, хотя бы до перебазирования.
- Опытные специалисты, выполняющие научно-исследовательские работы по направлению шелководства, особенно селекционные работы, должны быть финансированы из бюджетных средств.

2. Поставить вопрос перед исполкомом BACSA:

- Делегация Грузии поддерживает идею профессора Паномира Ценова по кооперированию и интеграции между странами BACSA и поочередного осуществления практических вопросов.
- Должна создаться комиссия, которая изучит целесообразность интеграции проблем в шелководстве между странами BACSA, направления в шелководстве и представит рекомендации (предложения), которых рассмотрит на расширенном заседании исполком BACSA и пошлет соответствующим органам стран-участников.
- Необходимым является возобновление в странах BACSA ране апробированное правило испытания пород тутового шелкопряда и начать производство гренвсеобще признанных лучших пород по регионам в вновь созданных интегрированных гренажных заводах.
- Первоначальной задачей является: разрешить между странами BACSA проблемы интегрированного производства грены, разработать соответствующие нормативы и на базе вышеуказанных подобранных пород распространить заготовленную грену.
- Ученые Грузии считают целесообразным начать интегрирование (по регионам) производства грены в Грузии на базе гренажного производства Чохатаурского района (муниципалитета), а окоренение произвести в теплом открытом грунте на базе теплых вод перезимовавших черенков устойчивых пород шелковицы к заболевании курчавая мелколистность, в Ванском районе (муниципалитета), (Западная Грузия. Имеретинский регион).
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SILK IN GEORGIAN CULTURE AND RELIGION: PAST AND PRESENT

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Key words: sericulture in Georgia, silk art, Batika, silk application in design, fashion, medicine, religious items and household items, Georgian embroidery, reconstruction of historical garment, Silk Museum, Tbilisi.

Introduction

Silk is philosophy which unites many nations; it is **a bridge** between different religions and civilizations (Ancient Silk Rout), between the epochs - past and present; it is everywhere and yet invisible;

Silk is from God, it exists in many religions - appearing in religious attire, embroidery and in different religious items; it is a part of **material and immaterial cultural heritage** of many countries, including Georgia;

Radiance, firmness, and simplicity of Silk thread charmed millions throughout the world;

Its softness, elegance and grace **inspire poets and artists**, and it is admired by rich and poor alike.

Silk could become our **visionof peaceful world** which is not cruel, vulgar and coarse; Silk is our wish to see the future relations between the nations as soft and transparent, as firm and clear as silk itself;

Silk is curing – widely used in medicine;

Silk is valuable commodity and brings wealth to its producers;

Silk is like **Sphinx** which is being revived all the time; it finds new life forms and is virtually immortal! It continues to find **new applications in industry, art, design, fashion, medicine, and cosmetics,** and yet silk hides many secrets.

Silk is a network made of delicate thin silk thread which unites world nations, many of which are presented here at the International BACSA Conference in Batumi, Georgia.

Part 1. Historical roots: the role of silk in Georgian civilization

Sericulture and silk production has always been a part of common historical memory for people living in different countries and belonging to different religions. Historical roots of silk production in Georgia, wide application of silk fiber and silk thread in different branches of industry, culture, religion, art and lifestyle, also many historical records and artifacts testify that sericulture and silk production was highly developed in Georgia. Ancient trade route from West to East -"Silk Route" passed through Georgia which played an important role in popularization of silk production and silk trade. Marco Polo, (born in 1254), a 13th century Venetian explorer, writer and merchant who travelled to Central and Eastern Asia and visited Georgia, describes in his *Kingdom of Georgia* the capital city - Tbilisi: "In this country is a fine city of great size named Tiflis, surrounded by

subordinate towns and townships. The inhabitants are Christians (that is Armenians and Georgians) besides a few Saracens and Jews, but not many. Silk and many other fabrics are woven here. The inhabitants live by their industry and are subject to Great Khan of Tartars" (Marco Polo about Georgia).

Russian Ambassador Tolchanov (15th c.) wrote that in Imereti and Samegrelo Regions of Georgia, silkworm cocoons were cultivated in all peasants' families. Same is said by the member of the Russian Academy of Sciences, I.A. Güldenstädt (17th c.), who traveled around Eastern Georgia. According to N. Shavrov's records "In XVII century silk was exported to Turkey from Georgia." (Lekashvili, 2016).

Throughout centuries, silk has found application in different branches of industry and culture of Georgia. Historically, silk garments often richly decorated with embroidery, were sown for the royal family members and for high society members. Silk cloth and embroidery was also used for production of religious items and for decoration of chambers (wallpaper, upholstery, cushions and other items). Nowadays, Georgia is striving for the revival of sericulture which,for centuries, was considered to be an inseparable part of its cultural heritage. A wide range of silk articles produced in Georgia have many passionate admirers; they find their way to the museums, galleries, homes, and are the symbols of luxury and high taste; For example, silk painting, called "Batika", is one of the art forms which has become very popular lately; it requires a very delicate taste and knowledge of rather sophisticated, labor-consuming technique.

The purpose of the present paper is to study significance of diverse application of silk fiber in Georgia in the past and today – its practical and aesthetic aspects. The rationale is that this will presumably lead to restoration of Georgian silk production, provided substantial political and material support from Georgian Government is definite.

Part 2. Silk in Georgian Orthodox Church, Georgian embroidery

In 1940, in one of the small churches near the village "Pataragori", a human body which was preserved in a cave beside the church wall was excavated. Kept in Monastery of Zarzma (Samtskhe-Javakheti Region), the scientists identified the body of a church servant being preserved since the 10th century. as being . The body was later moved to Georgian I. Javakhishvili State Museum.) The age of the cloth and of the body was defined with the help of morphological study and carbon dating method. It belonged to the 990 +/- 90. The body was dressed in greenish - brownish attire decorated with natural silk blaze. The cloth was identified to be woven in Georgia. (ზარზმის მონასტერი.ეხრწნელიგვამი)This and other findings testify that Georgian used to wear garments early in the 10th century sown from silk cloth, and/or decorated with silk embroidery.

Many scientific researches have been conducted dedicated to Georgian silk embroidery. In 2018, Georgian National Museum and Shalva Amiranashvili Art Museum organized Scientific Conference: ***Medieval Century Georgian Embroidery: Traditions and Modern Tende*****ncies.** The results of the most recent findings and analysis of historical artifacts once again testified that Georgian silk embroidery is unique, authentic and has no analogues in the world.

The set of Aers from the Church of Nikortsminda deserves exceptional attention amongst the rich collections of silk embroidery objects housed in Museum of Fine Arts. Distinguished by their artistic qualities and elaborate technique, the art works exhibit both deep theological thought and decorative treatment. The depiction of the „Victim“ as well as of sacred vessels – paten and chalice implies the liturgy performed in the temple and indicates the **Eucharist mystery**, a theme being so actual for Aers' paradigmal program. The precious metal and **silk threads, gold and silver hair and bullion** have been used as embroidery materials. (Baratashvili, G. 2018).

Georgian ecclesiastical embroidery is an organic and original part of Christian art in which artist's refined taste and mastery, profound knowledge of the Christian liturgy as well as canonical symbolism and iconographic schemes and technical skills are perfectly reflected. Embroiderers were equally mastered in monumental (Epitaphios, curtains, bigomophorions), as well as in tiny (reliquaries, cases for icon, an adornments for bishop's vestment) embroidery methods. The objects of ecclesiastical and secular embroidery collection preserved in the museum are attractive by their harmoniously created, dynamic and elegant compositions, and some historical inscriptions containing interesting historical data, among them are **Dedicatory inscriptions** depicted on hierarchical and liturgical cloth which bear witness to ecclesiastical and secular individuals' relationship and patronage. (Berelashvili. 2018)

The patterns of ecclesiastical embroidery which are preserved in the storage rooms of textile and embroidery collections housed in the Dadiani Palaces Historical and Architectural Museum, date back to the 17th-19thcenturies. Many of them attract attention by their composition, dynamic and subtle design, iconography, inscriptions containing considerable data, refined color palette and exquisite technique. Among the ancient most samples of the embroidery collection a purple Shroud, one of the distinguished artifacts of Levan Dadiani's epoch merits special attention. It is to be noted that although the collection consists of only nine objects of embroidery, each of them greatly contributes to study of the region or country's history. In this respect should be mentioned the cuffs from Tsaishi with the inscription referring "Gulqana" and "Mtsignobartukhutsesi" (ქართულინაციონალურისამოსი. Beraia, 2018).

Silk yarn was used for embroidering breastplates, bibs, waistbands and purses along with the silver and golden threads. Silk was one of the main materials for the national garment of men and women. Fabrics were patterned or painted single colored. Thread interlacing varied too. Sewing thread mainly was made of woven silk weaving several tips (2, 3, 4, 6 tips). For gaining mixed type yarn silk was used together with wool, flax and cotton. For the silk coloring local natural dye was used, mainly blue and red. (Lekashvili, L..., 2015. Conference Paper).

Composition(13th century) is made of **silk cloth and silk thread**, also it is embroidered with gold and silver thin thread, decorated with pearl, coral beads. The embroidery was donated by Shergil and Natel Dadiani to Martvili Monastery. Size: 34x 34. Kept in Katskhi Trinity Church. Western Georgia.

Tapestry depicting Descent from the cross. Colored Silk thread embroidery on silk cloth. 1632/33 – 1680/82. Museum of Art. Tbilisi.

Part 3.Silk for production of sails and other household items

Georgia situated on the Black sea coast developed means of navigation many centuries ago. Ancient Georgians used silk to construct sails because they need fabrics that may be woven or manufactured as films. The sail are often assembled of multiple panels that are arrayed in a manner that transfers the load from the wind to the sail's attachment points—a combination of corners and edges—that transmits the load into the mast and powers the boat. Construction of such sails requires stitching, bonding, reinforcements and other features to achieve this. It is also important to have high resistance to ultraviolet light and flex strength – strength lost due to bending and folding. Other sails

are constructed directly from fibers, filaments and films. There are several key factors in evaluating a fiber for suitability in weaving a sail-cloth and one of them are the ability to resist stretching and higher resistance for upwind sails.

Cotton and silk textiles and raw silk from a rough sail cloth was particularly used for this purpose which allowed ships to sail into the wind. Silk fabric used for making sails, tents, and other items where sturdiness is required. Silkfabric was also used for sails in Europe. (Source: Main articles: Sailcloth and Sail components and Materials).

Historically, cotton and silk was used in Georgia to produce household products such as **curtains, rope, upholstery, buttons, umbrellas and clothing** which are usually made out of light, strong fabric originally silk. Silkfabric also was also popularly used for bookbinding and in fashion – clothes and decorations, handbags and shoes manufactured in Georgia.Many historical sources verify that silk garment was worn not only by aristocracy and the rich, but also by lower class representatives, which once again indicates that silk cloth was popular, and affordable for most population because greater part of them was involved in cocoon production and silk yarn weaving.

Part 4. Silk in medicine and cosmetics

Application of silk product in medicine and in cosmetics has long been known to Georgians. According to old medical books, a wide array of silk by-products was used to cure about 32 diseases most of which are connected with blood ailment. One of the unique qualities of silk by-product is that it is an antiseptic and anti-microbial remedy which also prevents ultra-radiation. It has some unique anti-diabetic and anti-microbe functions.

From the interview with Ms. Lamara Bezhashvili, a founder of experimental silkworm rearing and silk thread weaving farm in Kakheti Region, we learned about some important applications of silk by-products produced by Lamara in cosmetics and in medicine. She also tries to revive ancient Georgian tradition which used silkworm egg for fertility. It also can be used for the treatment of stomachache, headache, and joints. This is pure biological product which cures some diseases associated with blood abnormality, it also aids blood circulation. From silkworm excrements pillows, cushions and mattresseswere made which helped people to get rid from allergy and had many other healing characteristics. According to ancient tradition, a sick person was wrapped in silk cloth. Silkworm oil is used in cosmetics and has many positive effects, used against hair loss, among other.

Part 5. Silk Museum in Tbilisi

Georgian artists, culture managers, museum specialists give new life to some wonderful ancient samples of silk embroidery and historical silk attire, religious items decorated with silk needlework by studying, investigating, collecting, promoting and displaying them.

Founded in 1888, **Silk Museum in Tbilisi** hosts wonderful collection of different items presenting history of development of sericulture and silk production in Georgia, including samples of exported textile and collection of Caucasian Jejim, ancient traditional handmade thick textile used in the household and weaved mostly by women by mixing rough silk and wool threads. (Bakhtadze, 2016)

The design of the Jejim textile was distinguished as having narrow, interchanging color (green, red, white and red) stripes and a diversity of ornaments including geometric shapes and traditional animal figures, such as peacocks and birds. (Caucasian Jejim, 2015).

The Museum and its library give clear understanding about the glorious past of Georgian sericulture demonstrating the samples of silk cloth produced in our country with wonderful patters and colors reflecting historical traditions and fashion trends of that period. For example, when we studied the colors traditionally used in silk paintings and in modern textile designed by Georgian designers, we easily identified that those are the most frequently applied coloration in modern silk art.(Bakhtadze, 2016).

Georgian silk never seizes to attract attention of wide public

Today the Museum is involved in activities which aim to remind to young generation about the glorious past of Georgian silk. E.g. a very creative event, installations and performance on silk theme - ***Art Intervention*** – presented by popular Georgian artists, (Mindiashvili, and others) was covered by TV channels and attracted attention of wider community. Awakening from the 30 year lethargy, silk industry production is in need of support from the Georgian government, as well as from national and foreign investors. (Sidamonidze &Girod, 2016. Renaissance of Silk Industry in Georgia).

Our belief is that once Georgian silk material was so popular not only in Georgia but also in Europe, the government and wide community – researchers, farmers, manufacturers and businessmen should mobilize and take active measure to raise interest among wide population so that they should support and invest money into revival of once so successful Georgian silk product.

Another example of attempt to popularize Georgian silk has been recently made by **Art Palace,** Tbilisi (Director Giorgi Kalandia). The project involves creating patterned materials that mimic the garments worn by Georgian historical figures. Local artists are recreating fashion history by mimicking the colors and patterns of ancient garb and transferring it onto material used in the modern world. Historically, garment of high class were particularly made from fine quality Georgian silk. The project: "Historic Garments Brought to Life" restores wonderful pieces of silk fabrics worn by Georgia's medieval century nobility. (Georgian State Museum of Theatre, Music, Cinema and Choreography - Art Palace. Tbilisi's Art Palace restores fabric worn by Georgia's medieval nobility. (Bakhtadze, 2016)

Part 6. Silk Art – Georgian Batika

Increased popularity of silk art is a reflection of century-old traditions of silk production in Georgia. Our talented artists create wonderful pieces of Silk Art – continuing Georgian traditions and responding to modern world tendencies, gaining popularity not only in Georgia, but outside it.**Silk art -*"Batika*"**, which today is one of the most popular forms of art in Georgia, has reached high artistic level and has a wide potential to develop beyond "applied art". Its style varies from historical and ethnic figurative paintings - to modern abstraction: floral compositions, still life, landscapes, urban motives, sites of Old Tbilisi, and other. Georgian artists create emotional gamut of colors to render different emotions and inspiration. Many talented artists today work in silk art. *"Batika is truly one of the most labor-consuming, and only very industrious and diligent artists continue working in this direction. Besides, the material is very expensive and requires particular knowledge and experience*

to work in silk art", says in her interview Eka Khuntsaria, one of the popular silk artists. (Bakhtadze, 2016). The technique of silk painting is very complicated and labor-consuming, therefore, it needs to be learned under experienced artists. Silk painting is taught at Tbilisi State Academy of Arts as one of the branches. Batika has been exhibited in Tbilisi art galleries and museums, as well as abroad, and has gained a wide popularity. One of the artists who work in silk art, Ekaterine Khuntsaria is now known to a wide circle of silk art lovers. In her saloon, Tbilisi, she exhibits silk art pieces which attract attention as unique compositions, colors, wide diversity of themes, and subtle technique of painting. Furthermore, she offers to the visitors different accessories, scarves, handbags, unique souvenirs, such as Georgian alphabet, national attire, and other produced by same technique. Perspective achieved in her landscapes and other features characteristic for oil painting lead to the conclusion that the silk painting can not be considered only as a decorative art.

The study of the historical patterned materials that mimic the garments worn by Georgian historical figures exhibited at the Museum of Art in Tbilisi, and analysis of paintings and artifacts testifies that modern silk art has been inspired and stimulated by unique historical patterns of Georgian silk textile. There is a hope that one day the artists will paint on silk material produced in Georgia. In the beginning was silk fabric and it gave birth to silk art, there is a hope that now art will give inspiration to revival of once glorious Georgian silk textile to play its exclusive role in industry and art.

Part 7. Silk in Georgian Fashion designers

SIlk has always been one of the favorite materials for clothes, today, silk producers and designers have found new application of silk fiber. It is ageless and seasonless, and always look fashion. Nowadays, silk clothing is no longer a domain of the rich, luxury-goods purchasers who wants timeless investments. Silk material has gone through democratization process, garments made of silk are available in an affordable prices and has a wide circle of customers.

Georgian fashion designers create collections in silk that are relevant in many situations; it fits mood and lifestyle of many who prefer natural fiber. The technologies of silk fiber are being developed and now silk is more wearable, washable and comfortable. Another quality of silk is that it is feminine and sexy for young customers, yet sophisticated enough for an older customer that embraces its relaxed, bohemian sensibility.

Demna Gvasalia is an artistic director of *Balenciaga*. Signature of the house of Balenciaga is a strict, well-shaped clothes created from a high-twist silk – "gazar", cut with a minimum of seams. At Paris Fashion Week Gvasalia presented his triumphant first collection for Balenciaga, where he offered the audience, a mix of Balenciaga's legacy with new, radically different innovative clothing. Shimmering lurex knits teamed with oversized puffer coats and architectural proportions excited the fashion industry.

In December 2013, *House of Thierry Mugler* announced David Koma, 29 years old Georgian born, London based fashion designer, Koma graduated from the prestigious *Central St. Martin's College of Art and Design* and is famous for his ultra-body contouring silhouette designs. David is a participant of London Fashion Week, presenting two women's collections a year. Koma's collections are inspired by feminine forms. Through his women's ready-to-wear collections, Koma has

reinterpreted the brand's fashion codes and introduced mixture of minimalist style with metal details. (David Koma. Fall 2019. Ready-to-wear collection).

Georgian brand, *Materiel Tbilisi* is a popular Fashion House, founded in 2012 which unites Georgian designers. Tbilisi has become a playground for a new generation of young, creative and talented Georgian artists. Its *Mercedes Benz Fashion Week Tbilisi* has been held twice a year since 2015 and has attracted attention of world fashion world. Many young Georgian designers chose silk for their new collections. (Materieltbilisi.com)

Tamuna Ingorokva is one of the more recognizable names on the Georgian fashion scene. Since 2002, she has been producing designs under her namesake label and cultivating a solid client base. A self-proclaimed minimalist, having worked under Nina Ricci in Paris, Ingorokva Fall/Winter 2016 collection displays modest elegance that many other Georgian designers are struggling to achieve. In each of her collection presented at fashion weeks she has number of pieces from silk material. My perception of Ingorokva's clothes made of light and tender silk material, its delicate patterns and colors, simple style and elegant cut - continue Georgian traditions. Most importantly, we witness new treatment of 5000 year old fiber which has been rediscovered anew. (www. ingorokva.com).

Part 8. Silk in household

Georgian women have always been particularly talented in needlework. Their creative talent and high artistic taste is clearly seen from numerous samples of artwork that the museums keep today. Those are: Lace collars, cream silk tulle, hand embroidery, table clothes, lamps, beadwork, embroidered shawls, wide range of antique and vintage items. Also many different articles, such as embroidered silk pictures, wedding dresses and veils, tapestries, shoes and accessories, women's outwear, silk needlework, silk embroidery tapestry, and others have been produced in Georgia.

Production of textile/fiber work has a long history in Georgia. This can be proved by series of discovered handmade objects, fragments of fabric, sewing thread and yarn, different kinds of necessary tools like spindles, skein machines, devices like looms, textile combs & accessories found during the archaeological explorations and excavations on the territory of our country.

Conclusions:

Silk is a part of Georgian national mentality, a common memory of our community. Application of silk in art, fashion and design, in industry and production of religious items, preservation of century-old traditions, silk museum activities and exhibitions dedicated to popularization of silk, restoration of historical cloth samples, testify that modern silk is respected and highly evaluated by Georgians. Silk affection can be traced through artistic activities inspired and stimulated by the unique quality of silk, by its virtues and splendor. There is a hope that silk production traditions will regain after a 30-year disruption because silk cloth is an organic part of Georgian family life, fashion and home design.Hopefully, initiatives started for restoration of sericulture in Georgia will continue as substantial projects and bring into life unique Georgian silk fabric.

Recommendations:

Georgian artists should unite and create an **international organization** of painters, designers, practitioners and educators to promote Georgian silk work throughout the world. Also they may initiate publication of journal *Georgian Silk Art,* conduct and publish researches in this area. Batika,-

painting on silk, clothes, accessories and household items created from silk, silk embroidery, Georgian national garment of men and women, and other creative inventions will establish silk art as a recognized art form, validate and encourage the production, collecting, and displaying Georgian silk through education of all segments of the population in the world.

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MULBERRY PLANTATION ESTABLISHEMENT METHODS, SUITABLE FOR EUROPE, CAUCASUS AND CENTRAL ASIA

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ABSTRACT:

In the light of specific climatic and technological conditions and traditions in Europe, Caucasus and Central Asia the paper gives detailed information about the economical importance of mulberry and its requirements for water, land, air temperature, soil conditions and elevation. The World mulberry geographycal distribution is presented. It is stressed on the regional specificities in mulberry planting, concerning the choice of land, plotting, land preparation, planting season, direction and planting methods. Some special techniques like intercropping and mulching are also discussed. Special attention is paid on the mulberry irrigation methods, manuring and prunning techniques.

Key words: Mulberry**,** Europe, Caucasus, Central Asia, plantations, establishment

1. INTRODUCTION

The mulberry, Morus sp. is a perennial tree with a wide geographical distribution, frequently occurring in tropical and temperate areas, and as relief forms from sea level up to 4000 m altitude. This is the only source for feeding silkworms of Bombyx mori L, which produce the largest amount of natural silk. Under natural conditions, the mulberry grows as a high tree, up to 15-18 m, with a life span of about 200 years. However it is reported in the literature that some mulberry trees have reached up to 300 and even 500 years (Central Asia, Caucasus, Estern Europe). Under the operating conditions for silkworm feeding (repeated production cuts), the mulberry life span is much shorter (20-30 years

in the Tropics and 80 – 120 years in some temperate countries), requiring additional fertilization, irrigation, etc. Originally from the Himalayas, the mulberry is known from the years 2800-2500 BC, then spread to India and other Asian and European countries, with the spread of silkworm rearing. The northern limit of its spreading is up to 60^0 parallel, and to the south mulberry is available even at the equator. The biggest area under mulberry is in the Far East and South Asia, the Middle East and southern Europe. The production of mulberry leaf on scientific basis is essential for the organization of an economically viable sericulture industry. Usually the mulberry is cultivated in order to produce high yield of leaves with good nutritional quality for the silkworm larvae Therefore the mulberry selection and culitivation techniques aim to obtain a maximum leaf yield which meets the physiological and nutritional requirements of the silkworm larvae.

2. ECONOMICAL IMPORTANCE OF MULBERRY

As the silkworm, Bombyx mori L. is a monphagous insect it can not be grown economically on any other plants. The mulberry leaf protein is the direct source for about 60% of the silk thread protein.

It is grown both as tree – type and bush-type for the mulberry leaves and for the fruits having high sugar content as well. Mulberry trees are planted also at the forest shelter belts.

Mulberry is a fast growing tree and produces large quantity of renewable biomass in the form of branches, shoots, leaves and fruits. In the Tropics usually one hectare of mulberry garden yields up to 20-30 tonnes/ha/year of green leaf and 4 tonnes of mulberry sticks. The energy generated per hectare is 27 940k calories and 4 600 calories/kg of mulberry wood. It promotes employment generation of 12 persons/ha/year.

The mulberry is an interesting species since it is a rustic plant, which in the temperate belt of Europe and West/Central Asia grows well on flat lands, on hills and on mountains, up to the limit of the chestnut tree. Although the best vegetative development is achieved in fertile lands with discrete water sources, the mulberry also grows well in calcaric soils with good water availability. The plant prefers a temperate climate to colder areas but it can be cultivated in hot regions next to the sea or to the mountains, which have a mitigating effect on the high temperatures. For these characteristics it is suitable for the reforestation of marginal zones, and can be planted on slopes which are subjected to water erosion and other meteorological factors and in soils poor in nutrients and water, since its roots can go rather deep into the soil. Furthermore, some cultivars are salt tolerant, resistant to the most common fungal diseases and to extreme water scarcity. These characteristics may be further reinforced through the use of the selection and of appropriate biotechnologies.

Besides the variety and agrotechnics, the annual mulberry leaf yield depends highly on the number of crops. For example in the tempreate countries the mulberry vegetation period is from the mid of April to the mid of October, thus only two mulberry leaf crops per year are possible. On the other hand in the sub-tropical countries the leaf crops per year arise to 3, while in the Tropics the number of crops, if provide proper irrigation may reach 4. The annual leaf yield therefore depends highly on the number of crops. In the tempreate zone the maximum leaf yield is abour 25 t/ha/year, while in the Tropical countries the maximum leaf yield can be about 60 t/ha/year or 2.5 times higher. Of course these figures illustrate only the mulberry leaf yield potential, but the leaf crops at the field level are lower.

Considering the maximum potential for the mulberry leaf yield, the maximum theoretical fresh cocoon crop in the temperate countries can be about 1500 kg/ha/year and in the Tropics – up to 3500 kg/ha/year. At the field level however the maximum fresh cocoon crop is about two times lower.

The sericulture is one of the most profitable agricultural activities, with the advantage of not requiring large areas of land, important for countries with limited agricultural area or in severe competition with industry or rural development like Japan and Republic of Korea for example.

In addition, the mulberry has enjoyed a multiple uses, from medicine to home use, being appreciated for its diverse qualities. In 1906, the authors of the "Treaty on the Silk Worm and Mulberry", Maillot and Lambert, completed their work with the same appreciation of the Morus sp. that he had done over 200 years before them, Ollivier de Serres in his work "La cuillette de la soybean ", namely," this tree is one of the most useful to man, as it exists, it gives it the leaves, which make it harvest the most beautiful and most precious thread of all, a fruit that can eat and which can serve for animal feed, a bark from where it can draw a thread that can cloth it, and after all these products, its wood serves to heat and cook its food. "

In 1958, in the "Culture of the trees", its author, Eufrosina Craiciu lists the various uses of the tree, other than for the growth of silkworms, as follows: wood is widely used, it is used for the manufacture of furniture, musical instruments, wheels and barrels; long branches are used as supports in vineyards, and the ones left after the use of the leaves serve to make racks; by the wood of the branches it is made a high quality paper, and from the bark textile fibers for rope making are extracted; from the mulberry roots a yellow, very durable dye, used for the manufacture of vegetable dyestuffs is extracted; its fruits being rich in sugar, are used for the preparation of jam, marmalade and especially for the preparation of a kind a brandy; for its ornamental forms (Globosa, Pendula and Piramidalis), it is used to embellish parks, gardens, planting on roads, protective curtains and hedges.

From the enumeration of these uses of the mulberry, today, new directions of use are defined, some of which are the animal and poultry feed. The mulberry green leaf with rich protein content (up to 28% on dry wt. basis) is used as fodder for cattle in many countries.

Mulberry fruits are having 100% edible portion with 80% of moisture and rich in protein, iron, phosphorus, calcium, minerals and vitamins like carotenes, thiamine, riboflavin, niacin and vitamin C. To spend a healthy life, anthocyanins have recently been assigned to function as an anti-oxidative. It is well known that mulberry fruits contain a high concentration of anthocyanins. Moreover, it was found that 1-deoxynojirimycin, which is said to have a profoundeffect inlowering the blood-sugar level in diabetic patients, is amply present in mulberry fruits.

The root bark, twigs and fruits which contain phenolic compounds, morasin and cyclomorasin are used as restorative, tonic, pectoral, diuretic and are prescribed to treat cough, asthma, phthisis and other chest complaints, dropsy and rheumatism. The decoction of the leaves possess blood purifying properties as a febrifuge, diuretic and galactugogue and stringent. The syrup made from fresh fruits is used as laxative, refrigerant in fevers and as an expectorant in cough and sore throats dyspepsia and melancholia. The root extracts is having hypoglycaemic properties and used in treatment of diabetes. The root bark is used as a purgative and vermifuge. Mulberry root juice is administered to patients with high blood pressure. The shoot contains latex, which is used as plaster for sores and for preparation of skin ointments.

3. MULBERRY REQUIREMENTS FOR THE CLIMATIC AND SOIL CONDITIONS

3.1. WATER NEED

***Rainfall*:** Mulberry can be grown without irrigation in places with a rainfall range of about 600 mm to 2500 mm. The rain distribution throughout the year is very important. However mulberry could be grown even in the desert if provide the adequate irrigation, macro and micro fertilizers.

***Atmospheric humidity*:** Humidity range of 65 to 80 % is considered ideal for mulberry growth. This is the reason that the mulberry leaf quality is much better in the spring rearing season (May-June) than in summer-autumn season in the temperate countries.

The water insufficiency can cause:

- Low growth of shoots;
- Small and rough leaves;

- Low nutritional value;
- Inappropriate leaf production.

Excess water may lead to:

- Asphyxiation of the roots and plant death;
- The emergence of diseases.

3.2 THE NEED OF LIGHT

***Sunshine*:** In the temperate countries, mulberry grows with a sunshine range of 5 to 16 hours a day while in the tropics, it grows well with a sunshine range of 9 to 13 hours a day. In fact the sunshine day is longer during mulberry vegetation in temperate than in the tropical countries. There are about 1400 hours of sunshine throughout the growing season. Important is to keep an optimal density per hectare. Southern, south-eastern or south-western exhibition of the plantation are preferred.

Incorrect light determines:

- Low intensity of photosynthesis processes;
- Low synthesis of nutrients;
- Prolongation of internodes;
- Reduced leaf thickness;
- Increase the degree of withering of the leaves.

3.3. SOIL CONDITIONS

The soil should be deep, fertile, well drained, clayey loam to loam in texture, friable, porous and with moisture holding capacity. Slightly acidic (6.2 to 6.8 pH) soils which are free from injurious salts are ideal for good growth of mulberry plant. In places where there is a great pressure for land for agriculture and horticulture crops, mulberry can be grown even in marginal and slope lands where other crops cannot be grown profitably.

It does not develop well on soil which are too cold, too dry and with many stones, too solty, with too shallow underground waters.

3.4. CONDITIONS OF AIR TEMPERATURE

An atmospheric temperature, ranging from 24 ^{o} C to 28 ^{o} C is found to be optimum for good growth of mulberry. Growth and sprouting of buds can not be obtained at temperatures below 13 ^{o} C and above 38 ^{o} C.

In temperate region mulberry leaves are available for rearing purposes from April to October, while in the tropics, growth of mulberry is continuous throughout the year. The mulberry requires a sum of temperature degrees over the entire vegetation period around 3000^{0}C. The mulberry starts vegetation at 8-10^{0}C, the bud sprouting starts at a temperature of 12 - 14^{0}C, the increased growth of shoots is at temperature 25 - 30^{0}C. The mulberry varieties from the tempreate zone are able to tolerate cold up to 25^{0}C - 30^{0}C in the winter. Late frosts in the spring may cause partial injury of leaflets at 0.7 - 1^{0}C.The leaves are totally damaged at at -2 - 4^{0} C. If already frozen the new so called „sleeping buds" become sprouting in about 10 days, but the trees produce enough new shoots with leaves, suitable for silkworm feeding in about 20 – 25 days after the late frost.

3.5. ELEVATION

In the temperate countries an elevation up to 800 m MSL is considered as the limit to grow mulberry for silkworm rearing. In the tropical/sub-tropical countries the elevation limit could reach much higher values of 2000-3000 m MSL.

4. MULBERRY GEOGRAPHYCAL DISTRIBUTION.

Mulberry is native to temperate Asia and North America. Presently *Morus* L. grows in warm climatic zones between 50 °N latitude and 10 °S latitude (Yokoyama, 1962) which includes South of Europe, Caucasus, Central Asia, India, Sino-Japanese region of the old world and of continental America in the new world and distributed over 29 countries or more. It is found that most of the mulberry growing countries lie north of the equator. Mulberry can be grown under various types of climatic conditions, ranging from temperate and tropics. In the temperate climate mulberry does not sprout during the winter season, while in the tropics the growing is continuous .Mulberry can be grown in a rainfall range of 635 mm to 2500 mm. Under the low rainfall conditions, the growth of mulberry is limited due to shortage of moisture, resulting in low yields where supplement irrigation is necessary. So far there are about 150 species of genus *Morus* have been described and presently 50% of them have been reduced as synonymous or varieties of the same species. Today *Morus* comprises about 68 recognised species and distributed in different countries mainly from Asian countries like Japan, China, India, Korea and Taiwan. Continental America is also rich in *Morus* species.

5. MULBERRY PLANTING

5.1. Choice of land

Mulberry is a light-loving plant, so the placement of the culture must be done in bright, airy, southern, south-eastern or south-western places, protected from strong winds. It is advisable to plant it near the silkworm rearing areas to avoid leaf transport at great distances, which would depress its quality and would not be economical. It is preferable that the land can be mechanized and irrigated, especially in precipitated areas, in low fertile or sandy soils.

Trees cultures should not be placed close to tobacco crops - nicotine being toxic to silkworms, or near crops requiring repeated treatments to control disease and pests because the insecticides, contaminating the mulberry leaves, even in a small amount of toxic substance, can cause serious poisoning to silkworms and compromise the cocoon crop.

It is not recommended to plant the trees in areas with high industrial pollution, close to chemical plants (pesticides), aluminum products, etc.

The most suitable lands for the cultivation of trees are flat, medium-sized, clay or sandy, with the highest natural fertility, permeable to water and air, with granular structure. The subsoil must be deep and the ground water below the level at which the roots rise to be below 1.5-2 m.

The trees are not planted on salt or muddy land with stagnant water or surface water that causes root asphyxiation.

Mulberry can also be planted on sloping terrain, up to a 15-20% slope, on the sunny slope and, if necessary terraces. It can also be grown on the edge of irrigation channels and fences.

5.2. Land plotting

It is the technical operation that is related to other planting operations, agro-technical works, mechanization, exploitation, leaf transport, etc.

The mulberry plots should allow easy access to mechanized means of soil cultivation, harvesting and transporting the leaf.

5.3. Preparing the land

The land on which the trees are planted must be well prepared, leveled and where necessary, to improve its fertility.

On large surfaces, the land is plunged with the plow at the depth of 60-70 cm, and on small surfaces with the spatula, at 40 – 50 cm. Before landfilling, the land is fertilized with 40-60 t / ha manure and 60-120 kg / ha. superphosphate and potassium salt, which is incorporated into the soil - work that is good to do at least 30 days before planting. Horizontal cord and live hedges are digging trenches along

the length of rows, 1 m wide and 50-60 cm deep.

5.4.Planting season

For proper establishment of mulberry plantations in the temperate climate, early spring and late autumn seasons are best suited. When planting is made in the spring, care is taken not to delay the planting, otherwise the sprouted buds fall off and the plants do not grow well.

5.5. Direction of planting

In temperate regions the direction of the rows of planting is important. The saplings have to be planted in rows either in north-south or east-west directions, making the rows parallel to the direction of the wind. In tropics where sunlight is not a limiting factor, mulberry rows can be planted in any direction. In slope lands the rows should be parallel to the contour lines.

5.6. Planting distance

The planting distance depends upon the agro-climatic conditions (sunshine, precipitation etc.), soil fertility level, intensity of cultivation practices adopted including the training and harvesting methods and also the variety of mulberry planted. The mulberry is trained as bush form, low cut, medium cut and high cut. In the case of bush type and low cut type the plants are trained through pruning and kept with the main stem height at 0.3 to 0.6 m above the ground level. The rows are about 1.5 to 4.0 m apart and within the rows the plants are 0.6 – 1.0 m apart.

Figure 1. Mulberry bush type plantation.

In the case of medium stem cut forms the stem height is maintained at about 0.6 m to 1.2 m. The rows could be from 2.0 m to 4 m apart and within the rows the plants are 0.8 to 1.5 m apart.

Figure 2. Medium stem mulberry plantation.

In the case of high cut form the main stem is maintained at about 1.5-2 m height, the row spacing 2.5 – 6.0 m and within the rows the plants are spaced 1.2 to 4.0 m. In the case of management with a tractor the inter row distance must necessary be wider, according to the width of the machine. A wide inter - planting distance will ease the farming operations and the leaf yield per tree, but decrease the number of trees planted in a unit area and will result in less harvest per ha.

Figure 3. High stem mulberry plantation.

5.7. Planting method

After preparation of land, pits of a standard size of 40 cm width, 50-60 cm depth are made. Trenches of 45 cm X 45 cm can be also opened in the planting row. Farm yard manure (FYM) or compost is applied in the pits or trenches and it is mixed very well with some soil. Instead of FYM, NPK fertilizer in amount of 150-200 g/pit can be used as well. In order to plant the saplings at fixed intervals ropes with suitable marks are used for guidance. After planting, the saplings are cut to a uniform height. The height at which the saplings are cut varies according to the training system. It is advisable to cut the saplings in the end of May (temperate countries) when the alive buds have already sprouted.

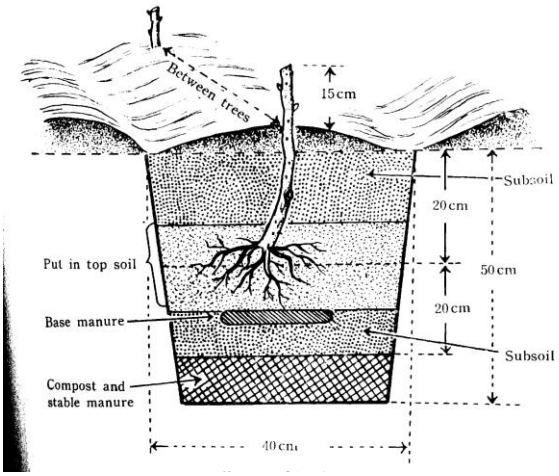

Figure 4. Mulberry planting method.

5.8. Inter cultivation

The main object of inter cultivation is to remove the weeds and loosen the soil so as to allow the rain water to soak deep into the soil and for better aeration and nitrification. A more recent trend is to carry out minimum cultivation operations but to control the weeds through the application of chemical herbicides.

Figure 5. Mulberry intercropping.

5.9. Mulching

Mulching is covering the soil in between the row space with some protective material. It helps in conserving moisture, keeps the soil loose and friable, protects the plants from winter injury, and keeps down the weeds. Pruned mulberry twigs are spread in between rows as mulches. Also straw, autumn leaves, stubbles etc. serve as natural mulches. Artificial mulches of black polyethylene sheet are also beneficial.

5.10. Irrigation

Most of the countries in South Europe, West and Central Asia and North Africa have comparatively dry summer season when mulberry trees need of irrigation In most of these countries the summer-autumn silkworm rearing can not be practiced without mulberry irrigation. The high stem mulberry trees are more able to tolerate only rain fed conditions, because of their deeper roots and wider inter-plant/row distance. Normally irrigation water for mulberry should contain less than 1000 ppm of total soluble salts. Of the different methods of irrigation adopted, the furrow, flat bed and basin methods are normally practiced. In the furrow method the field is laid out into a series of ridges and furrows. The basal part of the furrows is made wet by the flowing water and the ridge is moistened by the capillary movement of water**.** This method is more efficient from the points of view of economy in water use. In the flat bed method the field is divided into rectangular beds with bunds all around the channels on the sides. The bed size may vary from 3.5x2.0 m, to 4.0 x 6.0 m. The basin method is suitable mostly for tree plantations or single high stem trees. In this system irrigation water from the supply source is lead into the basin around the trunk. The diameter of the basin may vary from 1 to 1.5 m.

Overhead or sprinkler method is highly efficient and can be practiced in undulating lands where low and high bushes are cultivated. The advantages are that it is more efficient in economizing water use; there is uniform distribution of the water on the foliage; the percolation loss in porous and sandy soils is avoided; this is most suited for emergency irrigation; it can be followed with advantage on slopey and shallow lands. The high cost of installation is the main disadvantage of this method. Other method who can be practiced successfully in mulberry is the drip irrigation. In this method the fertilizers could be supplied dissolved in the water and it is called “ferti- gation” in this case.

5.11. Manuring

It is fully realized that for any increase of leaf yield of mulberry per unit area of land, the native soil fertility alone can not be relied upon and recourse has to be made to the application of fertilizers and manures. Of the three major elements, viz. nitrogen, phosphorous and potassium, nitrogen is the most important and vital for increased production. No nitrogenous fertilizer means no manuring in respect of mulberry crop. Leaf yield was reduced by about 10 % and 6 % when P_2O_5 was not applied, by 3 % and 12 % when K_2O was not applied, as per the studies conducted in Japan and India respectively. The common organic manures used for mulberry are farm yard manure and compost. Nitrogen is usually applied in the form of ammonium sulphate (20 %), urea(45 %), calcium ammonium nitrate(20.5 %), ammonium sulphate nitrate(26 %) and calcium cynamide (20 %). Acidic fertilizers may be preferred for alkaline soils, alkaline fertilizer for acid soils and neutral fertilizer for other types of soils. For mulberry the phosphate fertilizers, the water soluble single or triple superphosphate, are commonly used as it is neutral in reaction and the available phosphorous is as high as 90 %. The chief commercial potassium fertilizers are sulphate and chloride forms. For mulberry potassium sulphate and potassium chloride are generally used. Instead of applying each nutrient separately, compound fertilizers containing NPK and also minor nutrients in small quantities are being recommended. Compound fertilizers are applied as basal doses and the straight fertilizers containing nitrogen are applied in split dose as top dressing in order to meet the full requirements of the plant. Of late, various complex fertilizers suited to different crops are available on the market.

The NPK used for fertilizing the mulberry is usually in the ratio of 2:1:1 or 5:2:3. The standard dosage of fertilizer is 300 kg N, 150-180 kg P_2O_5 and 180-200 kg of K_2O per hectare per year. The first application in amount of 1/3 is made in the late autumn (November). If mulberry is under rain fed conditions the rest amount of the fertilizers is provided in the spring, i.e. March – April. In this case urea is preferred to be used as nitrogen source. In the case of mulberry under irrigation the rest of fertilizers are applied in two equal split doses, first in the spring and the second in June after

pruning. Phosphorous and potash are applied in single doses along with the first application of nitrogen. The organic manures which decompose and release nitrogen slowly, are applied during the winter when the mulberry plants are in dormant stage.

The fertilizer is spread in between the mulberry plant rows and incorporated into the soil by forking in or by working a rotary cultivator. In the case of single trees, side dressing of fertilizer is done around the plant and is called “spot application”.

6. MULBERRY PRUNING

Pruning is practiced solely to improve yield of foliage and to maintain the shape of the plant for early harvest of the leaves for silkworm rearing. Pruning of mulberry is also useful for adjusting the production period to synchronize with the leaf requirement for silkworm rearing, and also to extend the leaf production period.By proper timing and method of pruning, it is possible to get two or three harvests in temperate regions in a year and up to five harvests under tropical climates.

For the bush/low cut training in the temperate regions, the saplings are cut to a height of 15 cm (bush type) or 50-60 cm (low cut type) above the ground level in May. From this plant 3 or 4 branches arise. If it is bush type in the late autumn the branches are cut in the middle of them. In the following year the branches are cut at the base (bottom pruning) for harvesting leaves for spring rearing and followed by the ½ medium pruning of new shoots for autumn rearing. Thereafter the alternative practices of bottom and medium pruning is repeated every year. When the branches coming forth on the main stem are pruned every year, the part cut which the cutting is repeatedly practiced gets thick and shows a fist shape in a few years, so called “fist form”.

In low cut type on the next year spring after planting, the branches are cut in the middle, and the leaves could be used for spring silkworm rearing. In the autumn the newly sprouted shoots are medium pruned for autumn rearing. In the following year the branches are pruned bottom and thereafter the alternative practices of bottom and medium pruning is repeated every year. Normally the low cut type can be used for spring silkworm rearing harvesting on the 3rd year after planting.

In the medium stem cut type the sapling is cut at a height of 0.6 – 1.3 m above the ground level in the first year and then the young trees are trained as the low cut. It is possible to make “second floor” of the crown by repeating the training procedure of the second year again in the 3rd year. The medium cut trees can be used for spring silkworm rearing harvesting on the 4th -5th year after planting.

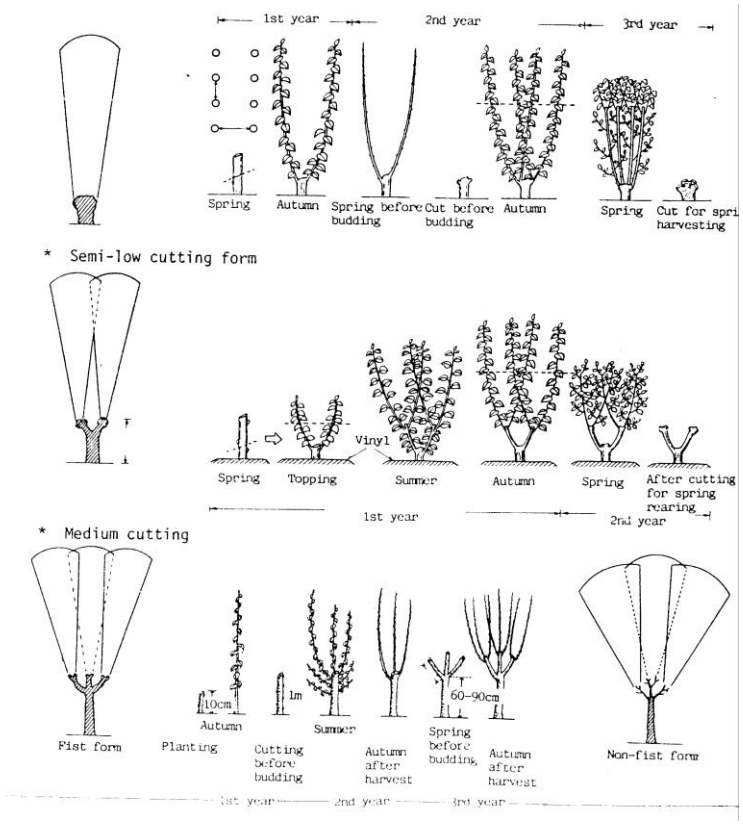

Figure 6. Mulberry pruning schemes.

In the high stem cut type the sapling is cut at a height of 0.10 m above the ground level and only one shoot is left to grow on the first year. Then in the following year the shoot is cut at 1.5-2.0 m above the ground level and further the young trees are trained as the low cut until they form one, two or even three "floor" crown. The high stem cut trees can be used for spring silkworm rearing harvesting on the 5^{th} - 6^{th} year after planting.

In the "non-fist form" the branches are cut leaving basal parts to some extent and in this style the trees become taller every year.

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MORPHOMETRIC STUDY ON MAIN QUANTITATIVE CHARACTERS IN SOME BULGARIAN MULBERRY VARIETIES

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ABSTRACT.

A detailed study on main quantitative characters in five Bulgarian mulberry varieties has been made. Stability, variability and analysis of variance of these characters have been determined. Some characters have a low changeability, viz. stem circumference; size and weight of leaves on growing and non-growing shoots, other ones have a moderate changeability, viz. length of one branch; total length of branches; number of growing and non-growing shoots per branch. Number of branches per tree, number of growing and non-growing shoots per branch and leaf yield per branch and per tree traits are characterised with high variability. The effectiveness of selection will be enhancing with shortening the volume of selection material at expense of selection on informative characters only. Vratsa 1 and Vratsa 18 varieties are the most perspective as initial material for further selection, because they significantly exceeded the rest of the varieties at almost all quantitative characters and productivity. They are more constant as regard leaf and total biomass production and constitute an excellent option for moriculture development and sericulture revival in Bulgaria.

Keywords: mulberry varieties, quantitative characters, morphometric study, selection

Mulberry (*Morus alba* L.) is an economically important multipurpose tree, which in addition to its traditional uses for silkworms rearing (*Bombyx mori* L.) and as forage for livestock, providing fruit for human consumption and wood. When mulberry is used in sericulture the most important trait is the yield of foliage, which is mainly dependent on variety, soil properties and cultivation (Madan and Sharma, 1999, Ramanjulu and Sudhakar, 2000). It is well known that mulberry shows great adaptation to various climatic conditions (Kuliev, 1988; Biasiolo et al. 2004; Rodríguez et al., 2018).

Different mulberry morph-types and varieties are known to exist in nature and in cultivated form. They are distinguished by morphological characters and productivity. Evaluation of mulberry and selection of superior varieties for rearing performance mainly depends on leaf quality. Around 60% of the total cost of cocoon production in sericulture goes towards mulberry leaves production (Bongale et al., 1997). Maximum attention has been given recently for improvement of mulberry in terms of both quality and quantity, because quality of mulberry leaves fed for silkworms plays a vital role in sericulture.

Many authors described and discussed some elements of general mulberry productivity, their variability and changeability (Kumar, 1990; Bindroo et al., 1990; Bari et al., 1990; Yadav and Goswami, 1992). Biometric studies are very useful for identification of varieties (Agira, 1980). Now the question which confronts selection is the increasing the effectiveness of variety evaluation by quick and precisely assessment of initial material (Gupta et al., 1991).

The main objective of our study was to assess the response of five promising Bulgarian mulberry cultivars to climate conditions by detailed study on their main quantitative characters and productivity.

Material and Methods

The investigations have been made with Vratsa 1, Vratsa 18, Veslets, No 24 and No 106 mulberry varieties at SCS-Vratsa's mulberry germplasm. In view of our study tested varieties were

planted in experimental plantation with scheme 3 x 1.5 m. They were in form of medium stem trees and have been cultivated under standard practices (Petkov and Penkov, 1980). Ten trees from each variety have been analysed. Every year the whole bottom pruning was done in spring at term of five silkworm instar. Variety's morphological data was analysed using various characters. Some of main quantitative characters of mulberry were used: viz. number and average length of branches (two years old shoots); total length of branches per one tree; number of buds per one branch; number of growing shoots (shoots of current growth with active growing point) per branch; number of non-growing shoots (shoots of current growth with formed dormant bud on the top, which growth is stopped) per branch; number, size and weight of leaves per one branch or per one shoot; leaf yield per branch and per tree. The tested parameters were recorded when the leaves are in fully expanded state. Leaf length was measured from the leaf base at the juncture of the petiole attachment to the leaf tip leaving the extended portion of the tip. Lamina width was measured from the widest point of the leaf. These measurements have been adopted from Petkov (2000).

Comparison the differences between variety's means, computation of critical differences (CD at 5 per cent level of significance was done and the significance of different sources of variation at tested characters was made with two-factor ANOVA according to Lidanski (1988). The mean square deviation and coefficient of variation were also calculated and selection and economical evaluation of tested characters and varieties has been made.

Results and Discussion

Mulberry (*Morus* spp.) is grown under varied climatic conditions ranging from temperate to tropical (Kafkas et al., 2008). Plant species with a wide range of environmental adaptations like mulberry have been found to exhibit differ morphological and physiological characteristics.

The average data of main quantitative characters and their modification variability are presented in Tables 1 - 2.

The results obtained show that absolute values of tested characters, which indirectly or directly participate in leaf yield form up have varied according to climate condition and to nature of the characters.

Studying the number of branches per one tree has a practical meaning, because total length of branches and leaf yield are depended of it. In general more productive varieties have more branches. The tested varieties were significantly distinguished in respect of this character and No 24 and Veslets varieties have significantly lower branches. From the analysis of variance it was found, that two sources of variance - variety and year were significant at 0.1% level for number of branches per tree character, and significant at 0.01% level for branch length character. The values of CV and σ in all varieties attest for additional possibility of increasing the number of branches by respectively cultivation and especially with correct forming of tree crown. It is considers also that the most productive varieties have the longest branches (Yamamoto, 1985); however this was not confirmed in our study. According to values of σ and CV we think that branch length may be increased by optimal cultivation of trees. Out of all varieties Vratsa 1 could be used as initial form in selection for improving the number of branches per tree character, and Vratsa 1 and Veslets - for improving the branch length character.

The complex character - total length of branches per tree is also genetically dependent one, with moderate to high level of changeability (variety and year sources of variance are significant at 0.01% level). Vratsa 1 variety was characterised with highest total length of branches (57.46 m), followed by Vratsa 18 (55.11 m) and Veslets (53.63 m), respectively.

The number of buds per one branch has the great importance for quantity and quality of leaf yield. In our study we determined that all varieties have enough buds. From the analysis of variance it was found that both variety and year as factors influenced significantly at 0.05% level. In attitude

with selection Vratsa 18 and Vratsa 18 are the best varieties. Number of buds per branch character has average to high variability and this indicates the possibility for improving this character.

Numbers of growing and non-growing shoots per one branch characters have a great economic and selection meaning. They were most unstable ones and this testifies the great possibility for their improvement by purposeful selection and optimal cultivations. From the analysis of variance it is evident, that variety is significant at 0.01% level and therefore year is significant at 0.5% level. No 24 and No 106 varieties are the most perspective in relation to percentage of growing shoots per branch, with 32.45 % and 32.18%, respectively.

A considerable part of leaf yield is realised on mulberry non-growing shoots, therefore this influenced negatively on quantity and especially on yield quality. Numbers of growing and non-growing shoots per one branch are low to high changeable indices, dependent by genetic structure of varieties and by their reaction towards environment conditions as well. Varieties with ratio between growing and non-growing shoots on one branch between 1:1.5 and 1:2 are very good. In our study the followed data was recorded: No 106 variety - 1:2.11, No 24 1 - 1:2.08, Veslets - 1:2.30, Vratsa 18 - 1:2.35 and Vratsa 1 - 1:2.37.

One of the most important quantitative characters, which influenced yield of leaves are the number of leaves on growing and non-growing shoots per one branch. In our study we found significant differences between tested varieties and between different years in connection to these characters. They are highly changeable ones, depend mainly by environmental conditions and attest for possibility of increasing the number of productive (growing) shoots and number of leaves on them by selection.

Mulberry biomass production is the consequence of the interaction of a multiplicity of factors, mainly environmental conditions as climate, soil characteristics and water availability (Cordoví et al. 2013).

In confirmation of Sadiihov (1982) we think that leaf yield per one branch should be used for mulberry varieties evaluation, because it hold a lot of valuable information and is easy to record. The highest leaf yield per one branch was determined in Vratsa 1 variety (403.18 g), Vratsa 18 (374.25 g) and Veslets (359.51 g), and lowest yield was observed in No 24 variety (309.81 g). The leaf yield per tree was also highest in Vratsa 1 variety (11.23 kg), followed by Vratsa 18 (10.62 kg) and Veslets varieties (9.03 kg).

The weight of one leaf on growing and non-growing shoots has an important selection and economic significance. In our study this character had moderate changeability and may be used in selection, because the higher weight of one leaf corresponds always with the bigger leaf yield. The leaves were heaviest in Vratsa 1 and Vratsa 18 varieties, respectively 3.86 g and 3.46 g on growing shoots and 3.53 g and 3.16 g on non-growing shoots.

It is important to emphasize that Vratsa 1 and Vratsa 18 cultivars were more constant as regard leaf and total biomass production than other tested varieties. Because of this Vratsa 1 and Vratsa 18 mulberry cultivars are an excellent option for moriculture development under Bulgarian conditions and for revival of Bulgarian sericulture.

Conclusions

Some of mulberry quantitative characters have a low changeability: viz. stem circumference; size and weight of leaves on growing and non-growing shoots, other ones have a moderate changeability: viz. average length of 1 branch; total length of branches; number of growing and non-growing shoots on one branch. Numbers of branches per tree, number of growing and non-growing shoots on one branch and leaf yield per branch and per tree traits are characterized with high changeability. The effectiveness of selection will be enhanced with shortening the volume of

selection material at expense of investigations on only informative characters. For improvement of selection choice only relatively constant and stable characters must be used.

Vratsa 1 and Vratsa 18 varieties are the most perspective as initial material for further selection of high productive mulberry varieties, because they significantly exceeded the rest of the varieties at almost all quantitative characters and productivity. They are more constant as regard leaf and total biomass production and constitute an excellent option for moriculture development and for sericulture revival in Bulgaria.

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BRIEF CHARACTERIZATION OF MULBERRY AND MAIN VARIETIES FOR REVIVAL OF BULGARIAN SERICULTURE

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ABSTRACT

Short botanical description of mulberry and general characteristic of mulberry accessions from SCS - Vratsa's mulberry germ bank was done. There are more than 200 mulberry accessions in the SCS's germplasm, but only 115 out of them have been studied in details till now. The most important and available mulberry varieties for revival of Bulgarian sericulture were characterized also. Description and characterization of mulberry and the proposed varieties were done according to Petkov (2000).

Keywords: mulberry, *Morus* spp., description, characteristics, varieties, sericulture

Mulberry which is cultivated mainly in temperate and subtropical regions of the world is widely grown in Bulgaria and mulberry cultivation has been performed since ancient times.

Mulberry is native to temperate Asia and North America. Presently *Morus* L. grows in warm climatic zones between 50°N latitude and 10°S latitude. A global survey of sericulture industry reveals that mulberry is cultivated at least in 30 countries. There is no doubt that mulberry can grow and flourish in many other parts of the world and because of this is being explored by FAO (Grekov et al., 2005).

So far more than 100 species of genus *Morus* have been described, but most of them have been reduced as synonymous or varieties of the same species. Today *Morus* comprises about 50 recognized species and is distributed in Asia, Europe, Africa and America. Main mulberry species are *Morus alba*, *Morus nigra* and *Morus rubra*.

In general areas with mulberry have been largely altered by the development of sericulture. Furthermore in many countries, mulberry fruit is consumed fresh and dry as well as bread, pies, puddings, mulberry wine, etc. Fruit juice is processed in various forms for products such as molasses, jam, fruit pulp, mulberry paste, mulberry fruit ice cream, vinegar and spirits. Many authors (Chatterjee and Awasthi, 2000; Noda et al., 2007; Yoganopva et al., 2013; Sharma et al. 2015; Rodríguez et al., 201) showed important potential of the mulberry and they expected that mulberry will become one of the most important plants in the future.

Petkov (2000) found that single mulberry trees in rural areas of Bulgaria areas are scattered in the garden or in the form of border trees, without maintenance procedures, collected fruits are used to meet family needs, and mulberry leaves are used for silkworm or small animals feeding.

Description and genotypic classification and characteristics of mulberry can be identified by using main phenotypic characters. Specialists identify the cultivars diversity by botanical traits, morphological characters and DNA markers. For this reason, there is urgent need of collection, characterization and evaluation of local gene banks (Dandin et al. 1992; Thangavelu et al., 2000; Rao et al., 2002; Biasiolo et al., 2004; Peris et al., 2013).

The aim of this study is brief description of mulberry plant, characterization of Bulgarian mulberry gene bank and the potential of the best mulberry varieties for revival of Bulgarian sericulture.

Material and Methods

In this study, a short description of mulberry and general characteristic of mulberry accessions from SCS-Vratsa's mulberry germ bank was done. The most important available mulberry varieties were characterized also. Description and characterization of mulberry genetic resources and the proposed varieties were done according to Petkov (2000).

Results and Discussion

1. General botanical description

Mulberry belongs to the genus *Morus*. Trees or shrubs, leaves alternate, entire toothed or three to five lobed, base three to five nerved, stipules small, lateral, caduceus. Flowers are mono or dioecious.

Plant habitat

The plant is a perennial, living for many years, cultivated or in wild state. Depending upon the type of cultivation, the plant is grown as a bush or tree. The plant is of branching type and the branching character varies considerably due to the influence of cultivation, mode of training, fertility of the soil, etc.

Plant height

The plants when allowed to grow as trees attain a height of 20-25 m with a girth of the trunk about 8 m. In Bulgaria the plants are grown as trees. Where the trees are grown as a fence, they are allowed to grow to the required height and then pruned at the desired height every year.

Stem and branches

Mulberry plants show different stem colors depending upon their species or origin: greyish; white reddish; brown; grey or greyish brown; greyish pink. There are different types of mulberry branches (figure 1).

Buds

In mulberry plant one bud is found in the axil of a leaf. Sometimes two independent buds on either side of the main bud are also found, called accessory buds. The growing point emerges as a shoot under favorable conditions. Mulberry varieties growing in tropical climate sprout throughout the year and farmers rear the silkworms throughout the year also. The size, shape and position of the axillary buds vary from variety to variety (figure 2).

Leaves

The size of mulberry leaf varies in different species and varieties. Varieties like Kinriu are characterized with very large leaves and local varieties bear only small leaves. The leaf size is an important character. The leaves are simple, alternate and stipulate. Leaves are petiolate, the length of the petiole varies from 1.5 to 7.5 cm. Mulberry is unique in possessing both lobed and unlobed leaves on the same twig. Most of varieties have only unlobed (entire) leaves, but others have mostly lobed leaves. The size of the lamina varies and it measures nearly 30 cm in length along the midrib and about 25 cm breadth at the widest region. The thickness of the leaf is about 100-200 μm. The shape of the leaf is generally ovate or ovate-cordate.

Phyllotaxy

Generally it is of 1/2 or 1/5 and 2/5 in many of varieties (figure 3).

Inflorescence

The inflorescence of mulberry is a catkin with its characteristic pendent or drooping peduncle, bearing unisexual flowers. The plants are generally dioecious (occurrence of male and female catkins on separate plants (figure 4) but there are also monoecious (both male and female catkins occur on same plants).

Fruits

After insemination, the stigma withers and the ovary and sepals gradually develop. They plump up and become fruits, which when coming together on the floral axis, become sorosis. The sorosis are green at first, but gradually turn red, eventually becoming violet black, signifying that they are ripening. The mature fruits of a few varieties turn red or white, rather than violet black (figure 5).

2. Characterization of Bulgarian mulberry gene bank

Characterization of mulberry germplasm is essential to identify the individual genotypes and to compare them for further investigation. The characterization is a process in which highly heritable characters are subjected for systematic data recording which finally helps in identifying the best ones. Enrichment of mulberry germplasm with high variability and the characterization of these resources is a continuous process for generating a data base.

There are more than 200 mulberry accessions in the germplasm, maintained at SCS in Vratsa, but only 115 out of them have been studied in details (Petkov, 1998). Most of mulberry accessions are of *Morus alba*, which is widely spread in Bulgaria. Less number of accessions is from the species *Morus rubra, Morus multicaulis, Morus nigra, Morus kagayamae, Morus latifolia* and *Morus bombycis*. Mulberry hybrids are prevailing. There are also three accessions, selected by the method of polyploidy, namely Kairiu improved, Tajik without seeds and Uzbek. Accessions from nearly all countries practicing Sericulture from the temperate and sub-tropical belt like Italy, Russia, Georgia, Japan, Armenia, China, Azerbaijan, Uzbekistan, Egypt and Ukraine are presented. 37 varieties have been recognized by the Bulgarian State Executive Agency for Variety Testing and allowed to be propagated for commercial use.

Usually when mulberry pruning is practiced every year the prevailing shape of mulberry crown is egg shaped followed by pile shaped and pyramid shaped crown.

The prevailing bud size is from 2 to 5 mm. Most of varieties have triangular shape of the buds. A big diversity was detected regarding the buds color from grey with different nuances to deep brown.

Other important character, characterizing mulberry is the position of the branches toward the stem. Only in so called "crying mulberry‘, *Morus alba v. pendula* the branches growth angle is from - 90° to + 90o toward a horizontal plain. In the other varieties this angle varies from 0 to 90°. The size of the angle influences the shape and density of the crown.

Most of mulberry varieties have curved shoots with different length. The distance between two neighboring leaves on one shoot is called internodal distance and is not only qualitative character, but also a very important commercial trait. The value of this character is not the same in different parts of the branch. Most of mulberry varieties have medium internodal distance.

With some exceptions most of mulberry varieties have alternative position of leaves. In the phylotaxy grade, the mulberry varieties having grade 1/3 are prevailing, but there are some accessions with grades 2/5 and 2/7.

Most of the accessions maintained at SCS Vratsa have unlobed leaves. Some varieties like P 10, Kenmoshi, Shinso 2, Kinriu improved, Ukrainian 107, Florio, Giaccola, No 106 and Kokuso 27 have different types of leaves. Many of the accessions manifested triangle and heart shaped leaves. The varieties having serrate leaf margin are prevailing. Most of mulberry varieties have slightly rough leaf surface. The majority of the varieties has green leaf color, followed by those with deep green and light green leaves. The leaf size varies widely among the mulberry varieties. Under temperate climatic conditions the highest leaf length (mean values), was observed in the following varieties: Pobeda (20.82 cm), P 27 (18.90 cm), N 59 (17.82 cm), Digmuri (17.53 cm), P 11 (17.49 cm), Kokuso 13 (17.46 cm), P 26 (17.42 cm), Kinriu (17.33 cm) and Azerbaijan 20 (17.31 cm). Most of mulberry varieties have a leaf width ranging from 9 to 12 cm. Generally thick

leaf, smooth in nature, is desirable for silkworm rearing. The leaf weight and leaf index vary widely among the mulberry varieties.

In most of mulberry accessions the fruit length is from 1.6 cm to 2.2 cm and the fruit width is from 1.2 to 1.3 cm and the most common fruit weight ranges from 0.8 to 1.6 g.

3. Brief description of the best mulberry cultivars in Bulgaria

A large number of mulberry varieties have been maintained in Bulgaria, but only a small part of them are introduced into practice today.

The local and hybrid mulberry multiplied by seeds still predominated in the country. They are well suited to local conditions, and because of delicate leaves are used for feeding young silkworms despite the low leaf yield of about 3 000 - 4 000 kg/ha.

Old mulberry varieties have many advantages over local mulberry trees. The yield of the leaves is often triple as high and the nutritional quality of the leaves is higher. Ones of the famous are No 3, No 24, No 26 and No 59 varieties.

No 3 variety is selected from the local *Morus alba* form. The tree has moderate growth; the stem is high with medium thick shoots. The leaves are large, light green, fragile and entire with uneven surface. No 24 variety is other local mulberry variety, famous for its white-pink colored fruits. It has a vigorous growth, high resistance against frost and gives a lot of fruit. The leaves are large, hearty shaped, smooth and entire. Leaf yield is over 10 000 kg/ha for low-stem plantation.

Vratsa1, Vratsa 18 and Veslets are the best Bulgarian mulberry varieties, selected by Prof. Iliya Penkov at SCS-Vratsa. Vratsa1 is a species hybrid between Kinriu and Hassak varieties. The trees have a round crown more than 50 shoots per tree. The leaves are large 21/18cm, heart-shaped, entire. Gives 13 000-16 000 kg/ha leaves. Vratsa 18 was created through initial selection from *Morus multicaulis* seedlings. The variety is female; the fruits are sweet and black. The leaves are very large 29/21cm and hearty-elongated. The variety is characterized by a high yield of leaves, low fruiting and is suitable for late spring silkworm feeding. Veslets variety is derived from a mutation of Kokuso 21 variety. Trees have a thickened globular crown and medium long, slightly kneeling branches. The leaves are medium-sized, thick, entire, slightly elongated, 20/16cm in size. The trees are male and the leaf yield is over 13 000 kg/ha.

Various varieties introduced from the Former USSR, such as Pobeda, Tadjikska bezsemenna, Tbilisuri, Kharkovska 3 and others, are also distributed in the country. From Italian selection, the most famous variety is No 106 variety. It has strong growth and yields a high yield of leaves - over 14 000 kg/ha with very good leaves nutritional quality for the silkworm.

Japanese mulberry varieties have very high economic quality. Kinriu variety is characterized with strong growth and a well-formed crown. The shoots are with medium length and light brown colored. The leaves are dark green and large, entire, thick and shiny and do not wither quickly. The variety is resistant to cold and gives above 13 000 kg/ha of leaves. Trees from Kokuso 27 variety have very strong growth and a well-rounded crown. Branches are long, straight to snake formed, good leafiness and slightly curved peaks. The leaves are large in size 22/17cm, dark green colored petioles with good, slightly glossy upper surface. Later developing variety suitable foe repeated spring silkworm rearing. Gives over 13 000 kg/ha leaves. The Kokuso 21 variety is characterized with strong growth and a medium compacted tree crown. The shoots are straight, long, with a short internodes and a gray green bark. The leaves are large 23/17cm entire, juicy and do not wither quickly. The leaf yield is over 13 000 kg/ha. The variety is suitable for silkworm feeding through all seasons.

Conclusions

Short description of mulberry plant was done according to Petkov (2000).

General characteristic of mulberry accessions from SCS - Vratsa's mulberry germ bank was made also. There are more than 200 mulberry accessions in the germplasm, but only 115 out of them have been studied in details till now.

The most important and available mulberry varieties for revival of Bulgarian sericulture were named and characterized.

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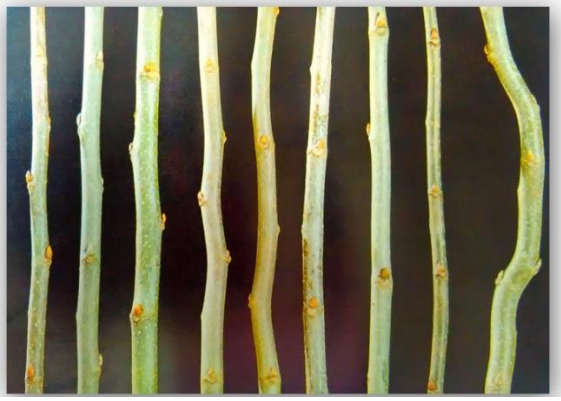

Figure 1. Mulberry branches

Figure 2. Mulberry buds

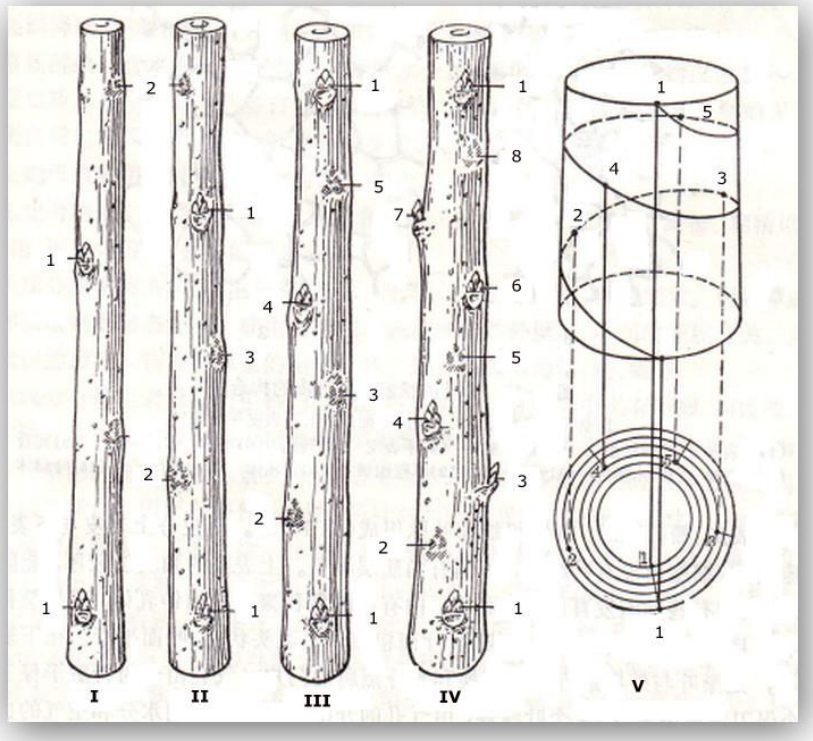

Figure 3. Phylotaxy in mulberry: I: 1 /2, II: 1/3, III: 1/5, IV: 1/8, V: 2/5

Figure 4. Mulberry inflorescence: 1: Female, 2: Male

Figure 5. Mulberry fruits

Characteristic of the best mulberry varieties in Bulgaria

Table 1.

Variety	Sex	Leaves		Fruits	Leafiness %	Leaf yield kg/ha
		Form	Dimensions cm			
No 106	Female	Entire Large	19/15	Pink Small	40-48	Above 14 000
Vratsa 1	Female	Entire Large	21/18	Black Moderate	46-54	Above 13 000
Vratsa 18	Female	Entire Very large	29/21	Black Large	50-56	Above 14 000
Veslets	Male	Entire Large	20/16		54-60	Above 13 000
Tbilisuri	Male	Entire Large	21/18		55-62	Above 12 000
Kinriu	Female	Entire Very large	25/19	Dark red Large	44-52	Above 13 000
Kokuso 21	Male Female	Entire Large	23/17	Black Large	50-57	Above 13 000
Кокуco 20	Female	Entire Large	21/17	Black Moderate	42-50	Above 12 000
Кокуco 27	Male	Lobed Large	22/17		53-60	Above 13 000

ВЛИЯНИЕ ФОСФОРНОГО УДОБРЕНИЯ НА УРОЖАЙНОСТЬ ЛИСТЬЕВ ТУТОВОГО ШЕЛКОПРЯДА СОРТА ХАНЛАР-ТУТ

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Как известно, в жизни растений физиологическая функция фосфора исключительно велика. Он участвует в построении молекул сложных белков (нуклеопротеидов), играющих важную роль в построении клеточного ядра и других органических соединений (фосфатов, фитина, крахмала и других важных соединений). Фосфор ускоряет течение ряда ферментативных процессов. При отсутствии фосфора крахмал не превращается в сахар. Имеются сведения, что фосфор повышает восстановительную реакцию в растениях.

Установлено, что фосфор ускоряет развитие генеративных органов растений, улучшает закладки плодовых почек, ускоряет созревание и сокращает их вегетационный период. Недостаток фосфора ослабляет рост побегов и листьев. Таким образом, фосфор играет весьма важную роль в жизни растений. Поэтому в практическом шелководстве Японии минеральные удобрения специализируются для племенных выкормок. Тутовые насаждения, предназначенные для промышленных выкормок, удобряются преимущественно азотными удобрениями, а насаждения для племенных выкормок удобряются преимущественно фосфорными удобрениями.

Однако, в литературе не встречаются конкретные экспериментальные данные о влиянии фосфорных удобрений на продуктивность шелковицы и племенные показатели выкормок. Многими исследователями установлено, что растения недостаточно используют вносимую суперфосфатом фосфорную кислоту. В году внесения она используется не более 25%. Это объясняется, во-первых, почти полной неподвижностью фосфорных удобрений, во-вторых, переходом фосфорной кислоты со временем в слаборастворимые формы.

Опытами, проводимыми Ю.З.Аббасовым, установлено. Что на светло-каштановой почве даже меньшие дозы суперфосфата в годы его внесения в некоторой степени увеличивали продуктивность шелковицы и показывали значительное последействие на урожай листа шелковицы Ханлар-тут. Данный вопрос для наших условий весьма актуален и пора его разрешить.

Для изучения влияния различных доз фосфора и его последействия на урожай и кормовые качества листа шелковицы нами в 2014-2015 гг. проводился опыт на Фахралинской базе Азшелкинститута на высокоствольный кормовой плантации сорта Ханлар-тут, заложенной 2005 году при густоте стояния деревьев 4х4 м, на площади 2-х гектаров. Схема опыта предусмотрела испытание 10 различных вариантов фосфорных удобрений на фоне 180 кг азота (см. табл.). Опыт проворился в четырехкратной повторности. Каждая делянка состояла из 12 деревьев, из которых 5, наиболее средние, были выделены в качестве учетных, остальные 7 деревьев использовались при проведении кормоиспытательных выкормок.

Удобрения вносились в зоны распространения корневой системы шелковицы в дно плужных борозд глубиной 15-20 см проведенным вдоль рядов с обеих сторон на расстоянии 40-50 см от них и заделывались культиватором.

Почва опытного участка относится к светлокаштановой разности и характеризуется следующими данными: в верхнем горизонте (0-20 см) количество общего азота содержится -

0,157%, в среднем горизонте (20-40 см) – 0,127%, а под пахотным горизонтом (40-60 см) - 0,101%. Аналогичную картину представляет собой также и содержание гидролизуемого азота, который для верхнего горизонта имеет содержание – 5,6 мг, среднего горизонта – 4,96 мг и для нижнего под пахотного горизонта – 3,92 мг на 100 г почвы.

Почва опытного участка характеризуется малым содержанием подвижного фосфора оно составляет: на верхнем горизонте-1,08 мг, на среднем горизонте-0,85 мг, в нижнем горизонте-0,61 мг на 100 г почвы.

Агротехнический уход осуществлялся согласно агроправилам по тутоводству для Азербайджанской Республики; он состоял из 6 прополок и 6 поливов за вегетационный период. Междурядья опытного участка содержатся в состоянии червого пара. Учет урожая листа проводился в период прохождения пятого возраста гусениц весенней выкормки в данной зоне. В 2015 году проводился учет структурных элементов урожайности, в частности, годичного прироста побегов, длина междоузлий, количества ростовых и неростовых побегов и среднего веса листа.

Перед закладкой опыта и ежегодно в конце вегетационного периода шелковицы устанавливали годичный прирост охвата стволов.

Данные урожайности листа отдельных вариантов опыта за два года приведены в таблице 1.

Из данных таблицы видно, что внесение на гектар плантации 180 кг азота повысило урожайность листа шелковицы в 2014 году на 10%, а в 2015 году на 19%, прибавка урожая листа в среднем за два года составляет 9,3 ц/га или 15%. На каждый килограмм внесенного азота прибавка составляет 5,17 кг листа по сравнению с контрольным вариантом.

У р о ж а й н о с т ь л и с т а

Таблица 1.

№	Наименование вариантов		2014		2015		Средн. за 2 года	
	дозы	сроки внесения	ц/га	%	ц/га	%	ц/га	%
1	Без удобр. (контрол)	-	61,1	100	63,7	100	62,4	100
2	Азот-180 кг/га (фон)	Ежегодно	67,3	110	76,1	119	71,7	115
3	Фон+фосфор-90 кг/га	---«---	73,7	121	81,5	128	77,6	124
4	Фосфор-180 кг/га	Через год	60,8	100	72,0	113	76,4	105
5	Фон+фосфор-220 кг/га	---«---	66,1	108	80,9	127	73,5	118
6	Фон+фосфор-260 кг/га	---«---	60,0	0,98	77,5	122	68,7	110
7	Фон+фосфор-300 кг/га	---«---	59,7	0,98	72,9	114	66,3	106

Из приведенных данных следует, что при ежегодном внесении азотных и фосфорных удобрений была получена наиболее высокая урожайность листа.

Внесение 90 кг/га фосфора на фоне 180 кг азота дало прибавку урожая листа в 2014 году на 21%, а в 2015 году 28%. В среднем за два года прибавка урожай составляла 15,2 ц/га. От этой прибавки на долю внесенных 90 кг фосфора падает 5,9 ц.

Таким образом, продуктивность каждого килограмма внесенного фосфора составляет 6,56 кг кормового листа. Самостоятельное внесение один раз в два года на га плантации 180 кг фосфора в годы внесения не дало положительного эффекта в урожайности листа. Однако во втором году его последействие обеспечивало получение прибавки урожая листа на 13% против контроля без удобрений. Примерно такая же прибавка была получена при внесении фосфорных удобрений в тех же дозах и сроках на фоне азота (вар.5). В этом варианте в год внесения от фосфора заметного эффекта не наблюдалось, а через год от последействия фосфора наблюдается некоторое увеличение урожайности листа.

Учет урожая листа шелковицы показал, что последействие больших доз фосфора как 260 кг/га и 300 кг/га на фоне 180 кг азота наблюдается на второй год его внесения. Как видно из таблицы 1 в год внесения таких высоких доз фосфора эффект почти не проявлялся. В отдельные годы внесения фосфора действие вновь вносимого фосфора (вар.3) снижается, а с повышением внесения почвы фосфором – последействия увеличиваются. Внесение минеральных удобрений под плантацию шелковицы способствовало улучшению структурных элементов урожайности листа.

Как видно из таблицы 2, внесение минеральных удобрений способствовало увеличению годового прироста с ветвей. На уровне годового прироста ветвей наблюдается полная согласованность с уровнем урожая листа при разных вариантах опыта. При ежегодном внесении 90 кг/га и раз в два года 180 кг/га фосфора на фоне 180 кг азота была получена высокая урожайность листа и высокий годовой прирост ветвей.

Как известно, шелковица в наших условиях в некоторой степени страдет от раннеосенних заморозков. Поэтому для увеличения морозоустойчивости растения одним из применяемых агротехнических мероприятий является внесение фосфорных удобрений.

Структурные элементы урожайности листа

Таблица 2.

№	Наименование вариантов		Годичный прирост на одном дереве, см	Процент ростовых побегов	Процент нерастовых побегов	Средний вес листа, г	
	доз ы	сроки внесения				От ростовых побегов	От нерастовых побегов
1	Без удобр. (контрол)	-	4112	23,7	76,3	1,42	1,18
2	Азот-180 кг/га (фон)	Ежегодно	4435	26,1	73,9	1,57	1,20
3	Фон+фосфор-90 кг/га	---«---	4652	27,2	72,8	1,61	1,21
4	Фосфор-180 кг/га	Через год	4526	25,0	75,0	1,56	1,21
5	Фон+фосфор-220 кг/га	---«---	4891	25,0	75,0	1,64	1,17
6	Фон+фосфор-260 кг/га	---«---	4557	26,4	73,6	1,57	1,23
7	Фон+фосфор-300 кг/га	---«---	4346	25,6	74,4	1,62	1,14

Применение фосфорных удобрений под шелковицу увеличивает содержание в листе и побегах фосфора и ускоряет созревание растений.

В нашем опыте учета обмерзания побегов показывают, что внесение одностороннего азота 180 кг/га заметным образом увеличивало обмерзание побегов. Внесение же фосфорных удобрений как на фоне азота, так и самостоятельно, особенно большой дозы, заметным образом увеличивало морозоустойчивость шелковицы.

Как известно, с началом вегетации на зимовавших побегах появляются новые ростовые и неростовые побеги. Обычно на верхней части веток образуются ростовые побеги, они до осени образуют все новые листья и основную массу листа дают они. По направлению к основную веток отрастают неростовые побеги, которые образуют верхушечные почки и прекращают рост в мае, и дают быстро грубеющие мелкие листья.

Данные нашего опыта показывают, что на фоне азота (табл.2) внесение под шелковицу в разные сроки фосфорных удобрений в некоторой степени изменяет соотношения ростовых и неростовых побегов. Это изменение является закономерным. В вариантах опыта с высокой урожайностью листа соответственно большой процент ростовых побегов. В показателе среднего веса листа в зависимости от влияния фосфорных удобрений между вариантами существенного изменения не наблюдается. Однако, наблюдается значительная разница в среднем весе листа от ростовых и неростовых побегов.

На основании изложенного можно отметить следующее:

1. На светло-каштановых почвах Гянджа-Казахской зоны при ежегодном внесении на га плантации шелковицы 180 кг азота и 90 кг фосфора урожайность листа повысилась в среднем за два года на 24%. Прибавка урожая на один килограмм внесенного фосфора составила в среднем 5,6 кг. Применение этих доз увеличивало годичный прирост побегов и количества ростовых побегов.

2. Все применяемые дозы и испытуемые сроки внесения фосфора проявила последействие, выразившееся в прибавке урожая листа шелковицы. Внесение один раз в два года 180 кг одностороннего фосфора дало прибавку урожая листа 13%.

Высокое последействие фосфора обнаружено при внесении его на фоне азота.

3. При внесении больших доз фосфора в год внесения эффекта не наблюдается, его эффект проявляется в урожайности листа только в последующие годы.

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ВЛИЯНИЕ ФОСФОРНОГО УДОБРЕНИЯ НА ПРОДУКТИВНОСТЬ ЛИСТЬЕВ ТУТОВОГО ШЕЛКОПРЯДА СОРТА ХАНЛАР-ТУТ

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Р Е З Ю М Е

Физиологическая функция фосфорав жизни растений довольно велика. Чтобы изучить влияние этого вещества на тутоводство, мы провели опыт на плантации 2 гектара высокоствольного сорта Ханлар – тут в 2014-2015 годах.

В результате эксперимента было установлено, что ежегодно при внесении 180 кг азота и 90 кг фосфора на гектар плантации светло-каштановой почвы Гянджа-Казахской зоны, в среднем урожайность листьев увеличивается на 24%.

Ключевые слова: почва,шелковица, минеральные вещества, азот, фосфор, сорт, урожай листа,

THE EFFECT OF PHOSPHATE FERTİLİZER ON THE PRODUCTİVİTY OF SİLKWORM LEAVES OF KHANLAR VARİETY

Hajiyev M. H., Hasanov N. M., Bekirov Q. M., Hajiyeva T. N.

SUMMARY

The physiological function of phosphorus in plant life is quite large. In order to study the effect of this substance on the breeding, we were trained on 2 hectare plantation of Khanlar - mulberry in 2014-2015.

As a result of the experiment, it was found that annually giving 180 kg of nitrogen and 90 kg of phosphorus per hectare of fathoms on light maroon soils of the Ganja-Gazakh zone, the average productivity of leaves was increased by 24%.

Key words: soil,mulberry,mineral substances, nitrogen, phosphorus, sorts, leaf productivity

STUDY ON SOME BULGARIAN PURE LINES, PARENTS OF F1 COMMERCIAL HYBRIDS PERFORMANCE

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ABSTRACT

17 Bulgarian pure lines, parents of F1 commercial hybrids have been tested during the period 2014 – 2018 at the Scientific Center on Sericulture, Vratsa, Bulgaria. The results obtained are shown in Table 1. It is evident that the pupation rate in all the silkworm pure lines, tested was comparatively normal – from 85 to 96 %. The highest pupation rate manifested the lines VB1, HB2 and Nova2. The fresh cocoon weight varied from 1736 mg to 2338 mg. The pure lines, having the highest fresh cocoon weight were Super 1, Merefa 2, Hesa 2 and Vratsa 35. The silk shell ratio ranged from 362 mg to 500 mg. With the highest silk shell weight were characterized the pure lines Merefa 2, Super 1, Vratsa 35, Hesa2, Lim1, Svila2 and Nova2. The silk shell ratio values varied from 19.48 to 24.73 %. The shell ratio was the highest in Hesa1, Vesletz2, Lim1, Svila2, SN1, Nova2 and Magi2. It was concluded that the pure lines tested manifested comparatively high viability and productivity.

Key words: silkworm, Bombyx mori L., pure lines, testing, performance

INTRODUCTION

During the last 40 years studies on selection of F_1silkworm hybrids, having a high heterosis expression have been accelerated to such a degree, that in sericulturally developed countries almost all cocoon production is based now on industrial manner of organization (OsawaandHarada, 1994; Petkov, 1995; Bharagava et al., 1996; Dattaetal., 2000).The heterosis and combining ability contribute the choice of parents and do have an important impact for improving of production traits in silkworm breeding (Petkov and Nacheva, 1996; Nacheva et al., 1990).

The selection is applied, in principle to the crosses with the aim of finding pairs of lines that cross well, so that the lines may be perpetuated and provide cross – bred individuals for commercial use. (Harada, 1952; Hirobe, 1956; Craiciu and Otarasanu, 1971; Craiciu et al., 1975; Akimenko, Braslavskii, 1976; Gvinipadze, Jobashvili, 1975; Nacheva, 1981, 1990; Compriranona, et. al, 1987;Jeongetal., 1990; Vijaya and Das, 1992; Gupta et al., 1992; Petkovetal., 1999).

In 2006 – 2007 (Tzenov, 2007) a comparative testing of the best 15 commercial F_1 silkworm hybrids, produced in Azerbaijan, Bulgaria, Turkey, Romania, Ukraine and Uzbekistan as countries from the Black, Caspian seas and Central Asia region and their comparison with hybrids from China, Italy, Japan and Korea as world recognized standards has been partly supported by the FAO and carried out in four testing centers in Azerbaijan, Bulgaria, Romania and Uzbekistan. It was detected that in all the four countries as the best silkworm hybrid performed the Japanese Shunrei x Shogetsu which scored in every point having both high cocoon yield by one box of eggs and high raw silk productivity. After the Japanese hybrid the local hybrids manifested the best performance in each testing country.

For the last 20 years seven F_1 commercial silkworm hybrids have been created in Bulgaria. All those hybrids were recognized by the government and protected by certificates, issued by the Patent agency.

In this respect, a very important job is the pure lines, parents of the commercial F_1 hybrids proper maintenance.

The present study aimed testing the parental pure lines of the existing in Bulgaria F_1 commercial hybrids.

MATERIALS AND METHODS

The study had been conducted during the period 2014 – 2018 at the Scientific Center on Sericulture, Vratsa, Bulgaria. The following pure lines were used in the study:

Japanese type: Hesa1, KK, Super1, Vratsa35, VB1, Lim1, SN1, AS; Chinese type: Vesletz2, Gergana2, Hesa2, Merefa2, HB2, Lea2, Magi2, Nova2 and Svila2. The main quantative characters and hybrid combinations of the pure lines are shown in table 1.

The silkworm rearing was conducted in the most favorable spring season (May). During the papionage 120 layings per each pure line were produced. Before incubation 60 layings, having the biggest number of normal eggs were selected in each pure line.

The layings were disinfected by 2 % formaline solution. After the hatching, 20 layings, having hatchability more than 98 % were selected for silkworm rearing. Only the larvae, hatched on the day of "mass" hatching were brushed for rearing.

Each laying was reared separately. After the 2ndmoult 200 larvae were counted from each laying for growing up to cocooning.

After cocoon harvesting, pupation rate, average cocoon weight, silk shell weight and shell percentage were checked for each laying. The silkworm larvae were reared following the standard method for spring rearing in Bulgaria (Panayotov and Ovesenska, 2002), and fed "ad libitum" with mulberry leaves of №106 Bulgarian variety. The mulberry plantation was rain fed only, without any irrigation. The data obtained were processed statistically (Lidanski, 1988).

RESULTS AND DISCUSSION

The results obtained are shown in Table 1. It is evident that the pupation rate in all the silkworm pure lines, tested was comparatively normal – from 85 to 96 %. The highest pupation rate manifested the lines VB1, HB2 and Nova2. The fresh cocoon weight varied from 1736 mg to 2338 mg. The pure lines, having the highest fresh cocoon weight were Super 1, Merefa 2, Hesa 2 and Vratsa 35. The silk shell ratio ranged from 362 mg to 500 mg. With the highest silk shell weight were characterized the pure lines Merefa 2, Super 1, Vratsa 35, Hesa2, Lim1, Svila2 and Nova2. The silk shell ratio values varied from 19.48 to 24.73 %. The shell ratio was the highest in Hesa1, Vesletz2, Lim1, Svila2, SN1, Nova2 and Magi2.

CONCLUSIONS

In the 17 Bulgarian pure lines, tested the pupation rate is from 85 to 96 %, fresh cocoon weight is from 1736 mg to 2338 mg, silk shell weight is from 362 mg to 500 mg and silk shell ratio is from 19.48 to 24.73 %. The lines manifest comparatively high viability and productivity.

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Characteristics of some Bulgarian pure lines, parents of F1 commercial hybrids

Table 1.

Pure line	Pupation rate (%)	Fresh cocoon weight (mg)/	Silk shell weight (mg)	Silk shell ratio (%)	Pure line characteristics	Parent of the commercial F1 hybrid
Hesa 1	87.87	1835	404	22.02	Japanese type, larvae with markings and peanut shape cocoons	Hesa1xKK x Vesletz2xGergana2
KK	87.80	1862	389	20.89**	Japanese type, larvae with markings and peanut shape cocoons	Hesa1xKK x Vesletz2xGergana2 and KK x Svila2
Vesletz 2	89.33	1774	398	22.44	Chinese type, plain larvae, oval cocoon	Hesa1xKK x Vesletz2xGergana2 and ASxKK x Vesletz2xGergana2
Gergana 2	87.15	1840	399	21.68	Chinese type, plain larvae, oval cocoon	Hesa1xKK x Vesletz2xGergana2 and ASxKK x Vesletz2xGergana2
AS	89.13	1959*	415	21.18*	Japanese type, larvae with markings and peanut shape cocoons	ASxKK x Vesletz2xGergana2
Super 1	87.60	2338***	496***	21.21*	Japanese type, larvae with markings and peanut shape cocoons	Super1 x Hesa2
Hesa 2	88.78	2165**	466**	21.52	Chinese type, plain larvae, oval cocoon	Super1 x Hesa2

Lim 1	88.95	2077*	463**	22.29	Japanese type, larvae with markings and peanut shape cocoons & sex-limited for cocoon color	Lim1xIva1 x Lea2xNova2
Lea 2	87.25	1891	406	21.47	Chinese type, plain larvae, oval cocoon & sex-limited for cocoon color	Lim1xIva1 x Lea2xNova2
Svila 2	89.50	1896	435*	22.94*	Chinese type, plain larvae, oval cocoon	KK x Svila 2
SN1	88.21	1827	414	22.66	Japanese type, peanut cocoon, sex-limited for larval markings	SN1xIva1 x Magi2xNova2
Iva 1	89.56	1771	362**	20.44	Japanese type, peanut cocoon, sex-limited for larval markings	SN1xIva1 x Magi2xNova2 & Lim1xIva1 x Lea2xNova2
Nova 2	91.30**	1860	460**	24.73***	Chinese type, oval cocoon, sex-limited for larval markings	SN1xIva1 x Magi2xNova2 & Lim1xIva1 x Lea2xNova2
Маги 2	87.84	1797	407	22.65	Chinese type, oval cocoon, sex-limited for larval markings	SN1xIva1 x Magi2xNova2 & 19 x Magi2
VB 1	96.00***	1863	363***	19.48***	Japanese type, larvae with markings and peanut shape cocoons	VB1xVr.35 x HB2xMerefa2
HB 2	92.00**	1736	359***	20.68**	Chinese type, plain larvae, oval cocoon	VB1xVr.35 x HB2xMerefa2

Vratsa 35	89.00	2148**	461**	21.46	Japanese type, larvae with markings and peanut shape cocoons	Vratsa35 x Merefa2 & VB1xVr.35 x HB2xMerefa2
Merefa 2	85.00*	2281***	500***	21.92	Chinese type, plain larvae, oval cocoon	Vratsa35 x Merefa2 & VB1xVr.35 x HB2xMerefa2

*P < 5%; **P < 1%; ***P < 0.1%

The data were processed statistically, compared with the pure line Hesa 1.

DIFFUSION KINETICS OF THE MOLECULES OF THE DYE FIZETIN AT ALL STAGES OF THE PROCESS OF DYEING SILK FIBROIN

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ABSTRACT

Development of new bioengineering structures made of fibroin – a unique natural silk biopolymer – and its use in regenerative medicine and consumer goods manufacturing is often mentioned in literature data. It is related to the fact that fibroin has many important properties such as biocompatibility, biodegradability, high strength, hygroscopicity and elasticity. All applications of fibroin are related to its physical and chemical properties, one of which is the dyeing affinity of this biopolymer. Dyeing is closely related to the process of mass transfer – diffusion. Consequently, when fibroin is dyed, the most significant part of the dyeing process is the penetration of dye molecules into microfibrils and this very complex process is not insufficiently studied. Diffusion is a gradual process, which speed or kinetics is a very important scientific and technological attribute that determines the degree of homogeneity of the adsorbate distribution throughout the adsorbent. We studied the penetration of fisetin molecules into the fibrin microfibrils to determine the effect of different temperatures of the dye solution and the concentration of electrolytes in the solution on the diffusion kinetics parameters. It is an established fact that the diffusion of the dye continues until reaching an equilibrium concentration in the entire volume of the fiber. Mentally divide this process into three stages: a) adsorption of the molecules of fizetin on the surface of fibroin fibers; b) the moment when the molecules of fizetin reach the center of the fibroin fiber; c) begins after the completion of the second one and continues until the equilibrium concentration in the whole fiber is established. The first stage occurs almost instantly, which makes it impossible to separate this stage from the second stage during the dyeing process itself. Therefore, we will combine the first and second stages of diffusion.Using a three-dimensional physical model of the diffusion of the dye in the fiber, we

established formulas describing the diffusion kinetics of the dye from the adsorption layer to the moment when the fizetin molecules reached the fiber center and the third stage begins after the second one is completed and continues until the equilibrium concentration in the whole volume is restored the fibers. This article is devoted to three stages of diffusion of the molecules of flavonoids of fisetin into fibroin fibers and mathematical relationships have been established that describe the kinetics of diffusion of the dye at all three stages of the staining process.

Keywords: fibroin microfibrils; dye solution temperature; fisetin dye; molecular diffusion of fisetin; concentration of dye molecules in solution; electrolyte concentration in the solution; diffusion kinetic parameters; physical distribution model; kinetic diffusion characteristic

1. Kinetic parametres of the first and second srages of the fisetin molecule diffusion in the fibroin

Introduction.

Software is developed to design, calculate and visualize ion-exchange technological schemes. This software aim is to be capable of calculating a multistage sorption process, as well as regeneration and cleaning in several columns of a technological scheme [1]. The relevant literature has many examples of the analytical solution to problems of diffusion kinetics, defined by difficulties in certain geometrical and physical conditions and having no general results that can be used. There is also a second type – those that refuse analytical approach and use scaling and modeling of transfer processes and chemical processes [1]. As suggested by the authors of [2], we also used the third method: the quasistationary method (as named by authors) or an equally accessible surface, due to simplified calculation and detection of physically significant limiting cases.

Silk fibroin is an amphiphilic protein – a chemical compound that has both hydrophilic and hydrophobic properties – with a significant predominance of hydrophobicity. Its isoelectric point is *pI* 4.2. Fibroin is insoluble in water for this reason. Diluted solutions of many acids and alkalis, and becomes negatively charged at *pH* 7 [3]. Due to the structure of protein fibers, including natural silk fibroin, period of diffusion of the dye is about 1.0–2.0 hours at temperature up to 100ºC. The fibroin obtained from the Bombyx mori cocoons has a high specific surface area, and its fiber diameter is 15–20 microns. The amorphous section of the fibroin is a structured medium with mobile part similar to a viscous liquid, but the possible forms of fluctuation cavities and slots are limited to an elastic frame [4].

Fisetin is a crystalline dark yellow powder, well soluble in methanol and ethanol. UV: λmax (ethanol): 258, 267, 321, 370*nm*; + *AlCl*3/HC*l*: 232, 277, 431*nm*; IR(*KBr*): IR spectrum has absorption bands at 3000 and 2850cm^{-1}, corresponding to stretching vibrations of C-H link, at 1600, 1560 and 1510 cm^{-1}, corresponding to stretching vibrations of -C=C- aromatic system, bands at 1350 and 1260cm^{-1}, corresponding to stretching vibrations of C-O, 3400cm^{-1}; corresponding to stretching vibrations of phenolic -OH, 1050, 970, 900cm^{-1}, bands of deformation vibration -C-*H*- substituted benzene ring and 1640 cm^{-1}, corresponding to stretching vibrations of C=O g-pyrone, 1425cm^{-1}, corresponding to deformation vibration of C-H_2, 3400–3300cm^{-1}, corresponding to the stretching vibrations of the hydroxy groups [5]. Water solubility of fisetin is less than 1*mg/g*. Dyeing is one of the most complex and important process of natural silk product processing. In order to solve a certain

part of this complex problem, we used the physical model of the distribution of the fisetin molecules in natural silk fiber.

The key feature of this approach is that its microparameters – the process of the distribution of the molecules of fisetin in the medium of fibrin microfibrils, are subject of the macroparameters of the medium (density, temperature, concentration). To study kinetics of this process, we used the postulate of chemical kinetics – "The limiting stage principle". Seeing that in our case, diffusion process is divided into three successive stages connected in a certain way through the raw materials and intermediate compounds. The speed of entire process is determined by the diffusion rate constant, which is smallest (and limiting) in the third stage. Body of mathematics used in this work is based on a system of differential kinetic equations that determines the distribution functions of particles in a selected medium with selected speeds.

Experiment

To study the kinetic characteristics of fisetin molecules diffusion in microfibril fibrin, 4*g* of fisetin was dissolved in 4 liters of distilled water and the reference solution was prepared in the same volume and at the same temperature from distilled water.

Natural silk fibroin (cocoon thread) was thoroughly cleaned and dried to a constant weight of 100*g* and added into the process solution and into the reference solution. The dyeing process was carried out with constant stirring, so that the entire surface of the adsorbent was available for adsorption and excluded from consideration the uneven distribution of the substance in the volume. Thermostatic control was used to maintain a constant temperature.

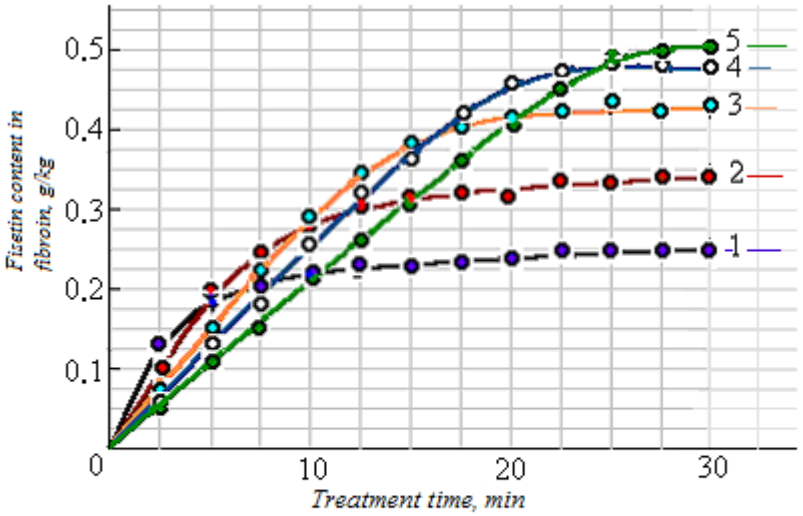

Figure 1. The relation between the diffusion magnitudes of fisetin in fibroin fiber and the duration of the treatment of fibroin with a dye at different temperatures: 1–293 *K*; 2–313 *K*; 3–333 *K*; 4–353 *K* and 5–373 *K*

The experiment was carried out at a temperature of 293, 313, 333, 353, and 373*K* and at *NaCl* electrolyte concentration of 1, 2, 3, 4, 5 and 6*g/l*. Every 150 seconds, 20*ml* samples were taken from the process solution and reference solution and distilled water was immediately added at an appropriate temperature to keep the solution volume constant. The concentration of fisetin in the solution was measured by spectrophotometer at a wavelength of λ = 313.3*nm*.

Results and discussion

Figure 1 shows the relation between the diffusion magnitude of fisetin in fibroin fiber and the duration of the treatment of fibroin with a dye at different temperatures, i. e. absorption isotherms: 1–293*K*; 2–313*K*; 3–333*K*; 4–353*K* and 5–373*K*.

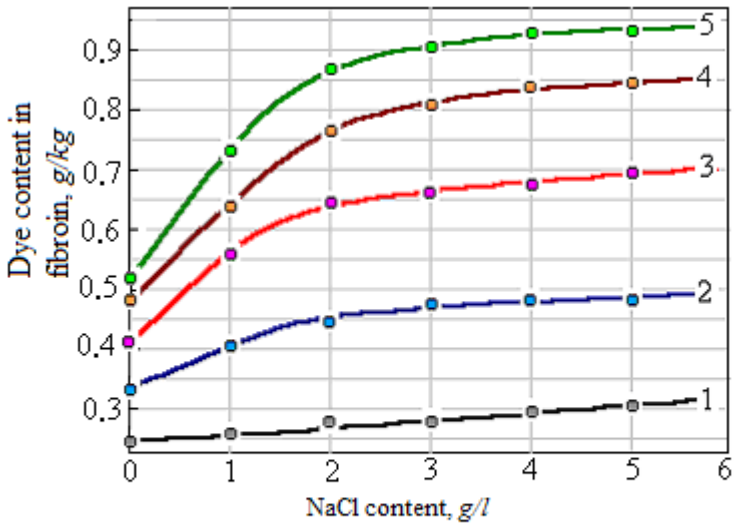

Figure 2. The relation between the content of fisetin molecules and the concentration of *NaCl* in fibroin at different temperatures: 1–293 *K*; 2–313 *K*; 3–333 *K*; 4–353 *K*; 5–373 *K*

As is seen from this, the adsorption isotherms are at first form a straight line and can be characterized by their saturation.

The introduction of neutral electrolyte *NaCl* into the fisetin dye solution drastically reduces the potential barrier, which makes the dye anions approach the microfibrils to a mutual attraction distance, and the dye is adsorbed by fibroin fiber. *NaCl solution was used as a neutral electrolyte*.

The obtained result (Fig. 2) show that fibroin molecules are bound to $Na^+$and Cl^-ions. Therefore neutral electrolytes not only reduce the potential barrier, but also compensate the electric charge, which results in better fiber adsorption. Figure 2 show that the concentration ofin the fisetin solution has an optimal value of – 5 *g/l*.

Experiments have shown that an excess of neutral electrolyte causes aggregation of fisetin anions, preventing their further diffusion into fibroin microfibrils.

In summary, it was confirmed that the presence of neutral electrolytes helps to increase the adsorption of the dye fibers. The adsorption process of fisetin by fibroin occurs almost instantaneously, and the diffusion of dye molecules into the inner fiber is interconnected with this process. In the process of actual dyeing, they cannot be separated. Therefore, the first and second stages of diffusion were studied by us as one, and the third stage was studied separately. Number of specific dyeing issues were solved by using the physical model of the diffusion of the dye in the fibers and mathematical formulas (Fig. 3), that describe the kinetics of diffusion of the dye from the adsorption layer to the establishment of an equilibrium concentration in the entire volume of the fiber.

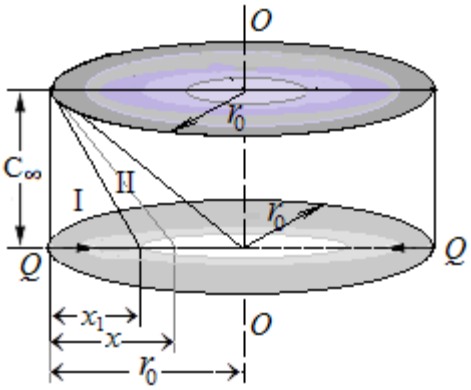

Figure 3. Three-dimensional physical model of the dye distribution in the fiber at the second stage of dyeing.

Mixing of substances that helps to balance the concentration occurs when there is a concentration gradient in solution. This is three-dimensional diffusion process. We use theoretical assumptions [6] to find a solution suggesting that if the concentration gradient exists only in one direction, then the diffusion issue can be perceived as a onedimensional problem.

As a part of diffusion process, an amount (or mass) of the substance δn (or δm) in a definite time δt, passes through area δS, located along the normal axis, along which the change in substance concentration occurs, and this amount (or mass) is proportional to the concentration gradient dC/dx, area δS and time δt:

$$\Delta m = -D\left(\frac{dC}{dx}\right)_T \Delta S \Delta t \quad (1)$$

where D – is the diffusion coefficient, $-D\left(\frac{dC}{dx}\right)_T$ – is the flux density of a penetrating substance (this means the amount of a substance passing through a unit of area per unit of time). With D directly proportional to u – the average molecules velocity, andλ– the average path of molecules:

$$D = \frac{\bar{u}}{3}\bar{\lambda}. \quad (2)$$

Where dC/dx is the concentration gradient of the solute (fisetin in our case) directed to x - center of the fiber. It should be noted, that concentration C is means a quantity that is numerically equal to the amount (or mass) of a given substance δn (or δm) to the volume V of the mixture and C is expressed in any suitable units, such as mol/cm^3 and g/cm^3. In our case: SI – [n]=1/m^3; CGS – [n]=1/cm^3.

Equation (1) formalizes Fick's first law and according to this Fick empirical equation, diffusion flux (J) of penetrant passing through sectional area is determined by the following equation:

$$J = -D\left(\frac{dC}{dx}\right)_T, \quad (3)$$

where J – is the diffusion flux is in the following units – $\left(mol/cm^3 \cdot s\right)$ [7].

The negative sign in equation (4) appears due to the fact that the particles move in the direction of decreasing concentration. By plugging (2) in the equation (3), we acquire the following (4):

$$J = -\frac{\bar{u}\cdot\bar{\lambda}}{3}\left(\frac{dC}{dx}\right)_T. \quad (4)$$

The amount of dQ_x dye (fisetin), diffusing into the fiber (fibroin fiber) through the outer surface S, in a lengthwise direction of fiber for an infinitely small period of time dt, can be reduced to the following equation:

$$dQ_x = JSm_0 dt, \quad (5)$$

where m_0 – is the mass of fisetin molecules. From (3) and (5) we determine the following:

$$dQ = -D\left(\frac{dC}{dx}\right)Sm_0 dt. \quad (6)$$

Using equation (6), we studied the diffusion of fisetin in fibrin fibers. It was assumed that the distribution of the dye concentration over the depth of the fiber is linear, and this makes it possible to compose the following equation:

$$\frac{dC}{dx} = \frac{C_\infty}{x}, \quad (7)$$

where C_∞ – is the equilibrium concentration of the dye until its fiber moves. This is the end of the first stage (the process of absorption) and beginning of second stage.

The equilibrium is concentration of the dye until its fiber moves. This is the end of the first stage (the process of absorption) and beginning of second stage.

To study the diffusion of the molecules of fisetin in the inner fibroin fiber a three-dimensional physical model of the dye distribution in the fiber at the second stage of dyeing was used (Fig. 3). It shows a cross section of fiber with unit length and the diffusion process reflected in the concentration scale. Therefore, fiber section with unit length has volume: $V = \pi r_0^2$ and side area: $S = 2\pi r_0$.

Considering that the change in concentration during the transfer of dye through the side area over a period of time *dt* will be equal *dCtII* and in the second stage the amount of penetrating dye in the direction *x* equals

$$dQ_x = \pi r_0^2 m_0 dC_t^{II}. \tag{7a}$$

Adding (7a) to (6) the following equation is obtained:

$$\pi r_0^2 m_0\, dC_t^{II} = -D\left(\frac{dC}{dx}\right) S m_0 dt \quad \text{or} \quad \pi r_0^2 m_0\, dC_t^{II} = -D\left(\frac{dC}{dx}\right) 2\pi r_0 m_0 dt. \tag{7b}$$

Equation (7) is written after the assumption that the dependence of the concentration of the dye from *x* is linear. Taking into account the fact that the direction of the fibroin fiber $\vec{r}_0$ and the direction of diffusion $\vec{x}$ are opposite, instead of dC/dx gradient, we can add C_∞ / x and compose (7b) as follows:

$$\frac{dC_t^{II}}{C_\infty} = \frac{2}{x} \cdot \frac{D}{r_0} dt. \tag{8}$$

The resulting last expression (8) is the **differential equation of the dyeing kinetics** in the second stage of the process. To solve this equation, we first integrate the expression *(7a)*:

$$Q_x = \pi r_0^2 m_0 C_t^{II} + c_1,$$

where c_1 – is the integral constant.

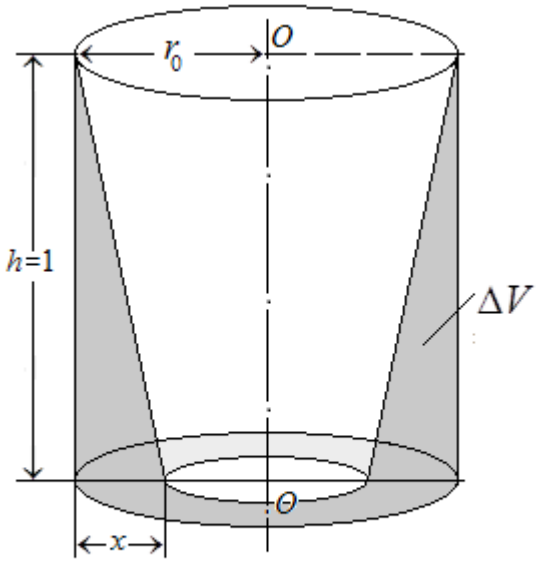

Figure 4. Model of changes in the volume concentration of dye directed to the center of the fiber

As the initial conditions, we assume that at the initial moment of dye contact with the fiber $(t = 0)$, the fiber has no dye: $Q_x = 0$ and, consequently, $c_1 = 0$. Therefore:

$$Q_x = \pi r_0^2 m_0 C_t^{II}. \tag{9}$$

As shown in figure 4, we use the model of the second stage of fiber dyeing. This model represents the magnitude of the change in ΔV – the volume concentration of dye directed to the center of the fiber, depending on the size of x (dark areas). It is evident that:

$$\Delta V = V_{\text{цилиндр}} - V_{\text{обрез.кон.}} = \pi \cdot C_\infty \left(r_0 x - \frac{x^2}{3}\right)$$

By multiplying ΔV by m_0 (the molecular weight of the dyes in this volume) and we find the amount Q_x (mass) of the dye that has already penetrated into the inner part of the fiber:

$$Q_x = \pi \cdot C_\infty m_0 \left(r_0 x - \frac{x^2}{3} \right). \tag{9a}$$

According to the expression (9) and (9a) we can conclude that:

$$r_0^2 C_t^{II} = C_\infty \left(r_0 x - \frac{x^2}{3} \right) \text{ or } C_\infty x^2 - 3C_\infty r_0 x + 3C_t^{II} r_0^2 = 0 . \tag{10}$$

Equation (10) is a quadratic equation in x and since $C_\infty \geq C_t^{II}$, it has two real solutions: $x = 1{,}5 r_0 \left(1 \pm \sqrt{1 - \frac{4}{3} \cdot \frac{C_t^{II}}{C_\infty}} \right)$. But $x \leq r_0$. Therefore, we choose the following solution:

$$x = 1{,}5 r_0 \left(1 - \sqrt{1 - \frac{4}{3} \cdot \frac{C_t^{II}}{C_\infty}} \right). \tag{11}$$

By plugging (11) into equation (8), we get the following equation:

$$\left(1 - \sqrt{1 - \frac{4}{3} \cdot \frac{C_t^{II}}{C_\infty}} \right) \frac{dC_t^{II}}{C_\infty} = \frac{4}{3} \cdot \frac{D}{r_0^2} dt . \tag{12}$$

After integrating the differential equation (12), as integrals of irrational functions, the following equation is acquired:

$$\sqrt{\left(1 - \frac{4}{3} \cdot \frac{C_t^{II}}{C_\infty} \right)^3} + 2 \frac{C_t^{II}}{C_\infty} = \frac{8}{3} \frac{D}{r_0^2} t + c_2 . \tag{13}$$

To determine the integration constant c_2, the initial time of the second stage of the diffusion process c_2 is combined with the point of the corresponding end of the first stage t_I. Therefore at $t_{II} = 0$, the ratio $\frac{C_t^{II}}{C_\infty}$ can be reduced to $\frac{C_t^{I}}{C_\infty}$, which means:

$$\frac{C_t^{II}}{C_\infty} = \frac{C_t^{I}}{C_\infty} . \tag{13 a}$$

By putting equality (13a) into equation (13), we get the following equation:

$$c_2 = \sqrt{\left(1 - \frac{4}{3} \cdot \frac{C_t^{I}}{C_\infty} \right)^3} + 2 \frac{C_t^{I}}{C_\infty},$$

where C_t^I – is the concentration of the dye inside the fiber at the end of the first stage of the diffusion process.

If we plug the expression c_2 into (13) we get the following equation:

$$\sqrt{\left(1 - \frac{4}{3} \cdot \frac{C_t^{II}}{C_\infty} \right)^3} + 2 \frac{C_t^{II}}{C_\infty} = \frac{8}{3} \frac{D}{r_0^2} t + \sqrt{\left(1 - \frac{4}{3} \cdot \frac{C_t^{I}}{C_\infty} \right)^3} + 2 \frac{C_t^{I}}{C_\infty} . \tag{14}$$

After simplification:

$$\frac{C_t^{II}}{C_\infty}=\alpha;\ \ \frac{D}{r_0^2}t=\beta;\ \ \left(\sqrt{\left(1-\frac{4}{3}\cdot\frac{C_t^I}{C_\infty}\right)^3}+2\frac{C_t^I}{C_\infty}\right)=\chi, \tag{14a}$$

and by plugging them into (14), we get the following equation:

$$\sqrt{\left(1-\frac{4}{3}\cdot\alpha\right)^3}+2\alpha=\frac{8}{3}\beta+\chi. \tag{15}$$

In its canonical form (13), in relation to α, we get the following equation:

$$\alpha^3-\frac{9}{16}\alpha^2+\frac{27}{16}\left(1-\frac{8}{3}\beta-\chi\right)\alpha+\left(3\beta^2+\frac{9}{4}\beta\chi+\frac{27}{64}\chi^2-\frac{27}{64}\right)=0. \tag{16}$$

and (16) is reduced to:

$$a\alpha^3+b\alpha^2+c\alpha+d=0, \tag{16a}$$

where $a=1,\ b=-\frac{9}{16},\ c=\frac{27}{16}\left(1-\frac{8}{3}\beta-\chi\right),\ d=3\beta^2+\frac{9}{4}\beta\chi+\frac{27}{64}\chi^2-\frac{27}{64}$.

The cubic equation (16a) can be reduced to a canonical form by replacing the variable $\alpha=y-\frac{b}{3a}$ that changes the equation form to:

$$y^3+py+q=0, \tag{17}$$

where: $p=\frac{c}{a}-\frac{b^2}{3a^2}=\frac{3ac-b^2}{3a^2};\ \ q=\frac{2b^3}{27a^3}-\frac{bc}{3a^2}+\frac{d}{a}=\frac{2b^3-9abc+27a^2d}{27a^3}$.

It is to be recalled that during the adsorption process, the equilibrium concentration in the adsorption layer is reached almost instantly: $t_1\cong 0,\ C_t^I=0$ (the concentration of the dye in the fiber at the end of the first stage of the diffusion process is zero). From (14a) we determine $\chi=1$. Given this: $a=1;\ b=-\frac{9}{16};\ c=-\frac{9}{2}\beta$ and $d=3\beta^2+\frac{9}{4}\beta$. Given that: $p=\frac{3c-b^2}{3}=-4,5\beta-0,10547$ and $q=\frac{2b^3-9bc+27d}{27}=3\beta^2+1,40625\beta-0,0132$. From this, we calculate the discriminant of the cubic equation:

$$\Delta=\left(\frac{p}{3}\right)^3+\left(\frac{q}{2}\right)^2=2,25\beta^4-1,2657\beta^3+0,317\beta^2-0,0148\beta. \tag{18}$$

Considering $\beta=\frac{D}{r_0^2}t,\ \beta>0$, (18) determines that $\Delta>0$. If $\Delta>0$, then the cubic equation will have one real root and two conjugate complex roots [8]. We are only interested in the real root. The roots of the reduced cubic equation (17) can be found by the Cardano formula:

$$y_1=A+B,\ y_{2,3}=-\frac{A+B}{2}\pm i\frac{A-B}{2}\sqrt{3}, \tag{19}$$

where $A=\sqrt[3]{-\frac{q}{2}+\sqrt{\Delta}}$; $B=\sqrt[3]{-\frac{q}{2}-\sqrt{\Delta}}$ and the real root of the canonical equation (17) is $y_1 = A + B.$

By plugging it into $\alpha = y - \frac{b}{3a}$, we find α for (16a):

$$\frac{C_t^{II}}{C_\infty} = y_1 - \frac{b}{3} = \sqrt[3]{-\frac{q}{2}+\sqrt{\Delta}} + \sqrt[3]{-\frac{q}{2}-\sqrt{\Delta}} - \frac{b}{3}. \qquad (20)$$

The resulting mathematical relationship (20) is a **kinetic equation that describes the first and second stages of the fiber dyeing process**.

Considering that $a=1$; $b=-\frac{9}{16}$; $c=-\frac{9}{2}\beta$ и $d=3\beta^2+\frac{9}{4}\beta$ is same for numerical calculation:

$$p=\frac{3c-b^2}{3}=-4{,}5\beta-0{,}1055 \text{ and } \quad q=\frac{2b^3-9bc+27d}{27}=3\beta^2+1{,}406\beta-0{,}0264.$$

Figure 5 depicts graph of the kinetic dependence of C_t^{II}/C_∞ on $t-$ in a unit of r_0^2/D, constructed using equation (20) and formulas p (the minus sign is placed before the relative concentration, since the gradient of the dye concentration is negative) and q. As graph shows, in the second stage of diffusion, the dependence of the relative concentration in time is parabolic, i. e. the process proceeds in accordance with the diffusion kinetics. As you can see, there is no tendency to saturation. This once again proofs the effectiveness of the chosen body of mathematics.

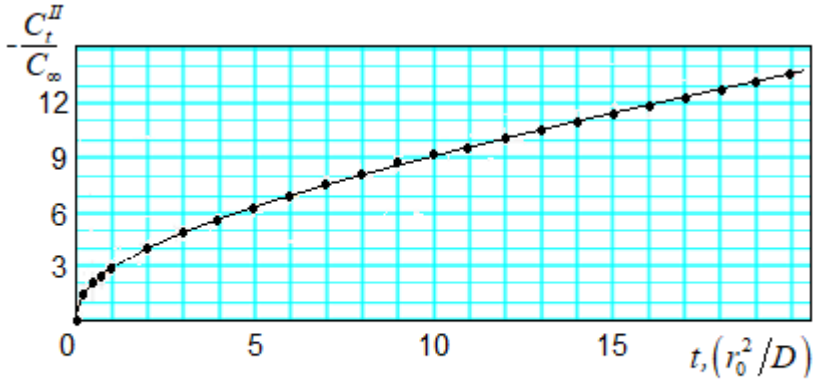

Figure 5. Dependency graph of C_t^{II}/C_∞ concentration of dye molecules on time in r_0^2/D unit of measurement

Conclusion. The kinetic equation of the first and second stages of the dyeing fibroin fibers dyeing process with fisetin using a physical model allows us to directly solve the problem of diffusion using numerical calculation. This approach has an advantage – the problem of diffusion does not require additional conditions when solving. This method allows you to fully describe the kinetic equation in both the first and second stages as one, as well as the third stage of the dyeing process, which is described in the next article.

2. The third stage of the diffusion process of fisetin molecule in the fibroin fiber

Results and discussion

By using the three-dimensional model and carrying out simple mathematical calculations, it can be shown that at the moment when the dye reaches the center of the fiber, the concentration of penetrating dye molecules is equal to $2C_\infty / 3$. The model uses figure with volumes equal to $2\pi r_0^2 / 3$ (Fig. 6) to express the concentration. As one can see during the third stage, the remaining volume with concentration: C_t^{III} is equal to $\pi r_0^2 / 3$, and in this volume the maximum concentration should be equal to one third of the concentration of the dye at the fiber edges: C_∞, which is equal to $C_\infty / 3$. Consequently, the dye diffusion intensity in the fiber at the third stage of the process is determined by the first Fick's law, the difference in concentration potentials at the edges and in the center of the fiber, can be composed as the following equation:

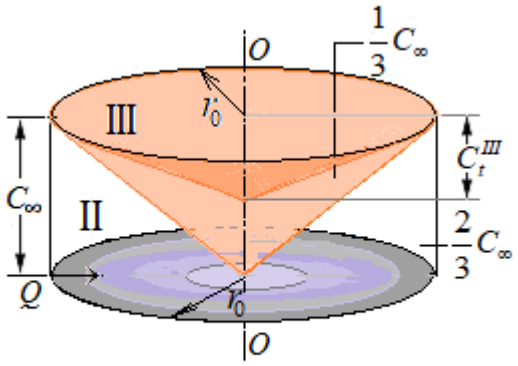

Figure 6. Three-dimensional physical model of the dye diffusion in the fiber at the third stage of dyeing

$$dQ_{III} = D\frac{\frac{1}{3}C_\infty - C_t^{III}}{r_0} S m_0 dt\,, \tag{21}$$

where dQ_{III} -is mass quantity of fiber transported over time dt, inside the fibers at the third stage of diffusion; C_t^{III} -is the concentration of dye molecules penetrating during an arbitrary period of time t, that has passed since the beginning of the third stage; D -is the diffusion coefficient; S -is the active area of the fiber.

In order to make sure that S, which is used in the formula (21), and determines area of the active fiber, is equal to $S = 2\pi r_0$, we shall take note of three-dimensional model of fiber (Fig.6). In this model, the height of fibroin fiber shown as a transparent cylinder, equals to one. Taking this into account, the formula (21) can be written as:

$$dQ_{III} = D\frac{\frac{1}{3}C_\infty - C_t^{III}}{r_0} 2\pi r_0 m_0 dt = 2\pi D\left(\frac{1}{3}C_\infty - C_t^{III}\right) m_0 dt \tag{21a}$$

Figure 6 shows that the mass quantity of the transported dye at the third stage of diffusion can be expressed by the following formulas:

$$Q_{III} = \frac{1}{3}\pi r_0^2 m_0 C_t^{III}\,. \tag{22}$$

By differentiating (22) with respect to C_t^{III}, the following equation is obtained:

$$dQ_{III} = \frac{1}{3}\pi r_0^2 m_0 dC_t^{III}\,. \tag{22a}$$

By comparing (21a) and (22a) with respect to dQ_{III}, the following eqaution is obtained:

$$\frac{dC_t^{III}}{\frac{1}{3}C_\infty - C_t^{III}} = 6\frac{D}{r_0^2}dt. \tag{23}$$

By integrating right-hand side of (23) to C_t^{III} and left-hand side to mol/cm^3, we obtain the following:

$$-ln\left(\frac{1}{3}C_\infty - C_t^{III}\right) = 6\frac{D}{r_0^2}t + c_3. \tag{24}$$

By accepting the end of the second stage and beginning of the third stage as check time, we determine the value of the integration constant c_3. The third stage of the diffusion process begins at $t_{III} = 0$. At that moment C_t^{III} is equal to 0. Considering that (24):

$$c_3 = -ln\frac{1}{3}C_\infty$$

By adding c_3 – (the constant of integration) to (24), we obtain the following equation:

$$-ln\left(\frac{1}{3}C_\infty - C_t^{III}\right) = 6\frac{D}{r_0^2}t - ln\frac{1}{3}C_\infty$$

$$6\frac{D}{r_0^2}t = ln\left(\frac{\frac{1}{3}C_\infty}{\frac{1}{3}C_\infty - C_t^{III}}\right)$$

or $$\frac{C_t^{III}}{C_\infty} = \frac{1}{3}\left[1 - exp\left(-6\frac{D}{r_0^2}t\right)\right]. \tag{25}$$

Formula (25) is the kinetic equation for the concentration of dye molecule that penetrates the fiber at the third stage of the diffusion process.

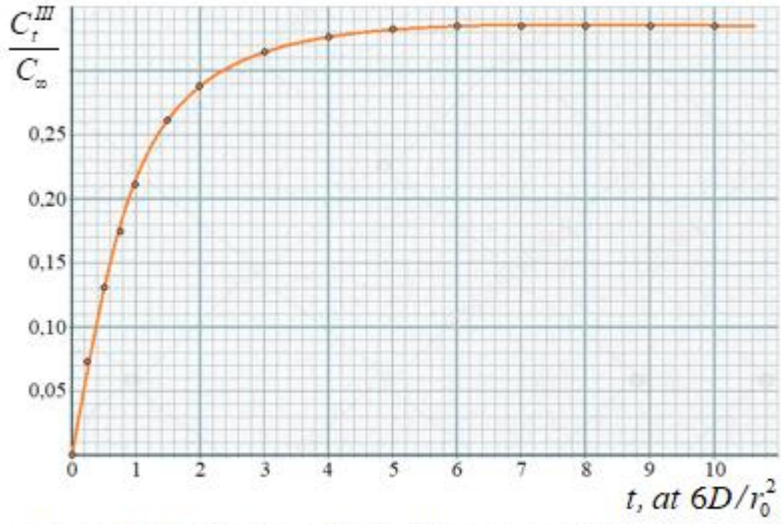

Figure 7. Kinetic curve of the relative concentration of the fisetin dye molecules in fibroin fiber at the third stage of diffusion

The kinetic dependence of the relative concentration of fisetin molecules in the fibroin fiber at the third stage of the diffusion process, which is shown in (Figure 7), was constructed based on this equation.

The kinetic equation for the diffusion of dye molecules into fibers (25) at the third stage of the process is especially significant due to the fact that by applying these equations at a given temperature and concentration of the dye, the diffusion coefficient D can be determined. The results of our measurements were used to determine D. As shown in Figure 1 (in previous article), molecules of fisetin dye that penetrate fibroin fibers introduced into the dye solution at boiling point (373 K) have the maximum concentration equal to $C_{max} \approx 0{,}56 g/kg$. This concentration is established in 30 minutes. The comparison shows that the concentration of penetrating dye molecules in the fiber in the

second and third stages of diffusion is equal to $C^{II}:C^{III}=2:1$. Using this dependence and knowing that $C=C^{II}+C^{III}$, we can construct the following equations: $C^{II}_{max}\approx 0{,}37 g/kg$ and $C^{III}_{max}\approx 0{,}19 g/kg$.

We used 4*g* of fisetin to prepare an aqueous solution of the fisetin dye for each 100*g* of fibroin. Consequently: $C_{\infty}=40 g/kg$. To caculate average value of D, we use the ratios of the volumes of the second and third stages equal to 2:1, consequently, the ratios between the time of fiber dyeing at the second and third stages is also 2:1. Therefore, by inserting the values of the duration of the second stage: $t_{II}=20 minutes$ and the duration of the third stage: $t_{III}=10 minutes$, the cross-sectional area of the natural silk fiber is ~370 μm^2 and by accepting the shape of the fiber as a cylinder, we obtain the value for the radius of the cylinder $r_0=10{,}8\cdot 10^{-6} m$. To calculate D by (25 blue), we use the following values:

$$D=\frac{r_0^2}{6t}ln\left(\frac{C_{\infty}}{C_{\infty}-C^{III}_{max}}\right)=\frac{118\cdot 10^{-12}}{6\cdot 600}ln\left(\frac{40}{40-0{,}19}\right)\frac{m^2}{s}=1{,}56\cdot 10^{-16}\frac{m^2}{s}=1{,}56\cdot 10^{-12}\frac{cm^2}{s}.$$

By comparison, for a rough safety assessment, diffusion coefficients were measured for 13 radioactive elements in clay media. Authors have found that D values range from $5{,}0\cdot 10^{-11} m^2/s$ for *I* and *Tc* (under oxidation conditions) to $5{,}0\cdot 10^{-14} m^2/s$ for *U*, *Np* and *Pu* actinides (under reducing conditions) [9]. This shows that the fibroin fiber exhibits viscosity to fisetin molecules hundreds of times higher than clay media to radioactive elements.

We use Nernst-Einstein equation that established relationship between mobility, diffusion, and temperature of the medium to calculate the mobility of the fisetin dye molecule in the *fibroin+water* medium [3]: $D=ukT$, where *u* is the mobility of molecules, *k* is the Boltzmann factor, *T* is the temperature of the medium. Consequently:

$$u=\frac{D}{kT}=\frac{1{,}56\cdot 10^{-16}}{1{,}38\cdot 10^{-23}\cdot 373}\frac{m^2}{s}\cdot\frac{K}{C}\cdot\frac{1}{K}=3{,}03\cdot 10^4 m/\left(N\cdot s\right).$$

Consequently, the mobility of fisetin molecules in the *fibroin+water* medium at the temperature of 373*K* is $3.03\cdot 10^4 m/(N\cdot s)$.

Due to the fact that in dye-fiber system, the relativity properties of diffusion and sorption determine the color formation rate [10] and correspond to the slow diffusion of the fisetin dye molecules into natural silk fiber $\left(D=1{,}56\cdot 10^{-16} m^2/s\right)$ and high-speed sorption ($u = 3.03\cdot 104\ m/(N\cdot s)$ demonstrate affinity between the fisetin dye and the fibroin protein.

As kinetic and thermodynamic parameters, there is a very complex relationship between the diffusion rate and the affinity between the dye and the fiber [11].

Textile materials have a specific requirement for the fiber and dye diffusion and sorption processes must simultaneously be active during interaction. Colorcannot be formed if any of those conditions is not met.

Electrostatic forces are undoubtedly affect the diffusion process. It is generally believed that a moderately high concentration of a medium high concentration of low-molecular electrolyte, such as *NaCl* , will remove any such effects and it is confirmed by the fact that D at moderately high ionic forces, becomes virtually non-affected by the total charge [12]. However, the added electrolyte,

apparently, will have minor effect if it (the added electrolyte) initially has the universally identical concentration [13].

Another important point is that, on the one hand, we are trying to create dyes with increased affinity for the fiber, since this provides high dyeing fastness to wet treatments, on the other hand, the increased dye affinity for the fiber reduces the diffusion rate, and, consequently, speed of dyeing process. This contradiction can be overcame in real conditions by building the technological process to ensure a decrease in the affinity of the dye at the time of the fiber entering the dye solution and to create conditions for the manifestation of this affinity after the diffusion is completed. Temperature changes, solvation of dye with auxiliary substances of hydrophilic solvents, etc. are used for these purposes.

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РЕЗУЛТАТЫ ПРИЗВОДСТВЕННЫХ ИСПЫТАНИЙ ВЫНОСЛИВЫХ ПОРОД ТУТОВОГО ЩЕЛКОПРЯДА ВЫРАЩЕННЫХ В ШЕКИ – ЗАКАТАЛАНСКОМ РЕГИОНЕ С ЕКОЛОГИЧЕСКИЙ ТОЧКИ ЗРЕНИИ

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Статья посвящена кормки сортов тутового шелкопряда, производимых в неблагоприятных условиях. В результате исследования урожайность 4 гибриди значительно превысила гибриди Seki-1x SEKİ-2. По результатам выкормки 2 породы дали более высокий результат по сравнению с контрольным вариантом.

Ключевые слова: 1.шелкопряд, 2.порода, 3.гибрид, 4.кокон,5.адаптивная селекция,6. биологический показатель

Наша республика имеет благоприятные условия для развития шелководства.Развитие шелководства в нашей стране является одним из наиболее экономически важных аспектов, которые стимулируют как экономикистраны, так и занятость населения. Из гибридов и сортов тутового шелкопряда получается только один вид сырьевого товара шелка. Выбор породы шелкопряда и гибридов этого продукта является одним из самых важных научных мест. В последние несколько лет резкое увеличение в потребности шелкопряда и чистого шёлка и в результате этого роста цен на эти продукты на мировом рынке стало важным для развития экономики нашей, только что проложившей путь к независимости республике[1].

В современной эпохе чистый шёлк благодаря своим дорогим и незаменимым свойством (гигиене, эластичности, изоляции, крепости, огнестойкости) широко используется не только в текстильной промышленности, но и в радиотехнологии и электротехнике, для изготовления музыкальных инструментов, в авиации и космонавтике, киноматаграфии, хирургие, в том числе глазной хирургие[2,3]. И этикачества приводет к постаянному росту в потребности чистого шёлка, и поэтому, наряду с традиционными странами, занимающимися шелководстом, некоторые станы тоже стараются развивать у себя шелководство. Для удовлетворения современных потребностей науки шелководства одним из важных задач стоит увеличение продуктивности на род шелковицы и создание сортов и гибридов, вращенных в неблагоприятных условиях. Сельское хозяйство шелкопроизводства учитывая рыночные отношения, меняютщиеся временами и учитывая увеличение потребности, считают

благополучными создание гибридных комбинации приспособленных к неблагоприядной окружающей среде[4,5,6].

В Азербайджане новая приоритетная цель формативная адаптационная селекция создание высокоустойчивых пород, сортов и гибридов. К экологическим факторам[7]. С этой целью с 2016 года начаты опыты по созданию экологически устойчивых пород тутового шелкопряда. В результате этих опытов создали 4 ряда, эти породы также высоки по продуктивным показателям. Показатели, полученные в результате опытов и промышленных выкормков, показали что, использование гибридов вместо чистых пород дают более высокий показатель продуктивности.

Шелкопроизводства требует, чтобы показатель полученного из сортов и гибридов кокона - цвет, свойство открывание, длины нить, открытой с одного кокона были высокие.

По показателям сортиспытаний новых гибридных линий видно, что высоки продуктивность и технологические показатели у сорта Маяк-3. Посредством адаптивной селекции экспериментальное исследование новых сортов и гибридов, проведённых в 2016-2017 годах было использовано в производстве. В результате промышленных исследований, проведенных в 2016 году гибридных линий, выращенных в оптимальных и пессимальных условиях и изучение технологических показателей были взяты 4 линий гибридных соединений, из каждой линии длясортиспытания взято по 0,5 грамм грены для проведения выкормки в Шекинской районе в деревне Чафарабад.

В 2016 году дляизучение технологических показателей кокона, было взято 3 кг сырые, которые были обработаны на воденой бане. Технологические показатели были изучены в лаборатории города Шеки.

Результаты промышленных показателей даны в таблице 1.

Биологический показатели инкубации

Таблице 1.

	Название гибрида	Грена взятая для инкубации, гр	Инкубационное время, дни	Количество живой грены			Взятое на выкормку, количество, гр
				1-й день, гр	Контроль %	2-ой день, гр	
1	Шеки-1xШеки-2	14,5	11,2	7,0	100,0	3,0	10,0
2	Szem-4xGE-143	14,5	10,0	9,0	128,6	2,0	11,0
3	GE-143xSZEM-4	14,5	10,0	9,0	128,6	2,0	11,0
4	Yaqub x Cingiz	14,5	10,0	9,0	128,6	2,0	11,0
5	Cingiz x Yaqub	14,5	10,6	8,5	121,4	2,0	10,5

Как видно, из таблицы 1. По результатам показателей новых гибридных соединений особенно по инкубационным показаниям у 4-х гибридных линий, SZEM-4 x GE-143, GE -143 x SZEM-4, Yaqub x Cingiz, Cingiz x Yaqub более высокий уровень оживляемости. SZEM-4 x GE-143, GE-143 xSZEM-4, Yaqub xCingiz в первый день по показателям количества оживших гусениц по сравнению с контрольным вариантам на 121-128% высоки. В первый день количество гусениц в сорте Seki -1 x Seki-2 была 7 гр, у новых сортов 9,0 гр. Взятая для контрольного варианта

грена сорта Seki -1 x Seki-2 на 2-ой день дала более низкий показатель по сравнению с первым днём.

Для выкормки были взяты выходы двух дней. Этот высокий показатель жизнеспособности хорошо влияет на выкормку гибридов, проведенных в оптимальных и пессимальных условиях. С помощью адаптивной селекции можно увеличить жизнеспособность сортов и гибридов. Результаты выкормки проведенной весной 2016 года приведены в таблице 2. Из таблицы видно, что разница между короткой выкормкой и контрольным вариантом составляет 2.0-3.0 дня. Между гибридами по этим показателям самый короткий срок наблюдается у гибрида SZEM-4 x GE-143.

В том числе указанные гибриды по сравнению с контрольным вариантом завили коконы на 1-2 дня раньше. А это имеет большое значение для производства. По весу каждого кокона высокие показатели во время выкормки были у гибридов SZEM-4 xGE-143 (1,97 гр), Yaqub xCingiz(1,95 гр.),GE-143 x SZEM-4 (1,92 гр.), Cingiz x Yaqub (1,90 гр.). В целом, по сравнению с контрольным вариантом, результаты исследуемого гибрида были намного высокие. Вконтрольным варианте эти показатели были 1,55 грамм. Показатели гибридов SZEM-4 x GE-143, GE-143 x SZEM-4 по сравнению с контрольным вариантом тоже были высоким на 19,4%-21,2%.

Результаты производственной выкормки

Таблице 2.

№	Назвамие гибридов	Время выкормки, день	Масса одного вложного кокона, гр	Масса кокона, полученного из 0,5 коропки грены, в том числе					Общая масса кокона	
				Высший сорт, кг	Первый сорт, кг	Второй сорт, кг	Треьий сорт, кг	порченные	По сравнении с контролным	
									в кг	%
1	Шеки-1x Шели-2	29	1,55	5,2	8,0	6,8	7,6	4,4	32,0	100,0
2	SZEM xGE-143	26,0	1,97	12,0	20,0	9,7	4,5	1,3	48,0	150,0
3	GE-143x SZEM-4	26,5	1,92	11,0	19,9	9,1	4,0	1,0	45,0	140,6
4	Yaqub x Cingiz	26,0	1,95	11,8	19,2	8,5	4,5	1,0	45,0	140,6
5	Cingiz x Yaqub	27,0	1,90	10,2	18,8	6,5	5,0	1,5	42,0	181,2

Длина шёлковой нити имеет большое значение для текстильной промышленности. Влияние внешных факторов оказывает влияние на метрический номер нити. Одним из важных показателей является результат, полученной с одной коробки. У гибрида Seki-1x Seki-2, находящегося в контрольном варианте у каждого 1 гр грены количество, полученного кокона составило 3,2 кг. У исследуемого материала было 4,5-4,8 кг. Порченных коконов у Seki -1x Seki -2 было 4,4 кг, у исследуемых гибридов было намного меньше 1-1,5 кг. Результаты сорт испытуемых сортов Seki-1x Seki-2 были намного меньше новосозданных гибридов. Так, у гибрида Seki-1x Seki-2-32 кг, SZEM-4xGE-143-48 кг, GE-143x SZEM-4 и Yaqub x Cingiz-45 кг, Cingiz x Yaqub-42 кг. Как видно, из выше указанного все результаты и показатели у испытуемых гибридов очень высоки. Новые линии гибридных соединений в промышленных испытаниях тоже доказали свои высокие продуктивные и технологические показатели.

Выводы

Биологические результаты испытуемых гибридов по весу продукции кокона, полученного из одного грамма тутового шелкопряда, превосходят контрольные гибриды Шеки-1 х Шеки-2 на 1,3-1,8 кг.

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RESULTS OF THE TESTINGS OF HARDY BREEDS OF MULBERRY LYE GROWN IN SHEKI-ZAKALANSKY REGION WITH THE ECOLOGICAL POINT OF VISION

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Summary

The article is devoted to the feeding of silkworm varieties produced under unfavorable conditions. As a result of the research, the yield of 4 species significantly exceeded the grade of the Seki -1 x Seki-2 breed. As a result of the results of the feeding, 2 breeds gave a higher result in comparison with the control variant.

Key words:1. silkworm, 2.breed, 3.hybrid, 4.coocon, 5.adaptive selection, biological indicatorю

THE DEVICE FOR AUTOMATIC SEPARATION OF SILKWORM EGGS BY COLOR BASED ON COMPUTER VISION

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ABSTRACT

The article presents the results of work aimed to develop a device for the separation of silkworm eggs by their colors. This device consist of three main blocks. The first one is designed for enlining sequences of the eggs, the second is to bring these eggs to estimation zone, where the third analizes and separates light eggs from dark ones.

Keywords: silkworm eggs, device, engine computing unit, single-board computer

Introduction. All the industrial sericulture based on feeding silkworm hybrids. In the production of high-quality hybrid silkworm eggs it is very important to separate the silkworm by sex with high accuracy, so that the females of one breed will be crossed with the males of the other and vice versa.

The practical implementation of this seemingly simple operation in a production environment is very difficult, due to the lack of appropriate engineering and technology, and therefore until now it is not possible to provide a pure separation of silkworm eggs by sex. Today, a large number of silkworm separating ways are known, but no one meets the needs of sericulturists.

The method of dividing silkworm at the egg stage is the most effective dividing way. Two silkworm greed's tagged by color had issued for this purpose, the dark greed's are female and the light ones are male.

There is a machine for dividing silkworm eggs by their color, based on a photomultiplier tube, the vacuum device with some electrodes, cathode, anode and the actuator inside it [4]. The main disadvantages of that device are high error of eggs separation, a limited lifetime of the photomultiplier tube has a limited service life (about 500 hours), the need for a high-voltage power source (from 500 to 1500V) to enhance the photocurrent in the photomultiplier, which leads to high power consumption of the device.

Main part.

To improve the accuracy of separation and reliability of the operation, the photomultiplier tube is replaced by a highly sensitive webcam with a linear CCD matrix, combined with an engine-computing unit (ECU) based on the Raspberry Pi 3B, the single-board computer.

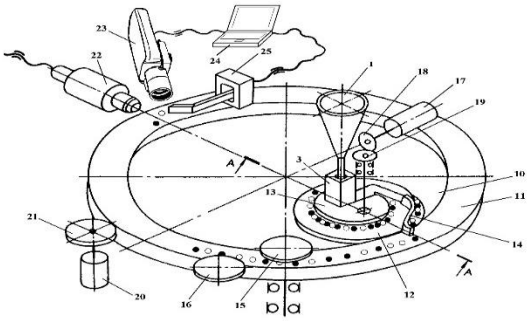

Figure 1. The automation for dividing silkworm eggs by color scheme.

Figure 1 represents a diagram of the automaton and Figure. 2 the section of the machine. This machine contains three main worker units: an egg dispenser, a forming unit, a transport mechanism, and the ECU.

The dispenser is designed to eggs feeding in portions. It supplied with a conical tank 1 for eggs loading and feeding device installed at the neck of the latter. The feeding device is made in the form of body 3, installed in a cylindrical chamber 2 over bearing 4 of the grooved coil 5. The last has two lateral shoulders 6 and 7, the diameter of which is equal to the diameter of the chamber, and it is larger then the one of the grooved coil 5. All of them, in the aggregate, form an circular space, communicating with capacity 1 through the opening 8 of the body 3. Width of this body is equal to twice the diameter of the egg, to ensure the of the egg's passage without injury.

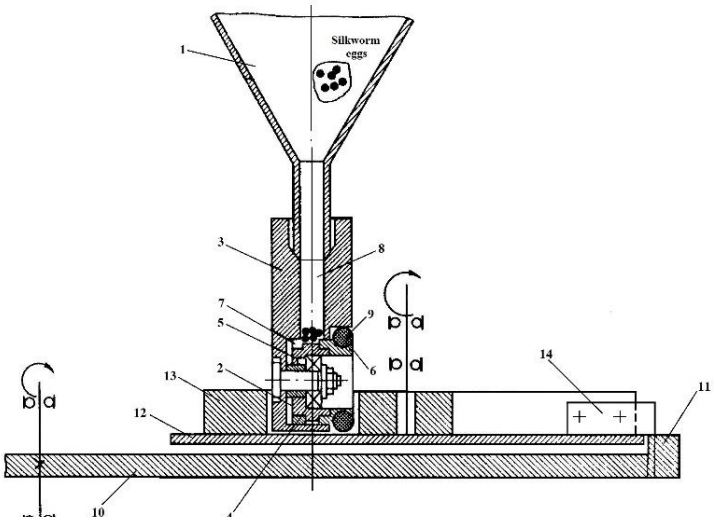

Figure 2. The sectional drawing of the automation for dividing silkworm eggs by color

One of the shoulders 6, provided with a rubber ring 9, is in friction engagement with the forming disk of the forming mechanism. Moreover, the teeth of the grooved coil 5 have a wave-like shape. The tooth size and teeth spacing provide 3-4 eggs portions transfer, that protecting the eggs from injury. There is a window for the eggs exit, in the bottom part of the body 3.

The formation and transfer mechanism is designed for to place the eggs in a chain, one after the other, with given interval between them.

It is composed of the discs, one of which has a working surface made in the form of a ring 1, and other, a forming disk 12, installed inside one so, that working surfaces of the both are on the same level. Another parts of the mechanism is a fixed guide rail 13 in the form of an Archimedean spiral and baffle 14, a curved bar, one end of which is connected to the rail 13, and the other is bent by the 0.3 mm towards the circular part 11 of the transporting disk 10 via the convergence point of the disks 10 and 12. The fixed rail 13 starts from the position of the forming disk 12, where it's line speed is equal to required one of the grooved coil 5. In that zone the fixed rail 13 and the forming disk 12 made up a cavity for locating the feeding device.

The eggs are transferred to the analysis zone and fixed there by a frictional engaged rubber rollers 15 and 16, located on ring part surface 11 of the transporting disk

The drive of the forming disk 12 is carried out by the electric motor 17 through a pair of interchangeable gears 18 and 19, designed to adjust the speed of rotation of the forming disk 12, and the drive of the transporting disk 10 is driven by an electric motor 20 and a friction pair 21.

At the positions of the analysis, eggs are classified by color and divided into two, groups, male and female, by the ECU 24 whose block diagram is shown in Fig. 3. This unit is connected to both WebCam and actuator 25.

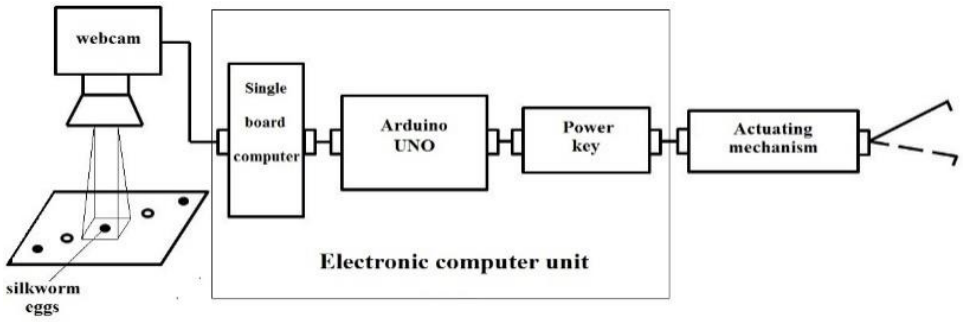

Figure 3. Engine control unit of the automation for dividing silkworm eggs by color.

The drive of the forming disk 12 is carried out by the electric motor 17 through a pair of interchangeable gears 18 and 19, designed to adjust the speed of rotation of the forming disk 12, and the drive of the transporting disk 10 is driven by an electric motor 20 and a friction pair 21.

The machine works as follows. Silkworm eggs are poured into a conical capacity 1 of the dispenser, from where they are enters the chamber 2 with side collars 6 and 7, through the opening 8 of the body 4. Then, the transporting disk 10 is driven, and then the forming disk 12.

The grooved coil 5 rotates, due to the friction between the forming disk 12 and the rubber ring 9. It's rotating fills the volume between teeth, and silkworm eggs enters on the surface of the disk 12. The forming mechanism transfers the eggs to the fixed guide rail 13. Then, placed in a chain on the surface and, moving one by one, these eggs get into the zone of action of the baffle 14 and at its edge, changing the direction, smoothly passes to the surface of the circular part 11 of the transporting disk 10.

Due to the difference in linear speeds of the disks 10 and 11 (at this point, the speed of the transporting disk 10 is about 3 times greater one of the forming disk 12), the silkworm eggs are separated from each other and transported further by disk 10.

Rubber rollers 15 and 16 align the eggs in line to the analysis zone of the ECU, where they are classified according to color to male and female individuals.

The video stream from webcam 23 is processed by a special program [5], installed on the single-board computer of the ECU. If an egg, illuminated by the light 22, is light, the program generates control signal to the actuator 25, the electromagnetic relay with a lever. It pushes that egg back into the corresponding box.

For a dark-colored egg, appeared at the analysis position, the signal from the ECU is not received by the actuator 25, and the egg is transported further to the other box.

Conclusion

The developed machine will allow high performance and accuracy separating the silkworm eggs, labeled by color, at the silkworm stations and plants for further production of the industrial hybrid, purebred, and male-only caterpillars, which are giving cocoons greater silkiness than female ones. Thus, the use of the device of such design will ensure reliability in operation, easiness of maintenance, high performance and accuracy, as well as eliminate silkworm egg`s injuries and even it`s minimal losses. It will allow to introduce new hybrids of the silkworm in production, and produce non-clogged, 100% hybrid silkworm eggs, which will give increased yields of cocoons with high technological properties of the raw silk and silkworm yarn.

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DEVELOPMENT OF METHODS FOR PERFECTION OF MULBERRY SILKWORM GENE POOL OF GEORGIAN BREEDS

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ABSTRACT.

The paper considers the issue of development of methods for perfection of biotechnologic characteristics of old Georgian breeds (“Telavi” and “Tetrparkiani Kartuli” (“White-cocoon

Georgian"), briefly "TK", characterized by unique properties which were obtained by folk selection. In this attempt method of gradual grading of breeds has been used. Uzbek breeds "Orzu" and "Yulduz" were used as components for breeds perfection. Criterion for assessment of results, alongside with biotechnological indices was estimation of changes of total proteins in hemolymph, ratio of silk gland and silkworm masses. As a result of experiments definite improvement of biotechnological indices of Georgian breeds was achieved.
Key words: mulberry silkworm, selection, hemolymph.

Introduction. Lately due to critical situation in Georgian sericulture the mulberry silkworm selection activity cycle was deranged and now only breed preservation is managed,while long-term inbreed crossing of breeds resulted in inbreed depression, which hinders silkworm growth and development. In the worm phase, when processes of intense growth take place, attentuation of metabolism decreases worm viability and other biological indices and increases duration of feeding.

Preservation of mulberry silkworm genofond's unique breeds is the necessary term for further development of sericulture, since sericulture inductry relies on rich genofond of mulberry silkworm. This is why the goal of the present research was preservation and perfection of Georgian mulberry silkworm breeds with their inherent hereditary characteristics, in order to use those breeds as starting material for selection.

Material and methodology. Inthe present research the preference was given to old Georgian breeds of mulberry silkworm characterized by unique properties (grain vivification capacity, cocoon spinning ability, short feeding period) obtained by folk selection: "Telavi" and "Tetrparkiani Kartuli" , that is "TK"("White-cocoon Georgian"), which need improvement of cocoon shell and silk capacity.To preserve mulberry silkworm genofond the scheme wasdeveloped which enabled the authors to improve major biotechnological characteristics in four generations. For perfection of mulberry silkworm breeds preference was given to introduced breeds kept in the collection material, which are successfully adapted and accommodated to climatic conditions of Georgia and are characterized by high biotechnological indices.

To overcome inbreeding depression the authors used method of gradual improvement of breeds, that is, grading. Russian breeders E.Mikhailov and P.Kovalenko, in their works stated that at multiple crossing, blood of a breed which is used for perfection will gradually mix with the blood of the breed to be perfected and desired characteristic of female silkworm will be enhanced. Therefore, parent-couples were sampled out which were crossed in various geographical media. The more contrasting these conditions in parent-couples, the more viable and resistant to unfavorable conditions of environment are the filial generations. Therefore, for such purposes Uzbek breeds "Yulduz" and "Orzu" were used as perfecting components which are characterized by high biotechnological indices.

The following methods were used in the process of work:

- Heightening of worm viability using worms hatched on the first day and transited to the next instar on the first day, as well as sampling of layings according to the grain of the first day;
- -Using the moths for crossing, which were emerged on the first day from the spun cocoon;
- -Sampling of families in pupa phase according to viability, shell weight and silk capacity;
- -Besides, the impact of hybrid combinations on silkworm and silk glands ratio and on quantitative changes in hemolymph proteins was studied.

Results. For sampling the families possessing high silk-capacity, cocoon samples were taken random from filial generation of those families, according to which average cocoonand shell masses and silk-capacity were determined. Crossing of families and individuals sampled for breeding was performed according to the principle of heterogenous selection. After reproduction and check-up of each breed, hybride combinations were prepared and the combinations were inspected for heterosis and then gene-types with high viability and high heterosis ability were sampled out.

Rational application of these methods enabled us to improve to some degree the breeds in the fourth generation, preservation of hereditary properties, viability, to increase shell mass and silk-capacity and correspondingly, elevation of productivity.

As to the Uzbek breeds "Yulduz" and "Orzu", their biotechnological characteristics have been gradually improved and currently cocoon shell mass equals to 514.3 mg and 538.3 mg and correspondingly cocoon silk-capacity equals to 24.5% and 23.4%.Their testing has proved that those breeds have rather high potential and gradually they will accommodate better to climatic conditions of Georgia and will be used successfully in further selction works.

Mulberry silkworm feeding results (2013-2018 yy.)

Table 1.

	Breeds	Grain vivifi-cation,%	Silkworm viability,%	Length of feeding, day	Live cocoon		silk-capacity, %
					Cocoon mass g.,	shell mass mg.,	
1.	Telavi(2014)	98	93	27	1,9	380	20.0
2	Telavi(2018)	98	95	27	2.0	410	20.5
3.	„Tetrparkiani Kartuli" 2014)	97	94	27	1,9	410	21.5
4	„Tetrparkiani Kartuli" 2018)	97	96	27	2.0	435	21.7
5	Iulduz(2014)	96	96	30	2.1	514.3	24.5
6	Iulduz(2018)	96	97	30	2.1	520.0	24.7
7.	Orzu(2014)	96	98	30	2.2	530.3	24.1
8	Orzu(2018)	96	98	30	2.2	540,4	24.5

According to the table, mass of cocoon of silkworm breeds to be improved in experimental period increased by1.0 g, shell mass –by 25-30 mg, respectively silk-capacity - by 0.2-0.5%, which is a rather good result in selection work.

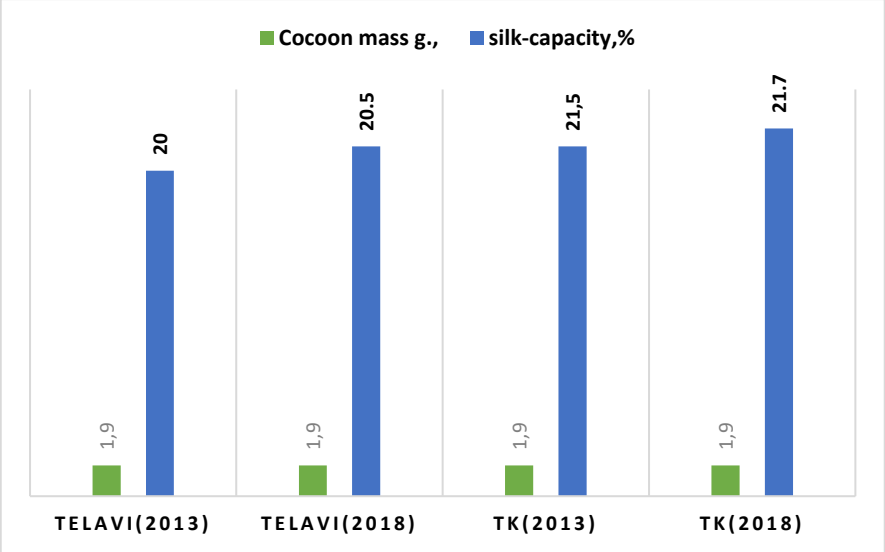

Diagram 1. Changes in cocoon mass and silk-capacity of the breeds to be improved (2013-2018 yy)

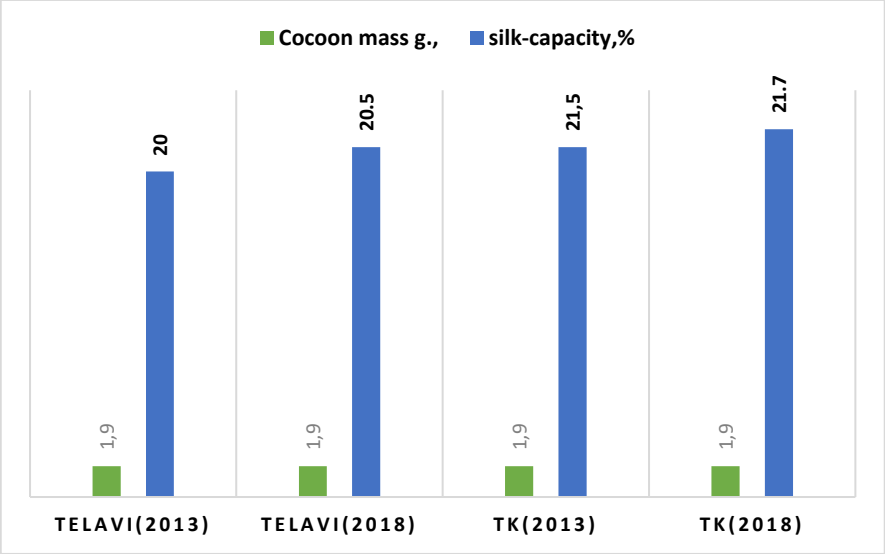

Diagram 2. Changes of cocoon shell mass of breeds to be improved (2013-2018)

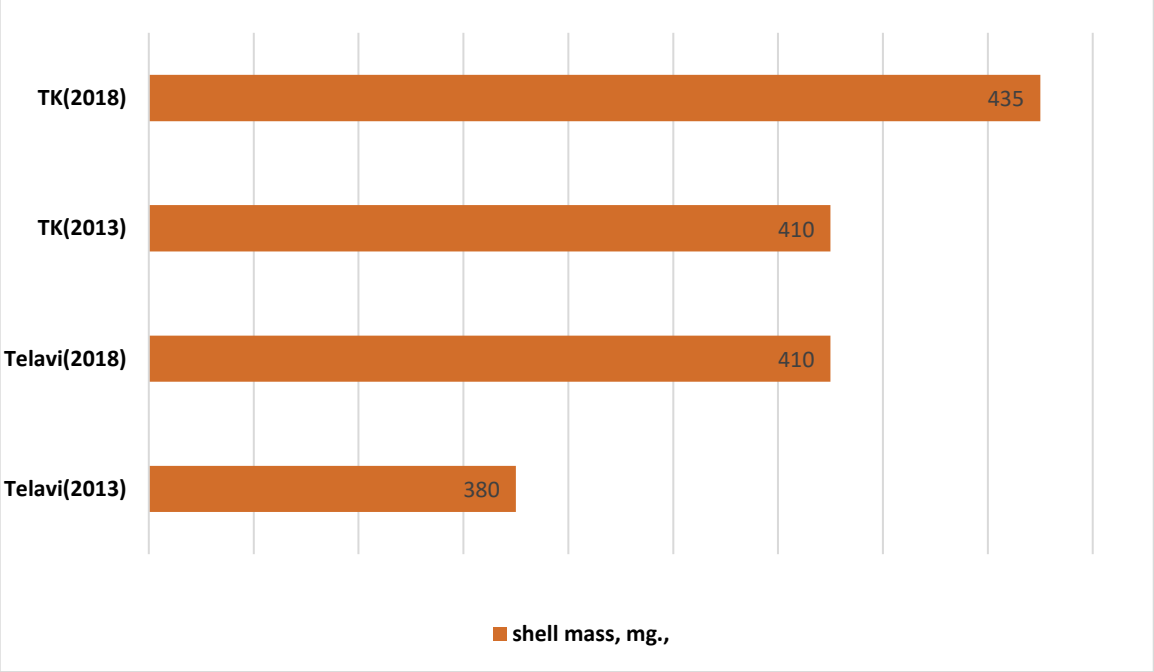

Diagram 3. shows increase of cocoon shell mass.

The obtained generations were assessed not only according to biotechnological characteristics, but also by application of a method of hemolymph testing, since there is a direct correlative connection between protein rate in hemolymph and cocoon silk-capacity. This is why increase of total protein rate in hemolymph is significant.

With this in view, biochemical testing of hemolymph was carried out and total protein composition in mulberry silkworm hemolymph was determined. To achieve it, concentration of total proteins was

determined in 5-5 worm hemolymph of each variant. BBiochemical testing was carried out in late period of the insect ontogenesis, in fifth instar worm, according to the concentration of total proteins. In this period organism of a worm needs great quantity of proteins to spin cocoon, while a pupa needs protein to provide thorough development of genital bodies, as well as the synthesis of gonado stimulation hormon and diapause hormon, since both hormons are protein formations.

Experimental worms, before excision of hemolymph, were processed together with the needed instruments, first by ethyl alcohol and then by distilled water.

Hemolymph specimens were taken in the morning, before feeding. By injection of the insect pseudopod the hemolymph left the body and was immediately placed on the lower lence of refractometer and total proteins concentration was determined by successive procedures, by means of ray refraction index and by special tables.

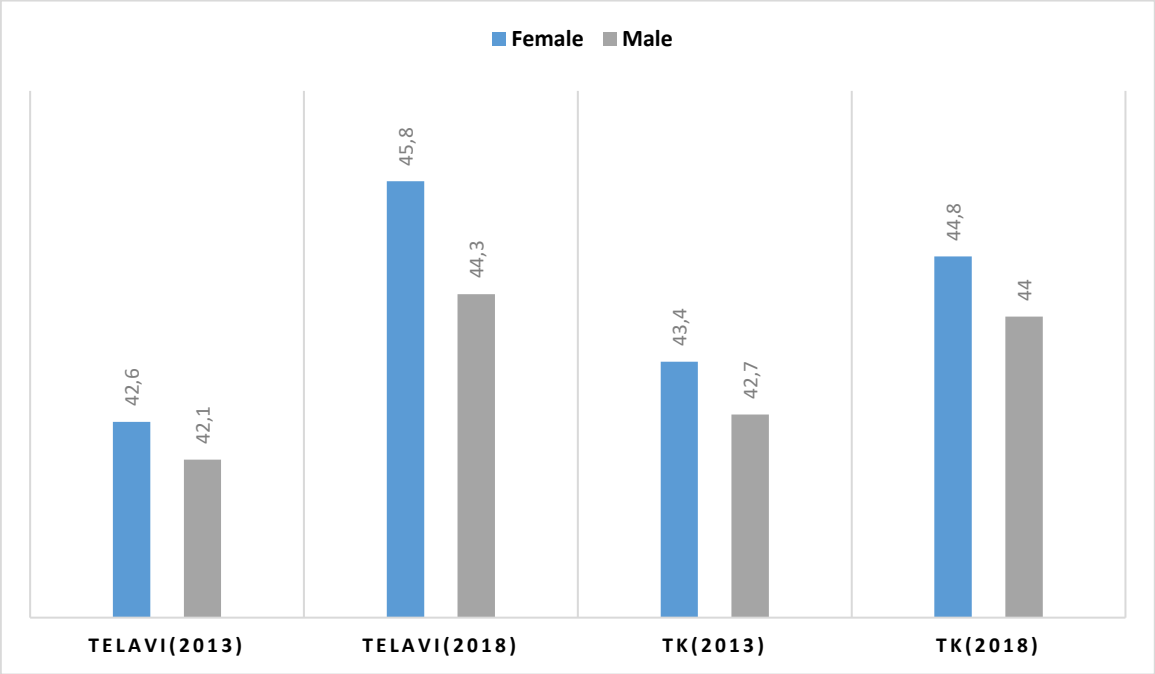

Diagram 4. PProtein rate in silkworm hemopymph according to gender.

As seen from Diagram 3, there is a difference in total protein concentration in hemolymph according to female and male worms; in case of male individuals protein composition is 0.3-0.5% lower. This is quite logical, since female worms need proteins not only for cocoom spinning but also for gran production.

Experiments have proved that there is a direct correlation between silk gland mass and cocoon silk capacity. Silk gland mass grows especially intensely from the third day of the fifth instar till the eight day, up to cocoon spinning, which is conditioned by silkworm feeding by mulberry leaf rich in carbohydrates, proteins and nitrogen. The great significance in qualitative and quantitative formation of silk mass is attributed to nitrogen rate in mulberry leaf, because it is known that a silkworm that consumes mulberry leaf rich in nitrogen yields more crop. Silk mass is synthesized in silk forming gland, and the cocoon silk capacity level depends on its growth and intensity of silk synthesis.

Size of silk gland and its mass depend on silkworm breed and age. At about 70% of silk mass is formed by processing of proteins obtained from mulberry leaf consumed by a worm, while 30% - is formed by silkworm hemolymph and synthesis of mulberry plant proteins. Besides, definite portion

of proteins (almost 15%) is formed in a worm body in the process of cocoon spinning, that is, when a silkworm does no more take food.

Silk gland should be considered jointly with its developemnt, because these processes are closely connected with each other and occur simultaneously. Speed of the gland growth increases rather intensely in the fifth instar. In the first instar the gland mass equals to 4% of a worm, and in the fifth instar it reaches 25-26%, while the gland length exceeds fife-times the length of a worm.

In our experiment, from the third day of the fifth instar till cocoon spinning, we weighed from every variant 5-5 worm dayly, in the morning, before feeding; then, at every worm was cut and silk glands were removed and weighed and their ratio was precised according to the worm gender. The obtained results are presented in Diagram 5.

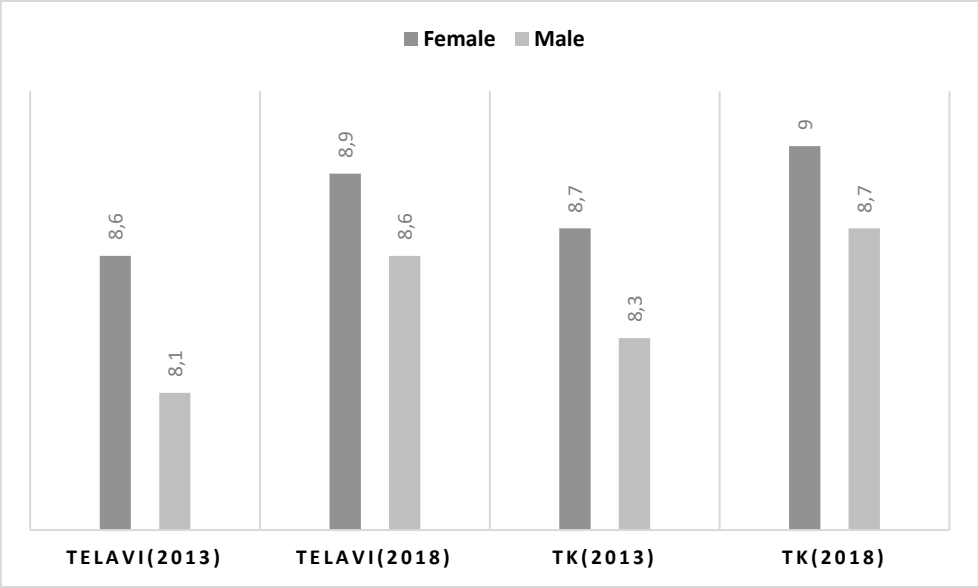

Diagram 5. Silkworm and silk gland ratio according to gender(2013-2018)

Diagram 4 shows that according to the ratio of silkworm and its gland in case of female worm of „Telavi“ breed the ratio is increased by 3.2%, in case of male worm – by 2.2%; while the ratio of silk gland of female worm of „Tetrparkiani Kartuli“ („White cocoon Georgian“) is increased by 1.4%, while that of male worm – by 1.3%.

It is known that a mulberry leaf suffers destruction in the digestive system of an insect and aminoacids transit to hemolymph, while synthesis of silk proteins start in the walls of silk gland cells and transit to its duct. Maximum accumulation of proteins in hemolymph takes place in the fifth instar of silkworm.

We took into consideration the situation that silkworm growth is characterized by acellerated and slowed down periods; ability to assimilate food reaches its maximum at the fifth and sixth day of the fifth instar, silkworm growth reaches its maximum by that period too, then it decreases. Silk gland intensively develops on the seventh and eighth day, which enables us to suppose that if we feed a worm by highly nutritive leaf we will be able to affect the relative growth of silk gland volume.

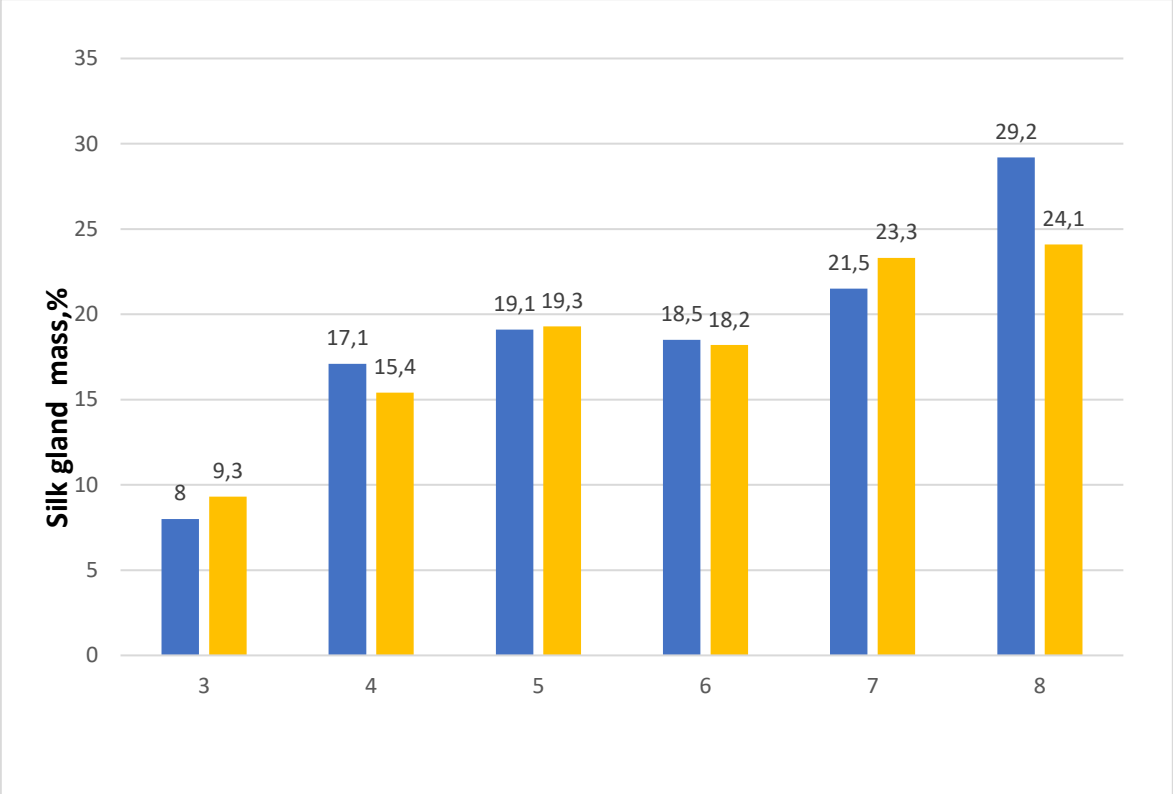

Diagram 6. Growth of silk gland mass in the fifth instar of a worm, according to days and gender.

As we see from the Diagram 5, according to the fifth instar days and gender of a worm, index of silkworm and silk gland growth is logical. Silk gland reaches its maximum volume on the eighth day of the fifth instar, while growth of silk gland mass is in direct correlative dependence with synthesis of proteins in hemolymph, with total protein rate and hence with cocoon mass and silk capacity.

Conclusion. 1. Cocoon mass of mulberry silkworm to be improved in the investigation period increased by 0.1 g., shell mass – by 50 mg; correspondingly silk capacity by 0.6%, which is a rather good result in selection work.

2.There is a difference in concentration of total proteins in hemolymph, in concentration of total proteins of female and male worms; in case of male individuals protein concentration is lower by 0.3-0.5%. This is quite logical, because female worms need proteins for not only cocoon spinning but also for grain production.

3. Silkworm and silk gland mass ratio in case of female worm of „Telavi“ breed increased by 3.2%, in case of male worm – by 2.2%; while in case of „Tetrparkiani Kartuli“ the ratio of female worm and silk gland mass increased by 1.4%, and in case of male worm -by 1.3%.

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WORK ON THE NEW METHOD STIMULATING THE DEVELOPMENT OF SILKWORM IN GANJA-GAZAKH REGION

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ABSTRACT

Based on the results achieved it can be brought forward that when the caterpillars were fed with mulberry leaves processed with sodium solution, their living capability was comparatively higher than other variants. The variants, where the caterpillars were fed with mulberry leaves processed with mineral water containing iodine were lower than variants processed with sodium solutions and higher than test variants. The results of the test experiments show that it is possible to feed silkworms with mulberry leaves with mentioned ingredients and obtained silkworm grain is useful for industrial production. The conducted experiment can be applied to get comprehensive development of sericulture relevant to modern needs, to get quality product and to satisfy the industrial needs. The selection of initial material, defining the technological characteristics in preparation of grain is considered one of the important issues. The indicators which vitally influence to grain selection and reproduction should be included as well.

Keywords:mulberry silkworm, silkworm eggs; physiological indicators of caterpillars; the quality of cocoons; mulberry leaves treated with sodium solution; mulberry leaves treated with iodine-containing mineral water.

Introduction

Sericulture is one of the important fields of agriculture. The objective of this field is to obtain cocoon for getting raw silk via growing silkworm.

The need for natural silk is increasing in the countries with developed sericulture year by year. Thus, silk production had been over 200 thousand tons since 2000.

It is certain that instability in the development of sericulture had been taken under the control of the President of the Republic of Azerbaijan, and the State Program for "The Development of Silkworm Breeding and Sericulture" (2018-2025 years) was adopted in 2017. The main target in this Program is to bring the cocoon production to 6 tons in 2025. 1 million mulberry saplings bought from the Republic of China by the Ministry of Agriculture were brought to the country on November 29, 2017. These saplings were distributed to farmers in 38 districts for free according to the distribution plan prepared by the Ministry. 505 tons of wet cocoon were handled in the Republic in 2018. Zardab district was in the first place with 53.9 tons.

Farmers, entrepreneurs, peasant farms are busy with sericulture as in other fields of agriculture. Their main expectation is high-quality grain and mass ill-resistant caterpillars which enable high cocoon harvest.

The analysis of literature shows that some researchers dedicated their work mainly to research of productivity of mulberry silkworm, biological indicators, quality of cocoon, and the factors affecting the silk productivity.

It is certain that the main sericulture profitability indicator in Azerbaijan is the improvement of the biological properties of mulberry silkworms, and improvement of the mentioned properties of mulberry and oak silkworms in other countries.

High productive mulberry silkworm species and hybrids have been acquired with the application of different technologies in the last years. Despite the high bio-technical indicators, these species are vulnerable to diseases and the influence of environment in processing, feeding, eggs (grain) growing, and especially, in diapause and hibernation periods, and these factors still remain as limitations. This worth to mention that worse veterinary-sanitary conditions than required in grain farms and the unfavorable influence of ecological environment also affect negatively to the development of mulberry silkworm which is poikilotherm (internal temperature varies considerably). Surviving ability of eggs becomes low in these farms even though optimum conditions are set. The reason for this is the influence of pathogen microorganisms because various microflora (bacterial natured ones prevail) accumulate on the eggs in the initial development stage of mulberry silkworm. This decrease living ability of eggs and increases the death rate in hibernation phase (R.Sato, H.Vatanabe,

1986; Al Kobavashi, 1990; L.F. Kashkarova, 1994; V.A. Golovko, 1996 and others). It is possible to achieve high physiological indicators in the subsequent phases with the provision of proper embryogenesis which is considered the main phase of ontogenesis.

As it is seen the development of sericulture farming and the provision of high-quality cocoon harvest depend on the improvement of keeping a condition of mulberry silkworms, application of new methods which are economically efficient and ecologically clean and enable high bio-technical indicators.

MATERIAL AND METHODS

The main objective is to research the influence of different ingredients of watery solutions to the living capability of silkworm eggs, physiological indicators of caterpillars and to the quality of cocoons, and to identify the effectiveness of new processing method on the basis of the results achieved.

To achieve this objective the followings have been carried out:

1) We learned the influence of mulberry leavesto local species of caterpillars (5% H_2O; $NaHCO_3O$; mineral water containing iodine) during egg incubation and diapause in Ganja-Gazakh region.

2) We learned the influence of the most effective ingredient to the productivity of the mulberry silkworm, and quantity and quality indicators of the cocoons.

3) We assessed the effectiveness of new processing technology of mulberry leaves and mulberry silkworm eggs on the basis of the optimum ingredient which was found out by us.

We conducted biotechnical researches in all phases of the silkworm species developing in Ganja-Gazakh region on the various local ("Sikhgoz-tut", "Zarif-tut") mulberry leaves in consistent with the methodology. The scientific research was conducted in two main orients.

1) We researched active and diapause variants of embryogenesis with the presence of different ingredients in tested silkworm eggs. We put 3 samples with 10 series and each series consisted of 20 eggs.

2) Before feeding the caterpillars with mulberry leaves, the prophylactic processing was conducted with generally accepted P.A.Pervushev's and U.A.Abdullayev's general methods (1989). Each caterpillar was fed as follows; the processing of the leaves was carried out in three variants (that is was processed with watery solution of the ingredient); 1) processing with 5% hydro-carbonate; 2) processing with artesian mineral water containing iodine; 3) testing (one time sprinkler with still water and dry, unprocessed variants) (Kuliyeva, 2002; 2005).

The influence of ingredients to the eggs was learned in the circumstances of $+25^0$Cand 65% humidity (that is relevant to the temperature of the solution) and on the paper or on the gauze knots. The processing, that is influence was carried out when the eggs were put for incubation. After the incubation, the number of awakening (surviving) eggswas noted. After the sorcerer awakened, we counted their numbers for five days. Test feedings were also

conducted to assess the effectiveness of the processing in various variants. Effectiveness in each variant with 3 repetitive action each consisting of 100 caterpillars was confirmed (that is the development was continued till the end - the cocoon phase). In this test feeding we noted the following indicators:

- The number of awakened eggs (with pieces)
- The living ability of the caterpillars hatched out (%)
- The average weight of a cocoon including pupae (with mg)
- The average weight of a silk layer of a cocoon (mg)
- The weight of wet cocoons (with mg)

Economic effectiveness will be conducted as applied in agriculture, that is, the assessment of the efficiency of the new method: the amount paid for ingredients will be compared with the prices of harvest (caterpillars).

Statistical analysis will be conducted according to N.A.Plokhinski (1969) and G.F.Lakina (1990). The results of this research are shown in Table 1.

The grains of "Azerbaijan", "AzNIISH-1", "Agbaramali-1", "Ukraine-1" species were used in this research.

RECOMMENDATIONS

One of the important problems before the sericulture science is increasing the resistance of mulberry silkworm species and the improvement of the quality of cocoon. That is why, besides keeping biological indicators and quality of cocoon in the intended level in our Republic, work on new relevant technologies should be considered one of very crucial issues.

Species name	Azerbaijan						AzNİİŞ-1						Ağbaramalı-1						Ukrayna-1					
Mulberry sorts	Sikhgoz-tut			Zarif-tut			Sikhgoz-tut			Zarif-tut			Sikhgoz-tut			Zarif-tut			Sikhgoz-tut			Zarif-tut		
Variants	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test	With sodium	With Minerals	Test
Living ability of caterpillars	97,5 %	94,3 %	90,7 %	96,1 %	93,8 %	90,3 %	94,6 %	93,0 %	90,0 %	93,5 %	92,7 %	89,6 %	91,4 %	89,8 %	88,8 %	90,2 %	89,8 %	88,0 %	88,5 %	87,6 %	83,9 %	86,7%	85,4 %	81,1 %
Wet cocoon weight	1,83gr	1,80 gr	1,60 gr	1,82 gr	1,78 gr	1,59 gr	1,77 gr	1,75 gr	1,52 gr	1,73 gr	1,60 gr	1,49 gr	1,70 gr	1,56 gr	1,43 gr	1,66 gr	1,52 gr	1,40 gr	1,60 gr	1,47 gr	1,34 gr	1,57 gr	1,43 gr	1.30 gr
The average weight of silk layer of cocoon	0,83 mg	0,80 mg	0,60 mg	0,82 mg	0,78 mg	0,59 mg	0,77 mg	0,75 mg	0,52 mg	0,73 mg	1,60 mg	0,48 mg	0,70 mg	0,56 mg	0,43 mg	0,66mg	0,52 mg	0,40 mg	0,60 mg	0,47 mg	0,33mg	0,57 mq	0,43 mq	0,29mq
Weight of pupae	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,1 gr	1,0 gr	1,0 gr	1,0 hr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,0 gr	1,1 gr	1,0 gr	1,0 gr	1,1 gr

It is crucial to take relevant measures on the establishment of factories, and stations. To regulate cocoon seeds, to get rid of the import problems of grains, and to meet the demand of the silkworm breeders with the local grains cocoon seeds.

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КРАТКАЯ ИСТОРИЯ ХУДЖАНД – ЦЕНТР ШЕЛКОВОДСТВО СОГДА

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История развития шелководства в Таджикистане является одной из самых малоизученных и неразработанных проблем.

Существуют, как мы уже знаем, несколько точек зрения на вопрос о том, где возникло шелководство, а точнее, изготовление шелковых тканей из шелковины, создаваемой гусеницами шелкопряда при завивке коконов. Большинство исследователей признают родиной шелководства Китай, так как время возникновения шелкового ремесла у индусов до сих пор не установлено. Правда, Мукерджи считает родиной тутового шелкопряда горные местности Индии, где впервые научились использовать его шелк. По мнению этого автора, опубликовавшего свои работы в 1890-1897 годах, нет оснований утверждать, будто шелководство возникло в одном месте. Он основывается на том, что в наиболее древних памятниках санскритского языка уже упоминается о шелке, но ничего не сказано о китайском шелке из Китая. Возможно, доля истины в его утверждении есть, но все же, принято считать родиной тутового шелкопряда именно Китай.

Родиной натурального шелка, как и многих других прекрасных вещей – фарфора, чайной церемонии и искусства каллиграфии, является древний Китай. И две тысячи лет назад, когда европейцы носили еще грубые льняные ткани, чаше неокрашенные и небеленые, китайцы уже щеголяли в одеждах из нежного натурального шелка. Даже на

стоянках древнего человека обнаружены изображения тутового шелкопряда, сделанные на костях животных. С шелководством связано множество легенд.

В благодарность за получения первой шелковой нити императрицой СиЛинг-чи была возведена в ранг божества Небесной империи - как назывался тогда Китай. А.А. Тихомиров называет точную дату этого события – 2698 год до нашей эры, а Ж. Ростан пишет, что это произошло «приблизительно 2600 лет до н.э.». Во всяком случае память об этом хранится и сейчас во многих районах Китая, где проводятся ежегодные ритуальные празднества в честь Си.

Решающую роль в проникновении шелка в текстильное ремесло Согда сыграл известный в истории Великий шелковый путь, проходивший из Китая на запад через согдийские города[1]. Великий шёлковый путь был огромный сетью торговых дорог, которые связывали Азию и Европу с первого тысячелетия до нашей эры до середины второго тысячелетия нашей эры.

Известный историк, филолог и хадисовед Абу Саъд Самъани (1113-1167гг.) в «Китаб ал-ансаб» сообщил об авторитетной династии ученых,которые в течение жизни нескольких поколений в Мерве XI-XII вв. занимались развитием производства шелка. Поэтому они получили прозвание «девакашхо» - размотчиков коконов.

А. А. Кушакевич о Худжанде писал: «Это город среднеазиатского шелководства. Здесь производится огромное количество коконов, выматывается много шелка, ткется значительное количество шелковых материй (щаи - канаус), полушелковых тканей: адрас, бикасаб и др.

В Худжанде – лучшие вышивальщики шелком по сукну и коже, лучшие красильщики. Это промышленный город таджиков, того арийского племени, которое заселяло некогда всю Среднюю Азию и родственно нынешнем персам – иранцам[2]».

Северо таджикистанские города и ремесла упоминаются в многочисленных средневековых письменных источниках. И благодаря этому, среднеазиатский шелк, который по отзывам знатоков, лучше итальянского и французского, ежегодно вывозился из Средней Азии в сыром и обработанном виде в большом количестве в Россию, Персию, Индию и Афганистан.

Князь В. И. Масальский[3] на своем работе город Худжанда отмечал как место сосредоточения торговли и промышленности «Из отраслей важное значение имеет шелководство и в этом отношении Худжанд занимает первое место во всем Туркестане».

Город, как и в наши дни, исторически находится на стыке трех крупных экономических зон края. Это Фергана, Чач, Уструшана и прилегающая к ней с юго-запада Зеравшанская долина, включающая Центральный Согд. Тутовое шелководство и обработка шелка были одним из древнейших занятий населения и всегда имели важное значения в экономике края. В конце XIX в. в Худжанде, как и других шелководческих районах Средней Азии, была распространена местная порода шелковичных червей.

В 1892 году, впервые в Средней Азии, в г. Худжанде начали разводить новую породу шелкопряда. Французский гренер Алоизи открыл здесь гренажную станцию для обеспечения населения высококачественной греной.

Шелководы Худжанда также разводили японские, французские, самаркандские и ферганские грены. В 1892 году из французских грен получили 2000 пуд, из японских грен 6000 пуд, из местных грен 1000 пуд кокона.

Примечательно то, что первая премия выставки 1886 г. большая серебряная медаль для ношения была присуждена частному экспонеру - Акраму Аскарову. В выставке 1894г. организованной в Самарканде такую же премию получил худжандский умелец - Мирсолех

Мирсаидбаев за применением микроскопа, при помощи которого он определял болезни шелкопряда.

За выведение новые высокопродуктивные гибриды тутового шелкопряда, Мир Салих Заитбаев, Мирзо Ходжа Урунходжаев демонстрировавших на выставке шелководства в 1900 году, были удостоены серебряным и бронзовыми медалями[4].

В начале XX в. в Худжанде было распространено выращивание нескольких сортов коконов, получаемых из грены, поставляемой гренажными заведениями местных, русских и иностранных предпринимателей.

Высокопродуктивными считались такие породы тутового шелкопряда «Асколи» и «Алоизи».

В Худжандском уезде коконов из-за отсутствия шелкомотальной и шелкоткацкой промышленности частично производилась кустарным способом, а основная масса 80-85 процентов после примитивной морки и сушки в сухом виде вывозилась за пределы Средней Азии.

В 1919 году в Худжанде была введен в действие государственный гренажный завод. Таким образом, впервые в истории шелководства Таджикистана созданный при Худжандском Совнархозе государственный гренажный завод сыграл важную роль в деле восстановления и развития местного шелководства. В целях распространения среди шелководов заводской грены а, следовательно, и дальнейшего укрепления шелководства, Среднеазиатский экономический совет решил освободить производство и торговлю греной от всех налогов и сборов.

В целях популяризации достижений тружеников сельского хозяйства республики в 1937 году в г. Худжанде была организована республиканская сельхоз-выставка, участниками которой были победители районных сельхозвыставок, орденоносцы Робия Косымова из колхоза Сталина, Холматова из колхоза Молотова, Кодырова из колхоза Ворошилова.

В 1939 году лучшие червоводы добившие, значительных успехов в шелководстве награждены: из колхоза «Путь Сталина» Науского района Атабаева Зурбиби большой серебряной медалью ВСХВ, в 1940 году Канибадамский шелковод Джонон Урунова была награждена серебряной медалью ВСХВ и высшей правительственной наградой орденом Ленина.

В Согдийской области. работали всемирно известные мастера высоких урожаев коконов, кавалер ордена Ленина Джурабой Турсунов, герои социалистического труда Мирашурова Битоира из колхоза Саидкурган Спитаменского района, Джонон Урунова из Канибадамского района.

В целях удовлетворении потребности в грене шелководов области в 1957 году был введен в строй новый гренажный завод оснащённый технологическими оборудованием отвечающее всем требованием технологии грено производства. Новый грен завод до 1997 года поставлял качественные грены тутового шелкопряда по Согдийской области. После распада Союзных республик завод перестал произвести грены. А для нужд шелководов грена тутового шелкопряда закупается из Китая. В настоящее время в республике функционирует Республиканская опытная станция шелководство, где ученными и сотрудниками проводятся научно-изыскательные работы по созданию местной породы тутового шелкопряда.

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ИНТЕНСИФИКАЦИЯ СЕЛЕКЦИОННЫХ ПРОЦЕССОВ И ПРОГНОЗИРОВАНИЯ ШЁЛКОВОЙ ПРОДУКТИВНОСТИ ТУТОВОГО ШЕЛКОПРЯДА

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Данная научная исследования посвящена к изучению некоторых вопросов ускорения селекционных процессов с помощью основного параметра - шёлкоотделительной железы самой гусеницы тутового шелкопряда и её связи с биологическими, хозяйственно-ценными признаками.

Шелководство является одним из ведущих отраслей сельского хозяйства Таджикистана. Несмотря на специфические природно-климатические условия и наличие существенно отличающихся между собой географических зон, в которых выкармливаются гусеницы тутового шелкопряда, в республике до настоящего времени не разработаны эффективные пути, методы селекционно-племенных работ.

Несмотря на остроту проблемы в настоящее время проведением комплексных исследований выведены и районированы высокопродуктивные породы тутового шелкопряда- Таджикистан -1, Таджикистан -2, Худжанд-1 и Худжанд -2, которые превосходят по основным биотехнологическим показателям раннее выкормленные и завезённые зарубежные породы и гибриды. В настоящее время главной задачей отрасли шелководства Таджикистана является развертывание селекционно-генетических исследований, направленные на создание пород и гибридов шелкопряда, а также интенсивных методов их внедрения.

На начальных этапах развития селекционных работ наиболее пригодны простые в выполнении и быстрые методы оценки и отбора селекционных семей и индивидуумов. К категории таких можно отнести методы прогнозирования шелковой продуктивности по степени проявления отдельных признаков и свойств на ранних стадиях развития тутового шелкопряда.

Известно что, шелковая масса синтезируется в шелкоотделительной железе гусеницы. Количество синтезируемого шелка во многом зависит от роста и развития этого важного органа и других систем личинки, участвующих в переваривании, усвоении питательных элементов и синтезировании шелка.

Интересы интенсификации селекционного процесса и повышения его эффективности требуют разработки методов раннего прогнозирования шелковой продуктивности на основе изучения закономерностей роста и развития шелкоотделительной железы и корреляционных взаимосвязей параметров этого органа с основными признаками продуктивности. Исходя из этого наиболее верный и объективный способ прогнозирования шелковой продуктивности возможно разработать на основе ис-

пользования параметров шелкоотделительной железы гусениц тутового шелкопряда, которая способствует ускорению намечаемой целей селекции.

Создание метода предсказания степени проявления признаков шелковой продуктивности избавит селекционеров от больших и трудоемких выкормок, продолжительных анализов и откроет возможности вовлечения в селекцию большего количество семей.

Для решения поставленной задачи ежегодно в весенний и летний сезоны выкармливали гусениц коллекционных и перспективных пород Багдадская, Китайская, Советская 5 меченная по полу на стадии грены и новые породы Таджикистан-1 и Худжанд-1.

Показатели массы шелкоотделительной железы и гусеницы по возрастам развития шелкопряда

Таблица 1.

Наименование пород	Конец III возраста		Конец IV возраста		Конец V возраста	
	масса шелкоотдели-тельной железы, мг	масса гусеницы, мг	масса шелкоотдели-тельной железы, мг г	масса гусеницы, мг	масса шелкоотдели-тельной железы, мг	масса гусеницы, мг
Багдадская	4,77	274,4	38,4	1217,5	1348,0	4986,1
Советская 5 самки	3,76	225,5	41,0	1239,9	1469,1	4402,0
Советская 5 самцы	4,09	214,8	49,4	1204,1	1603,8	4294,5
Китайская 7х9	4,67	259	29,7	1185	1396	4216,2
Таджикистан-1	5,21	328,6	65,1	1526	1882	5294,7
Худжанд-1	5,19	332,1	70,2	1537	1779	5286,8

Отражённые данные таблицы 1 свидетельствуют о том, что наблюдаются определенные изменения в массе шелкоотделительной железы по возрастам развития гусениц. К концу пятого возраста достигается максимум этого показателя, которые показывают, что масса шелкоотделительной железы является признаком, изменяющимся в зависимости от породного состава. Замечено, что дифференциация пород по массе шелкоотделительной железы начинается уже с конца третьего возраста. Так, наименьшая масса шелкоотделительной железы к концу III возраста обнаружена именно у пород Багдадская (4,77 мг) и меченой по полу на стадии яйца породы Советская 5 (3,76-4,09 мг). Породы Таджикистан-1 и Худжанд-1 отличаются существенно повышенной массой шелкоотделительной железы уже с третьего возраста гусениц. (5,21-5,19 мг) соответственно. По этой причине нами были определены соотношения между этими признаками, т.е. выявляли долю шелкоотделительной железы в массе гусеницы по возрастам, которая к концу пятого возраста достигает своего максимума и варьирует от 0,2703 до 0,3734 .

Из этого положения можно придти к выводу о том, что в пятом возрасте следует организовать обильное кормление гусениц с целью активного роста шелкоотделительной железы и накопления максимального объема шелковой массы в ней.

Результаты наших экспериментов в определенной мере вскрывают причины происхождение высокопродуктивных и низкопродуктивных пород тутового шёлкопряда.

Так, повышенная продуктивность породы в определённой степены зависит от опережающем росте и развитии шёлкоотделительной железы. В больших по объему железах, очевидно синтезируется больше шелка, который реализуются на образование шелковой оболочки повышенной массы.

Параметры шелкоотделительной железы к концу пятого возраста и продуктивные показатели пород тутового шелкопряда

Таблица 2.

Наименование пород	Кратностьувеличения массы шелк. железы к концу V возраста	**Масса кокона, г**	Масса шелковой оболочки, мг	Шелконосность, %
Багдадская	286,8	1,82±0,002	319±17	17,5±0,7
Советская 5 самки	386,6	1,74±0,001	389±21	22,3±1,2
Советская 5 самцы	391	1,68±0,001	446±20	26,5±1,5
Китайская 7х9	379,2	1,71±0,002	386±19	22,5±1,3
Таджикистан-1	396	2,12±0,002	513±18	24,1±1,2
Худжанд-1	397	2,09±0,003	502±16	24,1±1,3

Данные табл. 2 подтверждают изложенную выше гипотезу и убедительно доказывают то, что породы тутового шелкопряда существенно отличаются по темпу роста шелкоотделительной железы. При этом наблюдается четкая зависимость этого показателя от уровня продуктивности пород. Если масса шелкоотделительной железы к концу пятого возраста по сравнению с массой в третьем возрасте увеличилась у малошёлконосной породи Багдадская в 286,8 раза, то у высокопродуктивных пород кратность увеличения варьирует 379,2- 397 раза. Из полученных данных можно сформулировать такую важную закономерность, как наличие определенной зависимости между темпом роста массы шелкоотделительной железы, фактической массой шелковой оболочки кокона и шелконосностью, а также породы, характеризующиеся максимальной массой шелкоотделительной железы, с быстрыми темпами роста этого органа, синтезируют и продуцируют больше шёлка, и следовательно, завывают коконы с тяжелой шёлковой оболочкой и шелконосностью.

Изучение динамики роста шёлкоотделительной железы представляет огромный интерес в деле установления глубинных причин различий пород и индивидуумов по уровню шёлковой продуктивности. Опережающие темпы роста шёлкоотделительной железы в пятом возрасте является ярким доказательством того, что именно в этом возрасте происходит окончательное формирование, развитие железы, синтез и накопление шёлковой массы в ней. Для того, чтобы добиться завивки полноценных высокошёлконосных коконов необходимо бесперебойно обеспечивать гусениц качественным листом шёлковицы в достаточном количестве.

Таким образом необходимость интенсификации селекции тутового шёлкопряда и повышения её эффективности настоятельно требует разработки способов раннего прогнозирования шёлковой продуктивности. Изучение закономерностей роста и развития шёлкоотделительной железы и её взаимосвязи с хозяйственно ценными признаками даёт ценный материал для разработки метода прогнозирования проявления признаков продуктивности шёлкопряда.

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ИНТЕНСИФИКАЦИЯ СЕЛЕКЦИОННЫХ ПРОЦЕССОВ И ПРОГНОЗИРОВАНИЯ ШЁЛКОВОЙ ПРОДУКТИВНОСТИ ТУТОВОГО ШЕЛКОПРЯДА

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Выведение новых высокопродуктивных пород и гибридов тутового шёлкопряда является одно из ведущих факторов повышения урожая коконов. Селекционные исследование безусловно определяют целы и задачи, по обеспечению необходимых параметров для выведения ценных материалов. По этому интересы интенсификации селекционных процессов и повышения его эффективности требуют разработки методов раннего прогнозирования шёлковой продуктивности на основе изучения закономерностей роста, развития шёлкоотделительной железы и её связей с основными биологическими показателями. Проведённая научная исследования и полученные данные свидетельствуют о том, что наблюдается определённые изменения в массе шёлкоотделительной железы по возрастам развития гусениц. К концу пятого возраста достигается максимум этого показателя в зависимости от породного состава в пределах 1348,0 мг у низкопродуктивной Багдадской породы и 1882 мг у высокопродуктивной породы Таджикистан-1. По абсолютным показателям массы шёлкоотделительной железы и массы самой гусеницы определены соотношения параметров которые варьируют от 0,2703 до 0,3734. Из этого положения можно придти к выводу о том, что в пятом возрасте следует организовать обильное кормление гусениц с целью активного роста шёлкоотделительной железы и накопления максимального объема шёлковой массы в ней. Изучение динамика роста шёлкоотделительной железы представляет огромный интерес в установлении глубинных причин различий пород по продуктивности и это положения о необходимости интенсификации селекции тутового шёлкопряда, служить основанием для разработки способов раннего прогнозирование шёлковой продуктивности.

Ключевые слова: *интенсификация, порода и гибрид, хозяйственно- ценные показатели, масса гусеницы, шёлкоотделительная железа.*

INTENSIFICATION OF SELECTION PROCESSES AND PREDICTION OF SILK PRODUCTIVITY OF THE SILKWORM

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Summary

Breeding new highly productive breeds and hybrids of the silkworm is one of the leading factors in increasing the yield of cocoons. Breeding research unconditionally determine the goals and objectives for providing the necessary parameters for the breeding of valuable materials.

Therefore, the interests of the intensification of breeding processes and increasing its efficiency require the development of methods for early forecasting of silk productivity based on the study of patterns of growth, development of the silk gland and its relationships with the main biological indicators. Conducted scientific research and the data obtained indicate that there are certain changes in the mass of the silk-gland by age of the development of caterpillars. By the end of the fifth age, a maximum of this indicator is reached, depending on the breed composition in the range of 1348.0 mg in the low-productive Baghdad breed and 1882 mg in the highly productive breed Tajikistan-1. In absolute terms, the mass of the silk-separating gland and the mass of the caterpillar itself are determined by the ratio of parameters, which range from 0.2703 to 0.3734. From this position it can be concluded that at the fifth age it is necessary to organize abundant feeding of the caterpillars in order to actively grow the silk-secreting gland and accumulate the maximum volume of the silk mass in it. The study of the growth dynamics of the silk gland is of great interest in identifying the underlying causes of breed differences in productivity and these are provisions on the need to intensify the selection of mulberry silkworm, to serve as the basis for developing methods for the early prediction of silk productivity.

Keywords: intensification, breed and hybrid, economically valuable indicators, caterpillar mass, silk gland.

A B S T R A C T S

I. SERICULTURE REVIVAL AND COUNTRY REPORTS

A SURVEY POSSİBLE REASONS OF NON-SPİNNİNG SYNDROME İN SERİCULTURE INDUSTRY AND ITS INCİDENCE İN TURKEY

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ABSTARCT

In recent years, cases of the non-spinning syndrome have been observed in different cities of Turkey. We don't know the exact reason right now, but it is one possibility that pesticide application to crop and vegetable fields especially close to mulberry trees might be involved. If this is really the case, the most common route of pesticide is exposure through mulberry leaves contaminated with pesticides. Pesticides have problem of residue in the mulberry leaves which inturn affect silkworm .Silkworm larvae are extremely susceptible to the ınsect growt regulators (IGRs) which induces a developmental arrest in fifth instar larvae at very low doses and also cause 'non-spinning syndrome. IGRs are a group of consisting of pyriproxfen, fenoxycarp, hydroprene and methhoprene and they act by maintain high the levels of juvenile hormone (JH) in the insect and also they molt inhibitors.

Researchers have extensively used larval mortality, non-spinning sendrome and, cocoon yield as role parameters to assess the toxicity of pesticides or physical agents. We selected of 14 breeder cocoon producers in two different regions (Bursa and Bolu) and analyzed their cocoon production records in years between 2016 - 2018 to detemine the effect of pesticide. Additionally, we took the hemolymph samples from the larvaes and analyzed for their pesticide levels. The results clearly indicated that hemolymphs obtained from the 3 villages in Bursa region contain hydropene more than 0.01 ppm. This is a very surprising result because hydropene is not registered as a pesticide in Turkey and in EU countries and must be not legally sold in the markets. Exact source of hydropene is not clear, but we know that hydropene is a ınsect growt regulator and used for stored-product insect control programs in the United States.

In addition to high hydropene levels in hemolymphs samples, we also observed that duration of the fifth instar prolonged up to 13-18 days and most of the larvaes died before spinning, became pupae did not survive to adulthood, but die in cocoon.Probably in a result of this problem, cocoon yield decreased by about 74% while the rate of defective cocoon was increased from 14.80 % to 64% in Bursa region during 2018.In Bolu region, on the other hand, hydroprene levels were determined under detection limits, and In 2018 the decrease in cocoon yield is 9.6% , the increase in the rate of defective cocoon is 6%. As a result in Bolu cocoon yield was found more high and defective cocoon rate was lower that the values seen in Bursa.

The survey study was carried out determine the mode of action of hydrophrene on silkworm (Bombxy mori L.) and to identify the factors that cause non-spinning sendrome. Also, the factors affecting the metamorphosis and molting processes were discussed. However, further research is needed on where or how Hydropen is used in agricultural areas and its effects on non-target insects.

Key words: Non- spinning sendrome, Bombxy mori L, IGRs, Hydroprene, Cocoon yield.

SERICULTURE IN GUANGDONG PROVINCE, SOUTH CHINA

A successful model for tropical and subtropical sericulture

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ABSTRACT

Guangdong Province is located in subtropical zones in the southern China, has a sericulture history of more than 2,000 years, which produced the sericulture world record-breaking annual amount of rearing silkworm and the annual cocoon yield of unit area. The Guangdong Silk-Tex. Corporation Group, which is a province-owned and trade-industry-agriculture-integrated corporate group, in cooperation with University and Institute, promotes the trade-oriented rational development of sericulture in Guangdong, and takes the lead in the silk industry as one of the top 500 biggest import and export enterprises in China. This paper reviewed the development of sericulture in Guangdong within the recent period. It will look back the Changes of sericulture over forty years in Guangdong, which included Succeeding in the strategic transformation of sericulture area and contributing to the prosperity of poor areas and foreign exchange-earning, and making huge improvement on the quality of silk by achieving bivoltine rearing all year around. Consequently, Guangdong could select bivoltine breeds suitable for room rearing according to climate condition and mulberry growth. Here we also will share the successful experiences of developing sericulture in Guangdong. The results show that sericultural science and technology serves as a key point to maintain sustained development and promote sericulture in Guangdong. During the past 40 years, research, education and productive branches in Guangdong, in close cooperation, have conducted comprehensive research on selection and breeding of mulberry trees and silkworms, technologies of mulberry cultivation and silkworm rearing, disease prevention and combined utilization of sericulture resource. The major achievements that greatly promote sericulture development in Guangdong are as follows, upgrading the mulberry breeds, introduction of excellent silkworm varieties, regulating and innovating on breeding technologies of healthy varieties, developing a series of disinfection and treating chemicals, building and promoting a high-quality and high-yielding sericultural technology system.Guangdong's Sericulture is a **successful model for tropical and subtropical sericulture.**

Key word: Silkworm, mulberry, sericulture, silk industry, Guangdong.

NEW STUDIES ON SERICULTURE IN POLAND

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ABSTRACT

In view of utilization of waste and environmental protection, sericulture focuses these days not only on the cocoons production, but also on other ways that can benefit the farm's economy. It is necessary to find new sources of income for small-scale farmers not only through cocoon selling, but also by the multidirectional uses of by-products. Silkworms breeding provides a cheap source of biomass, which may be a good material in biogas production.

New studies revealed that silkworms breeding waste and caterpillars excreta are characterized by a biogas yield comparable to commonly used substrates of agricultural origin. This examination has been not carried out to date. Thanks to the relatively short time of methane production and the HRT, the high content of dry matter, high methane content, which significantly increases the calorific value of the materials biogas production from silkworm waste and its excreta is more efficient in comparison to common used agricultural manures. Moreover, biogas had a high methane content, which significantly increases the biogas calorific value. Therefore, producing biogas from silkworm breeding waste may be a good source of additional income for small-scale farmers.

Another of the possibilities of breeding waste management is an organic fertilizer. The silkworm excrement-derived organic fertilizer improves the yield and quality of crops and significantly amends the acidity and fertility of soil. This manure does not contain inhibitory compounds, detergents, antibiotics. Therefore, the studied material is an ecologically-friendly fertilizer, which may be used in other bio-crops.

Keywords: Breeding waste, biogas production, energy, organic fertilizer.

BIOTECHNOLOGICAL ADVANCES IN SERICULTURE, SILK PROCESSING AND RESOURCE SAVING IN UZBEKISTAN

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ABSTRACT

Thisreviewexposesthelongtrailsofexploratoryinvestigationsandintensiveresearchcarriedoutinthefieldofsericultureandsilkindustry inUzbekistanforaperiodofthirtyyears.Ithighlightsthedevelopmentofbiotechnologicalapproachesemployedinsericulture,cocoon processingand resourcesavinginthesilkindustry.Theexhaustivestudiescomprisedofthrustareas*viz.*,chemicalandbiochemicalcompositionofmulberryleaves,mulberrysilkwormeggs,larvae,pupae andcocoonshellaswellasphysiologyandbiochemistryofnutrition,intricaciesofrespirationandnaturalproductsbiotransformation.Therecipesandmethodsofpreparationofartificialdietsforsilkwormonthebasisof localrawmaterialsandbiotechnologyforitsmassrearinghavebeendevelopedbesidesexplorationoffieldsof itsapplicationincludingspace experiments. Biocontrol methods of mulberry pyralid in IPM

system including by wild and genetically-modified viral and some other bioinsecticides have been studied.
Methodsofbioprotectivepostharvestcocoonprocessingandutilizationofsericultureandsilkindustryraw materialsandwastesforobtainingnewbio-andnano-technologicalproductshavebeenestablished.Asshownbytheresultsoftheresearchconducted,thechosendirectionprovedtobefruitfulenoughanditsfurtherdevelopmentwillresultina wasteless,diversifiedandprofitableproductionof high-techsilkproductsandgoods

Keywords: mulberry silkworm, artificial diet, nutrition biotechnology, space experiment, pest biocontrol, energy-resource saving, silk bionanotechnology.

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SERİCULTURE İN AZERBAİJAN

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ABSTRACT

Currently, silkworm production in Azerbaijan is organized in 30 regions of the country. In 2018, the production of silkworm cocoons will reach 500 tons, and in the future, by 2025, these volumes will grow and will be brought up to 6 thousand tons. If we look at the history of the silk industry, we will see. in 1970, cocoon production was 3,700 tons. In just ten years, these figures have grown to 5 thousand tons. Sheki Silk Mills, which employed thousands of people, worked effectively. Due to the shortage of raw materials, the plant suspended its activities. Today he works, and 600 people are already working here. Cocoon production was reduced annually and in 2015 it was reduced to 200 kg. For two years, the volume of deliveries of cocoons increased to 244 tons. In 2017, cocoon collectors from Zardab, Fizuly, Zagatala, Sheki, Agjabedi, Agdam, Barda, Gakh, Kurdamir, Balaken regions achieved the greatest success. More than three thousand families in rural areas are provided with materials and subsidies. Next year, villagers intend to collect 500tons of cocoons, and already in 2019-1000 tons.

Keywords: silkworm production in Azerbaijan, the history of the silk industry, the volume of deliveries of cocoons.

SERICULTURE IN GEORGIA AND THE STATE SILK MUSEUM

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ABSTRACT

The presentation talks about the long history of sericulture in Georgia: different points of view about the starting date, history of development throughout the centuries and its importance for Georgian identity. Georgian silk production traditions have been listed among the intangible cultural heritage of the country in 2018. This fact underlines the importance of considering the revival of silk production in Georgia.

Furthermore, the presentation focuses on the 19th century situation worldwide (spread of pebrine disease) followed by the initiative of Caucasian Sericulture Station establishment. The ultimate goal of the station was to study the local species of silkworms, as well as to supply locals with healthy silkworm eggs. Moreover, the Caucasian Sericulture Station held various educational activities and free courses for public. Frequent expeditions were organized across the Caucasus as part of their scientific work, followed by published reports.

The samples gathered throughout the expeditions enriched the collections kept in the museum and library. Unfortunately, the Caucasian Sericulture Station stopped functioning over time. Later, during the Soviet period the station started to function as a research institute again, having changed its name several times. However, the complex was gradually destroyed and various buildings were demolished towards the end of the 1960s. Only the main building and the former residential house for the employees remain today, out of which just the main building retains the function and currently serves as the State Silk Museum of Georgia.

To this day, the sericulture station has retained only a museum function with a focus on its 130 years of history, working actively locally, as well as internationally. Nowadays, apart from maintaining its collection and authentic atmosphere, the museum is also dedicated to implementing educational programs and being open to new initiatives, such as contemporary art projects, various workshops, etc.

Keywords: Silk, sericulture, Caucasus, museum, education, art.

II. MORICULTURE

ASSOCIATION OF LEAF ANATOMICAL TRAITS WITH POWDERY MILDEW RESISTANCE INMULBERRY (*MORUS* SPP.) GERMPLASM OF THE QUEEN SIRIKIT SERICULTURECENTER (SISAKET)

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ABSTRACT

Association of leaf anatomical traits with powdery mildew resistance of 35 genotypes of mulberry were studied by scanning electron microscope. This study was conducted during 2014-2015 at The Queen Sirikit Sericulture Center (Sisaket). The present investigation was undertaken to find out the two types pf trichome (glandular and non-glandular types) were observed on the both the leaf surfaces, adaxial and abaxial of all the mulberry genotype studied. On an adaxial surface, was found the Yai-Sisaket had the lowest value (11.8) while of Noi had highest value (63.0) of the trichome density. On the other hand, distribution of the trichome on abaxial surface, Sisaket-33, showed the lowest value (30.80) and Hung, showed the highest value of the trichome density. However, the ratio of glandular (GT) and non-glandular (NGT) in a particular genotype influenced the rearing parameter, higher the ratio better the rearing performance in Somyai (0.591). For the stomata density on abaxial surface, Hang-plalod and Hung had low density indicated that more penetration resistance to powdery mildew conidia. Cluster analysis of mulberry 35 genotypes using the unweighted pair group method with an arithmetic average (UPGMA).

The result of this study showed that the trichome density and the stomata density are useful tool to be promising markers for screening powdery mildew resistance in breeding program.

Keywords: Mulberry, Powdery mildew, Leaf anatomical, Trichome, Stomata.

EFFECTS OF TEMPERATURE, RELATIVE HUMIDITY AND RAINFALL ON EPIDEMIOLOGY OF MULBERRY RED RUST

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ABSTRACT

The observation was taken at The Queen Sirikit Sericulture Center)Khon khaen(,)Nan(,)Srisaket(,)Surin (and)Udon Thani (Data of temperature, relative humidity, rainfall and occurring of mulberry red rust was recorded during May 2012 – April 2013 in mulberry variety Buriram 60 plantation. The data of disease was recorded diagonally from 10 plants, 5 branches per plant and 10 leaves per branch in each diagonal line. The data included the disease occurring date, severity and other disease of the mulberry tree. There were 3 locations that symptom of the rust occurred. At Surin, the occurring was' the most severe)level 5-6 (during December to January. Meanwhile, it was found during August-September)level 2 (and November-January)level 2-3 (at Nan, and during July)level2) at Khon khaen.

It is found from the 3 locations that lowering of rainfall, temperature and relative humidity trends to induce the occurring of mulberry red rust. Supplying of sprinkler water during the decrease of temperature and low relation humidity period may reduce the severity of the symptom. The mulberry plant thinningor pruning before the out break may also decrease the severity.

Keywords: Mulberry, Red rust, Temperature, Environment.

EFFECTIVENESS OF MULBERRY TREE VARIETIES AND HYBRIDS IN LANDSLIDE ZONES

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ABSTRECT

Mulberry tree selected varieties which grow large (*Triploid 13*) should be planted on the territories damaged by erosion, and also in other places considering the specificity of the location. *Triploid 13*, according to M. Shablovskaya, has the following advantages in compare with other varieties:

- Fast and extensive grow; strong root system; As a leafy plant, it can be useful to protect soil against water erosion and landslides;
- Mulberry tree leaf is a permanent and inalterable food for silkworm, particularly during spring feed when silkworm is in its final stage of growth.
- In autumn, dry, coarse leaves and twigs of mulberry is fine, raw material for production of non-traditional food for cattle -Nekeri, which is 8 % more nutritious than the forest hay, and 46% more than cattle food produced from maple tree, it exceeds by 16,5 % the meadow-hay food, and is equal with food produced from alfalfa for its nutrition qualities.
- *Triploid 13* is a fast growing tree, so it should be successfully planted on the plots selected in advance.

Triploid 13 is permanent food for silkworm; mulberry fruit is good for production of canned food; and in autumn, the mulberry coarse leaves are nutritious food for cattle. The mulberry plantations are managed according to a three-year plan drafted earlier.

In autumn, from 1000 kg of mulberry tree course leaves can be obtained 450 kg air dry leaf, the nutrition quality of which corresponds to 255 kg food units. The cost price of 1 kg of the product is 0.7 Georgian lari, and its profitability is 101%.

Keywords: Mulberry, erosion, silkworm, production, food, plantations.

PRODUCTION OF ENVIRONMENTALLY FRIENDLY SOLID BIOFUEL FROM MULBERRY BRANCHES

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ABSTRACT

At the current stage, in the world has been noted the trend of growth of usage of solid biomass for the fuel purposes. As a result of gradual reduction of energy resources is very actual a search and use of alternative energy sources. Instead of habitual fuel sources, the emphasis has been placed for processing of the wood remains and use in the form of briquettes and pallets, which distinguished by high calorific value.

Advantage of modern solid biofuel is also their easy transportability and storage. Production of solid biofuel demands carrying out several technological processes (drying, separation, pressing, etc.). For optimization of process of briquetting at the Georgian technical university was developed the press of modern type and regime parameters, necessary for briquetting process,. In case of creation of a powerful intensive plantation of a food supply of silkworm breeding on 1 hectare of a plantation it is possible to receive 20 t of leaves of a mulberry and 20 t of one-year branches, of which it is possible to produce 8-10 tons of biofuel, to which is necessary to add wood shaving to form the briquettes. In case of the proper use of noted technologies, increase in additional profit in silkworm breeding is possible.

Keywords: Mulberry, solid biomass, calorific value, briquettes, energy resources.

NEW TECHNOLOGY OF RECEIVING THE GRAFTED AND HYBRID SAPLINGS OF A MULBERRY BY THE ACCELERATED METHOD

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ABSTRACT

Restoration of food supply of the sericulture industry of Georgia demands a large amount of the grafted and hybrid saplings of a mulberry. By the existing agro rules, cultivation of saplings of a mulberry requires 3 years that prevents fast restoration of the industry and promotes increase in prime cost of landing material. Receiving saplings of mulberry is possible by accelerated methods of grafting, including the method of carrying out a so-called prelanding grafting which is carried out by the mechanized way by means of the grafting device of a grapevine OMEGA. This method of grafting is carried out in the building on saplings, ready for landing, and differs in high output and performance of clean and exact cuts on the grafting components. For the carrying out of the grafting is necessary preliminary selection of grafting components, and after carrying out of the grafting, their waxing and stratification in the conditions of warm temperature 18-25^0 and high humidity - 70-80%. The conducted researches showed that this method of the grafting is very perspective and economic. The new technology of receiving hybrid saplings means sowing of seeds right after preparation (July) in plastic containers with the humus soil, replanting ofseedlings to the open ground for the second year and for the third year carrying out of the first

operation (cuttings) which is carried out at the height of 10 cm from a root neck. When using such method of operation, the plants do not develop flowers and fruits that is very important for receiving clean fodder leaves.

Keywords: Sericulture, mulberry, grafting, seedlings, modern technologies.

III. *SILKWORM GENETICS AND BREEDING*

REGULATION OF *BMNLK* EXPRESSION BY MICRORNA IN SILKWORM EGGS

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ABSTRACT

MicroRNA (miRNA) is commonly found in animals, plants and nematode organisms. It has a wide range of biological functions by specific binding to degrade target gene mRNA or inhibit protein translation. NLK is a serine / threonine protein kinase that regulates cell cycle progression from G2 to M phase, therefore influences cell division, cell fate and blueprint for embryos. In this study we used RNA hybrid for target prediction of NLK and found that bmo-miR-3384-3p has a target site on *BmNLK* 3'UTR. In order to verify the role of bmo-miR-3384-3p in silkworm embryonic development and regulation of *BmNLK*, real-time qPCR was used to determine the expression of bmo-miR-3384-3p and *BmNLK* in silkworm diapauses-related eggs and acid-treated eggs at day 3-7. We found that following acid treatment the significant up-regulation of *BmNLK* is closely correlated with the significant down-regulation of bmo-miR-3384-3p. Dual Luciferase Reporter (DLR) assays have also shown that bmo-miR-3384-3p has an inhibitory effect on *BmNLK* expression.

Keywords: Bombyx mori, *BmNLK* , MicroRNA, bmo-miR-3384-3p.

*BM*FADD EXPRESSION INVOLVED IN PROMOTING APOPTOSIS IN SILKWORM *BM*N CELLS

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ABSTRACT

Fadd (Fas associated death domain protein) is a kind of intracellular protein, which is known to transmit apoptotic signal by connecting death receptors on membrane and death proteinases in the cytoplasm. In this paper, we cloned the *Bm*Fadd gene by RT-PCR using cDNA

from the total RNA isolated from *Bm*N cells. Its sequence was 666bp long. Upon comparison of Fadd sequence in mammals and silkworm, we found that they were different in their structures, no Death effector domain (DED) but a Death domain (DD) does exist in *B. mori*. We conducted the *BmFadd*-siRNA interference and overexpression in *Bm*N cells. The results indicated *Bm*Fadd served as a positive factor in promoting *Bm*N apoptosis. Our researches also showed that *BmFadd* silencing led to a significant decrease of apoptosis in any of the UVC and Actinomycine D present in normal conditions. Furthermore, three *BmFadd*-siRNAs showed different effects on transcriptional expression, caspase activity and apoptosis. siRNA-1 and siRNA-2 were superior to siRNA-3. Structure analysis revealed that the target sites of siRNA-1 and siRNA-2 are located on the N-terminal region of *Bm*Fadd sequence, while siRNA-3 is located on the C-terminal Death Domain region. In addition, a comparison between the *Bm*Fadd N-terminal region and a region in prodomain of *Bm*Dredd revealed a high similarity, meanwhile, the transcriptional level of *BmDredd* in *BmFadd* interfered or overexpressed cell groups demonstrated a similar tendency with the change of transcriptional expression of *Bm*Fadd. At the same time, the results of *Bm*Fadd location experiment results also showed that Actinomycin D treatment increased the expression level of *Bm*Fadd, and combined with the flow cytometry experiments, which further indicate that *Bm*Fadd expression involved in promoting apoptosis in *Bm*N cells. The results may imply an interaction between *Bm*Fadd and *Bm*Dredd in the apoptosis pathway.

Keywords: Silkworm *Bombyx mori* (*B. mori*), BmFadd; Death domain (DD), Death effector 54 domain (DED), apoptosis.

RELATIONSHIPS BETWEEN *BMSMO* MEDIATED THE HEDGEHOGSIGNALING PATHWAY AND ADIPOGENESIS IN SILKWORM, *BOMBYX MORI* L

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ABSTRACT

Hedgehog (Hh) signaling pathway regulates the adipocyte differentiation, yet its regulatory mechanism of different species is still an open question. The bioinformatics analysis of the amino acid sequence of *Bm*Smo found that it is a conserved protein. We examined the effects of exogenous over-expression of *BmSmo* gene in cultured *Bm*N cells, and did the RNA interference experiments of *BmPtc*, *BmFu* and *BmCos2*. Functional analysis of these components in *Bm*N cell revealed that Smo, Ci and Fu are positive regulatory factors, while Ptc and Cos2 are negative regulatory factors of the Hh signaling pathway. These data are consistent with the idea that activated Hh pathway has a negative effect on AP2, while depressed Hh pathway has a positive effect on AP2, which implies that activated Hh pathway may inhibit silkworm adipose differentiation, and depressed Hh pathway may promote silkworm adipose differentiation. By adding purmorphamine and cyclopamine in silkworm *Bm*N cells or treated 5th instar larvae with purmorphamine and cyclopamine respectively, the results show that purmorphamine is the specific activator of the Hh signaling pathway while cyclopamine is the specific inhibitors of the Hh signaling pathway. In conclusion, the studies supported the notion that the activated Hh

pathway inhibits adipocyte differentiation, and depressed Hh pathway activates adipocyte differentiation in *Bombyx mori* L**.**

Keywords: silkworm *Bombyx mori* L (*Bm*), Hedgehog (Hh) signaling pathway, *BmSmo*, Adipogenesis, Adipocyte fatty-acid-binding protein (AP2).

MEASURES TO PERFECT BIOTECHNOLOGICAL CHARACTERISTICS OF GEORGIAN MULBERRY SILKWORM COLOR-COCOON BREEDS

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ABSTRACT

The paper considers the results of improvement methodused for perfection of biotechnological characteristics of old Georgian color-cocoon breeds obtained by folk-selection "Kakhuri Mtsvane" ("Kakhuri Green) and "Narinjisperi" ("Orange Color"). These breeds are characterized by high indices of grain vivification and worm viability and they form important selection material, and thanks to their high indices they are preserved in the genofond. Because of remoteness of these breeds their cocoon and shell masses and respectively silk capacity have decreased. To improve biotechnological characteristics of Georgian breeds "Kakhuri Mtsvane" and "Narinjisperi" we used Japanese breeds of the corresponding color-cocoon "Japanese Green" and "Khankou" as components for improving. Method developed by E.Mikhailov and P.Kovaliov enabled us to improve cocoon shell of Georgian color-cocoon breeds by 100-120 mg and silk capacity by 0.5-0.7 %.

Experiments proved that the tested breeds ("Kakhuri Mtsvane" and "Narinjisperi" possess great potential, therefore it is rational to continue works and to still more improve their biological characteristics.

Keywords:mulberry silkworm, selection, silk cocoon.

IV. *SILKWORM REARING TECHNOLOGY AND PATHOLOGY*

BOMBYX MORI NUCLEOPOLYHEDROVIRUS UTILIZES A CLATHRIN AND DYNAMIN DEPENDENT ENDOCYTOSISENTRY PATHWAY INTO BMN CELLS

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ABSTRACT

Bombyx mori nucleopolyhedrovirus (BmNPV) is a leading cause of silkworm mortality and economic loss to sericulture. The entry ofBmNPV budded virus (BV) into host cells is a fundamental process required for the initiation of infection. However, our understanding of the mechanism of virus entry is limited and it is unclear whether BV enter BmN cells via clathrin-mediated endocytosis. In this study, we found that BV enter BmN cells through a low-pH-dependent endocytosis pathway. Inhibition assays, transmission electron microscopy (TEM) analysis, and small interfering RNAs (siRNAs) knockdown assays revealed that BV entry into BmN cells is mediated by clathrin-dependent endocytosis. Moreover, after treated with dynasore, an inhibitor of dynamin, BmNPV entry was markedly reduced, indicating that dynamin also participates in the efficient internalization of BmNPV. In addition, suppression of Rab5, Rab7 or Rab11 through siRNAs demonstrated that BV requires early and late endosomes for endocytosis in infection of BmN cells. Taken together, BmNPV uses a clathrin- and dynamin-mediated endocytic pathway into BmN cells that requires participation of Rab5 and Rab7 but not Rab11.

Keyword: Bombyx mori, fundamental process, Inhibition assays, transmission electron microscopy.

NETWORKS OF PROTEIN-PROTEIN INTERACTIONS AMONG STRUCTURAL PROTEINS OF BUDDED VIRUS OF *BOMBYX MORI* NUCLEOPOLYHEDROVIRUS

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ABSTRACT

Baculovirus produce two kinds of enveloped virion phenotypes named budded virus (BV) and occlusion-derived virus (ODV). Although they contain identical genetic material, they have different envelope structures and different functions in the viral infection cycle. The structural proteins of baculovirus are well studied, however, the interactions between these structural proteins remains uncleaßr. In order to reveal protein-protein interactions among viral structural proteins and their associated proteins of the budded virus of *Bombyx mori* nucleopolyhedrovirus (BmNPV), the yeast two hybrid (Y2H) system was used to evaluate the interactions of 27 viral gene products. 57 interactions were identified with 51 binary interactions and 6 self-associations after direct-cross Y2H assays. Among them, 8 interactions were further confirmed by co-immunoprecipitation assays. Based on the direct-cross Y2H assays, three types of protein interactions were identified. These include complexes ofcapsid proteins, envelope proteins, and capsid/envelope-associated proteins) and these formed 5 complex interaction networks. VP39, 38K, and FP were identified to interact with most of the viral proteins, and may form main structural elements of the viral architecture. In addition, each envelope protein was detected to interact with more than one capsid protein. These results indicate that viral structural and structural associated proteins may contribute to the formation of a complete virus through interacting with each other. Finally, a summary of baculovirus protein-protein interactions, comprising 57 interactions identified in this study plus 63 interactions reported elsewhere, is schematically

presented. This information should contribute to understanding the mechanism of virion production and structure, as well as elucidating the mechanism of baculovirus infection.
Keywords: phenotypes, virus, genetic material, protein.

IDENTIFICATION OF A NOVEL HOST PROTEIN SINAL10 INTERACTING WITH GP64 AND ITS ROLE IN BOMBYX MORI NUCLEOPOLYHEDROVIRUS INFECTION

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ABSTRACT

Bombyx mori nucleopolyhedrovirus (BmNPV) is the most important pathogen of Bombyx mori, silkworm and causes severe losses in the silk industry. During the virus infectious cycle, budded virus (BVs) and occlusion-derived virus (ODVs) particles, which have identical genetic content but different phenotypes, are produced. The envelope glycoprotein GP64, specific in BVs, is involved in host cell receptor binding and is sufficient to mediate membrane fusion during the viral entry. However, the host cell factors, interacting with GP64 to mediate BVs infection, are still unknown. In this study, a cDNA library of Bombyx mori cells (BmN) was constructed and yeast two-hybrid screening was used to identify the host cell factors interacting with GP64. One of the eight candidate proteins encoded the E3 ubiquitin-protein ligase SINA-like 10 (SINAL10), was further confirmed through coimmunoprecipitation assays as novel GP64 binding protein. Moreover, overexpression of SINAL10 significantly enhances viral reproduction, and conversely, silencing its expression by small interfering RNAs showed significant inhibitory effects. Collectively, we demonstrated that SINAL10 is a novel GP64-binding protein that stimulates BmNPV proliferation.

BOMBYX MORI NUCLEOPOLYHEDROVIRUS ORF40 IS ESSENTIAL FOR BUDDED VIRUS PRODUCTION AND OCCLUSION-DERIVED VIRUS ENVELOPMENT

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ABSTRACT

ORF40 (*bm40*) of *Bombyx mori* nucleopolyhedrovirus (BmNPV) is a highly conserved gene that is found in all sequenced alphabaculoviruses. To investigate the role of *bm40* in the baculovirus life cycle, a *bm40* knockout BmNPV bacmid was constructed via homologous recombination in *Escherichia coli*. Western blotting analysis revealed that *bm40* is a late gene in the life cycle. Compared with wild-type and repair viruses, the knockout virus exhibited a single-cell infection phenotype. Titration assays confirmed that no infectious budded viruses (BVs) were produced due to the *bm40* deletion. Electron microscopy revealed that Bm40 is required for nucleocapsid egress from the nucleus to the cytoplasm and nucleocapsid envelopment to form occlusion-derived viruses (ODVs) and their subsequent embedding into polyhedra. Confocal microscopy showed that Bm40 was predominantly localized in the nuclei and condensed on the nuclear membrane and polyhedra during the late phase of infection. Taken together, these results demonstrate that Bm40 plays an essential role in BV production and ODV envelopment in the BmNPV life cycle.

BOMBYX MORI NUCLEOPOLYHEDROVIRUS *ORF133* AND *ORF134* ARE INVOLVED IN THE EMBEDDING OF OCCLUSION-DERIVED VIRUSES INTO POLYHEDRA

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ABSTRACT

Bombyx mori nucleopolyhedrovirus (BmNPV) *orf133* (*bm133*) and *orf134* (*bm134*), the orthologs of Autographa californica multiple nucleopolyhedrovirus (AcMNPV) *ac4* and *ac5*, are two adjacent genes with opposite transcriptional orientations and are highly conserved in all sequenced Group I NPVs. A double *bm133-bm134* knockout bacmid was generated to enable the functional study of each gene independently or together. Compared with wild-type and double-repair viruses, deletion of both *bm133* and *bm134* did not affect budded virus (BV) production or viral DNA replication in transfected BmN cells. Electron microscopy revealed that the double-knockout did not affect nucleocapsid assembly, virus-induced intranuclear microvesicle formation or occlusion-derived virus (ODV) production, however, the number of virions embedded in the polyhedra decreased significantly. Further investigations showed that disruption of either gene was unable to recover the defect of ODV occlusion, suggesting that Bm133 and Bm134 are indispensable to the embedding of ODVs into polyhedra. Confocal microscopy analysis showed that Bm133 and Bm134 distributed throughout the whole cell during viral infection and Bm134 concentrated on the mature polyhedra in lysed cells. These results suggest that although Bm133 and Bm134 are not essential for BV or ODV development, they play vital roles in polyhedra morphogenesis.

BOMBYX MORI NUCLEOPOLYHEDROVIRUS F-LIKE PROTEIN BM14 AFFECTS THE MORPHOGENESIS AND PRODUCTION OF OCCLUSION BODIES AND THE EMBEDDING OF ODVS

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ABSTRACT

In group I nucleopolyhedrovirus such as Bombyx mori nucleopolyhedrovirus (BmNPV), the biological functions of F-like protein (Bm14) still remain elusive. Here, we found thatthe deletion of *Bm14* reduced the production rate of infectious budded virusesin cell culture, delayed the lethal time of infected larvae by approximately 26h, and produced less occlusion bodies (OBs). Scanning electron microscopy demonstrated that its disruption affected OB morphogenesis, forming irregular OBs with a pitted surface and irregular profiles. Moreover, almost 45% less DNA was present in OBs produced by *Bm14*-null virus. This reduction in DNA content was consistent with fewer virions embedded into OBs. The titers of occlusion-derived viruses was 7.5 times less in mutant OBs. Western blot analysis revealed that Bm14 is present in the envelope of both BV and ODV. Taken together, Bm14 is a virulence factor that affects OB morphogenesis and production, and the number of ODVs occluded into OBs.

PROBLEMS OF MECHANIZATION IN SERICULTURE

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ABSTRACT

Sericulture consists of four inter-dependent sub-fields: food production - mulberry tree cultivation, cocoon production - raw material or fresh cocoon, cocoon processing and silk-egg production; technological processes of two sub-fields of sericulture are partially mechanized, but food and cocoon production processes - are not, which is one of the negative aspects of this branch and impedes its development. To address this problem effectively, it is necessary to solve some problems, such as, develope technical devices for reeling raw cocoon.

While working on sericulture mechanization problems, focus should be made on technological and mechanization processes of silk thread reeling and silkworm feeding. To make the field efficient, substantial work should be carried out in the direction of food and cocoon production including mulberry tree cultivation and feeding silkworm. One of the reasons which create difficulties in the process of sericulture restoration is existed drawbacks in mechanization of production practice because it is rather hard, time and cost-effective process.

In present conditions, the farmers' activity should be focused on food preparation, cocoon production, reeling and raw silk manufacturing. To accomplish these processes successfully, it is

very important to have technical means and small scale machines and devices. Mechanization of the branch will introduce world standard level structural elements and reduce the difference between urban and rural lifestyle.

The development of new technologies will eliminate the difference and bring closer cocoon manufacturers - farmers and farm cooperatives - and producers, which means that a farmer can take to the market and sell a ready-made product – silk thread. Production of silk material is still distant future perspective.) In this case, technological process of silkworm feeding is changed, and three more technical devices are added: cocoon collecting machine, cocoon cleaner and raw thread reeling simple machine.

Keywords: sericulture, mechanization, cocoon production, technologie, reeling simple machine.

V.POSSIBILITIES FOR USING SILKWORM AND MULBERRY FOR NON-TEXTILE PURPOSES

SILK PROTEINS AS A POLYFUNCTIONAL MATRIX MATERIAL IN THE DEVELOPMENT OF ADVANCED MEDICINES

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ABSTRACT

The use of silk cocoon proteins, fibroin and sericin in medicine and pharmaceutical production is one of promising and high-tech ways of their utilization. These proteins in the form of wastes were originally used as raw materials for the production of protein hydrolysates that possess a wide range of physiological, prophylactic, and therapeutic effects [1, 2]. But these proteins will find a more effective application not in the depolymerized form but in their natural polymeric form characterized by high mechanical and sanitary properties, biocompatibility, biodegradability and self-assembly which are much-needed in the designing, 3D printing and modulation of dosage forms and their properties.

The fibroin property of interconversion from the soluble to the gel and crystalline state allows to create on its basis and, especially, with the participation of sericin, a large variety of drugs with modified properties. This is important in the creation of low-toxic pharmaceuticals for the treatment of metabolic and conformational diseases, especially, in personalized therapy.

The research and development strategy in this area is focused on the selection of suitable raw materials and wastes of the silk industry, on their inexpensive processing into universal initial semi-products for bio-

and nanotechnology, on the development and selection of attainable methods for converting the initial semi-products into bio-sorbents and composites with targeted properties as well as on the methods of incorporating the samples of effective local and foreign medicines, both soluble and insoluble, and also possessing some other specific properties into the silk matrices.

The use of these methods allowed us to obtain samples for testing dosage forms with the inclusion of polyphenolics (based on gossypol, quercetin and its derivatives), proteins (insulin, lysozyme, lipases, phospholipase A_2, phospholipase D), protein hydrolysates (different peptides and amino acids), allapinin and other drugs.

We have examined EM-structure of the obtained samples, there solubility, cumulative releasing of drugs and model substances included in the silk matrices, antioxidant, antimicrobial, enzymatic and other studied activities and properties. The rate of ligands release varied in accordance with its concentration, temperature, pH, content of extragent and the ratio of fibroin and the bio(polymer) additionally introduced into the silk matrices. As shown obtained results silk proteins can be used in creation of large variety of drugs with modified properties.

Keywords:silk proteins, matrix material, advanced medicines.

NEW METHODS IN POLISH SERICULTURE

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ABSTRACT

The newly applied method of genetic material sterilization of mulberry silkworm and disinfection of breeding equipment introduced new standards for the use of bioactive agents in the sterilization of organic silkworm breeding. Formalin used so far is forbidden. Currently, 12% hydrogen peroxide is used in the gaseous state, which has a greater biocidal activity. The new method of sterilization has obtained the highest effectiveness in preventing the development of pathogenic bacteria. Moreover, new equipment for larger breeding has been prepared.

Keywords: breeding methods, hydrogen peroxide,breedingequipment.

VI. ECONOMY: DOMESTIC AND INTERNATIONAL MARKETS, PRICES, TRADING, ECONOMIC ANALYSES OF PROJECTS ETC.

INDO-BULGARIAN COLLABORATIVE RESEARCH PROJECT-A WAY FORWARD IN SILKWORM BREED IMPROVEMENT PROGRAMME IN INDIA AND BULGARIA

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ABSTRACT

An Indo-Bulgarian collaborative research programme on silkworm breed improvement was initiated in India and Bulgaria during 2016 with the initiatives of Central Silk Board (CSB), Ministry of Textiles, Govt. of India, Bangalore and Sericulture Experiment Station (SES), Bulgarian Agriculture Academy, Vratza, Bulgaria. In the beginning, Memorandum of Understanding (MoU) and Material Transfer Agreement (MTA) was signed by Central Sericulture Research and Training Institute (CSRTI), Mysore and Sericulture Experiment Station (SES), Vratza. Salient features of this project include exchange of pure silkworm breeds/ hybrids of interest, sharing of technical expertise, result/ outcome and publication. As wider/optimum genetic base expected to yield high heterosis in hybrids as well as it can generate best segregants to develop new silkworm genotype with superiority in many characters. Accordingly few silkworm genetic resources were exchanged between the India and Bulgaria and breeding programme was initiated with definite goal. In this paper, present status of breeding programme in developing new silkworm breeds and hybrids utilizing Indian and Bulgarian genetic resources are discussed.

Keywords: Bivoltine Silkworm Breeds, Bulgarian Genotypes, Indian breeds, Breeding, Hybridization.

THE ROLE OF SERICULTURE IN CREATING JOB OPPORTUNITIES AND IN POVERTY COMBAT IN GEORGIA

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ABSTRACT

Combat of poverty caused by high level of unemployment is one of the strategic goals in Georgia. The role of sericulture in this respect is unique and in particular it will effectively address poverty problem, particularly in the country area.

Unfortunately, cocoon production has been suspended for the last twenty five years in Georgia which has a negative affected on earnings of village population. Before mulberry leaf curl disease was spread in Georgia (in 1964), about 4.0 – 4.2 thousand tones of cocoon was produced and income was within 17 million roubles, so, the state budget also increased. About 100-120 thousand families were involved in sericulture. Moreover, village educational institutions, school and college teachers and public office staff were also involved in production of sericulture.

Population of west Georgia and some regions of east Georgia were occupied by production of cocoon. For example, Lagodekhi region (East Georgia) produced on average 325-329 tones of live cocoon per year. Earnings from this activity equaled to 4,0 million roubles which increased the farmers' income. Today, when cocoon is not produced in our country and thousands of mulberry trees have been cut down, the village population has not been able to cover this deficit with income from other branches of agriculture.

Commencement of Sericulture Revival State Program in Georgia will help rural community to increase their income and many villages will attain a new function.

SERICULTURE, EXPECTED RISKS AND BUSINESS

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ABSTRACT

In the system of Georgian Sericulture there are such risks which should be considered and to ignore them may cause serious difficulties for business and cooperative farmers. The risk is the possibility of gaining practically an ineffective outcome. So, the more problems the greater the risk. Farmers can attempt to incorporate risk in farm management decisions either by controlling exposure to risk or by controlling its impact on the farm business. According to the literary source, the risk can be defined as the probability or threat of quantifiable damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through preemptive action.

During the period of sericulture rehabilitation and revival in Georgia, special attention should be driven to financial issues, marketing activities, agricultural, technical equipment, labor organization, the formation of the adaptation, professional training and other factors. Investors, farmers, cooperatives or other interested people should be well aware of the recommended proposals and take into consideration the economically reasonable outcome.

Keywords: Silkworm breeding, risk, business, marketing, cooperative.

SOME PROBLEMS OF ECONOMIC EFFICIENCY OF SERICULTURE REVIVAL IN GEORGIA

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ABSTRACT

Economic effectiveness of sericulture production is the basis for rehabilitation and revival of the branch of sericulture in Georgia. Economic efficiency of production is a general economic category and has many aspects and definitions. Profit defines economic effectiveness, and the present article discusses from this point of view the problems of intensification and the quality of sericulture, also the production effects and its economic efficiency. Furthermore, production and resource capability in general, as well as purposeful exploitation of local potential of natural resources and its economic efficiency is analyzed in the present article.

RATIONAL COMBINATION OF SERICULTURE AND CATTLE BREEDING AND ITS ECONOMIC EFFICIENCY

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ABSTRACT

In Georgia, summer grazing land capacity three times exceeds of those pasture and winter grazing lands; it is seven times more than the product collected from winter pasture lands. Therefore, it is important to find other sources of food production and increase production of non-traditional food for cattle (Nekeri) by about 20-25 %.

Proper management of food base for cattle includes utilization of sericulture byproduct and manufacture of additional food for cattle. The revival of sericulture in Georgia should be based on cooperative form of organization which will increase its efficiency.

According to the sericulture experts' calculations (G. Zviadadze, G. Nikoleishvili, J. Kokrashvili), in case of 10 boxes of cocoon feeding, from 2 hectares of mulberry tree plantation (3X3 sq. m. area), ten tones of mulberry leaf, 50% out of 20 tones of bio-mass is obtained. In case of its rational use, besides silkworm feeding product (it can feed 600 kg live cocoon), feeding forage for cattle, a by-product containing twigs, shoots and implants can be produced.

According to researchers, in case of feeding 10 boxes of silkworm it is possible to get 19 tones of vegetables grown between rows. From mulberry tree twigs and shoots rabbit or nutria can be fed which will give hide and diet meet. This rational approach to sericulture will be economically efficient and researchers continue working in this direction.

SILK PRODUCTION AND WEST

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ABSTRACT

Development of Silk production is accompanied by an increase in the growth of mulberry and the emergence of mulberry fruits. Human health has a special significance for the production of black mulberry and its chemical composition. Among them are biologically active substances and phenolic compounds with antioxidant properties (anthocyanins).

The goal of the research was to study the biologically active substances of black mullet, the anthocyanins and the study of their accumulation dynamics. The object of research was the product of black mulberry and its products - mulberry juice, its concentrate, jam and low alcoholic spirits, liqueur vodka and non-alcoholic beverages.

It was established that these substances are especially rich in Kartli and Kakheti regions, including Samtskhe-Javakheti region. The study of the dynamics of accumulationof antioxidants in different periods of myelogenesis has shown that the second half of June-July is the optimal period for

mulberry processing. Definition of antioxidants was carried out on a spectrophotometer of 520 nm wavelength.

Keywords: Anthocyanin's, silk production, jam, black mulberry; biologically active substances; phenolic compounds;

THE BUSINESS PROJECT -THE WAY TO REVIVAL OF SERICULTURE IN GEORGIA

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ABSTRACT

Sericulture is Georgia's oldest and traditional sector. For many centuries he has contributed to the strength of the country's economy. There were many thousands of workers employed in the sector, while the manufactured products were in demand and competitive global markets. This sector is no longer functioning. Less wealth and business interest in this sector, as long as investments are made, requires a long period of time, thus increasing the risk factor.According to our project, rehabilitation and development of waste in the country should be implemented with the support of the state. In the regions, silk production-combinations will be created in which the silk worm's central feeding and the making of sodium are made. In this direction, the farm should be allocated 105-110 hectares of land in which 100 hectares should be planted on a strong intensive mulberry plantation (40 thousand plants at 1 ha) and 5 hectares of 25 hectares of buildings should be constructed in a single tunnel with 30-32 colouctures And cooked 1800-1900kg silk park. This enterprise will be built separately, refrigeration, filtration and turbine work / gran creator / buildings. In the combination should be implemented modern technology in all directions and must be equipped with modern machinery. Exploitation of mulberry plantation should be carried out in a mechanized manner, and the thin layer should be removed from the park for 20-25 days bypassing the park's vortex. 1 ha is made of 150-180 g of thread, followed by the technological process / thread briquette, dyeing, drying and knitting / finishing in a special workshop. In the combination of the park will be made in two stages: spring and autumn. During the spring season, the factory will be used in 50 hectares, and the remaining 50 hectares will be prepared for autumn disposal. 50 persons will be employed at the permanent place of work, while temporary / 4-5 months / work place - 500 persons. In order to increase the profitability of the plant, a combination of 800 tons of solid biofuel will be prepared in the combination, with the demand increasing yearly. In the combination, 40-50 kg elite will be cooked, and the chip will be used to prepare high quality oil. Total cost of the project is 6.5-7.0 million USD, the return of which will be invested within 3-4 years.

Keywords: sericulture, silk park,mulberry, markets,profitability, business.

CONTESTS

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ИНТЕНСИФИКАЦИЯ СЕЛЕКЦИОННЫХ ПРОЦЕССОВ И ПРОГНОЗИРОВАНИЯ ШЁЛКОВОЙ ПРОДУКТИВНОСТИ ТУТОВОГО ШЕЛКОПРЯДА

A B S T R A C T S

I. SERICULTURE REVIVAL AND COUNTRY REPORTS

II. MORICULTURE

შავი, კასპიის ზღვების და ცენტრალური აზიის ქვეყნების
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