The present Status and future of Sericulture industry in Korea

Department of Agricultural Biology
National Academy of Agricultural Science,
Rural Development Administration, Korea

Kang-Sun Ryu
Historical Overview on Sericulture in Korea

DanGun (BC 1123) | Encouragement of Mulberry & Silkworm
- Chosun: “”, “” / King SeongJong:
- ’46 Seric. Div. in Agric. Min., ’61 Law for Promotion of Seric.)

’70~’80 | Important Agricultural Product in Korea
- ’75 Raw Silk Export 114 million$ (52% whole Agric. Export)

Early ’90’s | Increased labor wage and importation
- Rapidly Decline, Abolition of Division in Min. (’94) & Seric. Law (’99)

Mid ’90’s | Silkworm powder’s effect Reported
- a Momentum of transition to Functional Sericulture

’09, Nov. | Law & Plans for Promotion of Functional Seric.
- Enactment 2009.5.27, Law No.9726, Enforcement 2009.11.28]
Current Status of Sericulture

Overview | Total Production Value: 70 million $
6,900 Farmers; 2,300ha Mulberry & 17,000 box silkworms

- Silkworm power, *Cordiceps*, etc: 12 million $,
- Mulberry: 28, Wine, Cosmetics, Silk protein, etc: 30

Silkworm raisers (thousands):
- 1976: 488.0
- 1998: 4.0
- 2009: 6.5

Mulberry cultivation (thousand ha):
- 1976: 82.9
- 1998: 1.6
- 2009: 2.2
<table>
<thead>
<tr>
<th>Crop</th>
<th>Gross Income (US $)</th>
<th>Earning rate(%)</th>
<th>Net income (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>854</td>
<td>57.4</td>
<td>490</td>
</tr>
<tr>
<td>Pear</td>
<td>4,317</td>
<td>60.6</td>
<td>2,615</td>
</tr>
<tr>
<td>Onion</td>
<td>1,725</td>
<td>57.6</td>
<td>994</td>
</tr>
<tr>
<td>Cabbage GH</td>
<td>1,377</td>
<td>37.0</td>
<td>509</td>
</tr>
<tr>
<td>Dried Silkworm</td>
<td>3,840</td>
<td>37.0</td>
<td>1,421</td>
</tr>
<tr>
<td>Mulberry Fruits</td>
<td>5,000</td>
<td>54.4</td>
<td>2,720</td>
</tr>
</tbody>
</table>
## 11 Functional Commodities developed from Sericulture

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Year Developed</th>
<th>Effect</th>
<th>Producer/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried Silkworm Powder</td>
<td>’95</td>
<td>Blood sugar level</td>
<td>Farmer, Union</td>
</tr>
<tr>
<td>Cordyceps mushroom</td>
<td>’97</td>
<td>Immunity, anti-fatigue, etc</td>
<td>“</td>
</tr>
<tr>
<td>Mulberry leaf tea</td>
<td>’99</td>
<td>Blood sugar level</td>
<td>“</td>
</tr>
<tr>
<td>Nuegra®</td>
<td>’01</td>
<td>Natural tonic</td>
<td>Geunhwa, GujiuCo.</td>
</tr>
<tr>
<td>Silk cosmetics</td>
<td>’02</td>
<td>Moisturizer, wrinkle control</td>
<td>Dongsung, Co.</td>
</tr>
<tr>
<td>Hair-dye</td>
<td>’03</td>
<td>Hair damage &amp; bleaching</td>
<td>“</td>
</tr>
<tr>
<td>Mulberry Fruits Wine, Juice, Jam</td>
<td>’03, ’04</td>
<td>Anti-aging, etc</td>
<td>Farmer, Union</td>
</tr>
<tr>
<td>Silk toothpaste</td>
<td>’05</td>
<td>Injury in oral cavity</td>
<td>Dongsung, Co.</td>
</tr>
<tr>
<td>Silk-peptides BF-7</td>
<td>’07</td>
<td>Memory, learning ability</td>
<td>Bioland, Co.</td>
</tr>
</tbody>
</table>
Transition of Sericulture in Korea

~1980’s
Textile Sericulture
Focused on Cocoon, Silk

1990’s
Functional Sericulture
Health food Alternative medicine

2000’s ~
Bio-Material Sericulture
Cosmetics Medical Appliance Theme Town, Tourism

Silkworm variety JS169×CS186 and their characteristics

- Production of golden colored silk
- DNJ content: 4.3mg/g, 14% more than control 3.8mg/g

For the special clothes and arts
Colored silkworms in each stage

Colored larvae
Colored cocoon
Colored eggs

Art flowers from colored cocoons

10/31
Mulberry breeding for fruit production

Daesung

Gugsang 204 for raw fruit

Turkey – D white colored
Breeding of mulberry for Jam, Juice, Wine
Silkworm powder for diabetes

Functional effect of sericulture products in oriental medicine

- Mulberry leaves & Root barks
  - Diabetes
  - Cough
  - Brain disease
  - Hypertension

- Pupae & Excrement
  - Diabetes
  - Palsy
  - Allergy

Pupae + Excrement + Mulberry
Activity by different preparation of Silkworm Powder

- 5th instar 3 days freezing dry: 73.4%
- 5th instar 3 days heating dry: 53.0%
- Fasting for 24 hours: 47.4%
- Artificial diet: 34.0%
- During molting: 39.9%
Change of blood glucose levels with long term feeding

![Graph showing blood glucose levels over time for different conditions and treatments, including normal, high blood glucose level, acaibose, and Sikwoom.](image-url)
## Polyhydroxylated alkaloid contents of sericulture materials

<table>
<thead>
<tr>
<th>Alkaloid</th>
<th>Mulberry fruits</th>
<th>Mulberry leaves</th>
<th>Silkworms</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNJ(1)</td>
<td>168</td>
<td>138</td>
<td>376</td>
</tr>
<tr>
<td>Me-DNJ(2)</td>
<td>1.0</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Gal-DNJ(3)</td>
<td>2.8</td>
<td>61</td>
<td>None</td>
</tr>
<tr>
<td>Gal-DNJ(4)</td>
<td>2.8</td>
<td>1.2</td>
<td>None</td>
</tr>
<tr>
<td>FAG(5)</td>
<td>3.6</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>Glc-FAG(6)</td>
<td>None</td>
<td>1.1</td>
<td>None</td>
</tr>
<tr>
<td>epi-FAG(7)</td>
<td>None</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>DAB(8)</td>
<td>2.4</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Glc-DAB(9)</td>
<td>4.0</td>
<td>13</td>
<td>8.2</td>
</tr>
<tr>
<td>CAL (10)</td>
<td>3.6</td>
<td>5.2</td>
<td>None</td>
</tr>
<tr>
<td>Gal-CAL(11)</td>
<td>1.6</td>
<td>1.8</td>
<td>None</td>
</tr>
<tr>
<td>HNT(12)</td>
<td>2.0</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

* 1-deoxynojirimycin (DNJ)
Activity of Purified DNJ from Silkworm Powder

Blood glucose (mg/dl)

Day

Control
STZ
Acarbose
DNJ
Silkworm powder for diabetes

Certificate of ‘Functional Health Food’ from KFDA(2009)
## Tonic effect of the male silkworm

### Comparison of Sperm counts

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Sperm counts (X10^6/g epididymis)</th>
<th>Percent(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>53.38 ± 2.18</td>
<td>100.0</td>
</tr>
<tr>
<td>Viagra</td>
<td>59.72 ± 0.80</td>
<td>111.9</td>
</tr>
<tr>
<td>Kissometer</td>
<td>51.51 ± 1.68</td>
<td>96.5</td>
</tr>
<tr>
<td>Silkworm moth extract 100mg</td>
<td>70.22 ± 2.37</td>
<td>135.6</td>
</tr>
<tr>
<td>Silkworm moth extract 250mg</td>
<td>75.47 ± 0.09</td>
<td><strong>141.4</strong></td>
</tr>
<tr>
<td>Silkworm moth extract 500mg</td>
<td>66.47 ± 4.71</td>
<td>124.5</td>
</tr>
<tr>
<td>Botany 1</td>
<td>70.95 ± 2.05</td>
<td>132.9</td>
</tr>
<tr>
<td>Botany complex</td>
<td>66.73 ± 1.11</td>
<td>125.0</td>
</tr>
</tbody>
</table>
Breeding of Sex limited silkworm variety

Sex chromosome in human

- men (♂) : XY
- women (♀) : XX

Sex chromosome in silkworm

- male (♂) : ZZ
- female (♀) : ZW

W chromosome : yellow cocoon, larval markers
Optimal stage for male pupa production

4days
8days
12days
14days

Nuegra® for stamina from male silk-moth
Cordyceps on silkworms

Effects of Cordyceps

- Anti-cancer
- Build-up of immunity
- Anti-fatigue
- Anti-stress

Mini-kits for growing 'Bulhee' wine drink
Mulberry leaves

Effect of mulberry leaves ice-cream on the blood glucose level

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After 45 min</th>
<th>Lowering effect(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>87.4±14.8</td>
<td>107.8±10.9</td>
<td>27.8</td>
</tr>
<tr>
<td>Mulberry leaves</td>
<td>113.4±7.8</td>
<td>111.4±14.0</td>
<td>-1.6**</td>
</tr>
</tbody>
</table>

Mulberry leaves ice-cream
- Simple prepared powdery mulberry leaves: green smell
- Preservation of original color

Healthy foods using mulberry leaves

Mulberry leaves jelly, noodle
Silk protein

■ Silk cosmetics
  ○ Moisturizing and activating skin tissue
  ○ Sericin: moisturizing factor, fibroin: collagen formation

Preservation of original color

Sericin soap

Silk toothpaste (wound care in mouth)

Fibroin cosmetics
Development of silk eardrum and artificial bone

Silk eardrum

Silk bone with implant
Bio-factory Silkworm

Construction of piggy Bac vector fused with Ac NPV

Transgenic efficiency: 2% → 70%

Improved piggy Bac vector

Comparison of pG and pT of transgenic vector
Transgenic silkworms

- Development of highly efficient transgenic vector
- Construction of transgenic technology
- Produce of materials with induction of valuable gene
- Expression control of specific gene: mass production of specific materials

Illumination under white light EGFP-excitation-wavelength light

Normal silkworm

Transgenic silkworm

pG-3XP3-EGFP-Hsp70-EPO
Silkworm Theme Town and Tourism

Sericulture-complex town

Silkworm farmer’s clean town

Buan Nue-Town & Museum

Asan silkworm town for the retired
Student’s experience of the nature ‘silkworm’

See the inside silkworm in Youngchon!
Strategies for Conserving and Expanding of Sericulture

R&D and Legal Policy for Next Generation Sericulture

- Genetic resources of silkworm & mulberry: special var. breeding
- Silkworm Powder: Authorization with Functional Health Food from KFDA and Natural Medicine
- New food industry of mulberry fruit: Wine, Food additives, etc.
- Silk Protein: new bio-materials for medical application
- Bio-technology in Sericulture: (transgenic)’bio-factory silkworm’
- Activation of rural community: town for aged man & tourism
THANK YOU