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NEW TECHNOLOGY FOR SILKWORM REARING FOR BREEDING PURPOSES

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Abstract

This article focuses on modern technologies used in silkworm (*Bombyx mori*) rearing for breeding purposes. It highlights recent advancements in sericulture, including controlled environmental conditions, automated feeding systems, disease prevention methods, and digital monitoring tools. These innovations contribute to improving silkworm survival rates, enhancing cocoon quality and productivity, and ensuring more efficient and accurate breeding processes. The study emphasizes the importance of integrating scientific and technological developments into traditional sericulture practices to achieve higher efficiency and better selection outcomes.

Keywords: Silkworm rearing, sericulture, breeding, *Bombyx mori*, cocoon quality, cocoon shell percentage, controlled environment, automated feeding, disease prevention, hybrid selection, smart monitoring, precision sericulture.

Introduction

Sericulture has long been one of the important branches of agriculture in Uzbekistan. Today, in the rearing and breeding of the mulberry silkworm (*Bombyx mori*), achieving high productivity and producing high-quality cocoons

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and silk remains a key task. In this regard, the use of modern scientific achievements and new technologies plays a crucial role.

In recent years, advanced methods such as controlled-environment rearing systems, automated feeding, early disease detection and prevention techniques, as well as digital monitoring and selection technologies have been widely introduced in sericulture. These innovations help to increase silkworm survival rates, improve cocoon quality and quantity, and make the breeding process more accurate and efficient.

This article discusses the new technologies used in silkworm rearing for breeding purposes and their practical significance.

To carry out breeding work, there should be a breeding laboratory, a silkworm rearing house with a separate mulberry leaf storage room, an incubation room, and a technological laboratory.

The laboratory must be equipped with refrigerators for storing silkworm eggs and cocoons, equipment for steaming and drying cocoons, microscopes, and the necessary materials for microscopic examination.

In addition, the laboratory should contain analytical and technical balances, “quadrant” or electronic scales for weighing individual cocoons, torsion balances for weighing cocoon shells, and other instruments such as forceps, magnifying glasses, scalpels, psychrometers, and similar equipment.

The breeding silkworm rearing house should have thick walls, be well equipped, durable, and provided with a heating system capable of evenly heating the entire building. It should also be sufficiently bright and well ventilated. Rearing houses with windows facing south or north are considered the most suitable buildings. The rearing house must be adequately furnished with silkworm rearing shelves, work tables, chairs, and other utility equipment.

For rearing separate families, four-tier rearing shelves with movable trays and dimensions of 90 × 50 cm are considered suitable. The breeding silkworm rearing house should also be equipped with a leaf cutter, a cocoon floss cleaning machine,

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garden shears, and baskets for carrying mulberry leaves. During the rearing of silkworms for breeding purposes, a sufficient amount of thick paper for covering the trays of the rearing shelves, as well as paper trays of various sizes for rearing young larvae, should always be available.

For silkworms reared for breeding purposes, artificial mountages made of straw are usually used. Compared to the mountages used for ordinary breeding silkworms, 1.5 times more mountages should be provided for these silkworms.

Before incubating (hatching or activating) the breeding eggs, their quality must be checked, and the best ones should be selected for continuing the breeding work. For this purpose, the egg masses laid by each moth are counted, and the percentage of normal eggs in each mass is determined. By weighing the normal eggs, the average weight of a single egg in the mass is calculated. Egg masses containing a small number of eggs, a high percentage of unfertilized eggs, or a large number of dried eggs are rejected.

After incubation, the hatching percentage of silkworm larvae or the viability percentage of the eggs is determined using the following formula:

$$\text{Popped out} = \frac{(T - O) \cdot 100\%}{T}$$

T – the number of eggs in the batch,

O – the number of unhatched eggs in the batch.

For rearing purposes, the families with the highest viability percentage are selected and retained.

Not all larvae that hatch from the eggs are viable. Only the larvae that hatch on the first day are kept for breeding purposes. If the number of larvae hatched on the first day is insufficient, larvae hatched on the second day are added to complete the required number.

During the incubation of breeding eggs and throughout the hatching period, all indicators and records of the eggs are carefully documented.

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During the rearing period for breeding purposes, the growth of the breeding families is closely monitored. Special attention is paid to the uniform growth of the larvae within each family, the duration of each larval stage, and the molting process. The number of weak, underdeveloped, and diseased larvae is also recorded.

The beginning of cocoon spinning is considered to be the day when the larvae climb onto the mountages en masse (at least 50% of the larvae). The number of cocoons spun by each family is recorded separately.

Seven days after the larvae begin mass cocoon spinning, the cocoons can be harvested from the mountages. During cocoon harvesting, the number of diseased cocoons (black-spotted cocoons), dead larvae in the mountages, and dead larvae remaining in the rearing beds are counted. After the cocoons are cleaned of floss, the cocoons of each family are examined by tapping them to identify “gluhari” cocoons — cocoons that appear normal externally but contain dead pupae inside. Such cocoons are also considered defective and rejected.

The results of cocoon grading are recorded in a special journal. Based on the
Worm survival rate = $(\text{Number of healthy cocoons} \times 100) / \text{Number of worms taken for rearing}$

All cocoons containing healthy pupae are considered healthy cocoons. A healthy double cocoon is counted as two cocoons. If one pupa inside a double cocoon is healthy while the other is dead, then one cocoon is considered healthy and the other diseased. In breeding work, it is useful to monitor the viability of each family from the beginning of the pupal stage until its completion, and even during the moth stage.

Nine days after the beginning of mass cocoon spinning, the average cocoon weight and cocoon productivity of each family are determined. To determine cocoon weight, average samples are taken separately from male and female cocoons in each family. If the sexes were not separated during the egg stage, the sample cocoons are cut open and their sex is identified according to the pupae

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inside. For sampling, at least 15–25 cocoons from each sex should be selected. The samples obtained in this way are weighed separately on technical balances, and the average cocoon weight for both sexes is determined.

Family number	Origin	Number of worms taken for rearing	Number of worms that died at each instar (larval stage)					Collected cocoons		Worm survival percentage		
			I	II	III	IV	V	Total	Healthy (cocoons)	Diseased (cocoons)	Double cocoons (paired cocoons)	
1	25x103	250	-	-	1	2	8	11	220	9	5	92

Each family's cocoons are weighed to determine productivity (on the 9th day after the beginning of mass cocoon spinning). To determine the average percentage of cocoon shell in the sample cocoons taken from the families, the pupae are removed and the shells of male and female cocoons are weighed separately.

The percentage of cocoon shell is determined using the following formula:

Cocoon shell percentage = $\frac{\text{Weight of cocoon shell} \times 100}{\text{Weight of cocoons}}$
 $\text{Cocoon shell percentage} = \frac{\text{Weight of cocoon shell} \times 100}{\text{Weight of cocoons}}$
 Or in plain text:

Cocoon shell percentage = (Weight of cocoon shell × 100) / Weight of cocoons

The data obtained from the average weight of cocoons and cocoon shells make it possible to determine the average amount of silk obtained from live cocoons.

The silk content of cocoons is one of the main indicators in silkworm breeding, because it shows how productive the breed is. The amount of silk in cocoons is determined both from large cocoons collected on the 9th day after the beginning of mass cocoon spinning and from dry cocoons.

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The silk content of cocoons is determined using the following formula:

Silk content of cocoons = $\frac{\text{Average weight of cocoons} - \text{Average weight of cocoon shell}}{\text{Average weight of cocoons}} \times 100$

Or in plain text:

Silk content of cocoons = $\frac{(\text{Average weight of cocoon shell} \times 100) - \text{Average weight of cocoons}}{\text{Average weight of cocoons}}$

Average weight of fresh (or dry) cocoon

The main average indicators of the families based on cocoons are recorded in the “Mass Cocoon Weighing” journal.

Mass cocoon weighing

Family number	Period		Sex	Number of cocoons in the sample	Cocoon size/weight ratio (%)	Average weight of one cocoon (%)	Cocoon shell amount	Cocoon shell weight (%)	Average weight of one cocoon shell (%)	Cocoon shell percentage	Average cocoon shell percentage per family foizi
	Start of cocoon spinning time	Weighing time									
32	1/VI	9/VI		15	34,13	2,27	15	7,11	474	20,8	19,6

When breeding is carried out to improve the technological properties of cocoons, average samples of male and female cocoons from each family are selected for silk reeling.

The collection of key average family indicators is completed by selecting the most valuable families for breeding. Each selected family’s cocoons are carefully and individually analyzed. Based on initial external morphological characteristics, the best cocoons are conditionally retained for breeding purposes.

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Then each of these selected cocoons is weighed separately on a scale, and the cocoon shell weight as well as the silk percentage of each cocoon is determined. This analysis ends with the final selection of the best cocoons for breeding and the rejection of those with lower value.

The results of weighing each cocoon and its shell are recorded in a special register assigned to each family.

Family № 35									
Female cocoons (♀♀)					Male cocoons (♂♂)				
Cocoon number	Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell percentage (%)	Note	Cocoon number	Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell percentage (%)	Note
1	1,89	411	21,7		1	1,50	384	25,6	
2	2,03	413	20,3		2	1,48	403	27,2	
3	1,97	458	23,2		3	1,59	437	27,4	
4	2,10	483	23,0		4	1,70	448	26,3	
5	2,11	442	20,9		5	1,69	427	25,2	

Each breeding cocoon is placed in a parchment bag. The bag contains the cocoon number, sex of the cocoon, individual cocoon identification number, and, to facilitate the selection of mating pairs, the main characteristics of the male breed are also recorded. These include cocoon weight, shell percentage, or cocoon weight, silk filament length, and similar indicators.

Before beginning papillonnage (mating), a plan for pairing the moths is prepared. When crossing unrelated breeds, pairs of families to be intercrossed are selected, and within these families the principle “the best male with the best female” is followed in selecting mating pairs.

In other cases, cocoons are paired with males from different, non-related cocoons of the family. After mating, each fertilized female moth is placed in its own

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isolation bag for egg-laying. This bag also contains information about the origin and characteristics of the male moth that fertilized it.

In addition to the general methods of breeding work with the mulberry silkworm, sericulture scientists have also developed many special and even original methods to improve certain economically valuable traits of bred silkworm breeds. The development of these methods is considered a major scientific achievement of Uzbek breeders. Due to the practical application of these methods, several valuable breeds of the Uzbek mulberry silkworm have been created, and they are now being successfully introduced into farmer households.

Selection aimed at increasing the viability of breeds: Some methods used in breeding work to improve the viability of cultivated breeds were described above. The main methods include using hybrids with strong vitality as the initial breeding material, rejecting egg masses with low viability percentages, and eliminating weak families that are susceptible to diseases and show poor growth. The correct selection of initial breeding material plays an important role in improving the viability of future breeds because the viability of subsequent generations largely depends on this selection. To increase the viability of the breed under selection, bivoltine breeds or even polyvoltine breeds are often used as the initial material. Sometimes the breed is crossed once with a highly viable breed in order to introduce its “blood.” Selecting the first-hatched larvae from the egg masses laid on the first day by the earliest and most active moths also increases the viability of the breeding material.

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