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| Research Article

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Analysis the Properties of Cocoon Shells Grown in Different Seasons

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Annotation
This article examines the geometric dimensions, thickness, strength, density and porosity of the cocoon shell of the first and fourth seasons of the Chinese hybrid cocoons grown at the Department of Silk Technology. The shell properties of cocoon hybrids grown in the first season were found to be higher than those in the fourth season. The results of the study are presented in tables and figures. The first season of the study revealed the possibility of obtaining high quality raw silk from cocoon hybrids.

Keywords: cocoon, raw silk, raw material, shell, hardness, thickness, density, porosity, strength, evenness, hybrid.

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Entrance The strength and stiffness of silkworm cocoon threads tend to increase with decreasing diameter or decreasing sericin content or increasing shell content [1-3].

discusses the results of a study of the primary processing of silkworm cocoons (Bombyx mori) [4].

Our scientists are working on the cultivation of natural silk raw materials , technological indicators of cocoons, production of high-quality raw silk, and improvement of the washing process, Several studies have been conducted on the status and prospects of laundry enterprises [5-6] .

First of all, it depends on the quality of the cocoon grown on farms, its breed, the method of preliminary processing, the development of technologies and other factors. The high properties of the cocoon shell ensure the quality of the raw silk obtained from it. Despite various studies on improving the quality of cocoons, industrial-quality silk production remains one of the pressing problems. It is known that the quality of cocoons is greatly influenced by the amount of silk in it, the technological properties of the shell, and the quality of the cocoon thread, in addition to the breed and hybrid of the silkworm, the method of its care and the conditions created during cocoon winding. In the past, silkworm breeders used the old method, that is, once a season, in the spring of May, but now they do it up to three times, and in recent years, the cultivation of cocoons has been increased to four times. The technological properties of cocoons grown in the fourth season of Chinese hybrids were studied [7-9].

The quality of the cocoon directly affects the quality of the raw silk extracted from it, and also has a strong impact on the efficient operation of silk factories, the quality of the fabrics, knitwear, surgical and sewing threads, medical gauze, bandages, and other technical products produced.

Our research included the first and fourth season "Chinese" cocoon hybrids grown at the "Silk Technology" department in 2021. The conditions created during cocooning, the breed and hybrid of the silkworm, and the technological properties of the shell have a great impact on the quality of the cocoon thread and the amount of silk it produces. First of all, the properties of the cocoon shell were studied to produce high-quality raw silk.

The results obtained and their discussion . Geometric characteristics of the cocoon, its length /D/, cross-sectional diameters /d $_{head}$, d $_{tag}$, d $_{waist}$ /, volume /V/ and surface /S/ are expressed (Figure 1.1). The geometric characteristics of the cocoon depend on the breed, hybrid, sex of the silkworm, the environmental conditions of the cocoon, and the type and size of the bundles wrapped in the cocoon. The cocoons are: cylindrical with a deep waist, oval, irregular, cylindrical, with one end pointed, with two ends pointed, and spherical (Figure 1). The shape of the cocoon can be expressed in terms of the coefficient of elasticity and density.

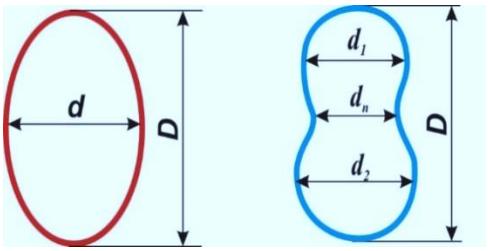

Figure 1. Geometric dimensions of the cocoon

The thinning coefficient is the ratio of the length of the cocoon to the average diameter of its hemispheres [13].

$$C_i = \frac{2D}{d_{head}+d_{head}} \qquad (1)$$

The degree of cocooning is the average value of the diameter of the cocoon hemispheres, as a ratio of its diameter to the diameter of the cocoon.

$$C_b = \frac{d_{head}+d_{base}}{2d_{waist}} \qquad (2)$$

Here :

D - *elephant length , mm*
d $_{head}$ - *head part, mm*
d $_{base}$ - *part t half, mm*
d $_{waist}$ - *diameter of the body , mm .*

Table 1. China Season 1 elephants geometric measurements

No.	Elephant length , D mm	Elephant part diameters , mmm			$d_{o'rm} = \frac{d_{6ou}+d_{max}}{2}$	Caliber	Thinning coefficient , C_i	Shoveling coefficient , C_b	H a jm k o effitsi e nti , f_V	KS	V ' cm 3	S, cm m ^{2}	D ^{3}	What is the pill ? picture
		d $_{bo\ sh}$	d $_{tag}$	d $_{bel}$										
1	31	16	16	17	16.5	middle	1.7	1	0.64	3.8	5.0	19.5	12.8	waist thin
2	27	15	15	16	15	small	1.8	0.9	0.65	3.9	3.9	15.4	18.2	oval
3	28	16	17	17	17	middle	1.6	1	0.65	3.8	4.8	18.7	19.5	cylindric al
4	22	12	11	12	11.5	small	1.9	0.9	0.65	3.9	1.8	7.3	14.2	oval
5	30	17	16	16	16.5	middle	1.7	1	0.64	3.8	5.0	19.5	12.8	waist

														thin
6	27	17	16	17	16.5	middle	1.6	0.9	0.65	3.8	4.6	18.0	19.2	cylindrical
7	29	18	18	18	18	middle	1.6	1	0.65	3.7	5.5	21.8	20.5	cylindrical
8	28	17	17	16	17	middle	1.6	1	0.65	3.8	4.8	18.7	19.5	cylindrical
9	22	12	11	12	11.5	small	1.9	0.9	0.65	3.9	1.8	7.3	14.2	oval
10	27	15	15	16	15	small	1.8	0.9	0.65	3.9	3.9	15.4	18.2	oval

Table 2. China Season 3 elephants geometric measurements

No.	Elephant length , D mm	Elephant part diameters , mmm			$d_{o'rm} = \frac{d_{6ou} + d_{mac}}{2}$	Caliber	Thinning coefficient , C_i	Shoveling coefficient , C_b	H a jm k o effitsi e nti , f_V	KS	V ' cm 3	S, cm m ^{2}	D^3	What is the pill ? picture
		d_{bosh}	d_{tag}	d_{bel}										
1	28	16	16	16	16	small	1.6	1	0.65	3.9	4.1	14.5	18	cylindrical
2	22	12	11	12	11.5	small	1.9	0.9	0.65	3.9	1.8	7.3	14.2	oval
3	26	15	15	14	15	small	1.8	1	0.65	3.9	3.7	14.7	18	cylindrical
4	27	15	15	16	15	small	1.8	0.9	0.65	3.9	3.9	15.4	18.2	oval
5	24	13	14	13	13.5	small	1.7	1	0.65	3.9	2.6	10.3	16	cylindrical
6	26	14	15	15	15	small	1.6	1	0.65	3.9	3.7	14.7	18	cylindrical
7	24	11	11	12	11	small	1.7	0.8	0.65	3.9	1.8	7.3	14.0	oval
8	22	15	15	16	15	small	1.8	0.9	0.65	3.9	3.9	15.4	18.2	oval
9	23	13	14	13	13.5	small	1.7	1	0.65	3.9	2.6	10.3	16	cylindrical
10	25	14	15	15	15	small	1.6	1	0.65	3.9	3.7	14.7	18	cylindrical

The quality indicators of the cocoon were determined using methods for studying its shell and the equipment available at the Department of Silk Technology.

g of each silkworm hybrid cocoon was sampled and measured using a “Tolstomer” instrument. It was shown that the thickness of the cocoon shell was higher in the first season than in the second season (Table 3).

Table 3. Cocoon shell thickness

Silkworm hybrid	Cocoon shell thickness, *mm*		
	Head pole	Waist	Tag pole
China (season 1)	0.90 ±0.04	0.93 ±0.06	0.91 ±0.05
China (season 3)	0.65 0.0 2±	0.6 1 ±0.0 4	0.6 8 ±0.0 3

The average thickness of the cocoon shell of locally grown 1st season Chinese hybrid cocoons is 0.91 *mm* , 4th season Chinese hybrid cocoons are 0.64 *mmm* It was shown that during the silkworm cocoon winding period, ensuring that the cocoon is wound horizontally, increasing the thickness of the cocoon shell, and ensuring that its shell thickness is uniform in parts, i.e., the unevenness was reduced by 11.5 *% in the 1st season Chinese hybrid cocoons and 7 %* in the 4th season Chinese hybrid cocoons . The thickness of the cocoon shell is different in different parts.

The strength of the cocoon shell *(M) is defined as the ratio of* the weight of the cocoon shell *(m_q) to* the surface area *(f)* and is calculated using the following formula [1 3, p. 56-64]:

$$M = \frac{m_q}{f} \qquad (3)$$

The strength of the cocoon shell varies in different parts of its thickness: the largest value is in the

shortened waist of the cocoon, the smallest value is in the upper part of the main hemispheres, and the average values are in the lateral parts of the hemispheres. Table 4 presents an analytical table of the strength of the cocoon shell for the breeds under study .

Table 4. Analysis of the strength of cocoon shell components

Hybrid	Cocoon shell strength, *mg/mm* ^{2}				
	head half balloon		waist part	base half balloon	
	pole part i	half balloon		pole part i	half balloon
China (Season 1)	0.295	0.2 37	0.3 18	0.315	0.2 45
China (Season 3)	0, 203	0, 196	0, 283	0, 20 0	0, 1 9 2

The shell strength unevenness of Chinese 1st season hybrid cocoons decreased by 9.33 % , and that of Chinese 4th season hybrid cocoons decreased by 6.05%.

Cocoon shell density is a measure of the weight of a cocoon shell per given volume, and is calculated using the following formula:

$$\delta = \frac{m_к}{ft} \qquad (4)$$

where, δ- shell density, *mg/mm* ^{3} ; f - disk surface, *mm* ^{2} ; t - shell thickness, *mm* .

The results of the study were calculated using formula (4), and the density and density-unevenness indices of the cocoon shell are presented in Table 5 [1 3, pp. 47-51].

Table 5. Unevenness of the cocoon shell density

Silk worm hybrid	Cocoon shell average Density , *mg/mm* ^{3}		
	The shell average Density , *mg/mm* ^{3}	Average quadratic deviation , *mg/mm* ^{3}	K square unevenness , %
China (season 1)	0.304 ±0.005	0.027	8.97
China (season 3)	0.2 01 0.00 3±	0.0 1 2	5 .52

During the silkworm's cocooning process, the arrangement of rings and ring bundles in the layers of the shell, and the adhesion of individual short cocoon threads, give the shell a porous structure, which is calculated using the following formula [1 4 ; p. 28] :

$$П = \left(1 - \frac{M}{1{,}37 \cdot t}\right) \cdot 100 \quad (5)$$

where y is the porosity, % , *1.37* is the bulk density of silk, *mg/mm* ^{3} .

Table 6. Cocoon shell porosity unevenness

Silk worm hybrid	Cocoon shell average porosity , %		
	the shell average porosity , %	average quadratic deviation , %	quadratic unevenness %
China hybrid (season 1)	77.75 ±0.29	2.4	3.41
China hybrid (season 3)	568.9 0 ±0, 2 2	1, 7	2 .07

In the experiment with Chinese 1st season hybrid cocoons, the shell porosity varied within the shell sections by 77.7 % . *The porosity of Chinese* 4th season hybrid cocoons varied within the shell sections by 5 to 9.9 % .

the shell thickness of Chinese 1st season hybrid cocoons was 20.6 % , strength 19.6 % , porosity 3.73 % (abs) and that of Chinese 4th season hybrid cocoons was 20.7 % , strength 17.8 % , porosity 3.03 % , and the unevenness in the cocoon shell parts was reduced according to these indicators.

Both hybrid cocoons have high porosity, and the unevenness in this indicator was smaller in cocoons grown in the first season of silkworm breeding.

CONCLUSION

From the results of the above research, it can be seen that the first and fourth season “Chinese” hybrid cocoons grown at the Department of Silk Technology can produce raw silk of class 2-3A from the first season cocoons, and silkworms can be obtained from the fourth season “Chinese” hybrid cocoons . It is possible to create new assortments of silk products using weaving looms from raw silk of such quality. In addition, it is possible to restore the assortments of crepe fabrics that have disappeared from the industry to date.

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