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Studies on reeling performance and quality characteristics of raw silk reeled from multibivoltine crossbreed and bivoltine hybrid cocoons

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The two varieties of cocoons viz., multi-bivoltine crossbreed cocoons (PM × NB4D2 race) and bivoltine hybrid cocoons (CSR2 x CSR4 race) reared during the same season were studied for the reeling performance and quality characteristics. The results indicate that the cocoon races have significant influence on the cocoon characteristics viz. Cocoon weight, shell weight, shell ratio percentage, average filament length, non-breakable filament length, single cocoon filament denier, on the reeling characteristics, viz. reelability, renditta, raw silk percentage, raw silk recovery percentage, waste generated during reeling and pelade weight and on quality characteristics, viz. neatness, cleanness, tenacity, elongation, cohesion, degumming loss characteristics of raw silk.

Key words: Multibivoltine, Bivoltine, Cocoon, Reeling and Quality characteristics.

INTRODUCTION

Shimazaki (1986) has explained clearly that cocoon race influences the reeling performance and quality of raw silk to the extent of 80%. India was producing multivoltine cocoons till 1960^{s}. Later bivoltine sericulture practices were introduced into the sector. The advent of bivoltine lead to a combination of multi x bivoltine races, which were more suitable to Indian environmental conditions and to the farmers who were accustomed to traditional rearing practices. Efforts are now being made by Central silk board, India in association with Japanese international cooperation agency for reviving the bivoltine cocoon production for reeling purposes [Hariraj (2002)].In Karnataka state, which accounts for 70% of cocoon production of India, still about 80 ~ 90% of multi-bivoltine crossbreed cocoons are being produced and the remaining bivoltine hybrid cocoons are being produced in. In order to establish the superiority of bivoltine hybrid cocoons over the commercially available multi-bivoltine crossbreed cocoons, a study has been taken up at CSTRI, to assess the cocoon characteristics, reeling performance and quality of raw silk of both varieties of cocoons.

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MATERIALS AND METHODS

Raw material: Commercially available multi-bivoltine crossbreed cocoons (PM × NB4D2 race) and bivoltine hybrid cocoons (CSR2 x CSR4 race) reared in Karnataka State, India, during the month of November 2002 have been used for the study. Four replications were conducted.

Green cocoon analysis: The green cocoons procured from the markets were analysed for cocoon weight from one kilogram of cocoons.

About 20 good cocoons are selected from the lot and cutting the cocoons, removing the pupa and weighing the shells, the shell weight was determined. From the cocoon weight and shell weight, the shell ratio of the cocoons were determined using the following formula:

$$\text{Shell ratio \%} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

Drying conditions: The cocoons were dried in Batch type hot air drier following the temperature pattern of 110-100-85-70-55°C for multi-bivoltine crossbreed and 115-100-85-70-55°C for bivoltine hybrid cocoons for a period of 5 h. The degree of drying achieved was 39 - 41% for both varieties of cocoons.

Cooking conditions: The hot air dried cocoons were cooked using two-pan following the temperature profile of 50°- 90°- 65°- 95°- 95° to 80°C for 4 minutes for multi-bivoltine crossbreed cocoons whereas the bivoltine hybrid cocoons are cooked following the temperature profile of 50°- 92°- 65°- 97°- 96° to 50°C for 7 minutes. The cooked cocoons are brushed at 80°C before taken for reeling.

Brushing conditions: The cooked cocoons were brushed at 80°C manually using paddy husk brush and then transferred to reeling basin for picking at 45°C.

Reeling conditions: The 300 good cocoons were selected for conducting reelability test and the test was conducted as per the procedure followed in cocoon testing houses, Japan (Takabayashi et al 1997). The cooked cocoons were then reeled on 3 ends of multiend reeling machine, maintaining fixed number of cocoons to a reeling end. The temperature of reeling bath was maintained at 45°C and reeling speed at 120 m/min (Omura 1991).

Silk quality testing: The raw silk after reeling was assessed for quality characteristics. The testing was conducted as per the International Silk Association (ISA) standards (Book of Standards 1952-68). Among the eleven characters used for grading of raw silk, five characters, viz. neatness, cleanness, tenacity, elongation and cohesion, were determined. The raw silk samples produced were also subjected to degumming loss test. The testing equipments, viz. seriplane tester (Okamoto Kasakusho, Toyo Sangyo Consulting Inc., Japan), tensile tester (Instron Company Ltd, U.K) and Duplan cohesion tester (Toyo Sangyo Consulting Inc., Japan), were used for the study.

Data collected: The cocoon characteristics viz., cocoon weight, shell weight, shell ratio, average filament length, non-breakable filament length, single cocoon filament denier, the reelability data, viz. reelability percentage, renditta, raw silk percentage, raw silk recovery percentage, waste % on silk weight and pelade weight were observed while reeling both varieties of cocoons. The quality data, viz. neatness, cleanness, tenacity, elongation, cohesion and degumming loss percentage of raw silk were observed after testing raw silk reeled with different varieties of cocoons. The data thus obtained were analysed statistically using SPSS package.

RESULTS AND DISCUSSION

The analysis of variance results of cocoon characteristics, reeling performance and quality characteristics of the multi-bivoltine cocoons and bivoltine cocoons are presented in Tables 1, 3 and 5. The mean results of the cocoon characteristics, reeling performance and quality characteristics of the multi-bivoltine cocoons and bivoltine cocoons are given in the Tables 2, 4 and 6.

Analysis of variance results

The analysis of variance results given in Tables 1, 3 and 5 showed that significant difference exists among the cocoon characteristics, reeling performance and quality of raw silk reeled from multi-bivoltine cocoons and bivoltine cocoons. The cocoon characteristics viz., cocoon weight, shell weight, shell ratio, average filament length, non-breakable filament length, single cocoon filament

Table 1. Analysis of variance results of influence of race of cocoons on cocoon characteristics.

Source	Degree of Freedom	Mean sum of squares: Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Average Filament Length (m)	Non-breakable Filament Length (m)	Single Cocoon Filament Denier
Race of Cocoons	1	0.165**	0.032**	26.4**	79600**	16109**	0.245**
Error	6	0.008	0.001	1.22	1436	2578	0.018

** - Significant at 1 % level.

Table 2. Mean results of cocoon characteristics of bivoltine and multi-bivoltine cocoons

Race of Cocoons	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Average Filament Length (m)	Non-breakable Filament Length (m)	Single Cocoon Filament Denier
Bivoltine	2.05	0.439	21.5	1004	803	2.9
Multi-bivoltine	1.76	0.313	17.8	804	714	2.6
CD at 5%	0.14	0.055	1.77	60.6	81.3	0.22

Table 3. Analysis of variance results of influence of race of cocoons on reeling characteristics

Source	Degree of Freedom	Mean sum of squares: Reel-ability (%)	Renditta	Raw silk (%)	Raw silk recovery (%)	Waste (%) on silk weight	Pelade weight (g)
Race of Cocoons	1	153.1**	11.8**	44.6**	130.9**	91.1**	2.45×10^{-5}**
Error	6	14.1	0.24	0.82	11.8	4.79	3.15×10^{-6}

** - Significant at 1 % level

Table 4. Mean results of reeling characteristics of bivoltine and multi-bivoltine cocoons

Race of Cocoons	Reel-ability (%)	Renditta	Raw silk (%)	Raw silk recovery (%)	Waste (%) on silk weight	Pelade weight (g)
Bivoltine	80.0	6.1	16.6	74.8	14.3	0.035
Multi-bivoltine	88.8	8.5	11.8	66.7	21.0	0.038
CD at 5%	6.01	0.79	1.45	5.49	3.50	0.003

Table 5. Analysis of variance results of influence of race of cocoons on quality characteristics

		Mean sum of squares					
Source	Degree of Freedom	Neat ness (%)	Clean ness (%)	Tenacity (g/d)	Elong ation (%)	Cohesion (Strokes)	Degumming Loss (%)
Race of Cocoons	1	60.5**	55.1**	0.18**	15.1**	800**	50.0**
Error	6	6.91	3.62	0.03	2.12	41.7	3.92

** - Significant at 1 % level.

Table 6. Mean results of quality characteristics of bivoltine and multi-bivoltine cocoons

Race of Cocoons	Neatness (%)	Cleanness (%)	Tenacity (g/d)	Elongation (%)	Cohesion (Strokes)	Degumming Loss (%)
Bivoltine	94	96	4.0	20.0	68	18.8
Multi-bivoltine	89	90	3.7	17.3	48	23.8
CD at 5%	4.21	3.05	0.26	2.33	10.3	3.17

denier, reeling characteristics viz., reelability (%), renditta, raw silk percentage, raw silk recovery percentage, waste (%) on silk weight and pelade weight are significant factors, which are influenced by the race of the cocoons. Similarly the raw silk quality characteristics viz., neatness, cleanness, tenacity, elongation, cohesion and degumming loss percentage of raw silk also show significant influence on race of the cocoons. From the results, it could be inferred that the bivoltine cocoons are superior in cocoon characteristics. These cocoons in association with proper reeling technology significantly improve the reeling performance and the quality characteristics of raw silk reeled from bivoltine cocoons compared to multi-bivoltine cocoons reeled raw silk.

Effect of race on cocoon characteristics

The ANOVA Table 1 indicated that, race of cocoons significantly influenced the cocoon characteristics viz. cocoon weight, shell weight, shell ratio, average filament length, non breakable filament length, single cocoon filament denier at 1(%) level with the contribution factor of 73.3(%), 78.6(%), 74.7(%), 88.6(%), 42.8(%) and 63.8(%) respectively.

From the results given in Table 2, significant improvement in the cocoon characteristics were observed viz. 16.4(%) in cocoon weight, 40.3(%) in shell weight, 20.4(%) in shell ratio percentage, 24.8(%) in average filament length, 12.6(%) in non breakable filament length and 13.7(%) in single cocoon filament denier in case of bivoltine cocoons compared to multi-bivoltine cocoons. The CD values at 5% level also indicated significant difference between the cocoon races on cocoon weight, shell weight, shell ratio, average filament length, non-breakable filament length and single cocoon filament denier. This is attributed to the superiority of bivoltine hybrid races over the crossbreed cocoons. The increase in the cocoon weight, shell weight of bivoltine cocoons lead to the more filament length in case of bivoltine cocoons. The single cocoon filament denier in case of bivoltine cocoons is on the higher side compared to crossbreed cocoons, thus reducing the number of filaments in the cross section of the yarn in case of raw silk reeled from bivoltine cocoons.

Effect of race on reeling characteristics

The ANOVA Table 3 indicated that, both bivoltine and multi-bivoltine cocoons significantly influenced the reeling characteristics viz. reelability, renditta, raw silk percentage, raw silk recovery percentage, waste percentage on silk weight and pelade weight at 1(%) level with the contribution factor of 58.4(%), 87.1(%), 88.5(%), 59.2(%), 72.0(%) and 49.2(%).

From the results given in Table 4, significant improvement in the reeling characteristics were observed viz. 9.9(%) in reelability, 39.9(%) in raw silk percentage, 12.1(%) in raw silk recovery, whereas the renditta, waste percentage on silk weight and pelade weight were reduced by 28.6(%), 32.1(%) and 9.10(%) respectively. The CD values at 5% level also indicated significant difference between the bivoltine and multi-bivoltine cocoons on the reelability, renditta, raw silk percentage, raw silk recovery, waste percentage on silk weight and pelade weight characteristics. This is attributed to the superiority of the cocoon race in-association with the optimum drying, cooking and reeling conditions adopted, leading to improvement in reeling characteristics.

Effect of silk reeled from bivoltine and multi-bivoltine cocoons on quality characteristics

The ANOVA Table 5 indicated that, race of cocoons significantly influenced the quality characteristics viz. neatness, cleanness, tenacity, elongation and cohesion at 1(%) level with contribution factor of 52.5(%), 67.0(%), 45.1(%), 46.6(%) and 72.2(%) respectively.

From the results given in Table 6 it could be observed that, the neatness percentage, cleanness percentage, tenacity, elongation of raw silk and cohesion was significantly increased by 6.2(%), 5.8(%), 8.1(%), 15.9(%) and 42.1(%) respectively in case of bivoltine cocoons compared to multi-bivoltine cocoons. The C.D values at 5(%) level also indicate that significant difference exists between the two varieties of cocoons, on the above quality characteristics. This is attributed to the cocoon quality in association with better binding of sericin in drying process and smooth release of agglutination points in cocoon shell during cooking process using suitable temperature profiles leading to better reeling efficiency and production of quality raw silk.

CONCLUSION

Based on the above results and discussion, it is inferred that the bivoltine race facilitate production of quality cocoons and if reeled with proper processing parameters can significantly improve the reeling performance and quality of raw silk compared to multi-bivoltine cocoons reeled silk. The cocoon, reeling and quality characteristics of raw silk reeled from bivoltine hybrid cocoons are significantly better compared to multi-bivoltine crossbreed cocoons. Even though India is having tropical climate, production of more quantity of quality bivoltine hybrid cocoons in favourable seasons and using them with proper production plan

through out the year could significantly improve the production of quality bivoltine raw silk using multiend reeling technology package. However for achieving the levels of International standards both in terms of productivity and quality, it is essential to adopt automatic silk reeling technology package and the farmers in the country shall produce huge quantities of bivoltine hybrid cocoons and make them available to the filatures.

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