

Development of Realtime Testing Apparatus to Test Quality of Mulberry Silkworm Cocoon Filament

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Abstract:- In this study the vital quality parameter of reelability of silkworm cocoons digital real-time testing apparatus and the sample preparation gadgets were developed to replace time consuming conventional reelability testing. sample preparation gadgets consists custome made integrated weighing, liquid dispenser, demineralizer and water bath. The validation of the apparatus reading with that of actual reelability testing results were correlated and found the correlation coefficient of 97 percent were observed.

Keywords: *Silkworm Cocoons, Quality testing, Reelability, Apparatus, Correlation coefficient*

INTRODUCTION

The detailed structure and function of the spinning of *Bombyx mori* L are still not elucidated¹, whereas according to Kei-Ichi Komatsu² cocoon fibre is formed by the insolubilization caused only by a mechanical action, the spinning, from the liquid silk stored in silk glands of matured silkworms. The insolubilization by the mechanical action is a characteristic of fibroin. From the viewpoint of molecular theory that the mechanism of fibre formation of liquid silk fibroin can be approached as a problem of unfolding molecular chains due to the shear stress caused by the passing of liquid silk inside silk glands. Further it was made clear by him that, the fibre formation by the spinning of liquid silk fibroin proceeds by two steps. In the first step, the critical shear rate required for β -transition by decrease of 10 percent water content in the gland liquid during travelling from the posterior to the middle division, and then, as soon as the fibroin flows into the anterior division, nuclei for the β -form are produced, creating a pre-state of three dimensional network, so that the fibroin is oriented along its flowing direction. The second step takes place at the spinneret which, causes unfolding of folded molecular chains of liquid fibroin, with the occurrence of β -transition and crystallization, thus completing the fibre formation. Whereas sericin is not crystallized, as it flows from the middle division to the spinneret without decrease in water content and assist as lubricant during fibre formation.

One of the most important quality characteristics of mulberry silkworm is reelability percentage and it

denotes number of casting or feeding of cocoons to be made to unwind fully the filament of a particular number of cocoons maintaining fixed number of cocoons in each reeling end during reeling operation, This characteristics determines the productivity and quality of raw silk to a great extent³. The productivity and quality of raw silk are based on quality of raw material, reeling process parameters, human skill and quality of water used in reeling. The cost of cocoons alone would contribute to the tune of 80 - 90 percent of cost of raw silk production and cocoon purchasing plays a vital role in determining the profitability of the reeling unit⁴. The reelability of mulberry cocoons varies as per the race, spinning conditions viz., temperature and humidity, types of mountages and other parameters.⁵⁻⁶ Sheigero Minami⁷ reported the Relationship between sericin solubility and cocoon layer swelling and subsequently by Shillin Sangappa³ were reported that, there is a significant correlation between sericin solubility and reelability i.e. higher the sericin dissolution showed better reelability and vice versa. Based on these concept reelability estimation apparatus (REA) for testing in real time has been designed and developed along with test sample preparation customized components viz. weighing system, Water De-mineraliser, Water dispenser and Water bath.

MATERIALS AND METHODS.

Popular commercial silkworm hybrids of Multibivoltine PM X CSR2 (MV), Bivoltine hybrid of CSR2 X CSR4 (BV) were used for the studies. The cocoons lots were collected from the Government Cocoon Market (GCM) of Kolar, Ramnagaram, Kanakapura and Sidlghatta of India. The mulberry silkworm cocoons arriving the different sericulture clusters were being transacted in these markets. Out of procured cocoon lots three random selected cocoon samples were used for testing on REA and rest of the cocoons were subjected to processing of cocoon sorting, hot air drying, conditioning and followed by actual test reeling studies as per the standard procedure⁸. Commercially grade Digital Nephelometric Turbidity meter (NTU) and developed reelability estimation apparatus was used to test the reelability of the cocoons lots tested under the study.

Reelability estimation apparatus (REA):In developing the apparatus, methodology used were software and

hardware. Sequential operations were shown in Fig. 1 and

its image in Fig. 2.

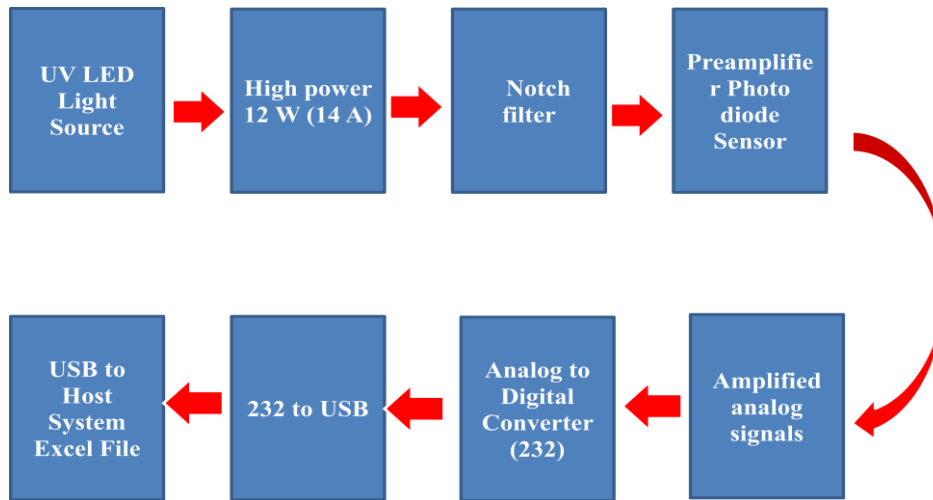


Fig. 1: Sequential operations of REA



Fig. 2: Mulberry cocoon reelability estimation apparatus

REA refers to absorption spectroscopy in the ultraviolet-visible spectral region of 260 to 280 nm. From the investigation during the study it was found that, the sericin component dissolved in water shows peaks at the said spectral region. This 260-280 nm spectral region UV LED source has been used to for quantitative determination of concentrations of the sericin dissolved in known quantity of water bath as per the Beer-Lambert law. The absorption value of the sample were calculated as per following expressions

$$((\text{Sample counts} - \text{Dark counts}) * (\text{Reference counts} - \text{dark counts})^{-1}) * 100 \%$$

RESULTS AND DISCUSSION

The actual reelability values and output values obtained from sericin dissolved water tested in Nephelometric Turbidity Units (NTU) had not shown any trend. Further the data were subjected to correlation analysis and found that the correlation coefficient of 0.022 in case of Multivoltine and Bivoltine hybrids, which is very weak and hence the value estimated reelability cannot be estimated from the regression equations. The scattered diagram with smooth line correlation of MV and BV cocoons lots were shown in Fig. 3

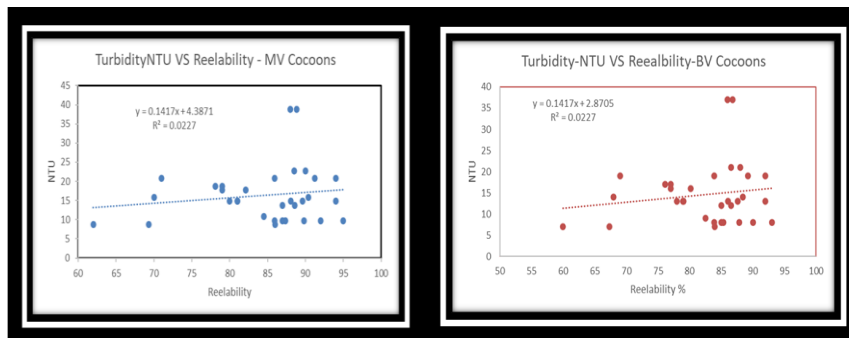


Fig. 3: Turbidity value and reelability % of MV & BV

The Descriptive statistics has been applied to summarize the data obtained from the regression equation to get ultimate estimated reelability and has been compared with

that of actual reelability in case of all varieties of cocoons Table -1 & 2

	Race	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Apparatus Estimated Reelability (%)	PM X CSR2	59	79.047	5.1096	.6652	64.2	93.0
Actual Reelability (%)		59	78.981	5.0483	.6572	64.2	92.5
Total		118	79.014	5.0574	.4656	64.2	93.0
Apparatus Estimated Reelability (%)	CSR2 X CSR4	59	79.047	5.1096	.6652	64.2	93.0
Actual Reelability (%)		59	78.981	5.0483	.6572	64.2	92.5
Total		118	79.014	5.0574	.4656	64.2	93.0

In order to make the developed REA the concept of statistical technique viz., Analysis of variance (ANOVA) has been carried out to find its effectiveness. From

ANOVA (Table-2) clearly indicates that the reelability results were insignificant at 5 & 1 percent level.

Reelability %	PM X CSR2				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.128	1	.128	.005	.944NS
Within Groups	2992.385	116	25.796		
Total	2992.513	117			
Reelability %	CSR2 X CSR4				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.128	1	.128	.005	.944NS
Within Groups	2992.385	116	25.796		
Total	2992.513	117			

NS – Not significant at 5% & 1% level

From the correlation coefficient (R-Sq) value of 0.9745 was found in case of CSR2XCSR4 (Fig. 4) and

0.9768 of PMXCSR2 (Fig. 5) was found, which is found to be perfect positive correlation.

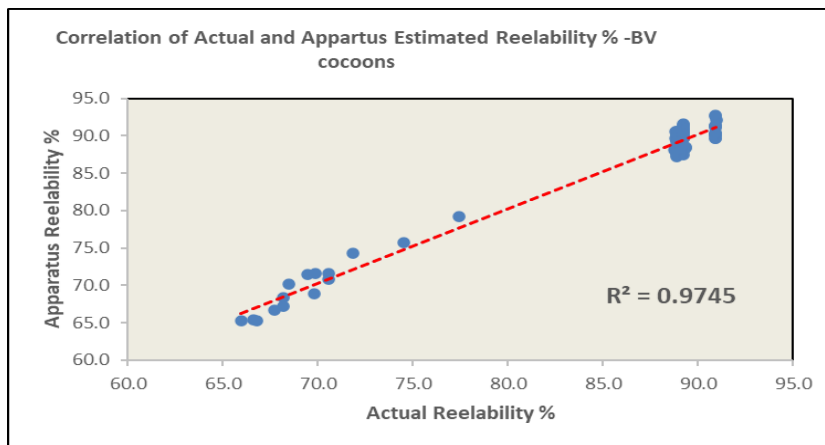


Fig. 4: Correlation between REA & Actual reelability of BV

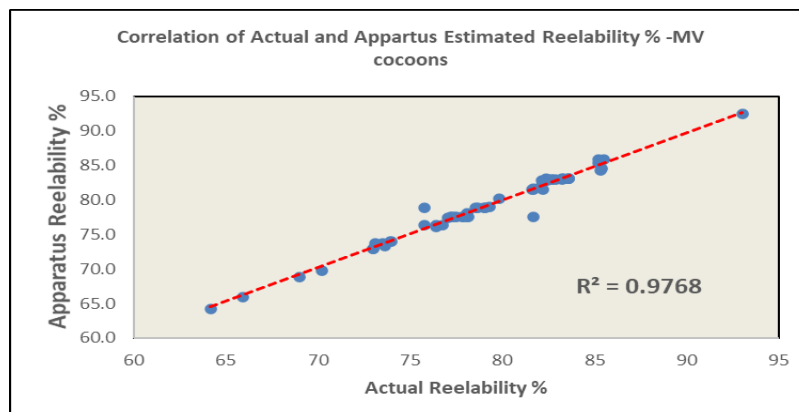


Fig. 5: Correlation between REA & Actual reelability of MV

CONCLUSION

By development of the custom made Reelability estimation apparatus package, it is evident that, mulberry silkworm cocoon lots arrives for transaction in different cocoon market can be tested for reelability characteristics prior to marketing of cocoon lots. The reelability percentage plays an important role in determining the yield and quality of raw silk, which in turn plays a vital role in determining the cocoon rate. Hence, the full-fledged reelability testing of cocoons may be done in all cocoon markets prior to lot auction. The mulberry silkworm cocoon reelability estimation testing and pricing will make the farmers and reelers to come in under quality-based price fixation platform.

ACKNOWLEDGEMENTS

We gratefully acknowledge the contributions to this work by Mr. Ashok Laxmanrao Deole, Statistician of CSTRI, Central Silk Board, Bengaluru, India for technical analysis; Mr. Ramanamurthy, K. V. Asst. Technician and Mr. Venu S T, Technical Assistant of CSTRI, Central Silk Board, Bengaluru, India for their contribution in development of the REA and also during its filed evaluation;

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