STUDY OF SURFACE MORPHOLOGY OF THE SILK FIBRE UNDER SCANNING ELECTRON MICROSCOPE (SEM)

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ABSTRACT

*The silk protein and Silk fibre of Lepidopteran insect (**Bombyx mori**) has been studied extensively through Scanning Electron Microscope for biomaterials. The results exhibit the range of conditioning under which these biomaterial matrices can be formed with a broader range of pore signs and smooth surface morphology. The ultimate goal of the analysis of results of seven breeds taken is to co - relate the physical and chemical nature of the different genetic races/ breeds / varieties of silk moth so that higher / better quality of silk fibre can be produced in future.*

Key words: Mulberry Silk Fibres, S.E.M.,

INTRODUCTION

Silk synthesized in the silkworm, *Bombyx mori* occur in the posterior and middle region of the secretory portion of the gland; in the anterior region of the gland is the silk outlet. The posterior region secretes fibroin and additional proteins, and the middle region secretes the outer Sericine layer around the fibroin column. The morphological alignment of proteins to form silk has been studied in different varieties of *Bombyx mori* (bivoltine and multivoltine).

Here, a unique attempt of thorough analysis of silk fibres under Scanning Electron Microscope(SEM) has been carried out includingphysical analysis of Cocoons, extraction of silk fibre and its processing. The results of different types of experiments show variation among different varieties of *Bombyx mori*. These results can throw light upon the quantitative as well as qualitative aspects of different varieties of silk fibres of *Bombyx mori*.

In the present investigation, SEM studies were carried out in the Department of Instrumentation Science, Jadavpur University; larvae of different silk worm races / breeds / varieties were supplied from the W.B. Govt. Sericulture Institute Zonal office / Rearing Centre of Silk worm at Lake Town, Kolkata.

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MATERIALS AND METHODS

The present investigations were carried out to analyze the physical texture of the silk fibre of Lepidopteran insect *Bombyx mori (*bivoltine and multi voltine) through SEM [Goldstein, J. *et al*, 2003;Cullity, B. D. and Stock, S.R., 2013; Tetsuo, A and Miller, T., 2014; Ling, S. *et al,* 2011; Zhang, H. *et al*, 2012]. Seven different samples were taken as described bellow:

Table 1:

Serial No	Sample No	Sample Name
1	I	Bivoltine, White.
2	II	Bivoltine, White.Double - cocoon (damaged).
3	III	M12WMultivoltine, Bangladeshi.
4	IV	Nistari (PI)Local, Multivoltine, Yellow.
5	V	MC 1 X BC 4(Chaitali - Chaitra Crop)
6	VI	FI of Nistari X Bivoltine [N X NB4D2P3]
7	VII	MC 4 X BC 4

Before taking the sample (I to VII) the fundamental physical characteristic (viz. shape, appearances, etc.Table 2) were taken. Silk filaments are approximately 900 — 1700 meters in length. The diameter of the silk filament is from 9 - 1 1 µ. A raw cultivated silk is off — white to yellow in colour. Unlike cultivated silks, wild silks are uneven, brown and slightly less lustrous than from the cultivated silk [Asakura, T and Kaplan, D.L., 1994].

Table 2:

A	B	C.	D	E	F	G	H	I	J	K	L
I.	Bivoltine, White.	White	Oval.	0.63	0.30	2.57	587.03	90.56	61.87	16.51	576.68
II.	Bivoltine, White, Double - cocoon (damaged).	White	Oval, defective.	0.91	0.71	1.26	412.21	53.12	49.03	47.22	101.02
III.	M12W Multivoltine, Bangladeshi.	White	Pointed end	0.32	0.16	2.54	356.51	84.80	48.80	52.06	294.65
IV.	Nistari (PI) Local, Multivoltine. Yellow.	Yellow	Pointed end	0.28	0.14	2.36	339.08	78.22	41085	35.40	147.38
V.	M C 1 X B C 4 (Chaitali - Chaitra Crop)	White	Oval.	0.44	0.20	1.89	544.81	83.08	59.14	31.39	481.63
VI.	FI of Nistari X Bivoltine [N X NB4D2P3]	Yellow	Oval.	0.69	0.34	3.12	729.96	88.85	64.47	19.63	614.74
VII.	MC 4 X BC 4	Yellow	Oval.	0.47	0.22	2.45	418.09	73.83	45.37	63.22	317.15

Where we have:

A. Sample No.
B. Name of the Race.
C. Colour of the cocoon.
D. Shape of the cocoon.
E. Single cocoon Weight (gm)
F. Single Shell Weight (gm)
G. Filament Denier.
H. Filament's Length (Meter)
I. Reliability (%)
J. Recovery (%)
K. Waste (%) on UR of raw silk.
L. Non-breakable filament length(meters)

Fromtheseven samples, required partsfor viewing under SEM were cut into small pieces. After that, they were pastedon the stubwith the help of both-side gummed tape. These mounted sampleswere then undergone into Gold - Sputter coating. Nowthe samples are ready for SEM. When theSEMis used, the column and sample chamber must always be ata vacuum ofthe order 10^{-5} torr. For Sputter coating, the chamber is to be also evacuated at the pressure range of 10^{-1} torr. If it is not evacuated, then before the sample is coated, the gas molecules would get in the way of the Argon environment and Gold. This could lead to uneven coating or no coating at all. [Watt, I.M. 1997]

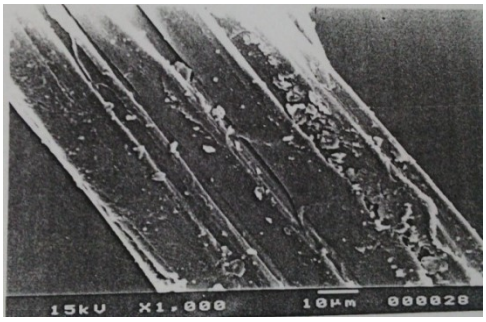
RESULT AND DISCUSSION

The SEM study or micrographs of the seven different samples show that the fibres have more or less smooth surfaces (though some of them show their roughness). Analysis of the cross - sections of the fibres shows that they have near circular cross - sections. Random structures (non -woven mat), aligned fibres and web like structure can be obtained. The addition of silk forms a coating around each individual rope and keeps them from aggregating or binding together.The analysis is based on the surface texture (in the photograph) and cross sections. The SEM micrographs of Electro-spun reveal the following surface texture of the seven different samples of silk fibres as follows.

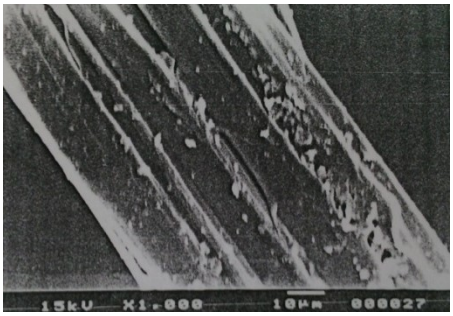
Table 3:

SampleNo.	Name of the Sample	Surface Texture
I	Bivoltine, White.	Much pores onthesurface.
II	Bivoltine, White. Double-cocoon (damaged).	Numerous pores on the surface. Number of pore is maximum among the seven samples.
III	M12WMultivoltine, Bangladeshi.	Less number of pores and smooth surface.
IV	Nistari (PI) Local, Multivoltine, Yellow.	Less pores and comparatively smooth surface.
V	MCI X BC 4 (Chaitali-Chaitra Crop)	No pores at all and comparatively smooth surface.
VI	FI of Nistari X Bivoltine [N X NB4D2P3]	No pores at all and comparatively smooth surface.
VII	MC 4 X BC 4	Least pores at all and comparatively much more smooth surface.

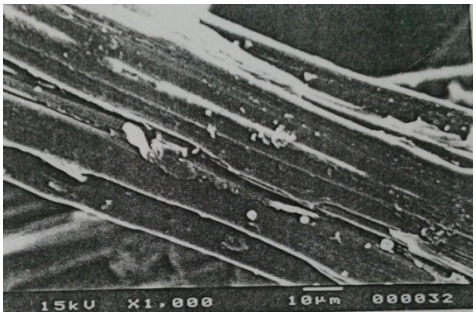
SEM images of Silk Fibres:-



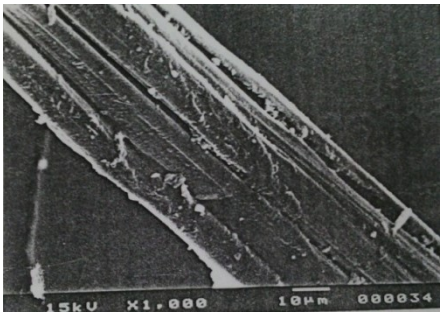
Sample - I



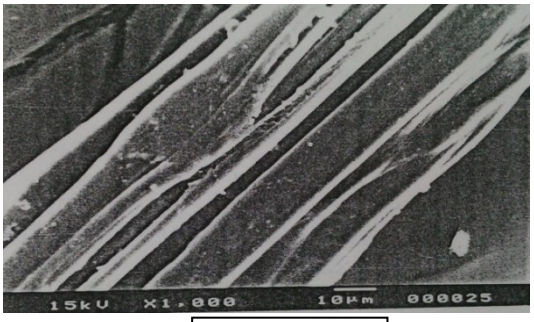
Sample – II



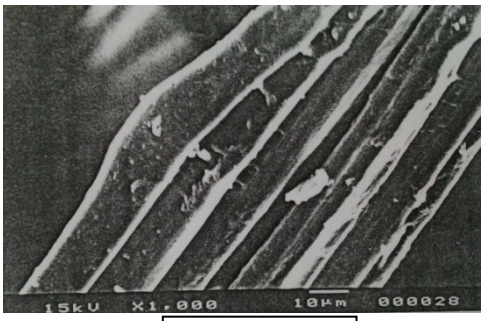
Sample – III



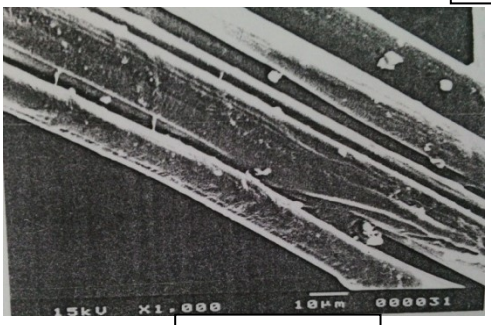
Sample – IV



Sample -V



Sample – VI



Sample - VII

From the study, we can conclude that surface texture is the best in the MC **4**X BC **4**(Sample No. VII). Then samples MC1**X**BC 4[Chaitali-Chaitra Crop] (Sample No. V) and F1 of Nistari X Bivoltine **[N X** NB4D2P3](Sample No. VI) are also smooth and comparatively less porous. So their compactness is also of higher quality. **MC 4 X BC 4 (Sample No. VII)produces the best quality silk fibre with maximum compactness and glaze in texture**.

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