EVALUATION OF PHYSICO CHEMICAL CHARATERISTICS OF SILK FIBRES OF *Litsea cubeba* Pers., REARED ON DIFFERENT HOST PLANTS

Faizah Hamzah[1]
[1]*Fakultas Pertanian Jurusan Budidaya Program THP-UNRI, Pekanbaru*

ABSTRACT

The golden-yellow silk fibres obtained from *Litsea cubeba* Pers., westwood reared on leaves of three different host plants belonging to the family Lauraceous, were studied to evaluate their characteristic physico – chemical properties. The host plants *M. bombycina* King, *L. cubeba* Pers., Juss and *L. citrate* Roxby, significantly influenced silk length, width, sericin and amino acid contents of the fibres. The contents of the predominant amino acid; glycine (10.55 µg), aspartic (5.43 µg) and (7.15 µg), were higher in fibres obtained from cocoons of *L. cubeba* Pers., fed on *M. bombycina*, while alanine (9.46 µg) was higher in the fibres of cocoons obtained from the two host plant. The breaking load (17.191 g) and tenacity (3.562 g) were higher in cocoons from the host plant *L. cubeba* Pers. The X-ray diffraction patterns showed the amorphous nature of the fibres obtained from the cocoons of *L. cubeba* Pers., fed on *L. polyantha and L. citrate* while fibres obtained from cocoons from *M.bombycina* showed amorphous bands with little tendency to two dimensional order. Above all, the natural golden yellow hue of the fibre, which is one of the most important and commercially valuable added properties of this particular silk variety, was better retained in the fibres extracted from cocoons of *L. cubeba* Pers., larvae reared on *M. bombycine*.

Keywords : *amino acids, breaking load, L. cubeba Pers., tenacity, x-ray diffraction*

INTRODUCTION

The muga silk worm, *L. cubeba* Pers., Westwood, a multivoltine, serico genic insect native to North Eastern India, is generally fed leaves of woody tress like *M. bombycine* King, *L. polyantha, L. citrate* Roxy, *L. salcifolia* Roxy and many other host plants produce variable effects on the relative survival of herbivorous insects by influencing food intake, digestion and assimilation which directly affect the larval growth and development[1]. Variation in total haemocyte counts (THC), blood volume (BV), body water (BW) content, head capsule widths and body weights *L. cubeba* Pers., were induced by host plants and seasons of the year[2,3].

Besides affecting variability in biology and physicology of *L. cubeba* Pers.,[4], the host plants influences spectaculary the colour pattern of silk cocoons of *L. cubeba* Pers.,[5]. Further, it is known that *L. polyantha* induces fecundity, whereas, *M. bombycina* improves the amount of silk production[6]. Though seasonal variation of cocoon characters of *L. cubeba* Pers., reared on *M. bombycina* has reported available on physical[7], no reports about physico-chemical properties of silk fibres are obtained by rearing worms on different host plants. The mechanism of cocoon fibre formation, structure of sericin and fibroin, and chemical compositions in different sericogenous insects like *Bombyx mori, A. yamani, philosomia ricini* have been studied[8]. In the present paper, were report the phenomenal changes in the physical and physico – chemical properties of silk fibres obtained from cocoons of *L. cubeba* Pers., reared on three different host plants : *M. bombycina, L. polyantha* and *L. citrata.*

MATERIAL AND METHOD

The tree species *M. bombycina, L. polyantha, L. citrata, L. cubeba* Pers., were naturally grown 3-3 years old plants. The trees were

individual covered by mosquito proof nets, before brushing newly hatched larva into them.

Throughout the larva period, the trees were covered in order to protect the larva from trees were covered in order to protect the larva from predator. Branches of dry leaves of *M. bombycina* were provided at the base of the respective host plants inside the net for cocooning. After 6 days, cocoons were collected for various analyses during the autumn brood[2]. Weights of cocoons and pupae were taken in an electronic microbalance (Mittler AE 240 dual range, Mettler instruments AG, Switzerland; sensitivity 0.01 mg), by following standard degumming and spinning techniques[6], lengths of silk threads per cocoon were measured by employing an emprowvette. Subsequently denier was also calculated. Sericin were measured by the procedure of Jolly and Krishnaswamy[9] and Borah *et al.,*[7]. For determination of amino acids, silk fibres were hydrolysed by 6 N HCL at 110°C for 22 h, taking proper precautions to conserve methionine, cystine and tyrosine. Following digestion 80, 40 and 40 µg of silk fibres obtained from larvae fed on *L. cetrata, L. polyantha* and *M. bombycina, respectively,* were analysed in a Pharmacia LKB alphaplus amino-acid analyser. Individual amino-acid were quantified as µg/100 µg[10]. For X-ray and infrared (IR) analyses, fibres were made into a powder that posed through a 60 – mesh sieve. X-ray diffraction data were collected using a controlled X-ray diffractometer (Type JDV – II P3A, JOEL, Japan) with pulse height analyser and scintillation counter with an Nal (TI) single crystal scientillator.

IR spectra were recorded in a Perkin Elmer Spectrometer (Model 2000 FTIR), using the KBr disk technique, from 4000 to 400 cm^{-1} with resolution of 2 cm^{-1} and a resolution of 2 cm^{-1} and five scans per sample. Scanning electron micrographs of fibre sample were in a JOEL JSM-35 M-35 CF electron microscope at an accelerating potential of 15 KV. Fibre sample obtained from the cocoons reared on the three different host plants were prepared and then mounted on the specimen holders of the electron microscope, with electron conductive tape. The sample were coated with gold in an ion-sputter coater (JFC 100, JOEL, Japan) in a vacuum to give a layer 150-200 nm thick before making observations.

Testing of fibres strength properties

The fibres were conditioned at 65% relative humidity at for 27°C for 2 h and then tested for various physical properties[11,12].

RESULTS AND DISCUSSION

Larvae fed on *M. bombycina* and *L. polyantha* produced golden-hued cocoons. Whereas those fed on *L. citrate* produced creamy-white cocoons. However, cocoons obtained from *M. bombycina* and *L. polyantha* different distinctly in colour pattern, the farmer were deep golden yellow and shiny, white the latter were dull.

The weights of cocoon, pupae, shell and silk a long with silk length, silk ratio and denier are presented in Table 1. All data were subjected to complete randomized design analysis of variance (ANOVA). Means were compared by the least significant difference (LSD) procedure[13]. Cocoons produced by larvae fed on *M. bombycina* were significantly heavier than those fed on *L. polyantha* and *L. citrate*, the trend was exactly, similar for shell and silk weight and also for silk length. However, there were no significant difference between pupae weight and silk ration. Sericin content was highest in the fibres obtained from cocoons produced by feeding on *M. bombycina* The fibroins showed variation in amino-acid composition depending on the host plant (Table 2). Alanine and glycine contents were highest in the fibres obtained from larvae fed on *M. bombycine* (*L. cubeba* Pers.), and the fibroin was similar to mulberry silk[14,15]. Table gives the rations of major amino-acids in the fibroins of *L. cubeba* Pers., in relation to the oust plants.

The physical strength properties of fibres of different denier are given in Table 4. The breaking load of fibres extracted from cocoons from *M. bombycina* was the highest. The cocoon fibres obtained from *L. polyantha* and *L. citrate* showed higher elongation than from cocoons of *M. bombycina* (*L. cubeba* Pers.).

Table 1. Variation Cocoon Characters of *L. cubeba* Pers., per Produced by Larvae Fed on Different Host Plants

Properties	*L. cubeba* Pers., (*M. bombycina*)	*L. polyantha*	*L. citrata*	P.0.05
Weight of cocoon (g)	4.463 ± 0.32[a] (10)	3.450 ± 0.23[b] (10)	3.765 ± 0.16[ab] (10)	LSD = 0.7271
Pupa	4.531 ± 0.36	3.732 ± 0.40	3.495 ± 0.21	NS
Shell	0.359 ± 0.01[a] (10)	0.247 ± 0.04[b] (10)	0.274 ± 0.01[b] (10)	LSD = 0.0799
Silk	0.256 ± 0.02[a] (5)	0.086 ± 0.01[b] (5)	0.106 ± 0.02[b] (5)	LSD = 0.0584
Silk length (m)	441.74 ± 26.25[a]	310.16 ± 3595[b]	258.54 ± 30.80[b]	LSD = 108.03
Silk ratio C %	7.39 ± 0.62	5.52 ± 42 (10)	7.20 ± 0.38 (10)	NS
Sericin	23.18 ± 1.07[a]	17.50 ± 1.07[b]	18.82 ± 1.12[b]	LSD = 3.76

Table 2. Amino Acid Content in Silk Fibres of *L. cubeba* Pers., (in µ/100 µg)

Amino acid	*L. cubeba* Pers., (*M. bombycina*)	*L. polyantha*	*L. citrata*
Aspactic acid	5.45	5.16	5.57
Thereonine	1.17	1.53	1.49
Serine	7.15	6.53	6.43
Glutamic acid	1.62	1.77	1.90
Proline	0.29	0.39	0.49
Glycine	10.55	9.28	7.81
Alinine	9.46	11.32	10.40
Cysteine	0.07	0.06	0.10
Valine	0.44	0.04	0.48
Isoleucine	0.32	0.36	0.32
Leucine	0.47	0.50	0.47
Tyrosine	0.10	5.38	5.92
Phenylalanine	0.49	0.59	0.57
Histidine	1.45	1.32	1.54
Lysine	0.34	0.48	0.40
Arginine	3.51	2.95	3.64

Table 3. Ratio of Major Amino-Acids in Fibroins of *L. cubeba* Pers., in Relations to Host Plants

Ratio	*L. cubeba* Pers., (*M. bombycina*)	*L. polyantha*	*L. citrate*
Alanine : Glycine	0.89	1.22	1.33
Tyrosine : Serine	0.85	0.82	0.98
Aspartic : Arginine	1.54	1.75	1.53

Table 4. Physical Strength Properties of *L. cubeba* Pers., Silk Fibres from Silk Cocoons of Different Host Plants[*)]

Physical	*L. cubeba* Pers., (*M. bombycina*)	*L. polyantha*	*L. citrate*
Denier	5.270	3.390	3.640
Breaking load (g)	17.791	10.443	11.287
Elongation (%)	19.564	24.160	25.942
Tenacity (g/d)	3.562	2.415	2.460

[*)] Results are means of three readings

The IR absorption bands displayed all the characteristic for groups present in different amino acid. The bands between 3070 cm^{-1} and 3100 cm^{-1} were due to NH – stretching of secondary amides, 1660 cm^{-1} being. The Co – absorption band of amide I. The amide II band of primary amides comes from the scissoring motion of NH_2 at 1650 – 1620 cm^{-1} and of the secondary amide at 1550 – 1500 cm^{-1}. The amide III bands appeared in the secondary amides between 1310 and 1200 cm^{-1} come from the mixed vibration in C-N stretching and N-H bending[16]. On the whole, the absorption bands displayed characteristic groups of the amino acids that were present in the *L. cubeba* Pers., silk protein.

The X-ray diffraction patterns of silk fibres of *L. cubeba* Pers., extracted from cocoons produced on *M. bombycina* (*L. cubeba* Pers.), *L. polyantha* and *L. citrate* did not show the orderly 3 – D crystal lattice. However, fibres of *L. cubeba* Pers., obtained from cocoons of *M. bombycina* fed larvae exhibited amorphous bands with little tendency to 2 – D order. Such a pattern was lacking in the other two samples and they were similar in from. That the fibroin molecule contains non-repetitive (amorphous fraction) and repetitive (crystalline fraction) amino acid sequences in several conformations of different stability[15] was exhibited in the present samples.

CONCLUSIONS

The importance and popularity in India of the silk fibre from *L. cubeba* Pers., particularly in the North Eastern region of the country is due to its natural golden yellow (muga in Asamese) colour. *L. cubeba* Pers., a polyphagous saturniidae, is being traditionally reared out door on the naturally grown host plant *L. cubeba* Pers., (*M. bombycina*) for commercial silk production. It is now established that the host plant for *L. cubeba* Pers., larvae has a significant affect not only on the natural golden yellow colour of the fibre but also on its physical strength properties.

REFERENCES

1. G. P. Waldbauer, *The Consumption and Utilization of Food by Insects, Advances in Insect Physiology*, 5, 1999, 229 – 288.
2. S. Bordoloi, L. K. Hazarika, Seasonal Variations of Body Weight, Lipid Reserves, Blood Volumes and Hemocyste Population of *L. cubeba* Pers, *Environmental Entomology*, 20(6): 1398-1403, (2002).
3. L. K. Hazarika, S. Borbodoi, A. Kataky, Effects of Host Plant on Haemocyte Populations and Blood Volume of *L. cubeba* Pers West Wood, *Sericologia,* 34(2): 310–306, (2002).
4. A. Kataky, L. K. Hazarika, and B. G. Unni, Biochemical Analysis of *L. cubeba* Pers and its Host Plants. 6 1st Animal General Meeting. Society for Biological Chemist (India). Centre for Cellular and Molecular Biology Hydrabad 21-23 December 2002.
5. S. N. Chondhury, *Muga Silk Industry*, 1st ed, Directorate of Sericulture Assam, India, 2001.
6. S. N. Chondhury, *Silk and Sericulture*, 1st ed, Directorate of Sericulture Assam, India, 2002.
7. A. Borah, S. N. Phukan, M. V. Samson Variation in Cocoons Characters of *L. cubeba* Pers During Different Seasons

Scricologia, 28: 215-218, (2003).
8. K. Komatsu, *Chemistry and Structure of Silk JARQ*, 1999, 13(1): 64-72.
9. M. S. Jolly, S. Krishnaswanny, Sericin Content in Cocoon of Indigenous Silk Worm Races (Bombimory L) Indian, *J. of Sericulture*, 111(1): 17-18, (2003).
10. A. Kataky, and L. K. Hazarika, Effect of Host Plant on Certain Biological and Physiological Variable, of *L. cubeba* Pers., in Proceedings of Recent Advances in Life Science, Vol. 1 ed A.K. Rai, Dibrugarth University, India, 19-24, (2002).
11. J. E. Boath, *Principles of Textile*, 3rd ed, Butter Worth Scientific, London, 1999.
12. American Society for Testing Material, *Standard Test Methods for Tensile Properties of Single Textile Fibre Vol. 7* ASTM S1776 USA, 2002.
13. K. A. Gomez and A. A. Gomez, *Statistical Procedures for Agricultural Research*, 2nd ed, Wilwy, New York, 2002.
14. R. S. Dhavalikar, Amino-Acid Composition of Indian Silk Fibroin and Sericins; Part I Fibroins, *J. Sci and Ind. Res Zic.,* 10: 261 – 263, (1990).
15. F. Schnal, H. Akai, Insect Silk Glands: Their Type Development and Function and Effect of Environ Mental Factors, and Morphogenetic Hormones on Then, *Int J. of Insect Morphology and Embryology,* 19(2): 79-132, (2003).
16. F. S. Parker, *Applications of Infrared Spectroscopy in Biochemistry*, Biology and Medicine, Plenum Press, New York, 2001.