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A COMPARATIVE STUDIES OF TWO SILKWORM SPECIES IN RAIGARH DISTRICT FOR HIGH QUALITY YIELD

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ABSTRACT

The sericulture industry is very unique and popular for its high valued textile fiber, agricultural outputs including, cocoons and cottage based labor intensive and for the production of high quality textiles. An attempt has been made to formulate a strategic model to recognizethe potential strength and challenges of sericulture in Raigarh district at Chhattisgarh state. We report results of the comparative studies relating to the silk production and productivity at Raigarh district from the silkworm species *Antheraea mylitta* and *Bombyx mori*. The study indicates the commercial perspective of silkworm production at Raigarh district.

INTRODUCTION

India continues to be the second largest producer of silkin the world, providing gainful occupation to about sixmillion persons in the rural and semi-urban areas acrossthe country (Rahaman, 2013). India has unique distinction of being the only country on the world producing all the four commercially known verities of silk, *viz*, mulberry, tasar, eri and munga (Anitha, 2011). Sericulture industry has been identified as employment oriented industry (Devaraja, 2011). All the sections of sericulture industry, viz. mulberry cultivation, silkworm seed production, silkworm rearing, reeling and weaving of silk and collection of byproducts and its processing provide a large scale employment, thereby a source of livelihood for the rural and tribal people (Gregory, 1994 and Srivastava, 2003). Sericulture industry is rated as the second largest employer in India (Anitha, 2011). Sericulture have recently aroused much interest due to their wide industrial applications. Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen,and inherent affinity for dyes, high absorbance, light weight, soft touch and highdurability and known as the "Queen of Textiles" the world over (Li, 2012 and Bunning, 1994). Silk is composed of two major proteins, a fibrous protein (fibroin) and globular, gumming protein (sericin) (Takasu, 2002 and Mondal, 2007).

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Fibroin has been used in textile manufacturing and for several biomaterial and biomedical applications, whereas sericin is considered a waste material in the textile industry (Reddy, 2011 and Vepari, 2007). Sericin has recently been found to activate the proliferation of several cell-lines and has also shown various biological activities (Tsubouchi,, 2005 and Zhang,, 2006). Chhattisgarh state is a very popular for its high quality Kosa silk production. Silk a way of life in Chhattisgarh has become an inseparable part of Indian culture and tradition should be considered for rural management and development (Dewangan et al., 2011). Presently in Chhattisgarh three types of silk viz., Mulberry, Tasar and Eri silk are producing (Singh, 1993). Mulberry and Tasar farming is done in 6 major district such as Raigarh, Bilaspur, Korba, Champa, Bastar and Ambikapur. Chhattisgarh is the second largest producer of Tasar cocoons.

Mainly two types of silk produced in the Raigarh district; they are Tasar Silk & Mulberry Silk. Kosa of Chhattisgarh was famous in the world for its elegance and quality and it is still, a force considers. Raigarh district is major tasar growing area where tribal are engaged in sericulture activities(Dewangan, 1993). The Kosa industry is one of the industries that's currently blooming in Raigarh along with other industries producing iron ore, steel and power in the country. The production of Kosa is the main livelihood for some of the villagers in this district and many of them have now started running units for producing Kosa sarees and dress materials

for export (Dewangan, 2011). The present investigation was carried out inRaigarh district of Chhattisgarh state. Here,we report the results of the studies relating tocomparative study of silk production at Raigarh district. Present study focused on two silkworm species *Antheraea mylitta* and *Bombix mori*.Specifically, the main objectives of the study are: (1) to introduce in brief, the historical perspective of sericulture in Raigarh district at Chhattisgarh state. (2) Comparative Studies of two silkworm species such as *Bombyx mori* and *Antheraea mylitta*" and their life cycles studies. (3) To examine the growth and production of sericulture in Raigarh district at Chhattisgarh state (4) Study of the improvements of silk quality and production of silk up to industrial scale.

MATERIALS AND METHODS

Field of study

The present research studyhas been carried out inRaigarh districtat Chhattisgarh state (Figure 1). Raigarh is the second largest producer of tasar cocoons in Chhattisgarh, where both types of silk namely mulberry and tasar are being produced. Based on kosa silk, many villagers are running units for producing kosa sarees and dress materials of export quality.The study area has about 364acres under mulberry cultivation though effectivearea is only 80-120 acres. Mulberry gardens are18 in number and Mulberry Grainages are 1 in Urdana. Mulberry Reeling Unit in 1 number at Dharamjaigarh. Raigarh district is major tasar growing area where tribal are engaged in sericulture activities. Tasar culture is a traditional and exclusive craft of the tribal of study area and isbeing practice from 30 years. Maximum numberof total production of tasar cocoons in the Statecomes from the district. Total area covered undertasar centres is about 3153.25 acres though effective area is about 2350 acre. Tasar centresare 22 in number (Dewangan, 2011).

Climatic factors

The weather in Raigarh varies during different months. In the summer the temperature can vary from 29.5 ^{o}C to 49 ^{o}C and lasts during the month from March to May. The temperature during this pre-monsoon period increases rapidly during the night and day.

It's usually extremely dry during this time. During the monsoon which last from June to September, the maximum temperature is 38 ^{o}C in the month of June and in the month of September the temperature goes down to 24.50 ^{o}C. At times, the monsoon also extends up to mid-October. Even though the temperature drops to 17.10 ^{o}C during the nights of October, the official winter season starts from December and goes on to the month of February to January with the minimum temperature going down to 13.20 ^{o}C (Chakraborty, 2015).

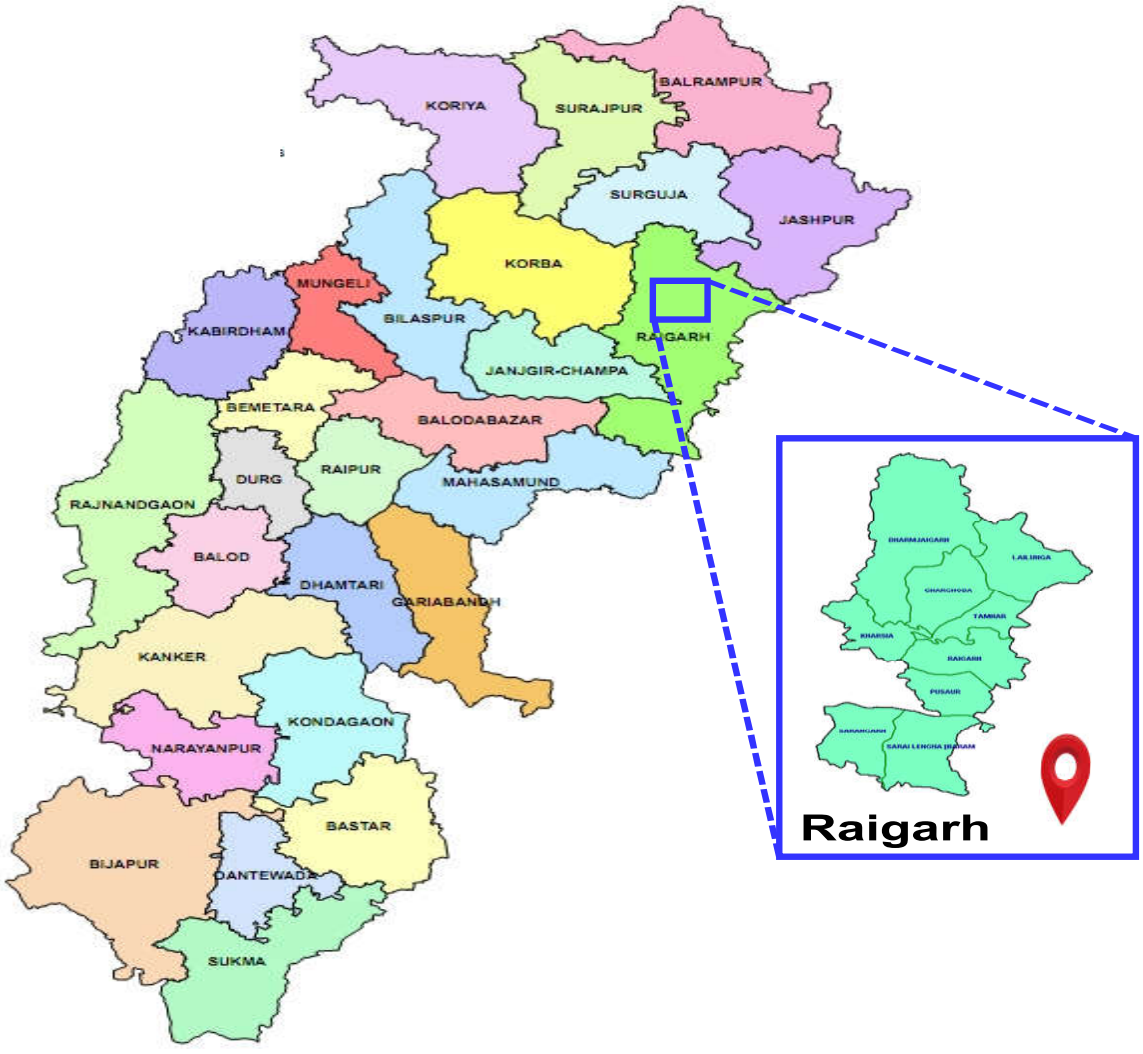

Figure 1. Sericulture in Raigarh district at Chhattisgarh state

Sample collections

The present investigation was carried out in Raigarh district at Chhattisgarh state, was intentionally selected for the study, as it is the second largest producer of Tasar cocoons in Chhattisgarh, where both types of sericulture - mulberry and tasar are being accomplished. The present research study has been carried out in nearby sericulture research centre in Raigarh district such as Baramkela, Boirdadar and Degaon.

Rearing of silkworm

Rearing of Tasar and mulberry silkworms was carried out on Arjun (*Terminalia arjuna*) and mulberry plant respectively. For this, freshly hatched healthy silkworms were brushed on to each of the plant species during the 1st crop (July - August) season following the rearing protocol developed byCentral Silk Board, Bangalore (Dandin, 2010).

Mulberry silkworm

Cultivation of mulberry plant is mainly for its leaves the sole food for the silkworm, *Bombyx mori* L. for commercial production of raw silk. The silkworms are actually larvae of the silk mothas shown in Figure 2 (A) and (B). They are reared in specially made trays in rooms with controlled temperature and humidity and regularly fed mulberry leaves. At a certain stage they convert themselves into cocoons. These cocoons are made from a single filament of material secreted by the pupa and wrapped around itself for protection. These filaments upon hardening constitute silk. On an average, 1 acre of plantation would yield 240 kg of cocoons in a year, starting from 100 DFLs. Depending upon whether it is dryland or irrigated mulberry, farmers can harvest the cocoons 4 to 8 times in a year.

Tasar silkworm

The tasar silkworms belong to the genus Antheraea and they are all wild silkworms. The Indian tasar worms feeds on leaves of Terminalia and several other minor host plants. The *Antheraea mylitta*silkworms larvae and moth as shown in Figure 2 (C) and (D). The worms are either uni or bivoltine and their cocoons like the mulberry silkworm cocoons can be reeled into raw silk.In Tasar culture, the silkworms are reared outdoors on the trees, for better management of rearing it is desirable that the plants are given proper height and shape. Since in Tasar culture, it is the leaf and not the wood or fruits, which are required, plants should be induced to produce more of quality leaves. The plants are cut at 6′ height for Arjun and 7′ height for Asan while in light pruning only the branches of 1′ diameter or less are cut. Arjun and Asan plantation of more than four years ago with spacing of 4×4′ are maintained by pruning at the height of 3-4′.pruning should be done during February-March and march-April for 1st and 2nd crop, respectively.

Life cycle study

Life cycle of *Antheraea mylitta* and *Bombyx mori* have been studied for comparative studies. Life cycle of the silkworm consists of four stages i.e. adult, egg, larva, and pupa. The duration of life cycle is six to eight weeks depending upon racial characteristics and climatic conditions. Multi-voltine races found in tropical areas have the shortest life cycle with the egg, larval, pupal and adult stages lasting for 9-12 days, 20-24 days, 10-12 days and 3-6 days, respectively.

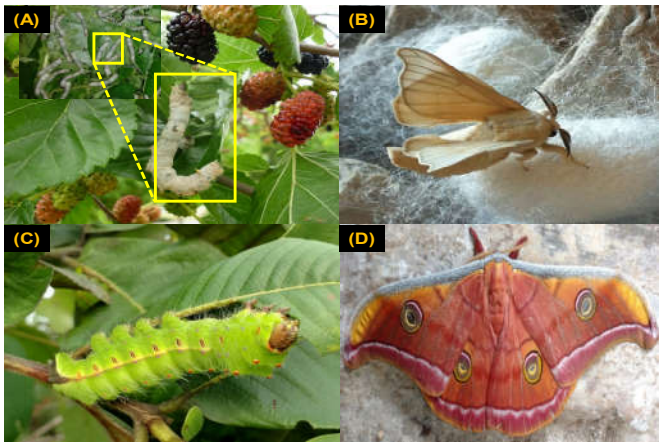

Figure 2. *Bombyx mori*silkwormlarva (A) and moth(B)in mulberry plant and *Antheraea mylitta*larva (C) and moth(D)in arjun plant respectively

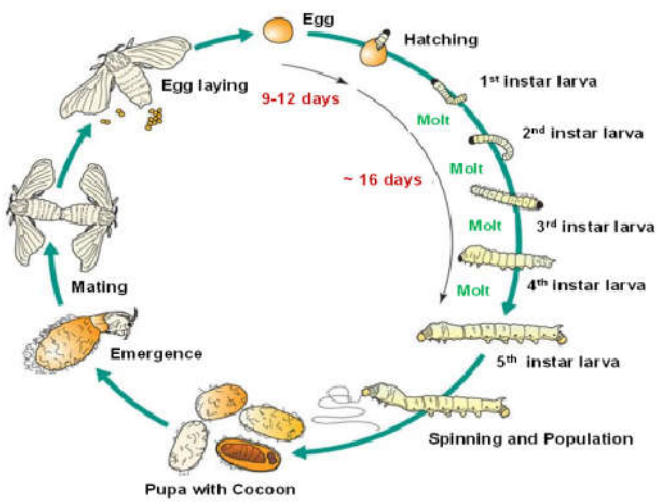

Figure 3. Life cycle of silkworm *Bombyx mori*

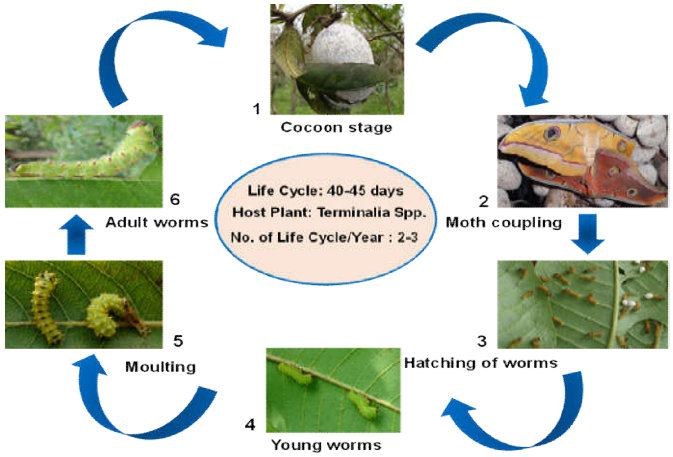

Figure 4. Life cycle of silkworm *Antheraea mylitta*

Seven to eight generations are produced in multi-voltine races. In uni-voltine races, the egg period of activated egg may last for 11-14 days; the larval period, 24-28 days; the pupal period, 12-15 days and the adult stage, 6-10 days. The life cycle of *Bombyx mori* has been shown in Figure 3. In nature, uni-voltine races produce only one generation during the spring

and the second generation of eggs goes through a period of rest or hibernation till the next spring. In case of bivoltine races, however, the second generation eggs do not hibernate and hatch within 11- 12 days and produce second generation normally during summer and it is the third generation eggs which undergo hibernation and hatches in the next spring, and thus producing two generations in one year. Several species of Antheraea are exploited for production of wild silk known as tasar silk. The tasar moths are fairly large insects. Females are larger and yellowish brown in colour, while males are smaller and brick red in colour. Both have prominent and colourful eye spots on their wings. The antennae of males are bushy, and abdomen is narrower in comparison to female. The important stages of the tasar silkworm life cycle have shown in Figure 4.

plants in relation to season compared to primary food plant and their commercial feasibility is an important factor for silkworm rearing and grainage performance. The present study shows that tasar rearing and graninage behaviour is better when the larvae were fed *Terminalia arjuna* food plant though commercial traits *viz*., cocoon weight, shall weight, silk ratio and egg fertility are much better than mulberry host plant for *Bombyx mori*. This is indicative of availability of suitable nutrients in the host plant *Terminalia arjuna*. The highest cocoon weight 12.35 gm was recorded for species *Antheraea mylitta* (female) as compared to *Bombyx mori* (female) cocoon weight 1.47 gm rainy season which are shown in Table 1 and Table 2. Wherever, the highest cocoon weight 9.30 gm was recorded for species *Antheraea mylitta* (male) as compared to

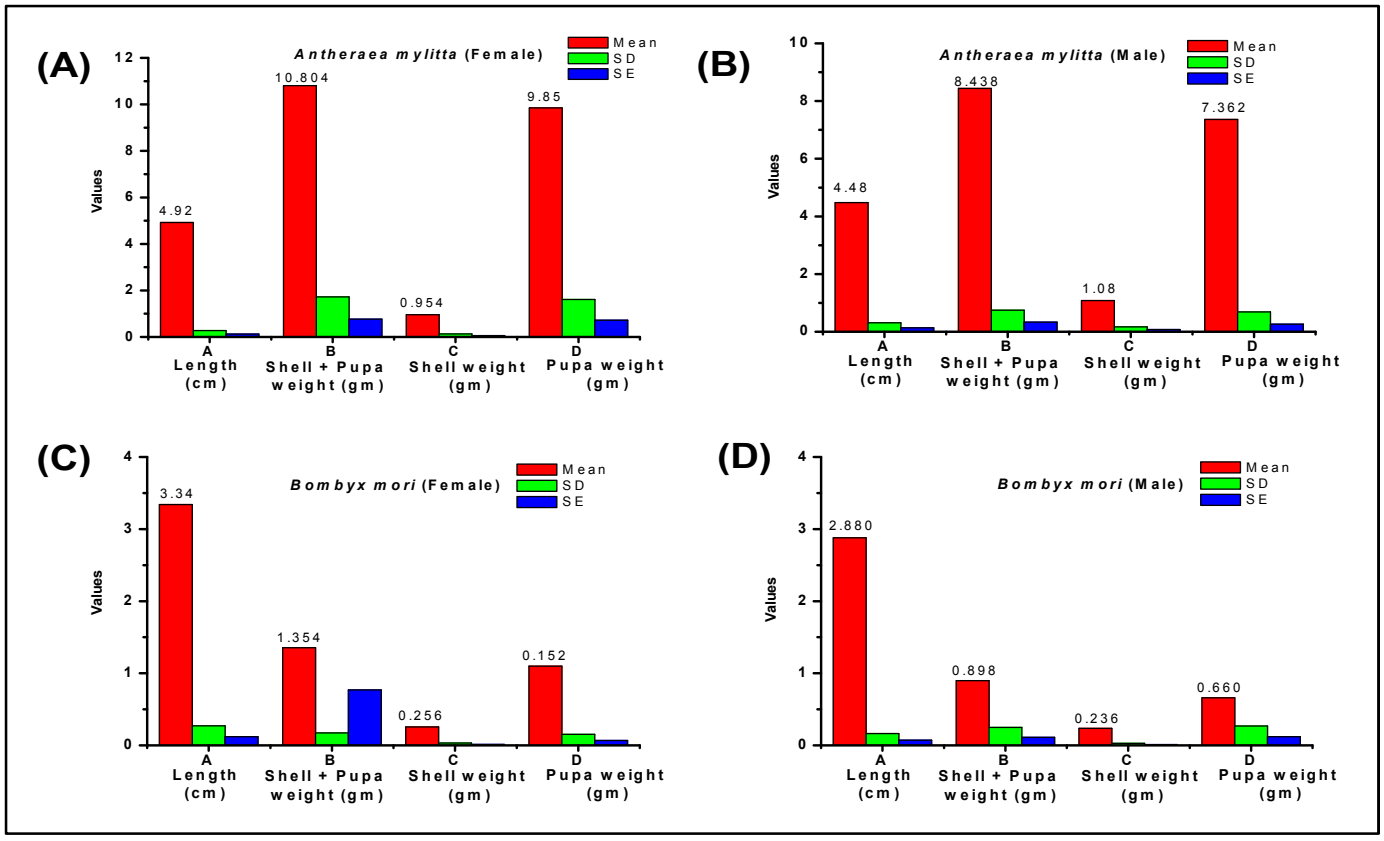

Figure 5. Statistical data of cocoon parameter from (A) *Antheraea mylitta* (female), (B) *Antheraea mylitta* (male), (C) *Bombix mori* (female) and *Bombix mori* (male)

Statistical analysis

Research methodology applied in this study was a combination of descriptive-analytical and quantitative methods and statistical methods. Primary and secondary data was analysed using various statistical tools viz., mean, mode and median. In addition to usual statistical measures coefficient correlation techniques were employed at appropriate context in the study to evaluate and analyze the collected data.

RESULTS AND DISCUSSION

The results in this study has been supported by the statistical data analysis presented in the form of tables given under different sections. Cocoon yield and seed quality of *Bombyx mori* and *A. mylitta* is dependent on variety and nutritional status of host plant but farmers for the economic advantage use alternative food plants based on availability and accessibility. The rate of leaf production, quantity, gestation period of host

Bombyx mori (male) cocoon weight 1.23 gm rainy season which are shown in Table 3 and Table 4. Comparative mean data for cocoon production from two silkworm species have shown in Table 4.5 and Table 4.6.Productivity of cocoon in outdoor rearing is poor due to attack of number of pests and predators besides natural vagaries such as, wide fluctuating temperature, heavy rain and stormy wind etc. Attempts were made in the past to increase the cocoon production by adopting various methods of indoor rearing was conducted in wooden tray supported with wooden rearing frames specially designed for young age and late age silkworms. Production of quality tasar seed is one of the most challenging task of tasar silk industry at base level. A systematic and methodological approach of silkworm seed production is required to sort out the problems during the preparation of quality seed. Tropical tasar *Antheraea mylitta* is wild sericigenious insect of commercial importance of tropical India. The rearing performance of *A.mylitta* (female) is presented in Table 4.1.

Table 1. Data showing individual length (cm), shell and pupa weight (gm), shell weight (gm) and pupa weight (gm) of *Antheraea mylitta* (female)

S.N.	Length (cm) [A]	Shell +pupa weight (gm) [B]	Shell weight (gm) [C]	Pupa weight (gm) [D]
1.	4.5	8.34	1.05	7.30
2.	4.8	9.09	1.23	7.85
3.	4.7	9.30	1.28	8.03
4.	4.4	7.91	0.91	6.99
5.	4.0	7.55	0.93	6.62
∑x/N	22.4/5	42.19/5	5.4/5	36.81/5
Mean	4.48	8.438	1.08	7.362
SD	0.311	0.749	0.169	0.590
SE	0.139	0.335	0.075	0.264

Table 2. Data showing individual length (cm), shell + pupa weight (gm), shell weight (gm) and pupa weight (gm) of *Antheraea mylitta* (male)

S.N.	Length (cm) [A]	Shell and Pupa weight (gm) [B]	Shell weight (gm) [C]	Pupa weight (gm) [D]
1.	5.2	12.30	0.97	11.34
2.	4.5	12.35	1.11	11.24
3.	5.0	11.37	1.05	10.32
4.	5.1	9.46	0.81	8.65
5.	4.8	8.54	0.83	7.70
∑x/N	24.6/5	54.02/5	4.77/5	49.25/5
Mean	4.92	10.804	0.954	9.85
SD	0.2774	1.723	0.132	1.615
SE	0.124	0.770	0.059	0.722

Table 3. Data showing individual length (cm), shell + pupa weight (gm), shell weight (gm) and pupa weight (gm) of *Bombyx mori* (female)

S.N.	Length (cm) [A]	Shell and Pupa weight (gm) [B]	Shell weight (gm) [C]	Pupa weight (gm) [D]
1.	3.7	1.46	0.31	1.15
2.	3.5	1.47	0.25	1.22
3.	3.0	1.33	0.25	1.09
4.	3.3	1.06	0.22	0.84
5.	3.2	1.45	0.25	1.19
∑x/N	16.7/5	6.77/5	1.28/5	5.49/5
Mean	3.34	1.354	0.256	1.098
SD	0.270	0.1738	0.032	0.152
SE	0.120	0.077	0.014	0.068

Table 4. Data showing individual length (cm), shell and pupa weight (gm), shell weight (gm) and pupa weight (gm) of *Bombyx mori* (male)

S.N.	Length (cm) [A]	Shell and Pupa weight (gm) [B]	Shell weight (gm) [C]	Pupa weight (gm) [D]
1.	2.6	0.89	0.25	0.63
2.	2.9	0.69	0.22	0.46
3.	3.0	1.23	0.21	1.02
4.	2.9	1.05	0.22	0.83
5.	3.0	0.63	0.28	0.36
∑x/N	14.4/5	4.49/5	1.18/5	3.3/5
Mean	2.880	0.898	0.236	0.660
SD	0.164	0.249	0.028	0.268
SE	0.073	0.111	0.012	0.120

The cocoon traits like cocoon length and cocoon weight, single shell weight, pupal weight in rainy seasons is related to the host plants fed to larvae.Figure 5 (A and B)shows the statistical data of cocoon parameter from *A. mylitta*(female and male).The rearing performance of *Bombyx mori* (female) is presented in Table 4.3.

The cocoon traits like cocoon length and cocoon weight, single shell weight, pupal weight in Rainy seasons is related to the host plants fed to larvae.Statistical data of cocoon parameter from *Bombyx mori* (female and male) has been shown in Figure 5 (C and D).

Conclusions

Sericulture is the science that deals with the production ofsilk by rearing of silkworm. Sericulture plays a vital role in the flow of income from the urbanrich sections of the society to the rural poor, as demand for silk is largely from the higher incomegroup. In Chhattisgarh tropical Tasar and mulberry arereared on commercial scale. Tasar is really namedas Kosa. Raigarh district is major tasar growing area where tribal are engaged in sericulture activities. Present study confirms that, bivoltine silkworms are superior over crossbreed and multi voltinesilkworms in biochemical contents in different body

tissues analysed. Difference between silkworms is due to genetic endowment of the races.

Quantity and quality of biomolecules insilkworms attributes the robustness and healthiness that reliably considered being better inrearing performance and cocoon yield. Screening of silkworm genetic resources using biochemical analysis as a tool may be more dependable for the selection in silkworm breeding programs as well as for commercial exploitation of silkworm races.

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