Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 73 (2014) 26565-26571

ISSN: 2229-712X

Technological parameters studies on the wild silkworm *Epiphora bauhiniae* (Guerin-Meneville): (Lepidoptera: saturniidae) in Gedarif State; Sudan

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ARTICLE INFO

Article history:

Received: 14 May 2013;

Received in revised form:

18 August 2014;

Accepted: 27 August 2014;

Keywords

Epiphora bauhiniae,
Silkworm,
Technological parameters,
Cocoons,
Shell,
Ratio.

ABSTRACT

This study was conducted in Gedarif town; Gedarif State, Sudan in (2003-2006). The objective was to test the hypothesis that, the wild silkworm *Epiphora bauhiniae* (Guerin-Meneville) has ability to produce a lucrative silk fiber (cocoons), of commercial value, during the rainy season. A comparative study was done to determine the average values and basic production indices, of the wild silkworm, fed during the various months of rainy seasons August, September and October). The technological traits (cocoon weight, shell weight and shell ratio) of the produced cocoons were investigated under laboratory. Cocoons produced showed high weights, during the rainy season, particularly in August and September. The study revealed that, the cocoon of *E.bauhiniae*, easy to be degummed and released from cocoon by hand, after treatment using NaoH solution (low con. 0.25%). The fibers have high ability or capability of dyeing absorbency. Sericin percentage was 44%. Cocoon weight, shell weight and shell ratio ranged between (1.5 - 2.98 g, 0.37 - 0.59 g, 22.5 – 24.5 %, respectively). The technological traits were significantly varied, within the period of the rainy season, i.e. the values obtained during August and September was higher than October values. This study showed the potential of *E.bauhiniae*, as an important wild silkworm, to be a candidate as a commercial insect, for silk production in Sudan, because it is a bi voltine race (generate twice a year) beside that its products covers all quantitative and qualitative traits and accordingly this insect will have prominent concerns to contribute and help in future to defeat poverty and boost farmer income. This study claimed to be the first study that, showing the technological traits of *E.bauhiniae* in Sudan and open the door widely for the insect not to be placed out in the cold.

Introduction

Fening, K.O.*et al*, (2008) reported that Chinese myths or legends date the culture of silk back to 2640 B.C., when the Empress Si-ling-Chi learned not only how to rear the caterpillars but what is more important, how to unwind the filament formed their cocoons. The silk industry is divided into a number of separate enterprises Mulberry culture, Egg production, sericulture and silk reeling or filament where the silk filament is unwound from the raw silk thread. Silk eggs are of two types those used for reproduction (used as stock by egg producers) and those used for cocoon production. China-leading the world in silk consumption and exportation nevertheless, Japan and South Korea consume a considerable amount of silk through importation Hassan,A.E,M. (1997). The present avails a good chance for developing countries to get into business, the intention should not be for selling cocoons Lee, Y.K (1994). But it should be for production of raw silk or fabrics, and encourage the nation to use silk in hand crafting for local use or export KimSam,Eun (1997). Sericulture provides diversification practiced in forest areas, arable lands or river banks. Diversification has a positive sign, on the environment. Also sericulture is a small scale labors industry that will create jobs in the rural areas, and cut down the movement towards big cities. In India 60.000 villages are practiced sericulture, produce income of 3200 of foreign exchange per annum, India produces four types of silk, Mulberry, Tassar, Muga and Eri which classified it as a larger country produces eri silk in the world 96% Rain, 2004 and Delort, (2006). African wild silk fibers from saturniidae [*Epiphora* and *Argema spp*., *lasiocampidae Gonometa* spp. and *Thaumetopoeidae Anaphe* and *Hyposoidae spp*.] Genera produce silk of potential commercial value and with significant importance due to their interesting mechanical properties Rain, (2004) and Delport, 2006. Most silk fiber contain matrix protein and a coating of similar compound called sericin .This sericin compound of silk fiber is usually expressed as weight loss and is an important additional factor affecting the quality of silk Vishuprasal, (2004) and (Addis *et al* 2011) determined the quantity of sercin gum and moister regain properties in African wild silk cocoon shells and fibers included *E.bauhinae* cocoon consist of three districted layers[outer leathery layer , fluffy intermediate layer and thick walled and rigid layer . The inner hard layers of both species have the highest regain 6.8 and 8.6 percentages for *E. bauhinae* and *A. panda* respectively (Addis *et al* 2012). The sericin content of fiber is estimated by boiling silk using arrange of chemicals and calculating the weight loss Sonthisombat and Speakman, (2004). (Addis *et al* 2011) reported the weight loss of wild silk fibers, ranged from 23-56%. Karumar (1999) stated that sercin gum, in

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tussah silk 5-15% , degumming loss in *Antherae proylei* , *Antherae assama*, *Antherae pernyi* and *Antherae yamamai* was range of 7-13 % *Antherae mylitta* 3.7 %, *philosamia cynthia recini* ,4.5% loss kato , (1991). The weight loss from raw silk filament, depends on the water solubility and higher alkali sensitivity, of the sercin as compared to the fibroin Choundhury, (2006). The sercin coating gives a callous and stiff felling to the fiber and hide the luster and whiteness of the silk brins (Arami *et al* 2007) there is a significant different in moisture regain of cocoon shell layers of *Epihora bauhinae* and *A. panda*. Dhavalikar (1962), (Ito *et* al 1992) were reported high sercin content for Thai silk cocoon shell 38%, Rondotica menciana cocoon shell 45% Bombyx mandarina cocoon shell 67.9%, quantity and nature of the sericin are fundamental characteristics in conferring distinctive traits to the cocoon (Mondal *et al*, 2007). The cocoon filaments of poly-phagous silkworms, with coarse filaments have high value of degumming loss, than conventional cocoon filament Kato and Hata, (1998). Bombyx mori fed on mixed leaves produce, cocoons of different quality (Fening *et al* 2008, (Ngoka *et al* 2007), (Nasreen *et al*, 1999). The silk quality produced from multivoltine strain is at low level when compared to the existing international standards .China silk is superior quality as they are of bivoltine strins V.KRamathula, (2012). Quantitative traits of silkworm reported by Jamuna Doreswamy and Subramanya Gopal (2012) as larval weight, cocoon weight ,shell weight ,shell ratio,pupation rate and filament length, while Fashid Ghasemi kasmaei and H.B. Mahesha (2012) stated on that the commercial characters of silkworm are fecundity ,larval weight ,larval duration, single cocoon weight ,single shell weight ,shell ratio, filament length and denier. Water content of cocoon layer should be less than 20% in order to obtain good quality and better reel ability in silkworm *Bombyx mori* V.K.Rahmathula (2012). (Eltayb *et al* 2013) reported that *E.bauhiniae* can be generated twice a year (bivoltine) which reflect the importance of the insect in term of the cocoon quality as bivoltine race. Life cycle is short (58-59.2 days) larval period 19-20 days, pupation rate 60-100%. Erisilkworm *Samia Cynthia recini* cocoon weight is varied from 1.5 to 2.5 and graded into four categories according to the size grade (Ksubramanian *et al* 2012). The wild silk moths play an important role in conservation and utilization of biodiversity Frankel (1982). Cocoons produced in sericulture are used for wall carpet, Lacework, table mats and other decorative items, all of which can added to household income Uma,H.,P. *et al* (1992). There are several types of silk including mulberry silk, Tassar, Muga, and Eri silk. Mulberry silk accounts for more than 90% of silk production in the world Ikpai, (1997). It is produced by rearing the silkworms *Bombyx mori* on leaves, and branches of mulberry trees Uma,H.,P. et al (1992). Sericulture as an art was not known in the rural areas of the Sudan, now it is not a secret. Search on native or land race silkworm that has a lucrative silk fiber in addition to mulberry silk worm, will be an essential step to introduce silk as a culture among Sudanese, for producing silk to satisfy growing demand for raw material (cocoons). This will assist in the development and expansion of small scale rural, perhaps national industries, which may generate additional income for the farmers and country. The aim of this research was to test the hypothesis that the land race silk worm in the Sudan can be able to produce good cocoons with commercial characters when feed on local trees (*Ziziphus spp*.). Data on silkworms in the Sudan is scanty. For this reason this study aimed to investigate the influences of rearing period at the rainy season on the technological traits of *Epiphora bauhiniae* such as characteristics of the cocoon weight, shell weight, shell ratio, silk filament size and length.

Materials and Methods

This study was conducted in the area of Gedarif State, eastern Sudan which lies between latitudes 12º 45` N, and 14º 15` N, longitudes 34º E and 37º E, (altitude 600m above sea level The rainfall varies from north to south. The average annual rainfall in Gerba (143 km from Gedarif), is 175 mm to 570 mm at Galabat (150 km South Gedarif). It is markedly seasonal in character. The length of the rainy season fluctuates during July to October and reaches peak in August. Records on relative humidity, and temperature during the studies were recorded.

Technological parameters (shell weight cocoon weight and shell ratio):

Three hundred healthy cocoons (not defective cocoons) were collected during the months of rainy season, August, September, October, 100 cocoons in each month were selected from a point about 10 cm beneath the surface of the batches of produced cocoon in that month to avoid variability of atmospheric conditions to cocoons. The weights of cocoons were obtained using a balance and data were recorded. The shell weight was done after pulling out pupae from cocoons with their exuviae. Pupal weight was achieved after separated from cast off skin. All data recorded and calculations were done later to obtain the mean weight of cocoon and shell for each month. The experiment was replicated three seasons. Shell ratio was obtained using mechanical test system that is used for classification of cocoon shell according to the formula below Lee, Y. W. (1999).

$$\text{Shell ratio} = \frac{\text{Shell weight (g)}}{\text{Cocoon weight (g)}} \times 100$$

The mean of shell percentage of cocoon produced during rainy season was obtained and all data were recorded.

The influence of sodium hydroxide (NaoH) on softening the sericin (silk gum) of cocoons of *Epiphora bauhiniae*:

Ten grams of sodium hydroxide (Flakes L.T) dissolved in 500 ml of water, gave 2%concentration of sodium hydroxide solution. Dilutions of the solution were done recently gave four different concentrations 1%, 0.5%.0.25% and 8%, the last concentration (8%) was obtained by dissolved 10g of sodium hydroxide in 125 ml of water. Fifty cocoons of *Epiphora bauhiniae*, were soaked in tepid sodium hydroxide solution at different concentrations (8%, 2%, 1%, 0.5%, 0.25) in five containers, 10 cocoons each and left for a period of time to react with gum of cocoons. The observation was done for the time required to help unravel the thread by softening the sericin. The sodium hydroxide was washed away from treated cocoons by watering them several times, and releasing of thread was done by hand.

Percentages rawsilk and sericin of cocoon:

Percent rawsilk was calculated using the below formula Lee, (1999).

$$\text{Rawsilk percentage/shell} = \frac{\text{Mean weight of raw silk}}{\text{Mean weight of shell}} \times 100$$

$$\text{Raw silk percentage/cocoon} = \frac{\text{Mean weight of raw silk}}{\text{Mean weight of cocoon}} \times 100$$

Percentage sericin according to Sonthisombat and Speakman, (2004) was obtained for each season by subtracting the mean weight of boiled silk (WBS) from the mean weight of cocoon shell (WCS) divided by the mean weight of cocoon shell multiplied by hundred.

i.e. % Sericin = $\frac{(WCS) - WBS)}{WCS} \times 100$

And the data were recorded.

Size of filament in denier:

The size of filament was obtaining by using denier measurement as in the formula below Lee, (1999):

Denier (D) = $\frac{\text{Filament weight (g)}}{\text{Filament length (m)}} \times 9000^*$

*D: Express size of silk thread

*9000: Constant expresses the weight of 450m length of silk thread divided by 0.05 (g) units.

Another 20 cocoons of different sizes (male & female cocoons) were treated with sodium hydroxide solution (8% concentration) for one hour dissolved sericin, and reeling process was done by hands. Dry fiber length and weight were obtained in meter and gram respectively for each cocoon and the average weight and length were found and hence the size in denier was calculated and recorded.

Fiber diameter measurement (micron):

Fiber diameters were directly measured for the separated silk materials which were already prepared on glass slides using the graduated micrometer scale under 1 mm length measuring 200 microns (magnified section of the caliber) and had taken trade name (Reichet 277878 Austria). A number of four fibers were taken, and the measurements were carried out at five different points of each fiber. The means were obtained in mm and converted into micron then the data were recorded. The measurements were done in the laboratory of Soba Research Center, assisted by a technologist Abd Elative Eltayb Mahmud.

Dyeing of fibers:

After degumming of cocoons fibers were separated by hand, dried and soaked in dye solution (by adding 0.40 g of dye powder) having the trade name sulphuric BR 200% to 250 ml of water. One hundred twenty five ml of remnant solution produced after degumming treatment (boil off liquor) was added to 250 ml of dye solution and boiled for 10 minutes, then immersed into cold water immediately, washed and dried.

Statistic analysis system (SAS) was used for data analysis least significant difference (LSD) was used to determine significance of difference between means. Transformation of data was carried before using the ANOVA to test for significant differences, to determine significant effect of period of rainy season (July, August, September & October) on technological parameters of the cocoons.

Results and Discussions

Cocoon and silk quality of silkworm E.bauhiniae*:*

The results obtained in these studies showed that the silk worm *E.bauhiniae* spun cocoon longer elliptical in shape with open mouth and 1.5 cm silken peduncle. (Plate 1) The behaviour of spinning process for building cocoon with open mouth, and silken peduncle is similar to that reported by Lee, (1999) for tussah silk worm behaviour in building cocoon with 1.5 cm peduncle and open mouth. And it is similar to European cocoon shape as reported by Lee, (1999). He stated that European cocoon shape is longer elliptical and cocoon shape assists in evaluating reeling process.

But Choe (1969) reported for Eri silkworm cocoon weight 2.4 – 2.6 g. *E.bauhiniae* in term of cocoon and shell weight falls The results showed that the average single cocoon weight of *E.bauhiniae* ranged from 1.50 – 2.98 g and shell weight from 0.37-0.59g which placed them in commercial character of silkworm according to (Jamuna et al 2012) and (Fashid *et al* 2012) for *Antherae assaminsis*. Dulal (2012) reported cocoon weight of *Antherae assaminaensis* 5.68-7.24g for wild race and 5.42-6.84g for semi domestic, shell weight 1.32-1.51g,o.39-o.49g respectively which higher than *E.bauhiniae* .Also he stated that, no significant variation, observed during different season , in semi domestic which opposite to this result where, the statistical analysis revealed a significant influence of temperature and RH (period of rainy season) on cocoon weight and shell weight for the three seasons (Table 1). The weight of tested cocoon in this study in term of silk production was higher than that reported by Dogalas (1972) and Rao (2000) for ordinary silk worm, they stated that cocoon weight of *Bombyx mori* ranged from 1.4327 – 1.4879 g, and shell weight from 0.2270 – 0.239 g, Lee, (1999) also reported the hybrid cocoon weight of *Bombyx mori* ranged from 1.8 – 2.5 g, and pure breed 1.5 – 2.2 g. in the range of commercial cocoon weight. This is in line with Gashe (1996) result. He stated that *E.bauhiniae* has produced cocoons of commercial value and candidate for silk production. This result coincided with that reported by (Addis et al 2011) on quality of *E.bauhiniae's* cocoon shell. The result showed that high cocoon weight was obtained in August and September when temperature ranged between 32 – 35.4º C and RH ranged between 65 – 71 %. So in rearing *E.bauhiniae* larva indoor (laboratory) for silk production, temperature, and relative humidity should be adjusted to 32 – 35◦ C, 65 – 71% respectively to achieve good quality cocoon to produce high yield of silk (Figure 1). This findings supported by Lee, (1999) who stated that temperature and RH should be maintained in rearing house during rearing period to obtain high quality cocoon. Shell percentage of *E.bauhiniae* was ranged between 22.5 – 24.5 % (Figure 2). This result classified the cocoon under the first grade according to cocoon classification system used by the main sericulture countries based on shell percentage as stated by Lee, (1999) who stated that shell percentage of fresh cocoon 22.5% above classified as first grade and 21.5% as second grade. He reported 19-25% shell percentage for cultivated silkworm *Bombyx mori*, Howard (1925) stated 21.3% shell percentage for *Bombyx mori* while Choe, B. H. (1969) mentioned 13% as shell percentage for wild silkworm Eri silk moth.

Means in the same column followed by the same letter (s) are not significantly different at 0.05 level of significance using LSD.

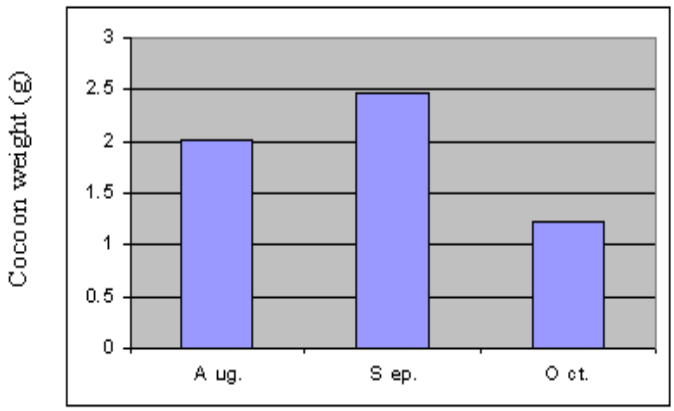

Figure 1: Effect of period of rainy season on cocoon weight of *E.bauhiniae* reared during season 2003.-2005

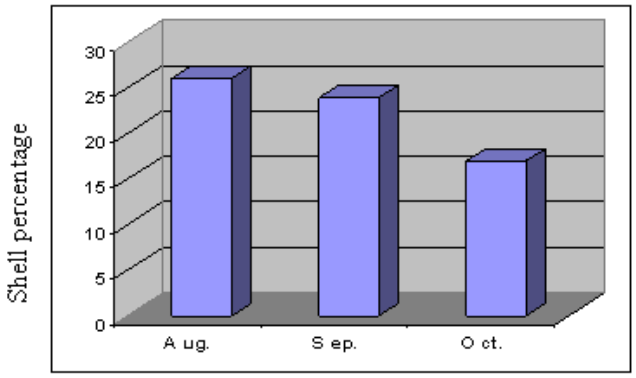

Figure 2: Effect of period of rainy season on shell percentage of *E.bauhiniae* reared during season 2003.-2005

Degumming and reeling process:

The results proved that sodium hydroxide solution has a marked effect on softening the silk gum of cocoon of *E.bauhiniae*, but the efficiency differed according to the concentration of the solution. The cocoons immersed in a solution of 8% concentration required only one hour to dissolve the gum and soften the sericin but that soaked in a solution of 2% concentration required 12 hours to work effectively. The 24 hours was the time required for 1% concentration of solution to dissolve sericin of cocoon. But 72 hours were enough to soften the silk gum of cocoon soaked in a solution of 0.5 % concentration and six days was the time required for 0.25% concentration .In the boiling solution the time was completely changed to 5 minutes, 4 hours, 12 hours, 24 hours, and 48 hours respectively, Table (2). This result in line with that reported by (Addis *et al* 2012) on using chemicals in a period of time for degumming sericin in *E. buahiniae's* cocoons. And in agreement with Sonthisombat and Speakman (2004) on using chemical and boiling silk.

Percentage sericin and raw silk:

The results showed that the mean weight of shell after treatment (softening of sericin) was equal to (0.2335 g) which was less than the average weight before treatment by (0.1865 g) which represented the weight of gummy substance (silk gum) dissolved by sodium hydroxide solution, i.e. sericin represent 44% of shell weight, this is agreed with (Adais *e t al* 2012) and Sonthisombat and Seakman (2004) in calculation of sericin, using arrange of chemical, for calculating a weight loss (Table15).(8aAddis *et al* 2011 reported the weight loss of wild silk fibers ranged from 23 to 56.8% (10)Karumer(1999) stated 5-15% sericin gum for Tussa silk fiber ,degumming loss in *Antherae proylei* , *A.assama*, *A.pernyi* and *A.yamamai* was in the range of 7-13% and *A.mylitta* (3.7%) *Phelosamia cynthia recini* 4.5% loss Kato.(1991), Dhavalikar (1962) and ito et at 1992 were reported high sericin content for Thaisilk cocoon shell 38% *Rondotica menciana* cocoon shell 455 and *Bombyx mori mandarina* cocoon shell 67.9% Sericin content of cocoon shell is at the maximum level, on the outside layer ,where this layer is compact and hardened ,then became lower on middle layers (2,3,4,5) and the absolute minimum at the inside layer (6) this result opposite to that reported by (Addis *et al*, 2012) on cocoon shell layers of *E.bauhiniae* .Also the result showed that raw silk per cocoon and raw silk per shell ranged (16-19.4%), (58-65%), respectively (Table The results showed that the cocoon of *E.bauhiniae* was easy degummed by boiled sodium hydroxide (Na oH) of 0.25% concentration Table 2(a-b)). This result in line with that reported by (Addis *et al* 2011). and in agreement with that stated by Sonthisombat and Speakman (2004) Also This type of processing for softening cocoon using NaoH is in agreement with that reported by Lee, (1999) in discharging tussah cocoon and also in line with results obtained by Rao, K.U.S. *et al*. (2000) on using chemical treatment, for discharging of wild silk moth cocoon, due to presence of calcium compound and also similar to that reported by Choe, B. H. (1969) for discharging of Eri cocoon and Sonthisombat and Speakman (2004) on using arrange of chemical.

The thickness of the filament reported in this study was 2.23 denier with a bave (filament) of 2.21 – 2.23 denier in size relevant to 20 microns (Table 5(a-b)) which lies in the range of a commercial size, as reported by Astbury, W. T., (1933) on the silk filament size; it was stated that the double silk filament (bave) ranged in size 1.75 – 4 denier. The same result was also supported by Howard, and Buswell, (1925) who stated that all the cocoons , produced for raw reeling industry, had filaments of 2 to 4 denier in size, which reflected the important of the filament of *E.bauhiniae*, in term of industrial use. Also, the results showed that, the size of filament of *E.bauhiniae* was 20 microns, which placed it in the range of filament size, of ordinary silk moth as reported by Lee, Y. W. (1999) who mentioned the size of silk filament, of bivoltine silk worm species, ranged between 15 – 20 microns and this actually placed the filament of *E.bauhiniae*, in the commercial range of filament size of bivoltine silk moth species. This result agreed with that reported by Farshid *et al* (2012), Jamuna *et al* (2012) and V.K *et al* (2012).

The result showed that the fiber of *E.bauhiniae* silk worm has capability of dye absorption, and readily to be dyed (Plate 2), this characteristic is not found, in most of the wild silk as stated by Howard, and Buswell, (1925) and Lee, Y. W. (1999) who were reported that, tussah silk produced an irregular and coarse filament, that is hard to bleach and hard to be dyed. As (Eltayb *et al* 2013) reported *E.bauhiniae* is bivoltine race which placed it in a list of high quality produced cocoon silkworm , according to the definition that reported by (V.K *et al* 2012) for bivoltine strain and (Jamuna *et al* 2012) for quantitative traits beside (Farshid *et al* 2012) who described the commercial characters, of silk worm by cocoon weight, shell weight shell ratio .filament length and denier (D).

The results showed that, the technological parameters, of *E.bauhiniae* are appeared, close resemblance to that of *Bombyx mori*, and cocoon processing behaviour, similar to Eri silk moth, which reflected the importance of *E.bauhiniae*, in term of silk production, and expected to contribute, to medicine protein production as Youshizato, C.(2000) stated that, any important protein, with a medicinal value, can be produced, using silk worms for spinning protein. Scientist used silkworms, as a bioreactor for producing vaccine against some diseases , as stated by Tewary, P.K. Subbarao, (1990

Plate 1: Cocoons of *E.bauhiniae* produced during rainy season

Plate 2: Silk yarns produced from cocoons of *E.bauhiniae*(hand reeling)

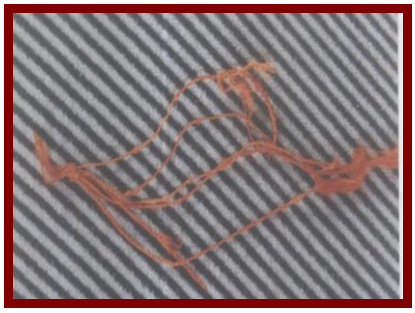

Plate 3:Silk yarns (Doubling) produced from Cocoon of *E.bauhiniae*.

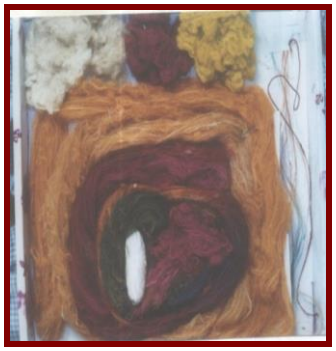

Plate (4): Fibers and Yarns produced from cocoons of *E.bauhiniae* (after dying).

The results of this study indicated that, the wild silkworm *E.bauhiniae* in Sudan has produced cocoons of commercial traits, during the period of rainy season (July – October). The harvesting of crops, twice a year is possible. However August and September could be a reasonable rearing period, for high yield and hence heaviest cocoons and shell weight. Furthermore, cocoon harvesting period, should be six days after mounting of silkworm. Sodium hydroxide solution (low conc.) for degumming and hand reeling process of *E.bauhiniae* cocoons, for silk production, is feasible

Table 1
The Mean weight of cocoon, shell weight, shell ratio, of *Epiphora bauhiniae* cocoons produced during the rainy months 2003-2004-2005.

Season	Period	Technological parameters		
		Cocoon weight (g)	Shell weight(g)	Shell ratio (%)
2003	August	2.230 a	0.450 a	4.550 b(20.2)
	September	1.520 b	0.490 a	5.720 a(32.2)
	October	1.000 c	0.170 b	4.70 b(21.5)
	G. M	1.583	0.370	5.00(24.5)
	M.S.E.	0.297	0.004	1.970
	C.V. %	36.030	17.870	26.240
	S.E.±	0.172	0.021	0.442
	L.S.D.	0.705	0.081	0.862
2004	August	2.140 b	0.500 b	4.880 a (23.4)
	September	2.980 a	0.590 a	4.510 ab (19.8)
	October	1.350 c	0.250 c	4.360 b(18.5)
	G. M	2.160	0.430	4.600 (22.5)
	M.S.E.	0.197	0.002	0.429
	C.V. %	20.600	9.910	14.950
	S.E.±	0.141	0.014	0.217
	L.S.D.	0.571	0.058	0.882
2005	August	1.680 ab	0.580 a	5.920 a (34.5)
	September	2.970 a	0.590 a	4.510 b (19.8)
	October	1.320 b	0.220 b	4.140 b(16.7)
	G. M	1.990	0.463	4.800 (23.7)
	M.S.E.	0.170	0.006	0.457
	C.V.%	21.010	16.970	14.070
	S.E. ±	0.133	0.023	0.214
	L.S.D.	1.479	0.099	0.870

Table 2
The effect of sodium hydroxide (tepid & boiled solution) on softening sericin of cocoon of *Epiphora bauhiniae*.

Time required (hours) for softening after soaked in boiled solution	Time required (hours) for softening after soaked in tepid solution	Concentration %	Treatment
0.083	1	8.00	1
4.000	12	2.00	2
12.000	24	1.00	3
24.000	72	0.50	4
48.000	144	0.25	5

Table (3)
Percentage sericin (gum) of *E.bauhiniae* produced during different months of rainy season (2003, 2004 and 2005).

Months	Season			Mean % sericin
	2003	2004	2005	
August	33.30	40.00	48.30	40.50
September	39.00	49.20	49.20	45.80
October	41.00	40.00	54.00	45.00
Total	113.30	129.20	151.50	131.30
Mean	37.76	43.06	50.50	43.76

Table (4)
Raw silk per cocoon and per shell of *E.bauhiniae* produced during different rainy months in season (2003,2004 and 2005).

period	Season						Mean	
	2003		2004		2005			
	Raw silk per cocoon %	Raw silk per shell%	Raw silk per cocoon %	Raw silk per shell%	Raw silk per cocoon %	Raw silk per shell%	Raw silk per cocoon %	Raw silk per shell%
August	13.95	69.11	14.53	62.20	18.50	53.60	15.66	61.64
September	20.46	63.46	10.43	52.70	10.50	52.70	13.79	56.28
October	23.00	58.82	23.03	80.00	11.40	68.00	19.14	68.94
Total	57.41	191.39	47.99	194.90	40.40	174.30	48.58	186.86
Mean	19.14	63.80	15.99	64.96	13.46	58.10	16.19	62.28

TABLE (5 a)
Filament length of the silkworm *Epiphora bauhiniae* cocoons large size (female)

Cocoon number	Weigh of shell (g)after treatment (NaoH)	Length of filaments (m)	Thickness (Denier)
1	0.330	1350	2.1960
2	0.320	1310	2.1960
3	0.330	1350	2.1987
4	0.300	1226	2.2023
5	0.300	1240	2.1771
6	0.300	1134	2.3814
7	0.330	1350	2.1960
8	0.300	1190	2.2689
9	0.300	1200	2.2500
10	0.300	1200	2.2500
Total	3.110	12550	2.2302
Average	0.311	1255	2.2302

Table (5 b)
Filament length of the silkworm *epiphora bauhiniae* cocoons small size (male):

Cocoon number	Weigh of shell (g)after treatment (naoh)	Length of filaments (m)	Thickness (denier)
1	0.1300	540	2.1663
2	0.1700	705	2.1691
3	0.1300	540	2.1663
4	0.1600	675	2.1330
5	0.1800	720	2.2500
6	0.1500	630	2.1429
7	0.2000	810	2.2221
8	0.2000	810	2.2221
9	0.1700	700	2.1861
10	0.1600	600	2.4003
Total	1.6500	673	2.2068

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