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SERICULTURE FARMERS' PERCEPTION AND PERFORMANCE OF *BOMBYX MORI* AJ X AC HYBRID COCOON REARED WITH S30 MULBERRY LEAVES UNDER NIGERIAN TROPICAL CONDITION

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ABSTRACT
The study examined the sericulture farmers' perception and the effects of S30 variety Mulberry leaves on the overall performance of the *Bombyx mori* L. AJ X AC Hybrid under the Nigerian tropical condition. A field survey of demographic status, Knowledge, Awareness and Perception (KAP) of sericulture practices was conducted using questionnaire and interview schedule. Also mulberry plant was cultivated and the leaves were used for feeding the reared silkworm. Evaluation of nature and characteristics of produced cocoon of silkworm was conducted. The result of the study revealed that majority of farming household heads 22(73.33%) and KWASU university staff 10(83.3%) fell between the age range of 31-50 years while the bulk of the students 24(96%) ranged between 20-30 years of age. The farming household head 10(33.3%), KWASU staff 10(83.3%) and all students respondents attended at least secondary education. KAP statements result indicated that bulk of the respondents (92.53%) were aware of government established sericulture centers, majority (95.52%) were cognizant of Mulberry plant leaves in feeding silkworm, 89% aware about rearing of silkworm and processing centers. About half of the respondents were either familiar with sericulture processes (52.23%) or participated in sericulture training (52.23%). The bulk of the sericulture respondents (74.63%) obtained their information about sericulture through informal sources, while (55.2%) got information from relatives and (32.8%) from extension agents. Based on the results of the study, the crossed variety (AJ X AC) has high quality, performed better in the parameters evaluated and recommended for adoption for quality silk production under Nigerian tropical condition.

Keywords: Silk worm, mulberry plant, rearing, KAP, cocoon

INTRODUCTION

Sericulture is the science that deals with the production of silk by rearing of silkworm. It is the practice of breeding silkworms for the production of raw silk. Sericulture is an agro-based enterprise that involves cultivation of host plants and rearing of silkworms for the production of cocoon to produce raw silk (Ali, 2010, Anitha, 2011, Anonymous, 2012). The major activities of sericulture comprises of food-plant cultivation to feed the silkworms which spin silk cocoons and reeling the cocoons for the silk filament processing and weaving to produce the valuable products. Sericulture enterprise is characterized by the cultivation of mulberry plant and the rearing of silkworm on the mulberry leaves to produce cocoons. A cocoon is an oval barrel-shaped object produced by a mature silkworm larva rounded up by spinning silk proteins inside which a pupa develop (Balakrishnappa and Rajan 2010, Dewangan *et al.*, 2011, Dewangan *et al.*, 2012). Sericulture plays a major role in rural employment, poverty alleviation and earning foreign exchange. A lot of entrepreneurial opportunities are available in various fields of sericulture (Usha, 2007, Geetha *et al.*, 2008 and Vijay *et al.*, 2018).

The silkworm is the larva or caterpillar of the silk moth *Bombyx mori* often referred to as silkworm of the mulberry plant (Hamamoto *et al.*, 2004, Hamamoto and Sekimizu, 2005). It is an economically important insect as it produces silk for the use of human benefits (Altman *et al.*, 2003, Matsumoto *et al.*, 2015). Both the wild and domestic silk-moths existed but only the domestic species that are bred by humans are commercially viable for the production of silk because the domestic species produce large amount of silk. The silkworm feed primarily on the mulberry species but are found to also feed on the osage orange species too (Kato *et al.*, 2010, Mahmood *et al.*, 2011, Rahmathulla, 2012, Patel *et al.*, 2013, Balasundaram *et al.*, 2013, Matsumoto *et al.*, 2015, Harinatha and Venkatappa 2016, Meeramaideen *et al.*, 2017, Kaleem *et al.*, 2017, Patil *et al.*, 2017).

According to Rao (1998) management in sericulture, or the raising of silkworms to produce silk, involves the incubation of the seeds (eggs) of the silkworm moth until they hatched and became silkworms. Eggs of the moths are laid on special kind of cards, which purposely act as a surface for hatching of the eggs (Dookia, 1980, Veda *et al.*, 1997). Brushing is the process

of transferring the newly hatched eggs to rearing trays (Sheker and Hardingham, 1995, Neelu *et al.*, 2000). To obtain uniform hatching, eggs are kept in black boxes on the day prior to hatching to prevent embryos from maturing and giving the late maturing embryos time to develop and catch up with the early maturing ones (Veerapura *et al.* (2013).). The following day they are exposed suddenly to diffused light so that the larvae hatch uniformly in response to phototropic stimulus (Dandin *et al.*, 2000).

The reproductive eggs or seeds are those intended for producing the seed cocoons, which are required in large numbers for producing commercial hybrid eggs or industrial seeds. These are pure lines, are difficult to rear and needs special care and ideal rearing conditions. The temperature is an important factor in the rearing of silkworm and it has a direct correlation with the growth. The optimum temperature for normal growth of silkworms is between 20 ^{0}C and 28 ^{0}C. For the maximum productivity the temperature ranges from 23 ^{0}C to 28 ^{0}C. Temperature above 30 ^{0}C directly affects the healthy growth of the worm. All the physiological activities are retarded in early instars of silkworm when the temperature is below 20 ^{0}C (Joshi, 1987, Huq *et al.*, 1991).

Mulberry is a very hardy and fast growing perennial plant belonging to the genus *Morus* of the family *Moraceae* but rarely exceed 10 - 15 metres (30 - 50 ft) tall. The leaf of mulberry is exclusively used for feeding and rearing of the silkworm (*Bombyx mori*) for the production of the silk. It is estimated that mulberry silk contributes around 90 percent of the total global raw silk production. The mulberry fruit due to its high nutritive value is also a valuable foodstuff. Recently, the plant is found to contain several pharmacological compounds of medicinal importance and could open up new avenues of research in the medical science (Elfalleh *et al.*, 2011, Somasundaram *et al.*, 2012, Zheng *et al.*, 2012, Yogananda Murthy *et al.*, 2013).

A KAP survey means a survey of the Knowledge, Attitude and Practices. An important step to properly carry out this type of survey is to establish a basic premise and provide definitions for each word. K, for investigating Knowledge measures a set of understandings, knowledge and of sericulture practice. It is also the respondents' capacity for imagining and way of perceiving. The degree of knowledge assessed by the survey helps to locate areas where information and education efforts remain to be exerted as regards the concept at hand-sericulture practice. The main goal of quantitative methods of this data collection is to quantify and measure a phenomenon through the use of questionnaires and statistical processing of the information collected. One advantage of a KAP survey is to allow, in a single survey, the collecting of a large amount of data that will be subjected to statistical analysis (ORC, 2001; MdM, 2010).

Limited information exists in literature on KAP, cultivation of S30 variety of Mulberry Leaves for feeding of silkworm, investigate the nature of silkworm *Bombyx mori* best for rearing and determine the nature and characteristics of produced cocoon under in the Nigerian tropical conditions. This research was designed to provide necessary data to fill these gaps in information on sericulture practice.

MATERIALS AND METHODS

The study site

The study area is Kwara State, Nigeria. The seeds of AJ X AC Hybrid Cocoon and S30 Mulberry initial plant stock was supply from Ondo State Agriculture Empowerment Center, OSAEC, (Sericulture Unit), Akure. The experiment was carried out at Zoology unit laboratory of the Kwara State University, Malete where *Bombyx mori* rearing was conducted and fed with mulberry leaves from plantation situated at KWASU IJMB Biological farm.

Techniques and Data collection

A multistage approach consisting of the field survey on the knowledge, awareness and perception of sericulture practice using questionnaire and interview schedule; field cultivation of the S_{30} variety of Mulberry plant for feeding and laboratory rearing of silkworm of *Bombyx mori* AJ x AC variety was adopted. The questionnaire sought demographic status, knowledge, awareness and perception (KAP) of sericulture practice among randomly selected farmers and scientists in Asa, Moro and Ilorin South LGAs (Kwara State) that shared boundary with the university and purposefully selected KWASU university communities comprising science students and workers who have industrial attachment and based knowledge on sericulture practices.

The land was ploughed repeatedly for 3 to 5 times to loosen the soil, gravel, stones and weed was removed to obtain a fine soil. The ridges and furrows are made at a distance of 1.0 m; stem cuts were planted at onset of rain in 2017 in a distance of 0.6 m along the row and nurtured for between March 2017 and May 2018 at the site with the application of manure. Harvesting of the leaves were done by plucking 50-60 days old leaves during 6.00 to 7.00 am hours of the day. These fresh leaves are used to rear the silk worms.

The silkworm (*Bombyx mori* AJ x AC variety) seed was laid on wooden trays of 60 cm x 90 cm at 25 ^{0}C - 27 ^{0}C temperature and 65 - 70 percent relative humidity. During rearing process the larva were fed mulberry leaves (S30 variety) harvested from the farm. The hatched larva from eggs were put in tray and fed continuously in the rearing research laboratory. Data on numbers of eggs laid, hatched larva, number of cocoons, characteristics of harvested cocoon including weight of cocoon (g), shell weight (g) and pupa weight (g) were measured and recorded. Twenty (20) randomly selected cocoons were measured using sensitive weighing balance of Model S-Metler DJ300BS for cocoon weight (CW), Shell weight (SW) and pupa weight (PW) in three replicates. Data collected were analyzed appropriately.

RESULTS

Socio-Economic Status of Sericulture Farming Households and other Respondents

The result in Table 1 depicts socio-economic status of sericulture respondents. The result in Table 1 revealed that majority of farming household heads 22 (73.33%) and KWASU university staff 10 (83.3%) fell between the age range of 31-50 years while the bulk of the students 24 (96%) ranged between 20-30 years of age. Furthermore, greater percentage of farming household heads 18 (60%), staff 10 (83.3%) and students 19 (76%) were males. Few respondents who are farming household head 10 (33.3%) and most respondents who are staff 10 (83.3%) and all students attended at least secondary education. The result also revealed that the three categories of respondents have diverse subsidiary occupation. For example, about 60% of farming household heads results to artisans in addition to their primary farming occupation while 16.6% of KWASU staff engages in farming as subsidiary occupation.

The results of various statements of knowledge of respondents on sericulture practices in Table 2 indicates that bulk of the respondents (92.53%) aware of government established sericulture centers, majority (95.52%) aware of Mulberry plant in feeding silkworm, 89% heard about rearing of silkworm, reeling and cocoon processing centers. However, about half of the respondents were either familiar with sericulture processes (52.23%) or participated in sericulture training (52.23%).

Table 1: Socio-economic status of respondents

Variables	Range	Farmers (30)		Staff(12)		Students(25)		Pooled (67)	
		F	%	F	%	F	%	F	%
Age	20-30	2	6.66	2	16.6	24	96.0	28	41.79
(years)	31-50	22	73.33	10	83.3	1	4.0	33	49.26
	>50	6	20.00	0	00.0	0	00.0	6	8.95
Gender	Male	12	40.0	2	16.6	6	24.0	20	30.00
	Female	18	60.0	10	83.3	19	76.0	47	70.00
Education	Nil	2	6.66	0	0.00	0	0.00	2	2.98
Level	Primary	18	60.0	2	16.6	0	0.00	20	29.85
	Secondary	10	33.3	4	33.3	0	0.00	14	20.89
	Tertiary	0	0.00	6	50.00	25	100.0	31	46.28
Religion	Islam	17	56.6	7	58.3	14	56.0	38	56.7
	Christianity	13	43.3	5	41.6	11	44.0	29	43.2
Subsidiary	Farmers	-	-	2	16.6	0	00.0	2	2.99
Occupation	Traders	7	23.3	4	33.3	0	00.0	11	16.42
	Artisans	18	59.9	3	25.0	3	12.0	24	35.82
	Govt. worker	2	6.6	3	25.0	0	00.0	5	7.46
	Others	3	10.0	0	00.0	22	88.0	25	37.31
Farming	1-5	21	33.3	8	66.6	25	100.0	54	80.5
Experience	6-10	5	16.6	2	16.6	0	00.0	7	10.4
(years)	11-15	2	6.6	0	00.0	0	00.0	2	2.9
	>15	2	6.6	2	16.6	0	00.0	4	5.9

Field Survey, 2017

Table 3 shows that the bulk of sampled respondents were not only aware of Ondo State Sericulture Project, Agriculture Empowerment Center in Akure (92.53%), but also aware that there are other sericulture centers located at Forestry Research Institute at Ibadan (86.5%), Ekiti Ministry of Agriculture Sericulture, Ado-Ekiti and wealth creation agency in Akure, Nigeria.

Table 2: Knowledge of Respondents on Sericulture practices

Knowledge parameters of sericulture practices	Yes	No	% of Yes
Aware of government established sericulture centers	62	5	92.53
Aware of non-governmental sericulture centers	26	41	38.80
Aware of plant varieties used in feeding silkworm	64	3	95.52
Aware about rearing of silkworm processing centers	60	7	89.55
Worked at sericulture center for some period of time	38	29	56.71
Familiarity with sericulture processes	35	32	52.23
Familiarity with equipment used in sericulture	37	30	55.22
Participated during training in sericulture processes	35	32	52.23
Aware of positive development of sericulture	28	39	41.79
Observed the process of making valuable products from processed cocoon	40	27	59.70

Field survey, 2017

Table 3: Awareness of the Existence and Locations of Sericulture Centers in Nigeria

Sericulture Centers and Locations	Yes	No	% 'Yes'
Ondo State Sericulture Project, Agriculture Center,	62	5	92.5
Forestry Research Institute(Sericulture unit) Ibadan	58	9	86.5
Wealth Creation Agency, Akure, Ondo state	60	7	89.5
Ekiti Ministry of Agriculture Sericulture, Ekiti state	57	10	85.7
Odo-ona-kekere Sericulture, Oluyole, Oyo state	37	30	55.2

Field survey, 2017

The bulk of the sericulture respondents (74.63%) obtained their information about sericulture through informal source such as their personal experiences, relative and friends as depicts in Table 4. In addition, more than half (55.2%) got information about sericulture from their direct siblings such as parents and grandparents. A handful of these respondents were informed through extension agents (32.8%), media (41.7%) and internet sources (38.8%).

Table 4: Responses on Sources of Information on Sericulture Practices

Sources of information	Yes	No	% Yes
Friends/community members	50	17	**74.63**
Parents/grandparents	37	30	55.2
Extension agents	22	45	32.8
Internet sources	26	41	38.8
Other agricultural agents/professionals	33	34	49.2
Media	28	39	41.7
Formal educational programs	25	42	37.3

Field Survey, 2017; multiple responses allowed

The results of various statements on attitude and knowledge towards sericulture practices in Table 5 indicate that majority of respondents (71.6%) agreed that sericulture is part of our culture and tradition. 89.5% suggests that the used of sericulture products should be encouraged among populace and 97.1% also opined that sericulture and its products knowledge should be made available and accessible to every rural community. Conversely, only 17.9% of respondents agreed that sericulture practice is popular in our country and less than half of respondents (44.7%) attest to their expert in sericulture.

Table 5: Attitudes towards Sericulture Practices

Items	Agree		Neutral		Disagree	
	F	%	F	%	F	%
Sericulture is part of our culture and tradition	48	71.6	2	2.98	17	25.3
Sericulture practice is popular in our country	12	17.9	5	7.46	50	74.6
Scientists/agriculturalist/Entomologists have sufficient knowledge on sericulture	42	62.6	10	14.9	15	22.3
As a Zoologist/Entomologist/Agriculturalist in training I have sufficient knowledge on sericulture	35	52.2	12	17.9	20	29.8
As a Zoologist/Entomologist/Agriculturalist as an expert in sericulture practice	30	44.7	7	10.4	30	44.7
Sericulture practice is less difficult to follow with patience and diligence	50	74.6	6	8.95	11	16.4
The use of sericulture products should be encouraged	60	89.5	0	00.00	7	10.4
Sericulture and its products knowledge should be made available and accessible to every rural areas	65	97.1	0	00.00	2	2.98

Table 6 depicts the opinion that could enhance sericulture practices. All the respondents (100%) agreed that awareness on importance of sericulture be rigorously pursued and needs for sericulture practice monitoring agencies. 98.5% appreciate the need for more government, NGOs and private owned sericulture centers and provide equipment for rearing silkworm and processing be made available at all centers. The majority of respondents (89.5%) agreed that private and individual organizations should be more involved in sericulture production and marketing.

Table 6: Opinion that could enhance Sericulture Practices

Items	Yes	No	% Yes
Need for Government, NGOs and private owned sericulture centers	66	1	98.5
Need for sericulture practice monitoring agencies	67	0	100.0
Private sericulture centers are more productive	57	10	85.7
Private individuals should be involve more in sericulture products & marketing	60	7	89.5
Safety information is important in sericulture practice	62	5	92.5
Needed equipment for rearing silkworm and processing be made available at all centers	66	0	98.5
Awareness on importance of sericulture be rigorously pursued	67	0	100.0

Field Survey, 2017

Cultivation of Mulberry and Production of Cocoons

Table 7 indicates that S_{30} mulberry is the variety of commonly planted and production pattern including repeated ploughing for fine loose soil and rain fed, constant weeding, tilling and adding manure to produce tender leaf used to rear silkworm. Table 8 shows the pattern of silkworm feeding on mulberry leaves as well as temperature and humidity requirements for feeding duration. The quantity of leaf fed increase from 310 (g) age 1 to 459 (g) age 5 days.

Table 7: Activities involved in cultivation of Mulberry Plant

S/No	Activity	Nature
(i)	Variety of mulberry planted	$S_{30,}$
(ii)	Nature of bed preparation	Repeatedly ploughed for fine loose soil and rain fed
(iii)	Maturity	Plucking at 50-60 days old
(iv)	Date planted	December 24th, 2017
(v)	Tendering of the plant	Constant weeding, tilling and manuring
(vi)	Date harvested	Six months after (24th May, 2019)
(vii)	Nature of leaf used to rear silkworm	Tender leaf

Table 8 shows the weight of silkworm cocoon in relation shell and pupa weights with twenty (20) replicates. The cocoon has a mean 0.328 g, standard deviation of 0.076, minimum and maximum values of 0.218 and 0.492 g respectively. The Corresponding shell weight had a mean 0.200 g, standard deviation of 0.031, minimum and maximum of 0.152 and 0.252 respectively. The pupa of silkworm had a mean of 0.181, standard deviation of 0.040, minimum and maximum of 0.132 and 0.234 respectively.

Table 8: Mulberry Plant/ Leaf Feeding Pattern during Silkworm Rearing

Feeding duration		**Molting duration**	**Quantity of leaf fed**		**Leaf size chop (cm^2)**	**No of feeding**	**Environmental conditions**	
Days	Hrs	Days	Quality	quantity			Temp. ^{0}C	Humidity
Age 1 4 days	7	1	Tender	310g	2 to 4	7	26-27	85-90
Age 2 3 days	10	1	Tender	276g	4 to 16	5	25-25	70-70
Age 3 4 days	10	1	Medium	448g	16 to 36	7	26-27	75-85
Age 4 4 days	8	2	M / C	468g	4 splits	8	25-27	65-75
Age 5 5 days	8	4	Course	459g	2 splits/ full leaf	10	25-27	65-75

Table 9: Weights of Silkworm Cocoon Characteristics

Replicate	**Cocoon wt(g)**	**Shell wt(g)**	**Pupa wt(g)**
(i)	0.370	0.197	0.132
(ii)	0.371	0.183	0.226
(iii)	0.281	0.252	0.234
(iv)	0.311	0.212	0.165
(v)	0.218	0.240	0.221
(vi)	0.244	0.180	0.169
(vii)	0.364	0.163	0.141
(viii)	0.491	0.202	0.223
(ix)	0.298	0.215	0.137
(x)	0.333	0.152	0.161
(xi)	0.370	0.197	0.132
(xii)	0.371	0.183	0.226
(xiii)	0.281	0.252	0.234
(xiv)	0.311	0.212	0.165
(xv)	0.218	0.240	0.221
(xvi)	0.244	0.180	0.169
(xvii)	0.364	0.163	0.141
(xviii)	0.491	0.202	0.223
(xix)	0.298	0.215	0.137
(xx)	0.333	0.152	0.161
Total	6.568	3.99	3.620
Mean	0.328±0.076	0.120±0.031	0.181±0.040
Minimum	0.218	0.152	0.132
Maximum	0.492	0.252	0.234

Table 10 elucidates the features of eggs used for producing cocoons. The result indicates that 84% of total eggs laid were hatched.

Table 10: Characteristics of Egg used for producing Cocoon

S/No	Parameter	Characteristics
(i)	No of eggs laid	146
(ii)	No of unfertilized eggs	16
(iii)	No of unhatched eggs	8
(iv)	Percentage of hatching	84%
(v)	No of larva brushed	122

Identified Respondents' Constraints on adoption of Sericulture Practices

The result of analysis of constraints in Table 11 militating against adoption of sericulture practices in the study area was ranked from most critical to the least.

Table 11: Responses on the constraints against adoption of Sericulture Practice

Constraints to adoption of sericulture	No	%	Ranking
High disease infestation of cocoon	67	100.0	1st
Inadequate of suitable rearing house	66	98.5	2nd
High incidence of pests such as. rats and gecko	65	97.1	3rd
Inadequate man power	64	95.5	4th
Climatic condition	63	94.2	5th
Lack of training	62	92.5	6th
Inadequate funding	61	91.4	7th
Inadequate rearing equipment	60	89.5	8th
Difficulties in grading cocoon	59	88.0	9th
None availability and supply of viable egg mass(seeds)	58	86.5	10th

The result reveals that high disease infestation of cocoon (100%), inadequate of suitable rearing house low (98.5%) and high incidence of pests (97.1%) were three most critical constraints towards adopting sericulture practices. Other important militating factors in sericulture practices include inadequate man power (95.5%), climatic conditions (94.25) and lack of training (92.5%) among others.

Figure A indicates that S_{30} mulberry variety commonly planted and Figure B: Patches of *Bombyx mori* AJ X AC Hybrid seeds on egg card while figures C and D identified the growing larva feeding and silkworm rearing tray respectively.

Fig. A: S30 variety Mulberry plantation

Fig. B: Patches of *Bombyx mori* AJ X AC Hybrid seeds on egg card

Fig. C: Growing larva feeding

Fig. D: Silkworm rearing tray

DISCUSSION

The result of socio-economic status showed that the majority of the respondents in this study were within the age range of 20-50 years. The farmers' and staff age ranged from 31-50 years while majority of the students were within age of 20-30 years. Both categories are within active and productive age and this is expected to be an advantage if they are to venture in the sericulture farming and practices because farming generally is labour intensive and labour productivity is a function of age. The result is consistence with findings of Oladimeji *et al.* (2017a) that recorded 45 and 47 years for earthen and concrete fish farmers respectively in Kwara State. Unexpectedly female respondents were more among the respondent interviewed about sericulture practices compared with male. The high level of education obtained for three categories of respondents is bound to have a positive effect on sericulture productions if they are to venture into the enterprise. This may enable them use improved and sophisticated sericulture equipment for harvesting cocoon and processing into silk. Majority of pooled respondents are experienced in farming which imply that embarking in sericulture may be less difficult. According to Oladimeji *et al.* (2017a), fish farming experience is an important factor determining fish harvest and processing in aquaculture in Kwara State, Nigeria.

The results of various statements on awareness, attitude and knowledge about sericulture production methods, processing, equipment and established government and non-governmental sericulture centers in some States in Nigeria were discussed. In consonance with the results of this study, several studies Devaiah *et al.* (1985), Ali, (2010), Vijay-kumar *et al.* (2018) have also discussed sericulture production in different areas. The finding is at variance with Munyuli (2010) that observed that majority of farmers in Uganda were not aware of the role played by insect pollinators in coffee yield and production.

The bulk of the respondents obtained mostly their information about sericulture through informal sources such as their personal experiences from their parents, relative and friends as depicted in Table 4. In addition, a handful of these respondents were informed through extension agents and formal education programs. The findings are comparable to the studies of Oladimeji *et al.* (2017b) who observed that about 60.6% soybean and watermelon farmers got their information on pollination services through informal services in Kwara State, Nigeria.

The study revealed that respondents suggested that there is need for sericulture practices monitoring agencies and private or individual should be more encouraged in sericulture production. Furthermore, awareness by both government and NGO should be vigorously pursued to encourage investment and products marketing in sericulture enterprise.

The result of cultivation of mulberry and production of cocoon revealed that S_{30} is commonly grown to feed the silkworm. *Bombyx mori L.* Larval growth and development and cocoon crop yield are chiefly influenced by yield and nutritional quality of mulberry leaf used as feed. Among a range of factors influencing silkworm growth and cocoon production, leaf quality plays a major role (Veerapura *et al.*, 2013).

The result obtained established fact that, leaf quality differs among mulberry varieties which in turn may be responsible for the difference in silkworm rearing performances in line with study of Arug, (1994). The results also revealed that degree and uniformity of moulting varies with mulberry leaf quality that aids higher moulting ratio, ensures better growth rate and silkworm cocoon, shell and pupa weight as elucidated in Tables 8, 9 and 10 (Chaluvachari and Bongale, 1994;1996).

The result of this study on performance of silkworm feed with mulberry leaf on moulting was in contrast with the work of Mishra *et al.* (1996) that recorded 89.16% and 92.82% moulting ratio in PM x NB4D2 and NB18 x NB7 races fed respectively with S_{54} mulberry genotype leaves. However, Mulberry genotypes S_{30}, showed superiority over M5 genotype in moulting ratio and larval weight. Mulberry variety S_{30} showed better performance than S_{36}, S_{41} and K_2 for commercial characters of bivoltine cocoons (Sathyanarayana *et al.*, 1990 and Mallikarjunappa, *et al.*, 2000).

The result of analysis of respondents opinion of their knowledge on constraints that are commonly encountered in sericulture production were ranked from most critical to the least showed

that high disease infestation of cocoon, inadequate of suitable conducive breeding laboratory/fields and high incidence of pests were the most critical impediment to mulberry and silkworm sericulture production practices in the study area. It may be concluded that if these constraints are looked into; other impediments with a lower percent may cease to exist or reduce to the minimum in the study area.

CONCLUSION AND RECOMMENDATIONS

The study revealed that the respondents comprising of farmers, staff and students were aware of the sericulture practices and location through friends and community members and exposure to extension agents and educational programs. The attitudes towards sericulture practices were positive. Awareness on importance of sericulture should be vigorously pursued by government and non-governmental organization. Sericulture farmers should be encouraged and trained to follow right practices. For obtaining tender, succulent and nutritious leaves of S_{30} mulberry variety to favour the good growth and development of young age silkworms; the cultivation pattern should include repeated ploughing for fine loose soil, constant weeding, tilling and addition of manure at 25 ^{0}C-27 ^{0}C temperature and 65-70 percent relative humidity. The quantity of leaf fed should be monitored and should increase from 310 (g) age 1 to 459 (g) age 5 days. For this recommended variety the cocoon shell weight should be close to mean 0.200 g.

There is a need for extension services to educate respondents about the importance of sericulture to increase the silk production in the study area and Nigeria at large. This will reduce the country overdependence on imported silk, reduce our huge foreign expenditure on imported products and create employment at both primary and secondary sectors of the production.

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REFERENCES

Ali SS, (2010). "Impact of Vocational Training on Sericulture on Socio Economic Characters of Rural Youths of Solapur District of Maharashtra State". KVK, Solapur, Dist: Solapur (MH).

Altman GH, Diaz FJC, Calabro T, (2003). "Silk Based Biomaterials". *Biomaterials*, 24: pp 401-416.

Anitha R, (2011). "Indian Silk Industry in the Global Scenario". *International Journal of Multidisciplinary Management Studies*, 1(3): pp 100-110.

Anonymous, (2012). "Statistics. Directorate of Rural Industries" (Sericulture Sector), Sonakhan Bhawan, aipur, Chhattisgarh.

Arug H, (1994). "*Principles of sericulture"*. Oxford and IBH publishing Co.Pvt.Ltd, 66 Janpath New Delhi, India, 376pp.

Balakrishnappa YK, Rajan RK, (2010). "Study on Socio-Economic Factors of Different Categories of Sericulturists on Bivoltine Sericulture Technologies in Karnataka". *Research Journal of Agricultural Sciences*, 1(4): 380-384.

Balasundaram D, Ganesh PP, Selvisabhanayakam MV, Ramesh V, (2013). "Studies on the Nutritional Supplementation of Vitamin C Treated MR2 Mulberry Leaves Fed by V Instar Larvae of Silkworm, *Bombyx mori* (L.) (*Lepidoptera: Bombycidae*) in relation to Feed Efficacy and Growth Rate". *International Journal of Research in Biotechnology and Biochemistry*, 3(1):11-18.

Chaluvachari, Bongale UD, (1994). "Leaf Quality Evaluation of Selected Mulberry Genotypes by Biochemical and Bioassay Studies, Proceeding Fourth All India Conf. Cytology and Genetics", Bangalore, India, pp 121-124.

Chaluvachari, Bongale UD, (1996). "Bioassay Moulting Response of Silkworm *Bombyx Mori L.* in Relation to Leaf Nutritive Constituents in Mulberry (*Morus spp.*) Genotypes", *Indian Journal of Sericulture*, 35(2), 160-162.

Dandin SB, Jayaswal J, Giridhar K, (2000). "Hand Book of Sericulture Technologies, Central" Silk Board, Bangalore. p. 259.

Devaiah MC, Rajashekar GR, Yelshetty S, Govindan R, (1985). "Growth and Silk Production in Samiya *Cynthia ricini* Boisduval (*Lepidoptera: Saturniidae*) Fed on Four Different Host Plants", *Indian Journal of Sericulture*, (24): pp 33-35.

Dewangan S, (2011). "Sericulture - A Tool of Eco-System Checking through Tribal". *Journal of Environmental Research and Development*. 6(1): 165-173.

Dewangan SK, Sahu KR, Soni SK, (2012). "Breaking of Poverty through Sericulture among the Tribe-A Socio-Economic Study of Dharamjaigarh Block of Raigarh Dist, C.G. (India). *Research Journal of Recent Sciences*, 1: pp 371-374.

Dookia, BR, (1980). "Varied Silk Ratio in Cocoons of Eri Silkworm (Philosamia ricini Hutt.) Reared on Different Castor Varieties in Rajesthan", *Indian Journal of Sericulture*, 19: 38- 40.

Elfalleh W, Tlili N, Nasri N, Yahia Y, Hannachi H, Chaira N, (2011). "Antioxidant Capacities of Phenolic Compounds and Tocopherols from Tunisian Pomegranate (*Punica granatum)* fruits". *Journal of Food Science*, 76: pp 707-713.

Geetha GS, Geetha Devi RG, (2008). "Technology Adoption and Training Needs of Sericulture Farmers" - A Case Study in NGO. *Indian Journal of Agricultural Resources,* 42(3): pp 157-163.

Hamamoto H, Kurokawa K, Kaito C, Kamura K, Manitra RI, Kusuhara H, Santa T, Sekimizu K, (2004). "Quantitative Evaluation of the Therapeutic Effects of Antibiotics using Silkworms Infected with Human Pathogenic Microorganisms". *Antimicrobial Agents and Chemotherapy*, 48: pp 774- 779.

Hamamoto H, Sekimizu K, (2005). "Evaluation of the Therapeutic Effects of Antibiotics Using Silkworm as an Animal Model". *Research Advance Antimicrobial Agents and Chemotherapy*, 5: pp 1-23.

Harinatha RA, Venkatappa B, (2016). "Effect of Staphylococcus Aureus Infection on Biochemical and Antioxidant activities of Fifth Instar Silkworm Larvae (*Bombyx mori L.*)". *Journal of Bacteriology and Parasitology*, 7(4): pp 1-7.

Huq SB, Haque MA, Khan AB, (1991). "Rearing Performances of Eri-silkworm, Philosamia ricini Hutt. (Lepidoptera: Saturniidae) on Five Different Host Plants", *Bangladesh Journal of Agricultural Sciences,* 18(2): pp 169-171.

Joshi KL, (1987). "Progression Factor for Growth in Eri Silk Moth in Relation to Diet", *Indian Journal of Sericulture,* 26: pp 98-99.

Kato T, Kajikawa M, Maenaka K, Park EY, (2010). "Silkworm Expression System as a Platform Technology in Life Science". *Applied Microbiology and Biotechnology*, 85: pp 459-470.

Kaleem S, Panthee S, Paudel A, Hamamoto H, Sekimizu K, (2017). "Advantages of the Silkworm as an Animal Model for Developing Novel Antimicrobial Agents". *Frontiers in Microbiology*, 8: pp 373.

Mallikarjunappa RS, Venkateshaiah HV, Bongale UD, Chandrakala MV, (2000). "Evaluation of Improved Mulberry Genotypes for Production of Leaf Suitable for Young Age Silkworm Rearing, With Annual 12 Leaf Harvest Schedule", *Indian Journal of Sericulture,* 39(2), pp 122-126.

Matsumoto Y, Ishii M, Hayashi, Y, Miyazaki S, Suqita T, Sumiya E, Sekimizu K, (2015). "Diabetic Silkworms for Evaluation of Therapeutically Effective Drugs against Type II Diabetes. *Scientific Reports Nature*, 29(5): pp 107-122.

Mahmood I, Ahmad, M, Bukhsh, MA, Wasaya A, Qayyum A, Raza MA, (2011). "Studies on Biology of a New Strain (K2) of Silkworm (*Bombyx Mori L.*) Under Different Sets of Temperature and Humidity". *The Journal of Animal and Plant Sciences*, 21(3): pp 556-560.

MdM, (2010). "Guide Data collection: Qualitative Methods, 2009, MdM, Health Education": A Practical Guide for Health Care Projects.

Meeramaideen M, Rajasekar P, Sumathi PG, (2017). "Studies on the Morphometric and Economic Parameters Analysis of Silkworm, *Bombyx Mori (L.)* (*Lepidoptera: Bombycidae*) Fed with Amino Acid (Lysine) Treated MR2 Mulberry Leaves". *International Journal of Modern Research and Reviews,* 5(1): pp 1468-1473.

Mishra RK, Choudhury PC, Mathur VB, Ghosh A, (1996). "Studies on the Development of Package of Cultivation for Mulberry Garden Exclusively for Young Age Silk Worm".Rearing. *Indian Journal of Sericulture,* 35: pp 10-18.

Munyuli TMB, (2011). "Farmers' Perception of Pollinators in Coffee Production in Uganda". *Agricultural Sciences*, 2(3): pp 318-333.

Neelu N, Jagadish PS, Nageshchandra BK, (2000). "Evaluation of the Volumetric Attributes of the Eri Silkworm Reared on Various Host Plants", *International Journal of Wild Silk moth & Silk,* 5: pp 36-38.

Oladimeji YU, Abdulsalam Z, Mani JR, Ajao AM, Galadima S, (2017a). "Profit Efficiency of Concrete and Earthen Pond Systems in Kwara State, Nigeria: A Path Towards Protein Self-Sufficiency". *Nigerian Journal of Fisheries and aquaculture,* 5(2): pp 104-113.

Oladimeji YU, Ajao AM, Abdulsalam Z, (2017b). "Arable Crop Farming and Adoption of Bee Pollination Services among Farming Households in Kwara State, Nigeria''. *AsianJournal of Agricultural Extension, Economics and Sociology,* 15(2): 1-10.

ORC (2001). "Macro, Model "A" Questionnaire with Commentary for H igh Contraceptive Prevalence Countries, MEASURE DHS+ Basic Documentation No". 1, USA.

Patel SR, Pandya HV, Patel SD, Naik MM, (2013). "Biology of *Bombyx mori L.* (Lepidoptera: Bombycidae)". *International Journal of Plant Protection*, 6(2): pp 382- 389.

Patil SP, Bhagas NV, Dongaejal RP, (2017). Biology of Mysore Silkworm Race on Leaves of Mulberry Varieties. *Indian Journal of Entomology*, 79(2): pp 214-219.

Rahmathulla VK, (2012). Management of Climatic Factors for Successful Silkworm (*Bombyx mori L.*) Crop and Higher Silk

Production: A Review. Psyche Volume 2012, Article ID 121234, 12 pages.

Rao MMM, (1998). "A Text Book of Sericulture. B.S. Publications". Hyderabad, India,

Sheker P, Hardingham M, (1995). "Sericulture and Silk Production". A Handbook. Intermediate Technology Publications, London.

Reddy DNR, Kotikal YK, Vijayendra M, (1989), Development and Silk Yield of Eri Silkworm, Samia *Cynthia ricini* (*Lepidoptera: Saturnidae*) as Influenced by the Food Plants, *Mysore Journal of agricultural Science*, 23: pp 506-508.

Sathyanarayana RCh, Pallavi SN, Reddy MM, Suryanarayana N, Singhal BK, Sengupta K, (1990). "Evaluation of Four New Mulberry Varieties through Silkworm Rearing Under Irrigated Condition". *Indian Journal of Sericulture*, 29(2): pp 240-247.

Somasundaram A, (1999). Evaluation of mulberry (*Morus spp.*) Genotypes Suitable for Chawki Rearing, Proceeding of National Semi Tropical Sericulture, Bangalore, India, pp 132-135.

Usha RJ, (2007). "Employment Generation to Women in Drought Prone Areas": A study with reference to the Development of Sericulture in Anantpur District of Andhra Pradesh.

Veerapura NYM, Ramesh HL, Lokesh G, Munirajappa P, Yada BRD, (2013). "Assessment of six Mulberry (Morus) Germplasm varieties through Moulting and Bioassay parameters by using Crossbreed Silkworms *Bombyx mori L.* for Commercial Exploitation in Kolar District", Karnataka, India, *International Research Journal of Biological Sciences*, 2(9),pp 69-75.

Veda K, Nagai I, Horikomi M, (1997). "*Silkworm Rearing (translated from Japanese)*" Science Publishers. Inc USA.

Vijay K, Jhariya MK, Yadav DK, (2018). "Socio-economic Status and Prospects of Sericulture in Tribal Region of Sarguja (CG.)", India. *Bulletin of Environment, Pharmacology and Life Sciences*, 7(4): pp 108-113.

World Medical Association, (1964). "Helsinki Declaration. Ethical Principles Applicable to Medical Research on Human Subjects". Adopted by the 18th General Assembly, Helsinki.

Yogananda-Murthy VN, Ramesh HL, Lokesh G, Munirajappa D, Yadav BR, (2013). "Leaf Quality Evaluation of Ten Mulberry (*Morus)* Germplasm Varieties through Phytochemical analysis". *International Journal of Pharmaceutical Sciences Review and Research*, 21(1): pp 182-189.

Zheng ZP, Tan HY, Wang, M. (2012). "Tyrosinase Inhibition Constituents from the Root of *Morus australis. Fitoterapia",* 83(6): pp 1008-1013.