Available online at http://ajol.info/index.php/ijbcs

Int. J. Biol. Chem. Sci. 9(2): 751-757, April 2015

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper

http://indexmedicus.afro.who.int

Influence of different varieties of mulberry leaves (*Morus alba*) on growth and cocoon performance of biovoltine strain of silkworm (*Bombyx mori*)

Sunday Adeniyi ADEDUNTAN

Department of Forestry and Wood Technology, The Federal University of Technology, PMB 704, Akure, Nigeria; E-mail: niyi_gbenga@yahoo.co.uk

ABSTRACT

The influence of different varieties of mulberry leaves used as feed on mortality and cocooning of silkworm as well as on cocoon qualities (good cocoon, flimsy cocoon, stained cocoons, cocoon shell weight and pupa weight) were examined. Their influence on oviposition, Eggs fertility and hatchability were also examined. The effects of anti nutrients presents on the variety mulberry leaves used as feed on silkworm performance were further examined. The result revealed that there were significant differences ($P \leq 0.05$) between varieties of mulberry leaves used as feed on mortality of larva and cocooning, while its influence on good cocoon, flimsy cocoon, stained cocoons, cocoon shell weight and pupa weight, oviposition, egg fertility and hatchability were not statistically significant ($P \geq 0.05$). It was also observed that K_2, variety has the lowest antinutrient components while S_{25} has the highest antinutrient component.

Keywords: Mulberry plant, varieties, cocoon, oviposition, nutrient.

INTRODUCTION

The production of natural silk through the rearing of the silkworm *Bobyx mon L.* (*Lepidoptera bombycidae*) on leaves of the mulberry plants *Morus alba* through, is popular in many Asian countries (Datta, 2000), it is relatively new in Nigeria and in many African countries (Akinkunmi, 1995), Jaiyeola and Adeduntan (2002) outlined the potential of sericulture in alleviating rural poverty in some part of Nigeria.

Sericulture is the art and science of rearing silkworm (*Bombyx mori)* by feeding them with mulberry plant of *Morus* species for the production of cocoon which are reeled into raw silk (Periasamy, 1986). This involves activities which range from Agricultural mulberry cultivation to biological silkworm rearing. This goes further to the industrial sector, where raw silk reeling and some other post cocoon activities takes place. In addition to nature of the silkworm specific quality requirement of worms during different phases of growth and production of eggs reflect the importance of different mulberry varieties use in feeding the silkworm. It was also reported that nutritive effects of leaf position play a major role in the quality of silkworm growth and silk production (Adeduntan, 2013). Lack of adequate feeding causes weakness in the young larvae and sometimes death, whereas over feeding causes fatness of pupae. The resultant effect in both extreme cases is that

DOI : http://dx.doi.org/10.4314/ijbcs.v9i2.15

lesser number of cocoon is produced (Narasimhanna, 1990).

Mulberry plants is spread over forty-two countries, but the bulk of the total-World production of mulberry silk comes from China. India Japan, South Korea and USSR accounting for 56, 166 tones (95%) (FAO, 1988).

Varieties of mulberry used during rearing of silkworm (*Bmbyx mori)* can have effect on the quality of the eggs produced as well as hatchability, unfertilized and fertility of eggs (Suttie, 2012).

The silkworm feeds only at the larva stage for duration of 25 days. Calves (1981) indicated that feeding during first phase (obligation feeding) induces the secretion of Juvenile hormone which helps to maintain the prolonged larva period but has no effect on pupa life.

The larva instars in Lepidoptera can be divided into two periods in relation to food intake, the obligatory feeding and facultative feeding control (Bounhiol, 1938). According to Sehnal and Akai (1990), food deprivation during facultative feeding period reduces body growth and also affects the silk glands in *B. mori* L.

The practice of rearing improved hybrid silkworm races preservation of eggs, bed cleaning frequency, number of feedings to be given to worms per day, type of leaves fed to worms during different stages and care at mounting during silkworm rearing is very important for successful high silkworm yield.

To improve the cocoon quality, mulberry and mountage must not only be improved on (Yokahama, 1954). Ullal and Narasinhanna (1987) also describe that a good rearing can, to a great extent, be spoiled by bad mounting.

To allow optimum production and utilization of mulberry plants as silkworm food the knowledge of the quality of the varieties of mulberry plant available in Nigeria is imperative. The present study therefore aimed at investigating the influence of different varieties of mulberry leaves on performance (mortality of larvae, cocooning, qualities of cocoon oviposition fertility of eggs and hatchability of eggs) of silkworm.

MATERIALS AND METHODS

Procurement and biovoltine strain *Bombyx mori*

The biovoltine strain of *Bombyx mori* was obtained from the sericulture centre of Ondo State 9 dfls (diseases free lay) of ND_{18} race of silkworm (*Bombyx mori*) and three varieties of mulberry plant used to feed the silkworm were obtained directly from Ondo State sericulture project centre.

The mulberry leaves were harvested from the plantation in the morning and late in the evening for the feeding of the bivoltine strain of *Bombyx mori*

Experimental procedure

The race of silkworm eggs were incubated for 10-days and black boxed two days prior hatching to have uniformly hatched eggs (i.e. 90 – 95%) hatching 24 hours prior to hatching the eggs attain blue egg stage and the black box eggs were removed and they were exposed to sudden light and the eggs were exposed to sudden light and the eggs were hatched. After hatching, brushing was carried out to separate the newly hatched larvae from the empty eggs shells into the rearing trays. The tender leaves of 0.5 cm – 1 cm square were spread over the eggs and were then brushed into rearing trays with the aid of feather.

The silkworms undergone four different stages of instars and at every instar the sizes of mulberry leaves given as feed were increased and the bed cleaning was done regularly.

The worms were read for 22 days and at the end of the 22 days the larvae began cocoon spinning. The worms were picked and were put on the mountages for cocoons spinning. The spinning took seven days before it was completed and after the end of the seven days the spun cocoons were harvested from the mountages during this period the pupation have been completed and the spun cocoon become hard. After the harvesting, the cocoon were cleaned and were separated accordingly to varieties of mulberry leaves (*Morus alba*) and they were sorted and separated accordingly and they were counted (Seetharama et al., 1988; Chikkana et al., 1993).

Ten cocoons were selected randomly from each dfl (diseases free lay) egg sheet. They were left for days for adult moth to emerge immediately after their emergence they were matted for six hours and allow to lay eggs for 24 hours. The eggs laid were acid treated (Diluted H_2SO_4) on the same day and incubated. On the 10^{th} day of incubation they were black boxed for 24 hours and exposed to sudden light until they were finally hatched.

Eggs laid were counted, fertile eggs, unfertile eggs and hatched eggs were noted.

(1) The effect of different variety of mulberry leaves on percentage survival of larvae (number of dead worms X 100/Number of brushed/or hatched eggs);

(2) Effect of different variety of mulberry leaves on percentage cocoon yield (number of harvested cocoon X 100/Number of brushed or hatched eggs);

(3) Effect of different variety of mulberry leaves on oviposition = (total number of egg laid per dfl);

(4) Percentage hatched eggs = (number of hatched eggs X 100/ total oviposition of eggs)

(5) Percentage unhatched = (number of unhatched eggs X 100/total oviposition of eggs) and

(6) Percentage unfertilized eggs = (number of unfertilized X 100/Number of oviposition of eggs) were calculated for each treatment.

Data on percentages were subjected to analysis of variance. Percentages of cocoon formed, mortality were subjected to square root transformation before they were analyzed using completely randomized design.

RESULTS

The effects of varieties of mulberry leaves (*Morus alba*) on percentage of *Bobyx mori* larvae was significantly different ($P \leq 0.05$). It was observed that larvae mortality in K_2 of mulberry variety was significantly ($P \leq 0.05$) lower than the rest of the treatment while mortality of worms fed with S_{54} was significantly ($P \leq 0.05$) lower than that of mulberry fed with S_{36}.

Table 1 Indicated that there was significant ($P \leq 0.05$) decrease in percentage cocooning of silkworm fed with K_2, S_{54}, S_{36} mulberry varieties respectively, while percentage worms mortality increases accordingly. It was also observed that there were no significant differences ($P \geq 0.05$) on the effect of mulberry varieties used as feed on percentage of good cocoon, percentage of flimsy cocoons as well as percentage of stained cocoons produced (Table 2). The effect of mulberry varieties on the oviposition of biovoltine silkworm was not significantly ($P \geq 0.05$) different, the result of percentage of shell weight and pupa weight (Table 3) shown that there were no significant ($P \geq 0.05$) differences between the effect of mulberry leaf on shell weight and pupa weight.

There were no significant differences ($P \geq 0.05$) on the effect of varieties of mulberry leaves used as feed on grainage parameters (i.e. egg oviposition percentage of unfertilized, percentage of hatched eggs, percentage of unhatched eggs) (Table 4).

The result of antinutrient components of mulberry leave (*Morus alba*) was presented in Table 5. The level of phytic acid increase from K_2 to S_{36} while the level of lignin followed the same trend (Table 5). Tannin content in K_2 was the least while the level in S_{54} was the highest. From this observation, it can be said that K_2 has low antinutrient component while S_{36} has the highest level of antinutrition. K_2 variety has the lowest moisture content (15.4%) followed by S_{54} (36.5%) while S_{36} (46.25%) has the highest value of moisture content.

Table 1: Effect of different varieties of mulberry leaves on mortality and cocooning of ND_{18}.

Treatments	% of Mortality	% of Cocooning
S_{36}	43. 39 ± 4.08a	56.62 ± 4.09a
S_{54}	**34.45** ± 6.46b	65.55 ± 6.46b
K_2	15.55 ± 12.36c	84.45 ± 12.39c
LSD (0.05)	16.17	16.61

* Means that follow with the different alphabet are significantly different ($P \leq 0.05$)
S_{36}, S_{54}, K_2, are the species of mulberry plant used to feed the silkworm.

Table 2: Effect of different varieties of mulberry leaves on quality of cocoon produced by ND_{18}.

Treatments	% of good cocoons	% of flimsy cocoons	% of stained cocoons
S_{36}	80. 00 ± 11.60a	17.00 ± 9.43a	2.91 ± 2.20a
S_{54}	79.79 ± 16.23a	18.75 ± 16.60a	1.47 ± 0.52a
K_2	86.04 ± 6.7a	10.09 ± 6.24a	3.88 ± 1.069a
LSD (0.05)	Ns	Ns	Ns

Ns = Not significant at 0.05
S_{36}, S_{54}, K_2, are the species of mulberry plant used to feed the silkworm.

Table 3: Effect of different varieties of mulberry leaves on quality of shell weight and pupa weight of ND_{18}.

Treatments	% of shell weight	% of pupa weight
S_{36}	18. 59 ± 0.87a	80.94 ± 0.98a
S_{54}	18. 80 ± 1.95a	80.73 ± 1.78a
K_2	19.47 ± 2. 89a	63.12 ± 16.92a
LSD (0.05)	Ns	Ns

NS = Not significant at 0.05
S_{36}, S_{54}, K_2, are the species of mulberry plant used to feed the silkworm.

Table 4: Effect of different varieties of mulberry leaves on grainage parameters.

Treatments	Oviposition	% of unfertilized	% of hatched	% of eggs unhatched
S_{36}	469. 00 ± 55.77a	1.12 ± 0.32a	96.90 ± 1.19a	1.88 ± 1.26a
S_{54}	416.00 ± 37.53a	1.01 ± 0.10a	96.90 ± 1.91a	2.42 ± 1.93a
K_2	434.25 ± 34.81a	1.22 ± 0.23a	98.0 ± 0.44a	1.74 ± 0.38a
LSD (0.05)	Ns	Ns	Ns	Ns

* Means that follow with the different alphabet are significantly different ($P \leq 0.05$)
S_{36}, S_{54}, K_2, are the species of mulberry plant used to feed the silkworm.

Table 5: Level of anti-nutritional component in the varieties mulberry leaves (*Morus alba*) used.

Components	K_2	S_{36}	S_{54}
Phytic acid (mg/kg)	0.15	0.23	0.16
Lignin (,g/kg)	21.00	23.00	14.50
Tannin (mg/kg)	15.00	17.37	18.95

DISCUSSION

Percentage of good cocoons, flimsy cocoons and stained cocoon produced by silkworm do not closely appear to be influenced by varieties of mulberry leaves in this study and may be function of high rearing efficiency. This could be as a result of prompt or quick peaking and mounting of matured larvae when they are about to spin cocoon and good spacing provided while mounting the larvae on the mountage.

Varieties of mulberry leaves have significantly ($p \leq 0.05$) higher effect on percentage of shell weight and pupa weight. Perhaps, this could be because of more frequent contact with food, the time for conversion of assailants into body tissue is reduced such that more of the assimilate is stored to be regurgitated as silk fibres. This is supported by the explanation of silk production in the silkworm by Narasimhana (1988).

Table 4 shows that there was no significant ($P \geq 0.05$) effect between varieties of mulberry leaves used during rearing of silkworm moth in respect to oviposition, fertility and hatchability of eggs. This observation contradicted the findings of Krishaswami (1988) who reported that varieties of mulberry leaves used during rearing of silkworm have effect on the qualities of the eggs produced as well as the fertility and hatchability of eggs. This observation could be attributed to the limited number of varieties of mulberry used during the experimentation.

The phytic acid levels are 0.15, 0.16, and 0.23 (mg/kg) in K_2, S_{54} and S_{36} respectively. Phytic acid is known to be the primary storage form of phosphorus in mature plant. The high phytin content is of nutritional significance, as not only make phytin unavailable to humans and monogsatic but also lowers the availability of many other essential minerals (Reddy et al., 1980). Forbes and Erdman (1983) observed that the anti-nutritional nature of phytin lies in its ability to chelete certain mineral element especially Ca, Mg, Fe, Zn thereby render them metabolically unavailable and leading to the subsequent development of oestiomalacia.

Lignin of S_{54} was the lowest while S_{36} was the highest. Funaoka and Abe (1987) observed that chemical structure of Lignin complex due to various type of linkage-between phenyl propane units and the presence of lignin that give celluslosic material, its hydroscopicity which make them resistance to break down (digestion). The combined effect of lower Tannin and Phytic acid level in K_2 (15.00 mg/kg) and higher phytic acid level in S_{36} couple with higher lignin level in S_{54} could be what resulted in Table 1. That make the mortality in K_2 to be significantly ($p \leq 0.05$) lower than what was observed in S_{36} and $S_{5.}$ Likewise that make percentage of cocoon formed in K_2 to be significantly ($p \leq 0.05$) higher in K_2 than what was observed in S_{35} and S_{54}. It could also be as a result of lower moisture content in K_2 that prevented moisture building up on rearing bed as well as excessive high relative humidity around rearing environment which in-turn prevented incidence of bacteria or diseases infestation and allowed silkworm larvae to be healthy.

The result of significantly ($p \leq 0.05$) lower cocoon production in S_{36} and S_{54} (Table 1) could as well be as a result of unavailability of some nutrients and minerals in the feed caused by some anti-nutrient present in the mulberry feed, which was in support of observation made by Marasimuanaa (1988) that varieties of mulberry leaves have significant effect on their cocoon production.

Conclusion

The present study has shown that varieties of mulberry leave during rearing of silkworm have significant ($p \leq 0.05$) effect on larvae mortality and cocooning. It further indicated that mulberry varieties used for rearing do not have any significant ($p \leq 0.05$) effect on moth oviposition, fertility, hatchability as well as on cocoon properties (good cocoon, flimsy cocoon, stained cocoon,

cocoon shell weight and pupa weight). The limitation to the full utilization of some varieties of mulberry leaves e.g. S_{54} and S_{36} was as a result of high concentration of antinutritional factors (mainly tannins phytins and Lignin) which almost render them useless for optimum performance.

More research is needed to evaluate more varieties of mulberry plant and to compare the Bioassay with chemical analysis of nutrition and anti-nutritional component of mulberry leaves.

ACKNOWLEDGEMENTS

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