

Nutritive Effects of Leaf Position of *Mulberry Plant Morus alba* on Silkworm *Bombyx mori* L. Performance

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Abstract This study examined the nutritive effects of leaf positions of Mulberry plant *Morus alba* on Silkworm *Bombyx mori* performance (percentage survival, cocoon weight, shell weight and pupa's weight, grainage parameters and cocoon qualities) were examined. 12 diseases free lay (dfl) eggs card were used. Newly hatched worms were brushed and rearing commenced immediately. The worms were fed thrice daily with chopped mulberry leaves. As the worms completed the first instars they were fed differently with top leaves, middle leaves and lower leaves and last set were fed with top leaved initially and they were fed with older or lower leaves progressively until the worms started to spin cocoon. 10 cocoons were selected for test from each treatment to test for grainage parameters and qualities of cocoons. The results obtained shows that leaf positions of Mulberry plants *Morus alba* has no significant ($P \geq 0.05$) effects on percentage of silkworm survival, moth fed with base, top, and control leaves having mean value of 143, 152, 229, and 267 respectively. The result further shows that worm fed with base, top, middle and control leaves produced the mean egg of 288, 388, 416, and 428 respectively but there are no significant ($P \leq 0.05$) effect on the percentage of hatched eggs, unhatched eggs and unfertile eggs. The result revealed that silkworms fed with base leaves produced lesser flimsy cocoons with mean value of 1.35 and higher number of good cocoons with mean value of 97.12. The older the mulberry leaves the higher the fibre content (fibres' length and strength) the better the cocoons formation. In addition leaf positions has significant ($P \leq 0.05$) effect on percentage of pupa's weight and cocoon's weight formed by silkworm (*Bombyx mori* L.). quality of.

Keyword Silkworm, Oviposition, Cocoon, Grainage, Leaf Position, Fiber Length

1. Introduction

Sericulture is a labour intensive agro-based industry ideally suited for all developing countries where unemployment and under employment continue to be a serious problem[1]. The production of natural silk through the rearing of the silkworm *Bombyx mori* L. (Lepidoptera bombycidae) on leaves of the mulberry plants *Morus alba* is popular in many Asian countries[2] but new in Nigeria and many Africa countries. It has being in practiced in China for over 4000 years before it was introduced to India, Japan and to more than 65 countries of the World today[3]. It is relatively new in Nigeria and in Africa countries[4]. The potential of sericulture in alleviating rural poverty was outlined by[5] in some part of Nigeria.

Sericulture is the art and science of rearing silkworm *Bombyx mori* L. by feeding them with mulberry plant of *Morus* species for production of cocoon, which are reeled into raw silk[6]. This involves activities, which ranges further to the industrial sector, where raw silk rearing and

some other pest cocoon activities takes place. In addition to nature of the silkworm, specific of growth and production of eggs reflect the importance of different mulberry variety use in feeding the silkworm. 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 lesser number of cocoon is produced[7]. [8] 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's life.

According to[9], food deprivation during facultative feeding period reduces body growth and also affects the glands in *Bombyx mori* L. to improve the cocoon quality and quantity, mulberry culture and silkworm rearing must not only improve but also method of moulting and mountage to be use should also be improved[10]. The energy consumed by the silkworm feeding is utilized for spinning by its conversion to protein.[11] described that when the supply of protein Nitrogen or energy is low, the silk production spinning is diminished or ceased altogether, which resulted to small cocoon formation. In addition, specific quality and quantity of food requirement of worms during different stages of growth to cocoon production reflect the importance of different leaf position of mulberry plant to feed the

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silkworm[12]. This study identifies the best leaf positions to use in order to attain maximum and high quality silk production.

2. Methods

2.1. Mulberry Leaves (*Morus Alba*)

The Mulberry leaves used to feed the silkworm was S₃₆. The Biovoltine strain of *Bombyx mori* used were obtained from Ondo state sericulture project centre Akure, Nigeria. The mulberry leaves were harvested from the field in the morning and late in the evening for the feeding of the silkworm.

The acid treated silkworm eggs were incubated for 9 days and there after black boxed for 6 hours to obtain a uniformly hatched eggs. Brushing was carried out to separate the newly hatched larvae from the empty eggs shells in to rearing trays with aid of chopped mulberry leaves and feather. The larvae of silkworms undergone four different stages of instars and at every instars the sizes and quantity of mulberry leaves given as feed increases and bed cleaning was done accordingly.

Immediately after the young worms hatched, they were fed with mulberry leaves of S₃₆ species. The worms were fed thrice daily (i.e. 8.00 am., 12 noon and 4.00 p.m. everyday). For the first instars, they were all fed with the full grown

tender leaves from the apex and they were chopped to a size of 0.5 cm – 1.00 cm as the worms completed the first instars, they were fed differently (i.e. some were fed with top leaves, and some with middle leaves and the last with lower leaves but the control worm were fed from tender leaves graduate down the stem of mulberry plant as they increases in age. The treatments were replicated thrice. As the worms developed the leaves sizes increases (1.5 – 2 cm). At the third state of instars those that were overcrowded were separated, while the whole leaves were fed to the worms at fourth to fifth instars.

The silkworms were reared for 22 days before they began to spin cocoon. The silkworm larvae were picked on to the moutange for the spinning of cocoons. Immediately after cocoon spinning, they were harvested and selections were made for grainage exercise. (i.e to test for cocoon qualities, egg production, fibre length and strength).

2.2. Data Analysis

The data collected i.e. cocoon qualities, silkworm survival, egg production, fibre length and strength and the data were subject to one-way analysis of variance. Duncan Multiple Range Test (DMRT) was used to separate means of variable found to differ significantly.

3. Results

Table 1. ANOVA Table Showing the Effect of Leaf Positions on Percentage of worms

		Sum of square	Df	Men square	F-Cal	Sig.
Survived Silk worm	Between Groups	749.730	3	249.810	2.682Ns	0.118
	Within Groups	745.345	8	93.168		
	Total	1495.075	11			
Dead silkworm	Between Groups	749.730	3	249.910	2.682Ns	0.118
	Within Groups	745.345	8	93.168		
	Total	1495.075	11			

Ns = not significant at 0.05 level of test

Table 2a. ANOVA Table Showing the Effects of Leaf Position on The Qualities of Cocoons Produced

		Sum of square	Df	Men square	F-Cal	Sig.
Harvested Cocoon	Between Groups	32403.667	3	10801.222	2.107Ns	0.178
	Within Groups	41010.000	8	5126.250		
	Total	73413.667	11			
Good Cocoon	Between Groups	53.518	3	17.839	4.059*	0.050
	Within Groups	35.64	8	4.396		
	Total	88.682	11			
Flimsy Cocoon	Between Groups	46.9384	3	15.646	9.141*	0.006
	Within Groups	13.694	8	1.7121		
	Total	60.632	11			
Stained Cocoon	Between Groups	0.150	3	0.050	0.444Ns	0.728
	Within Groups	0.903	8	0.113		
	Total	1.053	11			
Double	Between Groups	1.681	3	0.560	0.687Ns	0.585
	Within Groups	6.524	8	0.816		
	Total	8.205	11			

Ns = No. Significant at 0.05 level of test, * = Significant at 0.05 level of test

The result shows that leaf positions does not significantly ($P \leq 0.05$) affect the number of worms that survived with base, top, middle and control leaves with the mean p-value of 143, 152, 229 and 267 respectively and dead worms with control, top, middle and base leaves having the a value of 41, 72, 8 and 105 respectively at 0.05 level of test (Table 1). The follow-up procedure revealed that the worms fed with tender leaves and latter graduated down the stem as they advanced in age produced small flimsy cocoons and good cocoon with mean value of 1.61 and 97.13 respectively, while those fed with base leaves is preferred to control because they produced lesser flimsy cocoons with mean value of 1.35 and higher number of good cocoons with mean value of 97.12.

Table 2b. Means Separation of the Effect of Leaf Position on the Good Cocoon and Flimsy Cocoon

Treatment	Mean Good Cocoon	Mean Flimsy Cocoon
Control	97.1333 ^a	1.6100 ^a
Base leaves	97.1233 ^a	1.3533 ^a
Middle leaves	95.0433 ^b	4.1867 ^b
Top leaves	91.9700 ^b	6.1667 ^b

Mean with the same alphabet are not significantly different ($P < 0.05$)

Table 3 revealed that leaf positions has significant ($P \leq 0.05$) effect on percentage of pupa's weight and cocoon's weight formed by silkworm (*Bombyx mori* L.). It further revealed that the effect of leaf positions does not have any significant ($P \geq 0.05$) influence on the percentage of cocoon shell formed by silkworm (*Bombyx mori* L.). It was observed that top leaves and control are the best feed for silkworm to attain high cocoon weight because there were no significant ($P \geq 0.05$) differences between their percentage values (Table 3b). The percentage value for top and control leaves were

1.333 and 1.31 respectively but top leaves were preferred to control base on its highest value.

The follow up result in Table 3b further shows that base, middle, control and top leaves with percentage mean value of 0.81, 0.98, 1.03 and 1.06 shows that top leaves has the highest mean, which implies that top leaves will produce higher pupa weight that could be preferred by grainage farmers in order to obtain maximum egg productions.

Table 4 shows that there were no significant ($P \geq 0.05$) differences in effect of leaf positions of mulberry plant on percentage of eggs batched, unhatched eggs and unfertile eggs produced by silkworm (*Bombyx mori* L.). But the effect of leaf positions was significantly ($P \leq 0.05$) higher on total egg laid with moth fed with top, base, control and middle leaves with mean oviposition of 288, 388, 416, and 428 respectively.

The follow up procedure (table 4b) revealed that silkworm fed with middle leaves produced highest number of oviposited egg with mean value of 428 but there was no significant difference between the egg laid by the worm fed with middle leaves and control (i.e. those that feed with leaves that graduated down the stem as silkworm advances in age) leaves with mean value of 416.

The fibre length of cocoon produced were not significantly ($P \leq 0.05$) different from each other (Table 5).

Mean with the same alphabet are not significantly different ($P < 0.05$). Here, control and base leaves will produce good cocoon control is more preferred to base leaves because it will produce highest good cocoon.

Here, base leaves and control leaves will produce flimsy cocoon base leaves are more preferred to control leaves because it will produce least flimsy cocoon.

Table 3a. ANOVA Table Showing the Effect of Leaf Positions of Mulberry Plant on Percentage of Cocoon weight, Shell weight and Pupa's weight

		Sum of square	Df	Men square	F-Cal	Sig.
Weight of Cocoon	Between Groups	0.057	3	0.019	5.999*	0.019
	Within Groups	0.025	8	0.003		
	Total	0.082	11			
Shell Weight	Between Groups	0.056	3	0.019	2.677Ns	0.118
	Within Groups	0.056	8	0.007		
	Total	0.112	11			
Pupa's Weight	Between Groups	0.113	3	0.038	8.954*	0.006
	Within Groups	0.034	8	0.004		
	Total	0.147	11			

Ns = Nos Significant at 0.05 level of test, * = Significant at 0.05 level of test

Table 3b. Means Separation of the Effect of Leaf Position on Cocoon Weight and Pupa's weight

Treatment	Mean
Top leaves	1.3333 ^a
Control	1.3167 ^a
Middle leaves	1.2200 ^b
Base leaves	1.1667 ^c

Mean with the different alphabet are significantly different ($P \geq 0.05$)

Table 4a. ANOVA Table Showing the Effect of Leaf Positions of Mulberry Plant on Percentage of Total Egg laid, Hatched Silkworm, Unhatched Eggs and Unfertile Eggs produced by Silkworm (*Bombyx mori* L.)

		Sum of square	Df	Men square	F-Cal	Sig.
Total Egg laid	Between Groups	36561.333	3	12187.111	4.133*	0.048
Cocoon	Within Groups	23592.667	8	2949.083		
	Total	60154.000	11			
Hatched	Between Groups	3253.148	3	1084.383	3.347 Ns	0.076
Eggs	Within Groups	2591.755	8	323.969		
	Total	5844.903	11			
Unfertile	Between Groups	0.872	3	0.290	0.429Ns	0.738
Eggs	Within Groups	5.418	8	0.677		
	Total	6.290	11			
Unhatched	Between Groups	3209.672	3	1069.891	3.199 Ns	0.084
Eggs	Within Groups	2675.268	8	334.408		
	Total	5884.939	11			

Ns = Not Significant at 0.05 level of test, * = Significant at 0.05 level of test

Table 4b. Means Separation of the Effect of Leaf Position on Percentage of Egg Lay

Treatment	Mean
Top leaves	287.6667 ^a
Base leaves	388.3333 ^{bc}
Control	416.333 ^{cd}
Middle leaves	427.6667 ^d

Mean with the different alphabet are significantly different ($P > 0.05$)**Table 5.** ANOVA Table Showing the Effect of Leaf Positions on Fibre Length and Strength

		Sum of square	Df	Men square	F-Cal	Sig.
Cocoon	Between Groups	31792.667	3	10597.556	0.564 ns	0.654
Fibre Length	Within Groups	150315.3	8	18789.417		
	Total	182108.0	11			
Cocoon	Between Groups	0.137	3	0.046	1.519 ns	0.283
Fibre strength	Within Groups	0.240	9	0.030		
	Total	0.377	11			

Ns = No Significant at 0.05 level of test

4. Discussion

The nutritive effect of leaf positions of mulberry plant (*Morus alba*) on percentage of reared worms and survived worms were not significantly ($P \geq 0.05$) different. The implication of this finding is that leaf irrespective of their positions on mulberry plant could be used for feeding in order to achieve high percentage survival of silkworm.

Nutritive effect of leaf positions on percentage of harvested cocoons, good cocoons, stained cocoons and double cocoons produced by silkworm do not closely appear to be influenced by leaf positions of mulberry plants as shown in table 2a which is in agreement with [13] who observed that there were no significant ($P \geq 0.05$) differences in good cocoons, flimsy cocoons and stained cocoons produced as a result of different variety of mulberry plant used as fed which he attributed to prompt picking and mounting of matured larvae when they are about to spin cocoons and as well as good spacing provided while mounting the larvae on the mountage. The significance ($P \leq 0.05$) observed on the effect of leaf positions on good cocoons and flimsy cocoons produced could be as a result of variation on the fibre content of the leaf which could in turn

be as a result of age of leaves (Table 2 b), thus low fibre content in the leaves will results to lower quality of cocoon while the higher the fibre content in the mulberry leaves the better the cocoons formed.

The effect of leaf positions on percentage of pupa's weight and cocoon's weight formed by silkworm was significantly ($P \leq 0.05$) different (Table 3a) which was in agreement with [14] who observed that there was significant ($P \leq 0.05$) difference in nutritive value of leaf positions of mulberry plant. Table 3b also shown that top leaves or tender leaves produce significantly ($P \leq 0.05$) higher pupa's weight which is supported by [15, 9] who concluded that silkworm fed with tender leaves have high larvae weight. Likewise [2] stated that they also possess vigorous growth because the leaves are richer in protein, soluble sugar and carbohydrate, which are highly essential for good growth and performance.

The result obtained from Table 4a shows that silkworm fed with middle leaves produce significantly higher eggs (oviposition) while silkworm fed with top leaves produced significantly lower eggs (oviposition) but there were no significant differences between middle leaves and those that fed with top leaves and as growth progresses their feeding progresses with mature leaves (i.e. graduated down

the stem of mulberry plant). Also result obtained from table 4b reveal percentage of hatched eggs, unhatched eggs and unfertile eggs produced by silkworm (*Bombyx mori* L.) do not closely appear to be influenced by leaf position of mulberry plant. This is in agreement with [18] which stated that there were no significant ($P \geq 0.05$) differences on the effect of leaf positions of mulberry plant on hatchability, unfertile eggs and unhatched eggs of silkworm (*Bombyx mori* L.) [2] also observed that the effect of varieties and leaf positions of mulberry plant on oviposition, fertility and hatchability is such that any of the variety could be used to feed the silkworm in order to achieve maximum grainage performance.

5. Conclusions

The result obtained at the end of the research work shows that there were no significant difference on percentage silkworm survived, dead silkworm, weight of pupa, hatched, unfertile, unhatched silkworm eggs, good cocoons, stained, double cocoons and also on quality of fibre filament length and strength at 0.05 level of test. It was also revealed that there were significant difference on percentage of total egg laid, cocoon weight, pupa's weight and flimsy cocoon produced by silkworm (*Bombyx mori* L.). In this wise it can be concluded that feeding tender leaves graduated down the mulberry plant is the best so that all leaves on the plant could be fully utilised during the rearing period.

6. Recommendations

Having studied the nutritive effect of leaf positions of mulberry plant on silkworm performance the following recommendation was made:

For grainage farmer: feeding from tender leaves graduate down the stem of mulberry plant as silkworm matured should be adopted in feeding their silkworm in order to obtain larger number of egg that will be laid by silkworm with little or no unfertile and unhatched eggs.

For silk –based industry: They should start feeding their silk-worm with tender leaves graduated down the stem as silk worms developed in order to maximize the utilization of mulberry plant.

For sericulturist: To harvest large quantity of good cocoon, with little or no flimsy, stained, double cocoons, as well as long fiber (filament) length with minimum reeling breakage. Middle leaves are recommended for feeding silkworm.

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