Comparative Study on Varietal Quality of the Mulberry (*Morus alba koids*) and the System of Feeding Silkworm (*Bombyx mori*)

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Abstract

Four thousand and five hundred newly hatched silkworm Chul x Thai 12 strain were subjected to a feeding experiment to compare the effects of a mulberry variety (Batac and Taiwan), feeding system (chopped, whole leaf, and branch with leaf) and some feed storage (no storage, 4, 8, 12, and 24-hour) on the performance of cocoon production over a 27-day period. All treatments with 3 replications were arranged in a 2 x 3 x5 factorial experiment in a completely randomized design.

Results showed no significant differences were noted in the average fresh weight per cocoon at 1.88 g and 1.71 g and dried weight per cocoon at 0.71 g and

0.69 g when fed in Batac and Taiwan mulberry varieties, respectively. Variety and feeding system showed no significant differences in fresh weight per cocoon at 1.72 g, 1.76 g and 1.90 g in chopped, whole leaf and branch with leaf respectively in both varieties.

The feed storage of 24 hours significantly lower the weights of fresh cocoon at 0.25 g compared to 2.14 g, 2.31 g, 2.12 g and 1.16 g in no storage, 4, 8, and 12-hour, respectively. The same trend was observed in dried cocoon weights in variety and feeding system.

Average cocoon shell ratio and mortality rate was highly significant in the 24-hour feed storage at 90.19% and 85.88% respectively. No significant differences were observed between feeding system and varieties.

Computed average yield per box of silkworm was obtained significantly higher at 37.66 kg when fed with Batac variety, as compared to 33.91 kg with the Taiwan variety. Variety and feeding system revealed no significant differences in yield per box of silkworm. However, the feed storage of 24-hour showed the lowest yield at 5.33 kg.

Introduction

Moriculture and Sericulture are new industries in our country in which most of our farmers may engage to augment their income.

Mulberry leaf production is the only source of raw silk after feeding to silkworm (Choe, H.B. 1977).

Silk producing countries like Japan and Korea rear silkworm 3 to 4 times a year only and earn Php14,000.00 from a hectare of mulberry. In the Philippines, we can have a 6 to 8 rearings a year according to Dr. Lim, S.J. and Dr. Choe H.B. 1977, Korean sericulture experts and visiting trainors to the Philippines Sericulture Research Center.

Rearing house may be built with the use of local materials like cogon or nipa for roofing. Banana and coconut leaves and bamboo can also be used as cocooning materials and these are locally available in the area.

One box containing 20,000 eggs of silkworm can produce 25 to 30 kgs of fresh cocoon and can be managed by one farmer as an adjunct to his farming activities. After 21 to 27 days of rearing, cocoons can be produced and sold at the local market price at Php 90.00 to Php 100.00 per kilogram. Thus, with a production of 25 kgs of cocoon, a farmer earns Php 2,250.00 within a period of 3 to 4 weeks only.

Mulberry and silk production is one of the latest industries in our country particularly at MSU and in Lanao del Sur province.

Lanao del Sur has a very wide uncultivated fertile land which is suited to mulberry production as the main source of silk production.

The Maranaos especially the wealthy ones, wear expensive cloth made of silk. Silk clothes are even imported from Indonesia, Malaysia, China and other countries at a very high price.

Maranao farmers are also good at cloth weaving, but due to limited supplies, their expertise could not be fully utilized to improve their other sources of income.

Since this is a new industry, a research along this line is conducted with the end of establishing local packages of technology for the rapid development of the silk industry.

Objectives of the Study

The general objectives of the study are to find out and introduce the economic feasibility of evolving moriculture and sericulture in Southern Philippines, particularly at MSU and Lanao del Sur.

The specific objectives are: (1) To determine the variety of good quality mulberry, its keeping duration and the system of feeding preparation that will give the best cocoon; (2) To develop and test the adaptability of modified foreign technology at the least cost of effective silkworm rearing techniques under MSU conditions and the least cost possible within the reach of the end clientele, i.e., the farmers.

Time and Place of the Study

This study was conducted at the FFI, MSU Ceramic Center at the University, Marawi City, Philippines.

The experiment started on July 1, 1990 and terminated on June 30, 1991 with an experimental period of one year.

Methodology/Procedure

Two varieties of mulberry plants (Batac and Taiwan) and a newly hatched Chul x Thai 12 strain of silkworm larvae, obtained from Sericulture

Research Center, at Kalingagan, Misamis Oriental under DOST Region X, Cagayan de Oro City, were used in the study.

One half hectare area was thoroughly prepared and planted with Batac and Taiwan varieties of mulberry plants. A total OF 3,000 mulberry cuttings at 1,500 each variety were cut into the desired length of 10 c. and planted into the corresponding area at 1 m x 1.5 m. distance between plants and rows, respectively. An area of 2,500 m^2 was planted in each variety.

All accepted cultural practices and management such as irrigation, fertilization, weeding and control of pests and diseases were carried out until 7 months, when mulberry plants were ready for feeding to silkworm.

A total of 4,500 newly hatched silkworm larvae were reared in three replications. Each replicate was divided into: main treatment, which was subdivided into three and further subdivided into five sub-sub-treatments. Each sub-sub-treatment comprised of 50 young silkworm in one disinfected 60m^2 feeding tray.

A 2 x 3 x5 factorial experiment in randomized complete block design was used in the study.

The following treatments are as follows:

Factor A = 2 varieties of mulberry
- V_B = Batac variety
- V_T = Taiwan variety

Factor B = Feeding system
- S_O = Chopped mulberry leaf
- S_1 = Whole leaf
- S_2 = Branch with leaf

Factor C = Feed storage
- K_0 = No storage (feed immediately after harvest)
- K_1= 4 hours stored
- K_2 = 8 hours stored
- K_3 = 12 hours stored
- K_4 = 24 hours stored

A rearing house was prepared before feeding the silkworms. Rearing stands were constructed in a battery type of a triple deck at 2 x 2 ft. dimension with divisions to place the feeding trays. A total of 90 pieces of a winnowing-like baskets made of bamboo were used as feeding trays and a total of 190 pieces of cleaning nets to facilitate the cleaning of feeding trays were also used. Strict sanitation was implemented in the whole rearing house and all the materials used

were sun-dried and sprayed with disinfectants using formalin, biocid and creoline before feeding the silkworm.

Sample silkworms were distributed equally in 30 treatment combinations with 3 replicates at 50 silkworms per replicate. Each replicate group was kept in 3 adjacent feeding trays at the same level. The triple deck rearing stand type construction in generally adopted for commercial cocoon production.

Feeds were not given to the silkworm during molting period for 5 times during the larval stage.

All pertinent data were analyzed in terms of average weight (g) per fresh and dried cocoon; average cocoon shell ratio (%); average mortality rate (%); average yield (g) of fresh cocoon per treatment; and computed average yield (kg) of fresh cocoon per box of silkworms.

Analysis of variance by K.A. Gomez and A.A. Gomez, (1984) for a 2 x 3 x 5 factorial in completely randomized design was made to evaluate the effects of the treatments.

Treatment means were compared by way of the Duncan's Multiple Range Test (DMRT) where differences occurred.

Results and Findings

The average weight per fresh cocoon as affected by variety, feeding system and feed storage is presented in Table 1. There were no significant differences in the weight of fresh cocoon fed with Batac and Taiwan mulberry varieties having 1.88 g, respectively. Furthermore, no significant change was noted in systems of feeding either chopped, whole leaf and branch with leaf that gave 1.72 g, 1.76 g and 1.90 g, respectively.

However, significantly ($P<.01$) decreased the fresh cocoon weights by the interaction effects of both varieties and feed storage. At 24-hour feed storage, decreased the fresh cocoon weights at 0.15 g as compared to 2.14 g, 2.31 g, 2.12 g and 2.16 g when feed is not stored, 4-hour, 8-hour and 12-hour feed storage, respectively.

The above results indicated that any of the varieties and the feeding systems of mulberry leaf could not be stored beyond 24-hours before feeding to silkworms. On the other hand, feeding system of branches with leaves gave higher cocoon weight of 1.90 g.

The average weights per dried cocoon as presented in Table 2, showed the effects of the variety, feeding system and feed storage. No significant

increase in dried weight was indicated when the silkworms were fed to any of the varieties and feedings systems. However, the interaction effect on variety, feeding system and feed storage has affected the cocoon dried weight. Any of the two varieties and feedings systems when fed after 24-hour storage significantly ($P<.01$) decreased the average weight at 0.18 g, 0.79 g, 0.89 g and 0.79 g when no storage, 4-hour, 8-hour and 12-hour feed storage, respectively. These results indicated that variety and feeding systems can be applied and not to be stored beyond 12 hours.

Cocoon shell ratio in this study refers to the amount of shell in percent or not to the fiber content of the cocoon. The higher the percentage, the lower the fiber production. Data on cocoon shell ratio is presented in Table 3. No significant difference between variety was observed although the Taiwan variety has higher cocoon shell ratio at 55.74% as compared to 54.21% of the Batac variety.

Feedings systems showed no significant difference at 51.19%, 57.68%, and 55.74% when chopped, whole leaf and branch with leaves, respectively, although whole leaf has had higher cocoon shell percentage.

Table 1. Mean weight of fresh cocoon as affected by variety, feeding system and feed storage (g)

VARIETY	BATAC			TAIWAN	
	1.88^{a}			1.71^{ab}	
FEEDING SYSTEM	S_0		S_1		S_2
	1.27^{abc}		1.76^{ab}		1.90^{a}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	1.14^{abc}	2.31^{a}	2.12^{abcd}	2.16^{ab}	0.5^{a}

Means with the same letter(s) in a column and in a row are not significantly different at 5% level by DMRT.

Table 2. Mean weight of dried cocoon as affected by variety, feedings system and feed storage (g)

VARIETY	BATAC			TAIWAN	
	0.71^{a}			0.69^{ab}	
FEEDING SYSTEM	S_0		S_1		S_2
	0.76^{a}		0.65^{abc}		0.86^{a}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	0.86^{ab}	0.79^{abc}	0.89^{a}	0.79^{abc}	0.18^{e}

Means with the same letter(s) in a column and in a row are not significantly different at 5% level by DMRT.

The above observations indicate that the increase of cocoon shell ratio was due to the lower production of cocoon.

Interaction effects on variety and feed storage have significantly (P<.01) higher cocoon shell ratio of 90.19% than those 46.61%, 47.62%, 42.86% and 48.24%, when no storage, 4-hour, 8-hour, and 12-hour feed storage, respectively.

Mortality rate as affected by variety, feeding systems and feed storage is presented in Table 4. Significantly (P<.01) higher mortality rate was observed at 40.80% when fed with the Taiwan variety, as compared to 28.10% with the Batac variety. Feeding systems was significantly higher at 46.68% when branch with leaves was used followed by 33.14 and 23.54% when whole leaf and chopped, respectively. Feed storage of 24-hour showed significantly higher mortality rate of 85.88%, followed by 19.44%, 16.81%, 15.35% and 14.81% when stored at 4-hour, no storage, 12-hour and 8-hour, respectively.

Interaction effects on variety, feeding systems and feed storage showed significantly (P<.01) higher mortality rate at 59.77% when the Taiwan was chopped compared to 33.60% of the Batac variety. However, the lowest mortality rate of 14.08% was observed when chopped feeding system was used with the Batac variety compared to 29.64% whole leaf feeding system with the Taiwan variety. Variety and feed storage showed 100% mortality with the Taiwan variety when stored at 24-hour followed by 19.11%, 17.21%, 14.16% and 13.77% at no storage, 4-hour, 12-hour and 8-hour feed storage, respective. The Batac variety showed 71.77% mortality rate when 24-hour feed storage followed 21.67%, 16.60%, 15.85%, and 14.51% at 12-hour, 8-hour, and no storage, respectively. Analysis of variance revealed significant (P<.01) differences among variety and feed storage treatments.

Since the observed mortalities were mainly due to branch with leaves fed to young silkworm, it conformed to the recommendation of Dr. Choe, B.H. (1977) that young silkworms should be fed with chopped leaves to reduce mortality, which was due to longer period of feed storage. However, the Batac variety showed longer period of storage due to higher moisture content of 77.14% compared to 73.33% than that of the Taiwan variety, as shown in Table 7.

The average yield per treatment as affected by variety, feeding systems and feed storage is presented in Table 5. The yield obtained from the Batac variety was 78.71 g, as compared to 73.11 g of the Taiwan variety. The Batac variety and feeding systems have 83.77 g, 81.65 g at branch with leaves, whole leaf and chopped feeding systems, respectively, as compared to 75.80 g, 75.06 g, and 68.74 g at branch with leaves, chopped leaves and whole leaves, respectively, of the Taiwan variety. Analysis of variance revealed no significance between variety and feeding systems.

Table 3. Mean cocoon shell ratio as affected by variety, feeding system and feed storage (%)

VARIETY	BATAC			TAIWAN	
	47.54^{b}			55.10^{a}	
FEEDING SYSTEM	S_0		S_1		S_2
	51.90^{abc}		57.68^{a}		55.74^{ab}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	46.61^{abcd}	47.62^{abc}	42.86^{e}	48.24^{ab}	90.19^{a}

Means with the same letter(s) in a column and in a row are not significantly different at 5% level by DMRT.

Table 4. Mean mortality rate of silkworm as affected by variety, feeding system and feed storage (%)

VARIETY	BATAC			TAIWAN	
	28.10^{b}			40.80^{a}	
FEEDING SYSTEM	S_0		S_1		S_2
	23.54^{c}		33.14^{b}		46.68^{a}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	16.81^{abc}	19.44^{abcd}	14.80^{a}	15.35^{ab}	85.88^{a}

Means with the same letter(s) in a column and in a row are not significantly different at 5% level by DMRT

Table 5. Mean yield of fresh cocoon per treatment as affected by variety, feeding system and feeds storage (g)

VARIETY	BATAC			TAIWAN	
	78.71^{a}			73.11^{b}	
FEEDING SYSTEM	S_0		S_1		S_2
	78.28^{ab}		75.06^{abc}		79.78^{a}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	90.36^{abc}	89.28^{abcd}	84.29^{abcd}	93.73^{abcde}	11.68^{e}

Means with the same letter(s) in a column and in a row are not significantly different at 5% by DMRT.

Table 6. Computed mean yield of fresh cocoon per box (20,000/box) as affected by variety, of feeding system and feed storage.

VARIETY	BATAC			TAIWAN	
	37.66^{a}			33.91^{b}	
FEEDING SYSTEM	S_0		S_1		S_2
	33.81^{abc}		35.23^{ab}		38.32^{a}
FEED STORAGE	K_0	K_1	K_2	K_3	K_4
	41.68^{abc}	46.35^{a}	42.54^{ab}	37.43^{abcde}	5.33^{e}

Means with the same letter(s) in a column and in a row are not significantly different at 5% by DMRT.

Table 7. Proximate chemical composition of mulberry leaf.

NUTRIENT COMPOSITION	VARIETY	
	BATAC	TAIWAN
Moisture, (%)	77.14	73.33
Dry Matter, (%)	22.86	26.67
Protein, (%)	9.11	10.53
Fiber, (%)	2.40	2.80
Fat, (%)	1.14	1.33
Ash, (%)	1.8	2.83

Source: DOST, Region X, Cagayan de Oro City under the courtesy of Mrs. Zita Sanchez, Director, Sericulture Research project.

The yield obtained from variety and feed storage showed that the Batac variety has 102.73 g, 86.64 g, 85.83 g, 74.51 g and 27.36 g at 12-hour, no storage, 4-hour, 8-hour and 24-hour feed storage respectively, as compared to 94.08 g, 94.07 g, 92.71 g, 84.74 g, and 0.00 g at no storage, 8-hour, 4-hour, 12-hour and 24-hour feed storage, respective, of the Taiwan variety. Analysis of variance revealed significant ($P<.05$) differences among treatments due to variety feeding systems and feed storage, and significant ($P<.01$) differences among treatments due to feeding systems and feed storage.

Comparative economic efficiency of cocoon production based on variety, feeding systems and feed storage in one box of silkworms in kilogram of fresh cocoon produced is shown as follows: Table 6 presents the average yield per box of silkworm in treatment groups. No significant change was observed due to varieties although the Batac variety had 37.66 kg per box of silkworm as compared to 33.91 kg that of Taiwan variety. A similar trend was observed with reference to feeding systems although there was a decrease of yield in chopped leaves at 33.81 kg as compared to 35.23 kg and 38.32 kg in whole leaf and branch with leaves feeding systems respectively.

Furthermore, significantly ($P<.01$) lower yield was obtained at 5.33 kg when the feed was stored in 24-hour as compared to 46.35 kg, 42.54 kg, 41.68 kg and 37.43 kg when the feed was stored in 4-hour, 8-hour, no storage, 12-hour respectively.

Summary, Conclusion and Recommendation

Summary

Four thousand and five hundred newly hatched Chul 12 x Thai 12 silkworm strain were subjected to a feeding experiment to compare the effects of two mulberry varieties (Batac and Taiwan), feeding system (chopped, whole leaf

and branch with leaf) and feed storage (no storage, 4-hour, 8-hour, 12-hour and 24-hour) on the performance of cocoon production on a 27-day period. All treatments with three replication were arranged in a 2 x 3 x5 factorial experiment in completely randomized design.

Results showed no significant change was observed in average fresh and dried cocoon weights with the variety and feeding system. However, the 24-hour feed storage significantly lowers the fresh and dried cocoon weight.

The average cocoon shell ratio and mortality rate was observed significantly higher at the 24-hour feed storage both for Batac and Taiwan variety. The feeding system had no influence on cocoon shell ratio and mortality.

Significantly lower average yield per treatment was obtained from the 24-hour feed storage for both varieties.

Computed average yield per box of silkworm was significantly higher at the 4-hour feed storage and lower at the 24-hour feed storage. Variety and feeding system showed significant differences in computed average yield per box of silkworm.

Results of the findings under MSU, Marawi City and Lanao del Sur province conditions indicated that optimum cocoon production rate on yield may be obtained from both the Batac and Taiwan mulberry varieties. The chopped leaf is the best feeding system at early stage of growth development, at either whole leaf and branch with leaf at full grown silkworms. Feed storage indicated best results when stored at 4-hour to 12-hour and not stored beyond twelve hours.

Moriculture and sericulture projects are suited to MSU and Lanao del Sur province to augment family income of the farmers. A wider area of mulberry production should be established at MSU to have a continuity of the Sericulture Project as a show window to farmers in the locality.

It is further recommended that proper support and funding be ascertained by the University and or other government agencies to realize maximum benefits from the project. Continuous research should be conducted to attain the maximum cocoon production and to develop and establish textile industry at the University and in other localities.

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