BIBLIOGRAPHY

LUIS, LEILA P. MAY 2007. Effect of Rust-Infected Mulberry Leaves Fed to PTRI SW-3 Hybrid Silkworm (*Bombyx mori* L.) on the Quality of Cocoon Yield in La Trinidad, Benguet. Benguet State University, La Trinidad, Benguet.

Adviser: Valentino L. Macanes, MSc

ABSTRACT

The study was conducted to determine the effect of mulberry leaves infected by rust fed to hybrid silkworms (PTRI SW-3) on the quality and quantity of cocoons produced and to evaluate the susceptibility of silkworms (PTRI SW-3) fed with rust-infected mulberry leaves (Batac var.) to silkworm diseases.

Results of this study revealed no significant effect rust-infected mulberry leaves fed to silkworms on larval duration, whole cocoon weight, cocoon shell percentage and mortality rate. However, moderate and severe rust infection to mulberry leaves affected the raw silk properties of cocoons. Slight rust-infected mulberry leaves fed to hybrid silkworms had the highest mean on the number of good cocoons produced with a low number of defective cocoons. This was followed by silkworms fed with moderately rust-infected mulberry leaves. Meanwhile, the silkworms fed with mulberry leaves that were severely infected with mulberry rust produced the lowest number of good cocoons with a high number of defective cocoons. In addition, undernourished silkworm larvae were also observed in this treatment and these silkworms were not able to spin cocoons.

No silkworm disease occurrence was observed during the period of the study.

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INTRODUCTION

Rust is one of the most important diseases affecting mulberry plants. This maybe caused by either Ae*cidium mori* or *Cerotelium fici*. Both pathogens belong to Order Urticales of Class Basidiomycetes. The *A. mori* affects the leaves, petioles, tender buds and even fruits. On the other hand, *C. fici* affects the leaves only. Rust reduces the nutritional value needed by the silkworms (Bugnay, 1995).

The quality and suitability of the mulberry foliage have direct effect on both the vitality of the silkworm and the yield, quality of cocoons and quality of silk filaments, therefore, must be taken in choosing the best quality of leaves to be able to meet the requirements of the different growing stage of silkworm larvae particularly in the young ages. At the same time quantity of mulberry leaves must be provided to maintain regular growth (Pang-chuan et al., 1986).

The choice of mulberry leaves as the sole food suitable to the age and growth of the silkworm larvae is one of the most important considerations in sericulture. Leaves for young ages (1^{st} –3^{rd} instars) must be soft, succulent, rich in protein, carbohydrates and minerals. While for the grown up stage (4^{th} –5^{th} instars) wherein the silk glands are being developed leaves must be rich in protein and fiber (Balingan, 1994).

Krishnawasmi (1973) found that starvation and underfeeding of worms lead to poor growth and weakening which leads to susceptibility of silkworms to diseases. If the larval stage is prolonged, this indicates that rearing is not suitable. Therefore, the rearer must be accurate in feeding the desired number of worms so that the leaves given will be fully utilized. He further discovered that the adequacy of feeds minimizes prolonged

larval duration and undernourished silkworms whose effects results to poor quality and quantity of cocoons produced.

On the other hand, Celis (1997) stated that mulberry silkworms are fed three (3) times a day. Feeding them in proper time and giving the right quality of leaves contribute greatly to success of cocoon quality.

Silkworms are affected by various types of diseases. These include infection by pathogenic microorganisms like viral diseases, bacterial diseases, fungal diseases and protozoan infection. Likewise, the physiology of silkworms is easily affected by environmental factors such as weather conditions, technique of rearing, quality of mulberry feed and silkworm variety (Veda et al., 1997).

Thus this study was conducted to serve as a guide for students, researchers, and farmers who are presently engaged in sericulture and for those who intend to go into sericulture production. This study will help in choosing the quality of mulberry leaves to be fed to silkworms to avoid profit loss. In addition, the study aimed to determine the effect of mulberry leaves infected by rust fed to hybrid silkworms (PTRI SW-3) on the quality and quantity of cocoons produced and to evaluate the susceptibility of silkworms (PTRI SW-3) fed with rust-infected mulberry leaves (Batac var.) to silkworm diseases.

This study was conducted at the Benguet State University Sericulture Project located at Ampasit, Puguis, La Trinidad, Benguet and the Philippine Textile Research Institute (PTRI) Laboratory, Km. 6, La Trinidad, Benguet from January to May 2007.

REVIEW OF LITERATURE

Mulberry tree (*Morus* spp.) belongs to the family Moraceae of genus Morus. It is the sole food of silkworms (*Bombyx mori* L.) (Bugnay, 1995). However, the plants are affected by several types of diseases. There are about twenty (20) diseases which usually attack mulberry plants that needs careful preventive measures and some of these includes fungus, bacteria, mycoplasma, and viruses. Most of the diseases are infectious and affects either the entire plant or selectively the roots, stems and leaves (Veda et. al., 1997).

Diocares (1978) as cited by Cawa-it (2006) stated that rust-infected plants show increase water loss because they transpire more water through ruptured dermis. In addition, the fungus competes with the plants by absorbing more nutrients and water. Likewise, the photosynthesis of the plants is considerably reduced. Furthermore, UNDP-ESCAP (1999) stated that mulberry rust causes 90-100% damage to mulberry plants. Besides, rust-infected mulberry leaves affects the nutrition of the mulberry silkworms. Inferior quality cocoons maybe produced from silkworms fed with low quality of mulberry leaves.

Silkworms are stenophagous insects that feeds on mulberry leaves. Their life cycle is completed by passing through four (4) stages; egg, larva, pupa and adult (moth). At the pupal stage, the body is defenseless against external enemies hence the silkworm larvae spins a protective shell around its body called cocoons. These are made up of silkfibers which is secreted from a pair of silkgland extruded through the silkworms spinneret. In sericulture, the larvae are killed in the cocoon after several days of spinning.

Killing is done either by steam or hot air. This procedure is done to soften the sericin for easy filament winding (Veda et. al., 1997).

Diocares (1978) observed that young silkworm larvae require different diet in comparison with that of the later stages. Young larvae needs comparatively soft, succulent leaves with less starch and fiber. On the other hand, the mature larvae requires high protein and carbohydrate content but les moisture. He also reported that proper nutrient coupled with proper time of feeding and rearing techniques are necessary in obtaining high quality and quantity of silk.

Celis (1997) stated that attention must be given to ensure that the quality of harvested mulberry leaves is maintained. Mulberry leaves should be stored in cool place and out of direct sunlight, polyethylene and wet cloth sheet maybe used to provide cool temperature and high humidity. Leaves not well kept easily wilts, that which helps reduces silkworms feeding appetite.

Delayed feeding of mulberry silkworm affects the physiological functioning of their body. Hence, the growth rate of the worms is hindered. Starvation leads to poor and weakening of the worms. The worms ultimately becomes susceptible to diseases since prolonged larval duration of the different instars leads to poor growth of the latter stage and poor development of silkglands (Krishnawasmi, 1973).

Meanwhile, Pang-chuan et al. (1986) stated that water content of leaves losses more than 10% of its original weight. They further found that because of this the appetite of the silkworms will significantly lessen. If it losses more than 30%, the consumption of the mulberry leaves will decrease to less than half of the quantity of the food stuff and under ordinary conditions, silkworms will refuse to eat.

MATERIALS AND METHODS

The important materials used in the study were as follows: PTRI SW-3 hybrid mulberry silkworm (*Bombyx mori* L.) and mulberry leaves (Batac variety). The mulberry leaves were classified as follows: slightly rust-infected, moderately rust-infected, and severely rust-infected. The other materials and equipment included: power sprayer, rearing trays, rearing stands, weighing scale, heater, thermohygrometer, cocooning frame, knife, chopping board, cleaning nets, paraffin paper, news papers, pruning shear, mulberry baskets, wet cloth, and data sheets. The chemicals used were: formalin (3%), powdered lime, disinfectant soap and rubbing alcohol (75%)

Nine hundred newly-hatched hybrid silkworm larvae of PTRI SW-3 were reared in the rearing house and were fed with different quality of Batac mulberry leaves. The study was conducted using the simple Completely Randomized Design (CRD) with three (3) treatments each replicated three (3) times. The study used the percentage rate scale for mulberry rust infection rating as recommended by Subba Rao et al. (1991) as cited by Strange (1993). The treatments were the following:

Treatment	Leaf Quality	Disease Severity Rating
1	Slight Rust Infection	1-25%
2	Moderate Rust Infection	26-75%
3	Severe Rust Infection	76-100%

Rearing of silkworm was conducted following the rearing procedure recommended by the Philippine Textile Research Institute (PTRI) as adapted by the Benguet State University (BSU) Sericulture Project at Puguis, La Trinidad, Benguet.

Rearing house disinfection. Before rearing started, the room and implements were cleaned, washed and dried. The 3% formalin solution were prepared. The solution was sprayed to the rearing room using the power sprayer, After spraying, the rearing room was tightly closed for 24 hours to ensure effective disinfection. This was done ten (10) days before brushing. Disinfection is effective at higher temperature thus, it was done at 11:00 am. The other implements these were soaked in 2% formalin solution and sun dried.

Brushing. Newly-hatched silkworm larvae were separated from their shells by placing finely chopped mulberry leaves over them. Afterwards, it was transferred in a clean rearing tray by brushing the worms with the use of white, clean feather.

Feeding. Feeding was done three (3) times a day respectively; at 7:00 am, 1:00 pm and 6:00 pm. Young ages (1^{st} to 3^{rd} instar larvae) were fed with finely-chopped mulberry leaves taken near the shoot. On the other hand, the grown-up stage (4^{th} to 5^{th} instar larvae) were fed with the whole mature leaves.

Bed cleaning. Bed cleaning was done using nets placed on top of the rearing tray with finely chopped mulberry leaves for the young ages. On the other hand, whole mature leaves for the grown-up stage were placed on top of the rearing tray over the worms. The net was lifted when all the larvae have crawled up, and is transferred to a separate tray. This was done to prevent accumulation of uneaten mulberry leaves, fecal matters and dead larvae that would eventually ferment and produce poisonous gas that affect the silkworms.

Bed spacing. The silkworms in the rearing bed were regularly spread to prevent overcrowding that may cause irregular growth and even susceptibility to diseases. This was done using a clean bird feather or chopstick.

Mounting. Matured silkworm larvae were picked from the rearing trays and were mounted on the rotary mounting frame. Cocoon harvesting was done seven days after mounting.

Cocoon harvesting. Harvesting of the cocoons was done seven days after mounting. Harvested cocoons were deflossed and sorted, respectively, in each treatment replications.

All the required temperature and room humidity for each instars strictly followed during the silkworm rearing.

The data gathered were:

1. Larval duration. This was taken by counting the number of days from hatching to mounting.

2. Cocoon yield quality. Harvested cocoons were deflossed, sorted and were evaluated per treatment replicate using the following parameters:

a. Number of good cocoons. This was gathered by counting the number of good cocoons produced per treatment replicate.

b. Number of defective cocoons. This was taken by counting the number of defective cocoons which include the following: double, perforated, malformed, fluffy, thin end stained dead cocoons.

c. Number of good cocoons contained per one (1) liter cylinder. This was measured by counting the number of good cocoons contained in a one (1) liter cylinder.

d. Cocoon weight (g). This was measured by weighing the good cocoons using the weighing scale.

e. Whole cocoon weight (g). This was gathered by weighing five sample good cocoons using the Mettler's Balance. The samples were randomly picked from the treatment replicates.

f. Cocoon shell weight (g). This was taken by cutting the five sample good cocoons used in getting the whole cocoon weight. The pupae and exuviae were removed, afterwhich, cocoon shell of the five sample cocoons were weighed. The average cocoon shell weight was taken using the following formula:

$$CSW = \frac{\text{Weight of sample cocoons}}{5}$$

g. Cocoon shell percentage (%). This was taken from the five sample good cocoons using this formula:

$$CSP = \frac{\text{Weight of cocoon shell}}{\text{Weight of whole cocoon}} \times 100$$

3. Mortality rate (%). This was taken by counting the number of dead larvae from each treatment replicate from hatching to the mounting of the silkworms. This was taken using the following formula:

$$MR = \frac{\text{Number of diseased/dead larvae}}{\text{Number of worms per replicate}} \times 100$$

4.Rawsilk properties. This was evaluated using the following parameters:

a. Length of cocoon filament (m). This was measured by reeling three sample cocoons per treatment replicate in an epprovette.

b. Thickness of the filament (Denier). This was gathered by weighing the silk bave. Afterwhich, it was solved using the following formula:

$$\text{Denier} = \frac{\text{Weight of silk bave}}{\text{Length of rawsilk}} \times 9000\text{m}$$

RESULTS AND DISCUSSION

Larval Duration

Table 1 shows no significant differences on the number of the days that the silkworm (PTRI SW-3) had completed their larval stage. All the three treatments showed the same mean of 29 days.

.Table 1. Larval duration of the PTRI SW-3 fed with rust- infected mulberry leaves.

TREATMENT	MEAN (days)
1 – Slight rust infection	29
2 – Moderate rust infection	29
3 – Severe rust infection	29

Means with the same letter are not significantly different at 5% level using DMRT

Number of Good Cocoons

Table 2 shows the number of good cocoons produced from each treatment. Statistical analysis revealed that there was a highly significant differences among the treatments. The silkworms fed with mulberry leaves slightly infected by rust (T_1) had the highest mean which is 83.67 followed by silkworms fed with leaves moderately infected with rust (T_2) with a mean of 75.00. On the other hand, Treatment 3, (silkworms fed with mulberry leaves severely infected by rust) gave the lowest mean of 66.67.

. This signifies that the quality of mulberry leaves fed to the silkworms greatly affected the number of good cocoons produced. Results of the study confirms the

findings of UNDP-ESCAP (1999) that inferior quality of cocoons maybe produced from silkworms fed with disease infected mulberry leaves.

Table 2. Number of good cocoons obtained from the different rust- infected mulberry leaves

TREATMENT	MEAN
1 – Slight rust infection	83.69[a]
2 – Moderate rust infection	75.00[b]
3 – Severe rust infection	66.67[c]

Means with the same letter are not significantly different at 5 % level using DMRT

Number of Defective Cocoons

The number of defective cocoons harvested from each treatment replicate is presented in Table 3. Statistical analysis revealed that there was a highly significant differences among the treatments. Treatment 3, (silkworms fed with mulberry leaves having severe rust-infection) gave the highest mean of 83.33 defective cocoons followed by the Treatment 2, (silkworms fed with mulberry leaves having moderate rust infection) with a mean of 21.33 defective cocoons. Finally, Treatment 1 (silkworms fed with mulberry leaves having slight rust infection) gave the lowest mean of 13.00 defective cocoons.

This study affirms the discovery of Pang-chuan et al. (1986) that the quality and suitability of mulberry foliage have direct effect on both the vitality of silkworm and the quality of cocoons produced.

Table 3. Number of defective cocoons obtained from the treatments fed with rust – infected mulberry leaves

TREATMENT	MEAN
1 – Slight rust infection	13.00[c]
2 – Moderate rust infection	21.33[b]
3 – Severe rust infection	28.33[a]

Means with the same letter are not significantly different at 5 % level using DMRT

Number of Good Cocoons Contained
in a One (1) Liter Cylinder

Table 4 shows the number of good cocoons contained in a one (1) liter cylinder. Statistical analysis showed highly significant differences. Treatment 3 gave the highest mean number of good cocoons contained in one liter cylinder with 94.67, followed by Treatment 2 with 91.33. Finally, Treatment 1 gave the lowest mean of good cocoons in one liter cylinder with 78.67.

This finding implies that the quality of mulberry leaves fed to silkworms affected the cocoon size produced from each treatment. Slight rust infection of mulberry leaves produce bigger cocoon size while severe rust infection of mulberry leaves produce smaller size of cocoons

Table 4. Number of good cocoons contained in a 1 liter cylinder taken from mulberry PTRI SW-3 fed with rust -infected mulberry leaves

TREATMENT	MEAN
1 – Slight rust infection	78.67[b]
2 – Moderate rust infection	91.33[a]
3 – Severe rust infection	94.67 [a]

Means with the same letter are not significantly different at 5 % level using DMRT

Weight of Good Cocoons

The weight of good cocoons is presented in Table 5. Results showed that there was highly significant differences among the treatments as found by statistical analysis. Treatment 1 gave the highest mean weight of good cocoons with 140.180 grams, while Treatment 2 had 113.573 grams. Finally, Treatment 3 gave the lowest mean of good cocoons with 100.83grams.

Table 5. Weight of good cocoons per replicate harvested from PTRI SW-3 fed rust – infected mulberry leaves

TREATMENT	MEAN (g)
1 – Slight rust infection	140.180 [a]
2 – Moderate rust infection	113.573[b]
3 – Severe rust infection	100.083[b]

Means with the same letter are not significantly different at 5 % level using DMRT

Weight of Whole Cocoon

Table 6 shows the whole cocoon weight produced by silkworms fed with different quality of mulberry leaves. Statistical analysis showed no significant differences on the PTRI SW-3 silkworms fed with the rust–infected mulberry leaves. However, the silkworms fed with leaves having slight rust infection (T_1) recorded the highest mean of 1.80 grams followed by the silkworms fed with leaves having moderate rust infection (T_2) with a mean of 1.79. Finally, the silkworms fed with leaves having severe rust infection (T_3) gave the lowest mean of 1.75 grams.

Table 6. Whole cocoon weight produced by PTRI SW-3 fed with rust-infected mulberry leaves

TREATMENT	MEAN (g)
1 – Slight rust infection	1.80
2 – Moderate rust infection	1.79
3 – Severe rust infection	1.75

Means with the same letter are not significantly different at 5 % level using DMRT

Weight of Cocoon Shell

The cocoon shell weight obtained from each treatment is shown in Table 7. Statistical analysis found significant differences among the different treatments. Treatment 1 had the highest mean cocoon shell weight of 0.38 grams while both Treatments 2 and 3 gave the same mean of 0.35 grams cocoon shell weight.

This result proves that Treatment 1 (slightly rust-infected mulberry leaves fed to silkworms) produced better cocoon quality than that of the moderate and severely rust-infected leaves.

Table 7. Cocoon shell weight taken from PTRI SW-3 fed with rust-infected mulberry leaves

TREATMENT	MEAN (g)
1 – Slight rust infection	0.38 [a]
2 – Moderate rust infection	0.35 [b]
3 – Severe rust infection	0.35 [b]

Means with the same letter are not significantly different at 5 % level using DMRT

Cocoon Shell Percentage

Table 8 shows the cocoon shell percentage taken from the different treatments. Statistically, no significant differences among the treatments. However, Treatment 1 gave the highest mean of 21.41% cocoon shell percentage, while Treatment 2 gave a mean of 19.68%. Finally, Treatment 3 gave the lowest mean of 19.67% cocoon shell percentage.

Table 8. Cocoon shell percentage taken from the PTRI SW-3 fed with rust-infected mulberry leaves

TREATMENT	MEAN (%)
1 – Slight rust infection	21.41
2 – Moderate rust infection	19.68
3 – Severe rust infection	19.67

Means with the same letter are not significantly different at 5 % level using DMRT

Mortality Rate

Table 9 presents the mortality rate of the silkworms fed with the different rust infection of mulberry leaves. Statistical analysis shows no significant differences among the treatments. However, Treatment 3 gave the highest mean of 5.33% mortality rate and Treatment 2 had a mean of 3.66 %. Treatment 1 gave the lowest mortality rate with a mean of 3.33%.

Table 9. Mortality rate obtained from the different percentage of PTRI SW-3 fed with rust-infected mulberry leaves

TREATMENT	MEAN (%)
1 – Slight rust infection	3.33
2 – Moderate rust infection	3.66
3 – Severe rust infection	5.33

Means with the same letter are not significantly different at 5 % level using DMRT

Cocoon Filament Length

The filament length gathered from the different treatments is presented in Table 10. Significant difference among the treatments was observed as revealed by statistical analysis. The highest mean filament length was obtained from Treatment 1 (silkworms fed with mulberry leaves slightly-infected with rust) which gave 1170.67 meters. This was followed by Treatment 2 (silkworms fed with mulberry leaves moderately-infected with rust) with a mean of 1,024.00 meters. Finally, Treatment 3 (silkworms fed with mulberry leaves severely-infected with rust) gave the lowest mean of 996.78 meters cocoon filament length.

The quality of silk filament was greatly affected by quality of mulberry leaves given to silkworms.

Table 10. Cocoon filament length produced by PTRI SW-3 fed with rust infected mulberry leaves

TREATMENT	MEAN (m)
1 – Slight rust infection	11.70.67 [a]
2 – Moderate rust infection	1024.00 [ab]
3 – Severe rust infection	996.78 [b]

Means with the same letter are not significantly different at 5 % level using DMRT

Thickness of the Cocoon Filament

The thickness of cocoon filament is shown in Table 11. Statistical analysis showed that there were significant differences among the treatments. The silkworms fed mulberry leaves slightly-infected with rust (T_1) produced the thickest filament with 3.52 denier followed by Treatment 2 (moderate rust infection) with a mean of 3.48 denier. Finally, the silkworms fed with mulberry leaves with severe rust infection (T_3) gave the lowest denier size of 3.44.

Table 11. Thickness of the cocoon filament harvested from the PTRI SW-3 fed with rust-infected mulberry leaves

TREATMENT	MEAN (Denier)
1 – Slight rust infection	3.52 [a]
2 – Moderate rust infection	3.48 [ab]
3 – Severe rust infection	3.44 [b]

Means with the same letter are not significantly different at 5 % level using DMRT

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the effect of rust – infected mulberry leaves fed to hybrid silkworms (PTRI SW-3) on the quality and quantity of cocoons produced. Likewise, it was done to evaluate the susceptibility of silkworms (PTRI SW-3) to silkworm diseases when fed with rust - infected mulberry leaves The parameters used in evaluating the effect of rust-infected mulberry leaves were: larval duration, cocoon yield quality particularly, number of good cocoons, number of defective cocoons, number of good cocoons contained in one (1) liter cylinder, whole cocoon weight, cocoon shell weight, cocoon shell percentage and larval mortality rate. Raw silk properties were also taken, specifically, on the length of cocoon filament and the size of cocoon filament.

Hybrid silkworm PTRI SW-3 was used in the study. The silkworm was fed with different quality of mulberry leaves classified as: slight rust infection (T_1), moderate rust infection (T_2), and severe rust infection (T_3).

Nine hundred (900) silkworm larvae were reared at Benguet State University Sericulture Project located at Puguis, La Trinidad, Benguet from hatching to cocoon harvesting. The standard silkworm rearing procedure was strictly followed. The harvested cocoons were assessed at Philippine Textile Research Institute Laboratory located at Km. 6, Betag, La Trinidad, Benguet. The study was conducted from January to May 2007. The study used Completely Randomized Design (CRD).

The results of the study found that there were highly significant differences observed on the PTRI SW-3 hybrid silkworm on the number of good cocoons, number of defective cocoons, number of good cocoons contained in one (1) liter cylinder and the weight of good cocoons per replicate, when fed with rust-infected mulberry leaves. The silkworms fed with mulberry leaves slightly infected with rust gave the best cocoon quality and raw silk properties. This was followed by silkworms fed with mulberry leaves moderately infected by rust. Finally, the PTRI SW-3 hybrid silkworms fed with mulberry leaves severely infected with rust gave the lowest cocoon quality and raw silk properties. However, no significant differences were taken on the following parameters: larval duration, whole cocoon weight, cocoon shell percentage and mortality rate.

Conclusion

The result of the study showed that the hybrid mulberry silkworm (PTRI SW-3) fed with slightly rust-infected mulberry leaves produce the best quality of good cocoons compared with the other treatments.

Recommendation

The results of this study recommend that the percentage of rust infection to mulberry leaves to be fed to hybrid silkworms should be taken into consideration in silkworm rearing. Mulberry leaves with severe rust infection should not be utilized for silkworm rearing. However, this experiment should also be tried in rearing pure breed silkworms. Likewise this study should be done also in other locations and silkworm rearing seasons.

LITERATURE CITED

BALINGAN, S. 1994. Evaluation of the larval development and cocoon quality of four F_1 hybrid silkworms (*Bombyx mori* L.) in Benguet. BS Thesis. Benguet State University, La Trinidad, Benguet. P. 5.

BUGNAY, L. B. 1995. Performance of silkworm (*Bombyx mori* L.) fed with mulberry leaves sprayed with fungicides. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 1-4.

CAWA-IT, E. B. 2006. Field efficacy of fungicides for the control of mulberry red rust (*Aecidium mori* B.) in La Trinidad. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 4-6.

CELIS, S. P. 1997. Influence of different methods of storing mulberry leaves on the cocoon yield of JC 102 silkworm variety. BS Thesis. Benguet State University, La Trinidad, Benguet. Pp. 3-5.

DIOCARES, C. 1978. Comparative effects of feeding frequency on a strain of silkworm (*Bombyx mori* L.). BS Thesis. Benguet State University, La Trinidad, Benguet. P. 4.

KRISHNAWASMI, S. R. 1973. Silkworm feeding trials for evaluating the quality of mulberry leaves as influenced by variety, spacing and nitrogen fertilization. Biological abstract. Pp. 10, 79 and 89.

PANG-CHUAN, W. H. GUANG-XIAN, M. MABEN AND T. YUN-FANG. 1986. Mulberry Cultivation. Food Agricultural Organization. Agricultural Services Bulletin. Rome. Pp. 99-101.

STRANGE, R. N. 1993. Plant Disease Control. First Edition. Chapman and Hall. Boundary Row, London, England. P. 94.

UNITED NATIONS DEVELOPMENT PROGRAM - ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC. 1999. Handbook on Mulberry Pest and Diseases. UNDP-ESCAP. Bangkok, Thailand. Pp. 89-93.

VEDA, K., I. NAGAI, AND M. HORIKOMI. 1997. Silkworm Rearing. Science Publishers Incorporation. U.S.A. Pp. 1 and 90.

APPENDICES

Appendix Table 1. Larval duration (days)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	29	29	29	87	29
T_2	29	29	29	87	29
T_3	29	29	29	87	29
TOTAL	87	87	87	261	87

Appendix Table 2. Number of good cocoons

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	85	82	84	251	83.667
T_2	75	78	72	225	75.000
T_3	68	67	65	200	66.667
TOTAL	228	227	221	676	75.111

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	433.5555	216.7777	47.59**	5.15	10.92
Error	6	27.3333	4.5555			
Total	8	460.8888				

** highly significant CV = 2.84%

Appendix Table 3. Number of defective cocoons

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	12	15	12	39	13
T_2	20	19	25	64	21.33
T_3	30	28	27	85	28.33
TOTAL	62	62	64	188	20.88

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	353.5555	176.7777	33.85**	5.15	10.92
Error	6	31.3333	5.2222			
Total	8	384.8888				

** highly significant CV = 10.43%

Appendix Table 4. Number of good cocoons contained in a 1 liter cylinder

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	80	76	80	236	78.67
T_2	92	90	92	272	90.67
T_3	98	96	90	284	94.67
TOTAL	270	262	262	792	88.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	427.5555	213.7777	26.72**	5.15	10.92
Error	6	48.0000	8.0000			
Total	8	475.5555				

** highly significant CV = 3.20%

Appendix Table 5. Weight of good cocoons per replicate (g)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	148.16	135.69	136.69	420.54	140.18
T_2	116.28	122.38	102.06	340.72	113.57
T_3	97.85	99.40	103.00	300.25	100.08
TOTAL	362.29	357.47	341.75	1,061.51	117.94

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	2497.6374	124.88187	22.88**	5.15	10.92
Error	6	327.4225	54.5704			
Total	8	2825.0600				

** highly significant CV = 6.26%

Appendix Table 6. Whole cocoon weight (g)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	1.82	1.78	1.81	5.41	1.80
T_2	1.78	1.78	1.83	5.39	1.80
T_3	1.82	1.68	1.75	5.25	1.75
TOTAL	5.42	5.24	5.39	16.05	5.35

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	0.0050	0.0025	1.23^{ns}	5.15	10.92
Error	6	0.0123	0.0020			
Total	8	0.0174				

^{ns} - not significant CV =2.54%

Appendix Table 7. Cocoon shell weight (g)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	0.39	0.38	0.39	1.16	0.38
T_2	0.38	0.34	0.34	1.06	0.35
T_3	0.36	0.35	0.35	1.06	0.35
TOTAL	1.13	1.07	1.08	3.28	0.36

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	0.0022	0.0011	5.56*	5.15	10.92
Error	6	0.0012	0.0020			
Total	8	0.0034				

* - significant CV =3.88%

Appendix Table 8. Cocoon shell percentage (%)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	21.43	21.30	21.52	64.25	21.42
T_2	21.39	19.06	18.55	59.00	19.67
T_3	17.59	20.88	2057	59.04	19.68
TOTAL	60.41	61.24	6.64	182.29	20.25

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	6.0786	3.0393	1.63^{ns}	5.15	10.92
Error	6	11.2095	1.8682			
Total	8	17.2882				

^{ns} – not significant CV =6.74%

Appendix Table 9. Mortality rate (%)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	3	3	4	10	3.33
T_2	5	3	3	11	3.67
T_3	3	5	8	16	5.33
TOTAL	11	11	15	37	4.11

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	6.8888	3.4494	1.29^{ns}	5.15	10.92
Error	6	16.0000	2.6666			
Total	8	22.8888				

^{ns} – not significant CV =39.72%

Appendix Table 10. Cocoon filament length (m)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	1,085.00	1,220.67	1,206.33	3,512.00	1170.67
T_2	1,039.00	1,032.00	1,001.00	3,072.00	1,024.00
T_3	1,008.33	1,035.33	946.67	2,990.33	996.78
TOTAL	3,132.33	3,288.00	3,154.00	9,574.33	1,063.81

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	52489.95	26244.97	9.81*	5.15	10.92
Error	6	16059.50	2676.58			
Total	8	68549.45				

* -significant CV =0.72%

Appendix Table 11. Thickness of the cocoon filament length (Denier)

TREATMENTS	REPLICATION			TOTAL	MEAN
	1	2	3		
T_1	3.54	3.54	3.50	10.58	3.52
T_2	3.52	3.47	3.47	10.46	3.48
T_3	3.44	3.43	3.47	10.34	3.44
TOTAL	10.50	10.44	10.44	31.35	3.48

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SUM OF SQUARES	COMPUTED F	TABULATED F	
					$F_{0.05}$	$F_{0.01}$
Treatment	2	0.0096	0.0048	8.0*	5.15	10.92
Error	6	0.0036	0.0006			
Total	8	0.0132				

* -significant CV =0.70%