RESEARCH CORPORATION OF THAILAND

APPRAISAL REPORT NO. 23

ALTERNATIVE FOODS FOR SILKWORMS

BY

NIPHAN RATANAWORABHAN

MIGRATORY ANIMAL PATHOLOGICAL SURVEY GROUP

ASRCT, BANGKOK 1969

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By Niphan Ratanaworabhan*

Following a request from the Ministry of Agriculture for research on the development of a substitute food for silkworms which could be used as appropriate under adverse conditions as an alternative to the usual diet of mulberry leaves, it was decided that a preliminary assessment of current information should be made.

A literature search showed that Fukuda et al. (1962) evolved an artificial diet for silkworms which satisfactorily replaced mulberry leaf powder. An extended abstract of relevant parts of their paper is given in Appendix I.

Although work on this topic has been continued from 1960 to the present, it seems that it has not yet been successfully applied in practical sericulture. The mixture cited is complicated and would need considerable experience in preparation if constant quality is to be maintained; it also appears to cost more than the value of the silk produced. Furthermore, semi-synthetic diets have their drawbacks, as noted by Ito and Horie (1962) (see Appendix II).

An alternative is reported in a paper by Samokhvalova (1960). The viability and productivity of caterpillars was considerably increased by alternate feeding on young scorzonera (Scorzonera sp.) and mulberry leaves. It appears that scorzonera contained adequate food proteins and carbohydrates to maintain the silkworms but lacked the calcium salts necessary for silk production. Old mulberry leaves, on the contrary, lacked proteins and carbohydrates, but had abundant calcium. Alternate feeding on these two materials produced beneficial results.

Mulberry leaves represent a cheap source of food for silkworms, and it seems that they give the highest yield of silk. The artificial food reported by Fukuda et al. (1960) needed supplementation with mulberry leaf powder as a basic ingredient for the worms to undergo metamorphosis.

Before embarking on local research into alternative foods it would

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appear desirable to ascertain the extent of the potential demand and permissible cost.

Reports indicate that mulberry leaves are usually scarce in Thailand's silk growing areas during the hot, dry season. It seems, therefore, that another possible attack on this problem would be to introduce new varieties of mulberry which will produce more leaves under dry conditions or which will grow well under irrigation. Dr. Siribongse Boon-Long (personal communication) states that such a variety is now grown in Australia. A further possibility is to use another plant (see reference to Samokhvalova (1960) cited above), the leaves of which can wholly or partially substitute for mulberry leaves and which produces well in the hot, dry season.

Another approach to the problem would be to improve storage techniques so as to keep mulberry leaves for a long period whilst still retaining their freshness and palatability. It is difficult to forecast the potential outcome of work on this aspect.

REFERENCES

FUKUDA, T., SUTO, M., and HIGUCHI, Y. (1960).--Silkworm raising on artificial food. Nature 187(4738): 669-670.

FUKUDA, T., SUTO, M., KAMEYAMA, T., and KAWASUGI, S. (1962).--Synthetic diet for silkworm raising. Nature 196(4849): 53-54.

ITO, T., and HORIE, Y. (1962).--Nutrition of the silkworm, Bombyx mori. VII. An aseptic culture of larvae on semi-synthetic diets. J.Insect Physiol. 8(9/10): 569-578.

SAMOKHVALOVA, G.V. (1960).--The effect of a varied diet to increase the viability of the mulberry silkworm (Bombyx mori L.) in late fall. Referat.Thur.Biol. No. 11642 (translation).

APPENDIX I

RESULTS FROM THE EXPERIMENT OF FUKUDA ET AL. (1962)

TABLE 1

COMPOSITION OF SYNTHETIC DIETS

Component	Diet No. 20	Diet No. 15	Diet No. 10
Potato starch	1.5 g	1.5 g	1.5 g
Sucrose	1.5 g	1.0 g	1.0 g
Amino acids mixture	1.0 g	1.0 g	1.0 g
Vitamin mixture	16.0 mg	16.0 mg	16.0 mg
Mineral substance mixture	0.3 g	0.3 mg	0.3 mg
Cellulose powder	4.6 g	5.2 g	4.8 g
β-Sitosterol	100.0 mg	50.0 mg	50.0 mg
Alcohol extract of mulberry leaves	-	-	0.4 g
Water	11.0 ml	11.0 ml	11.0 ml

TABLE 2

GROWTH OF THE SILKWORMS REARED ON SYNTHETIC DIETS

(g per larva)

Fifth stage	Diet No. 20	Diet No. 15	Diet No. 10
1st day	0.64	0.64	0.64
2nd day	0.64	0.63	0.77
3rd day	0.76	0.66	0.94
4th day	0.83	-	1.18
5th day	0.98	-	1.54
6th day	1.09	-	1.86
7th day	1.14	-	2.08
8th day	1.20	-	2.17
9th day	1.15	-	2.40
10th day	0.86	-	2.23
11th day	1.15	-	-

Nutrients need to be substituted for the mulberry leaf powder. These were mixtures of amino acids, vitamins, and mineral substances (Table 3-5), on the basis of the amount of mulberry leaves, determined by microbiological methods; alcohol extracts of mulberry leaves were added, when necessary, to the diet to stimulate feeding. This was prepared by extracting dry mulberry leaves with hot absolute methyl alcohol for 5 hours and by removing the alcohol under reduced pressure. A mixture of all the vitamins except ergosterol and β-carotene, was stored in a refrigerator in solution. A certain amount of ergosterol, β- sitosterol, alcohol extracts of mulberry leaves and β-carotene were respectively dissolved in ether, and were added to a certain amount of the cellulose powder. The ether was completely removed first.

TABLE 3

MIXTURE OF AMINO ACIDS

(L-form)

Amino acids	Amount (g)
Alanine	1.0
Arginine	1.0
Aspartic acid	2.1
Cystine	1.0
Glutamic acid	2.3
Gylcine	1.2
Histidine-HCl	0.7
Isoleucine	1.2
Leucine	1.8
Lysine-HCl	1.5
Methionine	0.3
Phenylalanine	1.1
Serine	1.2
Proline	1.1
Threonine	1.1
Tryptophan	0.3
Tyrosine	0.7
Valine	1.4
Total	21.0

TABLE 4

MIXTURE OF VITAMINS

Vitamins	Amount (mg)
p-Aminobenzoic acid	2.0
Ascorbic acid	400.0
Biotin	0.1
β-Carotene	20.0
Choline chloride	550.0
Ergosterol	400.0
Folic acid	0.4
Inositol	100.0
Nicotinic acid	40.0
Calcium pantothenate	30.0
Pyridoxin hydrochloride	4.0
Riboflavin	15.0
Thiamin	4.0
Total	1,565.5

TABLE 5

MIXTURE OF MINERAL SUBSTANCES

Mineral substances	Amount (g)
$NaH_2PO_4H_{20}$	1.067
$MgSO_4$	2.360
$CaCO_3$	4.590
K_2SO_4	4.518
NaCl	0.813
Total	13.348

Preparing the synthetic diet

A beaker containing the sucrose, amino acids mixture, vitamins mixture, except for ergosterol and β-carotene, and water was heated, and the hot solution poured into a beaker containing the potato starch, and the cellulose powder. This cellulose powder contained the β-sitosterol, ergosterol, β-carotene and the alcohol extract of mulberry leaves (when necessary) and mineral substance mixtures. The contents were well stirred, formed as a pie, steamed for 3 minutes and stored in a refrigerator.

APPENDIX II

THE EFFECT OF SEMI-SYNTHETIC DIETS

(Ito and Horie 1962)

Larvae were reared from egg to adult on semi-synthetic diets which did not contain mulberry leaf powder. Mortality on this diet was quite high, particularly with first instar larvae. Growth was much retarded compared to results obtained with a diet containing 8 per cent mulberry leaf powder.