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Utilization of Blood Meal as a Source of Dietary Protein

2. Low cost diet consisting mainly of blood meal and chicken feed for the silkworm, Bombyx mori L.

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Abstract
In the previous paper, the use of blood meal as a protein source for artificial diet for the silkworm was outlined. In this paper, chicken commercial formula feed was used as a substitute component to maintain certain physical properties of the artificial diet. The cocoon quality of the silkworms reared on an artificial diet consisting of chicken commercial formula feed and blood meal was found to be superior to that of the controls reared on mulberry leaves. Chicken commercial formula feed was much cheaper in comparison with cellulose powder and starch which were used as shaping and solidifying substances for the artificial diet. Furthermore, it was confirmed that chicken feed mixed with blood meal was economical for use as artificial diet for silkworms.

Discipline: Sericulture
Additional key words: cocoon quality, substitute component

Introduction

In the last report[6], it was observed that the use of blood meal as a source of protein was effective as a substitute for defatted soybean powder conventionally added to artificial diets for the silkworms. Furthermore, it was also considered that blood meal was economical and enabled to lower the cost of artificial diet.

On the other hand, in order to maintain a 70% moisture level[8] and the physical properties of the artificial diet, it is necessary to add cellulose and agar which cannot be easily digested by the silkworm and are costly. It is thus important to identify a new substitute which would be cheaper.

Attempts have been made to use chicken commercial formula feed for the artificial diet of the silkworm[7]. As chicken commercial formula feed is produced in large quantities at a low cost, if it could be used in combination with blood meal, it may be possible to produce low cost artificial diet effectively. Here, in this report, studies were carried out to determine whether chicken commercial formula feed could be used as a substitute source in artificial diet and whether chicken commercial formula feed combined with blood meal could become economically viable.

Materials and methods

The blood meal used in this experiment was

the same as that described in the previous report[6]. There are two types of chicken commercial formula feed available, one for egg layer and the other for broiler. In this report, the chicken commercial formula feed for egg layer was used in its present form (powder passed through 80 mesh sieve).

The artificial diet for the silkworm used for the experiment is shown in Table. 1. Prices of each component of the artificial diet per kg in 1987 were considered. The diet used for the experiment which was prepared at 3 levels (A, B, C) contained mulberry leaf powder which is most palatable to the silkworms. Furthermore, to keep the prices of dry matter in the level B and C diet below ¥300 per kg, the amount of the costly component "Carrageenan", etc. was reduced, and then a balanced diet was designed. Based on the results of the previous experiment, blood meal was prepared at 3 levels (i.e. A>B>C) and based on the addition of chicken commercial formula feed (A>B>C), the moisture percentage (water content percentage) of the diet was adjusted to the required fixed percentage.

The components of the artificial diet used as control diet are listed in Table 2. The composition of this control diet was such that the diet could be used for research purpose[5] without giving much consideration to the low cost effect. The contents of antiseptic and antifungal substances as well as the moisture percentage were similar to those of the diet used for the experiment.

The method of rearing and of evaluation of the results obtained was similar to that reported in the previous report. However, the group of larvae used in the experiment consisted of 10 males and 10 females and 2 groups were reared in each experiment.

Table 1. Composition and cost of artificial diet consisting of blood meal and chicken commercial formula feed as main components

Substances	Price (¥/kg)	Diet A		Diet B		Diet C	
		Added amount (g)	Price (¥)	Added amount (g)	Price (¥)	Added amount (g)	Price (¥)
Mulberry leaf powder	700	100	70	150	105	200	140
Carrageenan	2,000	40	80	30	60	20	40
Sugar	220	60	13.2	60	13.2	60	13.2
Crude sitosterols	3,500	4	14	3	10.5	2	7
Ascorbic acid	2,000	15	30	10	20	8	16
Salt mixture	700	30	21	25	17.5	25	17.5
Citric acid	500	40	20	40	20	30	15
Vitamin mixture	1,500	5	7.5	5	7.5	5	7.5
Chicken feed[a)]	50	445	22.25	425	21.25	410	20.5
Blood meal	65	259	16.84	250	16.25	238	15.47
Sorbic acid, Antiseptics	1,000	2	2	2	2	2	2
Total		1,000	296.79	1,000	293.20	1,000	294.17

Method of preparation of the diets: After mixing the substances, pour 2,500 m*l* of water to knead, steam at 100°C for 40 min, and knead once again, then the preparation is solidified by heat radiation.

a): Components; Corn, milo (grain sorghum), fish meal, meat and bone meal, meat meal, fish soluble with carrier, soybean lees, rapeseed meal, corn gluten meal, corn gluten feed, calcium carbonate, alfalfa (Lucerne), calcium phosphate, animal fat, salt.

Nutritional composition; Crude protein (17.0%), crude fat (3.0%), crude fiber (5.0%), crude ash (13.0%), calcium (2.8%), phosphorus (0.55%).

Table 2. Composition of control artificial diet

Substances	Added amount
Mulberry leaf powder	300 g
Agar powder	50
Potato starch	70
Sugar	70
Safflower oil	10
ß-Sitosterol	3
Ascorbic acid	20
Salt mixture	30
Citric acid	40
Defatted soybean powder (cp 42%)	340
Cellulose powder	65
Sorbic acid, Antiseptics	2
Vitamin B mixture solution	100 ml
Water	2,400

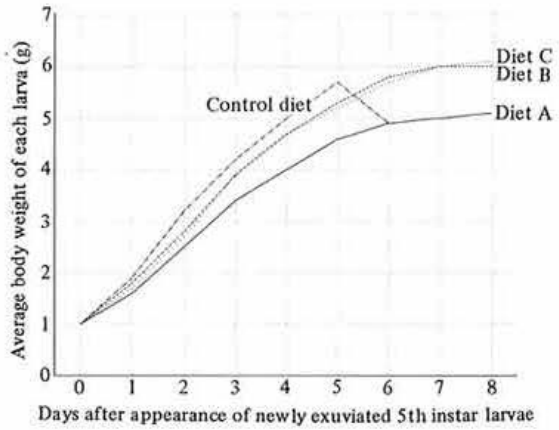

Fig. 1. Growth curve of 5th instar larvae in diets A, B and C consisting mainly of blood meal and chicken feed and in control diet

Results

As it was reported that NaCl in the diet inhibited the growth of silkworms[4], at the beginning, NaCl in the chicken commercial formula feed was removed by washing with water. As for the dietary composition, however, chicken feed with NaCl gave better results. Chicken feed for egg layer and for broiler was tested. As no differences were detected in the rearing of silkworms, the diet for egg layer which is cheaper was used without removing NaCl in this investigation.

The growth curves (changes in the average weight of silkworms) of 5th instar larvae in the A, B and C diet groups and the control diet group are shown in Fig. 1.

As in the A, B and C diet groups, the food intake was lower than in the control group, the increase in weight was small during the 2-day period after the start of feeding. Though there were no differences in the feeding behavior between the groups thereafter, the weight of silkworms up to the 5th day in the A, B and C diet groups was always lower than that of the control diet group.

In the control diet group, the growth pattern showed a sigmoid curve, as in the case of the mulberry diet. The amount of food ingested began to decrease after about 5 days and spinning started after 8 days. On the other hand, the A, B and C diet groups continued to ingest food for 8 days, and the weight of the silkworms increased.

The maximum weight in the B and C groups was larger than that of the control diet group. The larval body weight in the A group, in which the digestibility was low, showed very low values throughout the developmental period.

The spinning in the A, B and C groups started after 10 days. The experimental results for the cocoons are listed in Table 3.

The cocoon weight and cocoon shell weight in the B and C diet groups were larger than those of the control diet group. In particular, in the B diet group, the percentage of cocoon shell was higher than that of the mulberry leaf group. In the A diet group in which the food intake was the lowest, the cocoon weight and cocoon shell weight were the lowest, while the percentage of cocoon shell was higher than that of the control diet group. Although the cocoon weight showed maximum values in the C diet group in which the food intake was the highest, the percentage of cocoon shell weight

Table 3. Evaluation of cocoon quality of larvae reared on diets A, B and C, compared with larvae reared on control diet and mulberry leaf diet

Diet	Number of larvae			Parameters		
	Sex	Number	Group	Whole cocoon weight (g)	Cocoon shell weight (mg)	Percentage of cocoon shell weight (%)
A	♀	10	2	1.75±0.14[a)]	412±43[a)]	23.5±0.6[a)]
	♂	10				
B	♀	10	2	2.38±0.01	627±7	26.4±0.5
	♂	10				
C	♀	10	2	2.44±0.04	583±18	23.9±0.3
	♂	10				
Control	♀	10	2	2.05±0.01	415±7	20.3±0.2
	♂	10				
Mulberry leaf[b)]						
Early autumn	Mean value of males and females			1.98	470	24.3
Late autumn	Mean value of males and females			2.05	502	24.5

a): Values are mean ± S.D.
b): Statistical data of race Kinshu × Showa in Japan issued by National Institute of Sericulture were cited.

was low. The percentage of cocoon shell of the C diet group was lower than that of the B diet group in which food intake was lower.

Discussion

In the present study, investigations on a low cost diet based on components not yet used in artificial diets were conducted. Blood meal and chicken commercial formula feed were used and the artificial diet prepared with these components gave better results than the control feed.

It has been reported that the values of the cocoon weight and cocoon shell weight of silkworms reared on an artificial diet were higher than in the case of rearing on mulberry leaves, while the cocoon shell percentage was only 20%.

There are no reports on the percentage of cocoon shell exceeding 25%, a value which is usually obtained in mulberry leaf rearing. However, in the present study, the cocoon shell percentage was 26%, a value higher than that recorded in mulberry leaf rearing. Furthermore the composition of the artificial diet used in this experiment was superior.

Therefore, the author considers that the artificial diet consisting of blood meal and chicken commercial formula feed is superior to the diet made of defatted soybean powder, cellulose powder, starch, etc.

When 5th instar larvae were reared on the artificial diet under study, as shown in Fig. 1, the decrease of the larval weight started only on the 8th day and not on the 5th day as normally observed in mulberry leaf rearing.

In the case of silkworms treated with juvenile hormone[1)], it was reported that the increase of the larval duration was related to growth. However the cocoon shell ratio did not increase. The increase of the larval duration in silkworms reared on these diets may affect the cocoon production as well as feed efficiency, etc.

The artificial diets which contain cellulose and starch, etc. have given good results[3)] compared to mulberry feed rearing. Furthermore

it is considered that the components in the artificial diet are effective but are costly. In the current experiment, chicken commercial formula feed which is produced in large amounts and is cheap was used instead of cellulose and starch. Again, instead of defatted soybean powder, blood meal was added for the artificial diet.

This diet, showed superior results in the larval duration and amount of cocoon produced. As the chicken commercial formula feed contains a considerable amount of nutrients like vitamins or minerals, etc., it may be possible to reduce the contents of other components[2].

The blood meal and the chicken commercial formula feed are cheaper components comparable to other components used for artificial diet. Further studies will be carried to promote the use of this diet on a commercial basis and also to improve larval growth.

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