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Effects of Dietary Supplementation of Silkworm Pupae on Growth and Survival of *Cyprinus carpio* (Linnaeus, 1758) Fingerlings

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ABSTRACT: An experiment was conducted to evaluate the effect of silkworm (*Bombax mori*) pupae on the growth and survival of common carp (*Cyprinus carpio*). One hundred twenty common carp fingerlings, weighing an initial average of 10.2±0.02 g and measuring 9.63±0.03 in body length, were divided into four distinct experimental groups. Each group had three replicates, all according to a completely randomized design. A diet consisting of around 40% crude protein from silkworm pupae meal, supplemented to variable degrees with fish meal C(0%), T1(25%), T2(50%), T3(100%) was prepared by incorporating silkworm (*Bombax mori*) pupae for the basal diet. The growth parameter indices were examined after the end of 60 days experiment.When fingerlings were fed mixed fishmeal diets with silkworm pupae in ratio of 50:50, their rate of growth was higher *i.e.*, T2(50%) group and lower in those fed 100% of fish meal or silkworm pupae. No mortality was observed in all treatment groups. Weight increase, specific growth rate, average daily growth, and protein efficiency ratio all showed significant variations.

Keywords: Silkworm (*Bombax mori*) pupae, *Cyprinus carpio*, weight gain, specific growth rate and protein efficiency ratio.

INTRODUCTION

In aquaculture production, seed and feed are two important inputs, especially for carps, and their future availability could determine whether or not production targets are met. More than 60% of the cost of the diet is attributed to the dietary protein. The most crucial feeding component for cultured fish as a source of nutritional protein is fish meal. The selection of costly dietary protein is based on economic considerations, which include the price of the protein source and the anticipated growth and value of fish. Natural foods of plant and animal origin, especially animal wastes and unconventional feed sources, are the most cost-effective sources of
protein. Stressed that, Fish and farm animals have been fed insects in various phases of growth (Bondari and Sheppard 1981). Hickling (1962) mentioned that silkworm pupae have historically played a significant role in the diets of carp in China and Japan (Newton *et al.,* 1977). In central Asian nation the pupae of the silkworm (*Bombax mori*) are strong enough to feed fish. Silkworm pupae has been successfully used as a fishmeal replacement for fish like catla, rohu (Jayaram and Shetty 1980; Begun *et al.,* 1994), common carp (Nandeesha *et al.,* 1999), and jian carp (Ji *et al.,* 2015). *Bombax mori* is rich in nutrition as well as valuable product. The purpose of the current study was to assess how *Cyprinus carpio* growth performance was affected by the addition of silkworm (*Bombax mori*) pupae to the diet.

MATERIALS AND METHODS

For sixty days, an experiment was carried out. NaCl and $KMnO_4$ were used to treat 120 fingerlings (10.2 ± 0.02 g) of uniform size and age, the fingerlings were kept acclimatized for 15 days before starting the experiment and divided into four groups. During this period, it was fed with a basal diet of 5% of the body weight. Fingerlings were randomly allotted to four different groups with its three replicates of 10 fish per replicates . Pupae of the silkworm (*Bombax mori*) were gathered, cleaned, dried, and powdered then sealed in a plastic container. Four different diets with roughly 40% crude protein were created. Fishmeal was substituted with powdered silkworm pupae at several percentages of inclusion: 0%, 25%, 50%, and 100%. Diets are coded as C(SP0%), T1(SP25%), T2(SP50%) and T3(SP100%) respectively. Table 1 displays the percentage of components in each diet.

Table 1: Percentage of ingredients in diets (%).

Ingredients	Diets			
	Control (SP0%)	T 1 (SP25%)	T 2 (SP50%)	T 3 (SP100%)
Fishmeal	58	43.5	29	0
Silkworm pupae	0	14.5	29	58
Soybean Cake	18.4	18.4	18.4	18.4
Sunflower Cake	5.5	5.5	5.5	5.5
Wheat Bran	10.1	10.1	10.1	10.1
Sunflower oil	6	6	6	6
Vitamin premix	2	2	2	2
Total	100	100	100	100

The required amount of vitamin-mineral premix was added, mixed, and blended after all dried ingredients were crushed into powder and the proper amounts for each diet were combined with 10% of water. The dough was put through a 1 mm diameter pelletizer. Pellets were used to feed fish after being dried and labeled. In every tank, the water temperature was 26±1.5°C. Every day, excrement and other particles were drained out of tanks along with uneaten feed. Every day, 25% of the water was replaced, and every seven days, the entire water was changed.

Fish were weighed every week and daily rations were adjusted accordingly. Growth parameters were determined as follows :

— Weight gain (%) = [Final weight (g) - Initial weight (g)] / Initial weight (g) × 100

— Specific Growth Rate (SGR) (%) = [ln Final weight (g) – ln Initial weight (g)] / Culture period (days) × 100

— Average Daily Growth (ADG) (g/day) = [Final weight (g) – Initial weight (g)] / Culture period (days)

— Food Conversion Ratio (FCR) = Dry feed intake (g) / Wet weight gain (g)

— Protein Efficiency Ratio (PER) = Wet weight gain (g) / Protein intake (g)

Using the statistical program SPSS 16.0 for Windows, the collected data were first statistically analyzed using a one-way ANOVA and then Duncan's multiple range test to find the significant difference ($p<0.05$) between the treatments. Each of the three replicates for each treatment (n = 3) had its mean ± standard deviation (SD) represented.

RESULT

Feeding silkworm pupae demonstrates the beneficial effects. The growth performance of *Cyprinus carpo* exhibits significant differences ($p<0.05$) with the increased supplementation of silkworm pupae in fish feed (Fig. 1). The percentage of survivors was 100%. Table 2 displays the average of the feed-fed *Cyprinus carpio*'s IW, FW, WG, SGR, ADG, FCR, and PER values in addition to growth performance and feed usage metrics. The fish's growth performance and feed consumption were significantly ($p<0.05$) better with the experimental diets T1, T2, and T3 than with diet C (control).

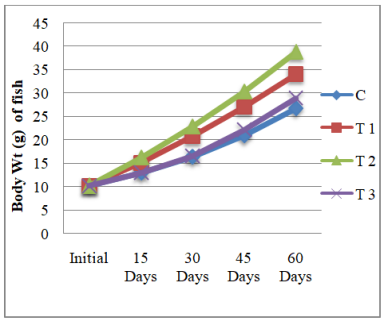

Fig. 1. Growth pattern of *Cyprinus carpio* on different experimental diets.

As presented in Table 2, average weight gain (g) of *Cyprinus carpio* were significantly ($p<0.05$) higher in T2 group (50% silkworm pupae meal and 50% fish meal), than T1 (25% silkworm pupae meal and 75% fishmeal) and insignificantly higher at T3 (100% silkworm pupae meal) in compare with Control group (0% silkworm pupae). SGR (%/day), ADG (g/day) and PER also increased with the increasing levels of silkworm pupae.

Table 2: Growth response and feed efficiency of *Cyprinus carpio* fingerling in fed experimental diets.

Parameters	Diets			
	Control (SP0%)	T1 (SP25%)	T2 (SP50%)	T3 (SP100%)
IW (g)	10.16±0.015	10.21±0.01	10.23± 0.03	10.02 ±0.02
FW(g)	26.7± 0.57	34.06± 0.82	38.75± 0.48	28.96 ± 0.33
WG (g)	166.48±3.22	240.03± 3.29	280.68± 2.49	183.76 ± 2.71
SGR (%/day)	1.07± 0.02	1.33± 0.02	1.47± 0.01	1.14 ± 0.01
ADG (g)	0.19±0.005	0.28±0.003	0.32±0.003	0.21 ± 0.005
FCR	2.02±0.02	1.35±0.02	1.17±0.02	1.74 ± 0.01
PER	1.54±0.05	2.23±0.07	2.66±0.04	1.74 ± 0.03

Growth performance values are expressed as mean ± SD of three replicates per treatment (n=3) and values with different superscript letters are significantly different ($p<0.05$) among treatments.
IW: Initial weight; FW: Final weight; WG: Weight gain; SGR: Specific growth rate
ADG: Average daily growth; FCR: Food conversion ratio; PER: Protein efficiency ratio.

Cyprinus carpio fed with Silkworm pupae 50% were significantly higher *i.e*., in T2 group than T1 and insignificantly higher at T3 in compare with Control group. FCR showed another result fish at group Control had significantly higher than T3 and insignificantly higher at T1 in compare with T2. This lower value of T2 group showed that all feed with replaced fishmeal had better quality for fish growth in compare with control group feed.

ANOVA analysis revealed significant differences ($p<0.05$) in metrics like protein efficiency ratio, average daily growth, food conversion ratio, and weight increase.

DISCUSSION

The results of this study show that feeding *Cyprinus carpio* a meal containing varying amounts of silkworm pupae considerably improved its growth performance. This suggests that *Cyprinus carpio* reacts favorably to every diet. Extending the feeding level of silkworm pupae beyond 50% did not yield significant impacts on their growth (Shyma 1990). The T2 group's growth rate was higher as they were fed a mixed diet consisting of 50:50 fish meal and silkworm pupae. Lower in T3 and Control group having fed diets 100% of silkworm pupae or fish meal. Studies showed that on 30% silkworm pupae supplementation enhance growth rate with common carp. Silkworm pupae provide high protein and numerous necessary amino acids, vitamins, and minerals in big quantities. Because these diets had higher protein intakes, the T1 group (which included 25% silkworm pupae) outperformed the diets with a single animal protein source (fish meal or silkworm pupae) in terms of growth performance. A combination of protein sources is always more beneficial than a single source.

According to the investigation, it is advised to replace 50% of the fish meal with silkworm pupae. Venkataramiah *et al*. (1975) discovered that feeding fry common carp artificial meal including animal protein can enhance growth. The effectiveness of a diet with silkworm pupae meal was reported by Nisha *et al.* (2014). According to Hossain *et al*. (1993), silkworm pupae meal can replace fishmeal with up to 75% of the protein. The growth rate at various protein levels in the current investigation revealed that the *Cyprinus carpio* exhibited its highest growth during the course of the 60-day trial at the 50% level.

CONCLUSIONS

Based on the investigation's findings, common carp could safely be fed a diet consisting of silkworm pupae meal, also better for growth parameter and it can be alternative source for fish meal up to 50%.

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