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# Potential value of a short horned grasshopper (*Oxya fuscovittata*) as a high protein alternative diet for black molly (*Poecilia sphenops*)

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## ABSTRACT

A feeding trial was conducted for 183 days to evaluate the nutritive value of *O.fuscovittata* as a possible protein source in diets for juvenile black molly *Poecilia sphenops*. All the calculated growth parameters were compared with three commonly available market feed of various crude protein levels (i.e. about 52% for tubifex, 46% for high protein spirulina and 32% for low protein spirulina). Proximate analysis revealed that protein percentage and energy content were highest in *O.fuscovittata* and tubifex respectively, whereas protein to energy (P/E) ratio was the most in *O.fuscovittata* followed by high protein spirulina (HPS). Low protein spirulina (LPS) contained the maximum amount of carbohydrate and nitrogen free extract (NFE). After feeding experiments it was observed that variations in survival percentage and all the growth parameters were not significant among the individuals fed with given diets. It is already known that *O. fuscovittata* can yield huge biomass in laboratory, and the present study revealed its nutritional potential as a high protein alternative feed source for fishes. These results are encouraging because if acridid farms are established, they may supply a huge amount of grasshoppers to the livestock feed industry to formulate low cost but high protein feed that will help lowering down the cost and thus the ornamental fish industry will be more viable worldwide. 

## KEYWORDS

Acridid;
Feed value;
Ornamental fish;
Grasshopper farming.

## INTRODUCTION

Keeping ornamental fishes as pet dates back to over a thousand years in the Far East and since the early 17th century in Europe[1]. Currently hundreds of fish species are being kept as pet fish by a large number of hobbyists worldwide. The implementation of ornamental fish breeding and rearing still relies greatly upon fish sourced from the wild. However due to popular demand and pressure on wild resources, farming of ornamental fish, especially the tropical live bearers (guppies, sword tails, mollies) is now an established industry in countries such as Singapore, which is the largest ornamental fish supplier in the world[1]. In Asia many other countries such as China and India are also emerging as suppliers of ornamental fishes very recently. But all the ornamental fish producing countries are facing trouble because the feed cost is one of the highest operational costs (50-60%) in aquaculture[2]. It is apparent that nutrition is a matter of great importance in aquaculture industry worldwide for better product quality. The optimum growth of this industry can be achieved by using appropriate feeds[3]. One important ingredient used in the formulation of commercial aquaculture feed is fishmeal, which has high protein quality and palatability. Substituting high price fish meal in aqua feeds with less expensive protein sources is one way of reducing production cost[4,5].

Ornamental fishes have traditionally been fed live feed[6], many of which are arthropods. Kruger et al.[7] demonstrated that a daily supplementation of *Daphnia* spp. as live feed to sword tail (*Xiphophorus helleri*) broodstock maintained on an artificial flake diet resulted in a significant increase in fecundity as a result of more rapid growth, a higher number of embryos and an improved feed conversion ratio. In fresh water ornamental fish culture, Moina used to be the most common live feed organism for feeding young fish in the industry[8]. According to Lim and Wong[9] the rotifer *Brachionus calyciflorus*, could be used to improve growth and survival of juvenile dwarf gourami (*Colisa lalia*) and brown discus. Moreover some insects that explore into water or near water are an easy meal to many carnivorous fishes in nature. The archerfish *Toxotes jaculator* is a highly specialized predator, which feeds on insects that it shoots down from above the surface with a jet of water[10]. Although the knowledge is very limited still there is a great possibility of insects to become an alternative protein source for ornamental fishes. Among insects grasshoppers have good nutritional quality[11] and some of them can yield a high biomass in laboratory condition[12]. These findings are promising for establishing acridid (short horn grasshopper) farms so that the livestock industry worldwide can use this high protein alternative food source as supplementary feed in formulating diets for various livestock. Therefore the present study investigates feed value of the short horn grasshopper *Oxya fuscovittata* (Marschall) as a diet for black molly *Poecilia sphenops* (Valenciennes). The feed value of the insect was compared with three other artificial fish diets available in the market.

## MATERIALS AND METHODS

### Obtaining fish and its diets

Juvenile black mollies *(P.sphenops)* were collected in the month of March 2008 from the nursery pond of a local fish breeder in Bolpur, near Santiniketan, West Bengal, India (23$^0$39' N, 87$^0$ 42' E). The juveniles were randomly selected and were initially placed in an indoor tank of 26 L capacity for 15 days acclimation period. Feed was not given for 48 hrs before transferring into the experimental tanks. Three most commonly available artificial aquarium fish diets were obtained from the market. Sufficient amount of grasshoppers (*O.fuscovittata*) were taken out to feed experimental fishes from the insectariums of the Dept. of Zoology, Visva-Bharati University, Santiniketan. This population has been derived from the individuals that were originally collected from nearby agricultural and grassland fields of Santiniketan by sweeping technique and reared under laboratory conditions providing 32± 2$^0$C temperature, 70-90% relative humidity and 14 D 10 N photoperiod using the method proposed by Haldar et al.[13].

### Analysis of proximate composition of diets

The feed ingredients of all the three artificial diets and the grasshopper of interest were analyzed to determine the proximate composition using standard procedures[14]. Analyses were done on three replicates per diet.

## EXPERIMENTAL

12 circular experimental tanks of 26L capacity were separated in 4 groups, 3 in each for four different diets. Supplemental aeration was provided to each tank and half of the total volume of its water was changed daily. Each tank was completely drained and thoroughly scrubbed once a week. 10 juvenile fishes were transferred from the collected stock to each of the experimental tanks. Prior to transfer each fish was taken randomly and weighed in water filled glass beaker (50 ml). Adult body weight and length were measured at the end of the experiment that spanned 183 days (1$^{st}$ Apr 2008 to 30$^{th}$ Sep 2008). Water quality parameters (temperature, pH, Dissolved Oxygen and hardness) were estimated fortnightly using standard procedures[15].

The daily ration was given twice at 6:30hrs and 18:30hrs in powder form by hand and fishes were fed as much as they could consume within five minutes. After five minutes of feeding uneaten diet was siphoned off. The data from the experiments were used to calculate survivality and following growth related parameters according to Singh et al.[16] and Jamil et al.[3].

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**TABLE 1: Proximate composition of experimental diets selected for feeding *P.sphenops***

| Diet | Crude protein % ±SD | Crude fat %±SD | Carbohydrate% ±SD | Crude fiber %±SD | Ash% ±SD | NFE% ±SD[1] | Energy Kcal /100g ±SD | P/E ±SD[2] |
|---|---|---|---|---|---|---|---|---|
| Tubifex | 52.22±0.26 | 12.17±0.30 | 25.69±0.74 | 2.32±0.12 | 9.92±0.22 | 23.37±0.62 | 485.09±6.61 | 107.66±0.93 |
| HPS[3] | 46.08±0.19 | 7.82±0.34 | 33.89±0.39 | 5.04±0.22 | 12.22±0.13 | 28.84±0.58 | 371.32±7.01 | 124.11±1.83 |
| LPS[4] | 32.15±0.43 | 5.64±0.25 | 52.17±0.45 | 5.08±0.09 | 10.05±0.37 | 45.84±2.35 | 338.18±2.23 | 95.06±1.15 |
| *Oxya* sp. | 64.07±0.23 | 6.48±0.31 | 24.18±0.47 | 7.47±0.09 | 5.27±0.09 | 16.71±0.51 | 464.87±3.16 | 137.83±1.13 |

[1]NFE = Nitrogen free extract, [2]P/E = protein to energy ratio, [3]HPS = high protein Spirulina meal, [4]LPS = Low protein Spirulina meal.

1. % Survival= (No. of individuals at the end of experiment ×100)/No. of individuals at the beginning of the experiment
2. Percent Weight Gain (PWG)= (Final weight - Initial weight) × 100/Initial weight
3. % Average Daily Growth (ADG)= $(W_{t2}-W_{t1}) \times 100/(W_{t1} \times T)$ (where Wt1= initial weight, Wt2= final weight, T= number of days).
4. % SGR (Specific Growth Rate) = $(\ln W_{t2} - \ln W_{t1}) \times 100/T$ (where Wt1= initial weight, Wt2= final weight, T= number of days).
5. Condition factor (K)= 100 × (weight/length$^3$) as suggested by Moyle and Cech[17].
6. Final length up to fin base.

### Statistical analysis

All the analyses and experiments were done with three replicates; data are presented as means ± standard deviation (SD). Variations in % survival and growth parameters for different diets were analyzed with one way analysis of variance (ANOVA) using Microsoft Excel 2000 software followed by Duncan's multiple range tests[18].

## RESULTS

### Water quality

The temperature varied from 25.4-30.5°C during the experimental period with the mean value of 27.33±1.92°C. The pH was slightly alkaline (7.54±0.2) while the concentration of dissolved oxygen (D.O) was 3.14 mg/L. Hardness of water was found to be 160mg $CaCO_3$/L.

### Proximate composition of diets

TABLE 1 shows the proximate composition of all the diets selected to feed the experimental juvenile black mollies. The results indicate that protein contents ranged from about 32-64% in the diets. Maximum amount of protein was found in *O.fuscovittata*. The percentage of crude lipid (ether extract) ranged between 5-12%. Carbohydrate contents of the selected diets were found to be in between 25-52%, where the low protein Spirulina (LPS) meal showed the highest and *O.fuscovittata*, the lowest amount. The energy contents ranged from 338-484 Kcal/100 gm of dry tissue. Here, maximum amount was observed in the freeze-dried tubifex meal. Ash content of the high protein Spirulina (HPS) meal was higher than the three other diets under study, whereas *O.fuscovittata* possessed the highest amount of crude fiber (7.51%). Nitrogen free extract (NFE) was highest in the low protein Spirulina meal. According to Kalita et al.[19] determination of protein to energy (P/E) ratio in fish diet is very important because the higher this ratio, the better is the diet. Hence P/E value was also calculated. Determination of P/E value revealed that all the diets have them in good amounts, where *O.fuscovittata* had the highest.

**TABLE 2 : Survival, average daily growth (ADG), specific growth rate (SGR), and condition factor (K) of *P.sphenops* fed with different experimental diets for 183 days.**

| Diet | % Survival | % ADG | %SGR | K |
|---|---|---|---|---|
| Tubifex | 83.33±5.78a | 27.52±0.82a | 0.933±0.006a | 2.62±0.17a |
| HPS | 83.33±5.78a | 27.29±1.68a | 0.933±0.011a | 2.62±0.43a |
| LPS | 76.67±11.55a | 27.06±1.85a | 0.926±0.015a | 2.21±0.14a |
| *Oxya* sp. | 76.67±11.55a | 27.19±1.52a | 0.930±0.010a | 2.35±0.27a |

Means within a column bearing the same letter were not significantly different (P>0.05).

### Survival and growth of fish fed with different diets

TABLE 2 summarizes percentage survival and growth of juvenile black mollies reared on four different kinds of diets (i.e. 3 artificial diets obtained from market and 1 grasshopper diet in dried form). There were no significant difference in the survival, % ADG, % SGR and condition factor (K) between the individuals reared on artificial diets and the ones reared on dried *O.fuscovittata* ($P > 0.05$ in ANOVA). Figure 1 reveals that variation in PWG is also insignificant. In addition there was no significant difference in final length of the fishes at the end of the experiment (Figure 2). These results indicate that dried form of *O.fuscovittata*

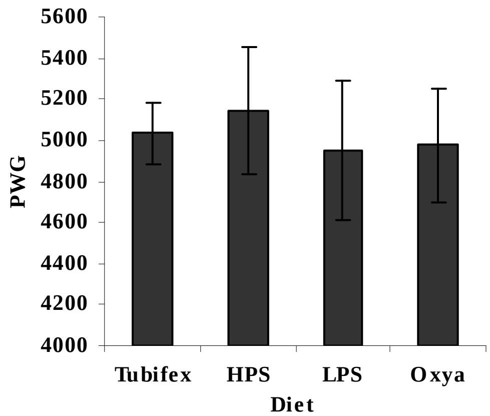


**Figure 1: Percent body weight gain of *P.sphenops* fed different diets for 183 days. Each bar is a mean ±SD for three replicate groups (n=3, each n consists of 10 fishes per replicate). Variations in the results are insignificant (P>0.05)**

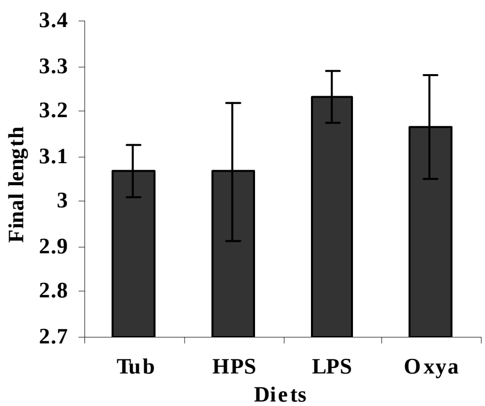


**Figure 2: Final length up to fin base of *P.sphenops* fed different diets for 183 days. Each bar is a mean ±SD for three replicate groups. The results did not vary significantly with each other (P>0.05)**

is comparable to the market available foods as an ornamental fish diet.

## DISCUSSION

According to Ueckert et al.[20] insects are known to have high nutritional value and may be an important source of protein, carbohydrate, fat, vitamin, minerals etc. Notably acridids, which comprises locusts and grasshoppers represent a huge insect protein source. The protein content of grasshoppers varies from 52.1-77.1% and the quality of this protein is good and rich in several amino acids than the Food and Agricultural Organization[21]. Because of their high nutritional value and ubiquitous presence, acridids present a potential sustainable food source in animal nutrition[11]. Results presented by various workers indicate that insects can potentially substitute for commercial products as a source of protein in animal diets. No significant differences in weight gain, food consumption, food conversion, carcass quality or palatability of poultry birds were observed by Ramos-Elorduy et al.[22] when *Tenebrio molitor* L. was substituted for soybean meal in the diets for young chickens. A similar finding was reported when chickens were fed with *Acheta domestica* L.[23], *Alphitobius diaperinus* Panzer[24] and termites[25]. These studies supported the nutritional quality of insects as a protein source without adverse effects. However all of these previous works were carried out to evaluate the feed value of insects as poultry diets. Although Ramos-Elorduy[21] used insects as a food source for, rainbow trout, further studies on insect feed value as a fish diet have not been done much intensively.

## CONCLUSION

From the present study it is concluded that acridids, such as *O. fuscovittata* has a huge amount of protein (near 64%) and a high calorie content. It was also observed that they contain a good amount of carbohydrate, fat and NFE whereas the crude fiber percentage is moderate and percentage of total ash is quite low. According to Anand et al.[11] they also contain some essential trace elements in very good amount. From the result of this study it is clear that their nutritional value is comparable to the common artificial fish diets available in the market as all growth parameters varied insignificantly in the feeding experiment of black mollies. Further studies investigating consumption and utilization of dried powder of *O. fuscovittata* by black mollies and other fishes, and knowledge on the effect of this diet on fecundity and fertility of fishes are necessary to arrive at any definite conclusion. Finally, this easily available and a huge biomass producible high quality alternative insect protein source can also be used to manufacture low cost artificial ornamental fish diets. Thus, established acridid farms may supply a good amount of grasshopper meal to the livestock feed industry and ultimately make the ornamental fish industry more viable throughout the world.

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