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Suitability of an earthworm *Perionyx sansibaricus* (Michaelsen) as verm meal for catfish, *Clarius batrachus* (Linn)

M. P. Sinha, D. K. Gupta, M. Kumar, R. Srivastava and Ratna Sinha*
Department of Zoology, Ranchi University, Ranchi - 834 008, India.
*Department of Home Science, Ranchi University, Ranchi - 834 001, India.
e-mail : m_psinha@yahoo.com

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Abstract

In order to test the suitability of an earthworm *Perionyx sansibaricus* (Michaelsen) as verm meal for carnivorous cat fish, *Clarius batrachus* (Linn.) experiments were designed to maintain fish population on three different fish food viz., earthworm, muscles of *Pila* (*Pila bengalensis*) and goat liver for 45 days under ideal and identical laboratory conditions. The growth rate of fishes as mg g^{-1} wet weight day^{-1} has been calculated to be the parameter of testing the suitability of feed. The growth rates were always higher for verm meal showing suitability and the statistical analysis of the data on growth rate by two way ANOVA revealed a highly significant variation ($p<0.001$) due to variation in food variety and non significant variation among the replica of the experimental sets. The suitability of verm meal has been explained on the basis of chemical composition of worm tissues. The difference in growth rates of fishes when fed on earthworm showed a significant variation ($p<0.01$) over the population fed on other meals.

Key words : *Perionyx sansibaricus*, Verm meal, *Clarius batrachus*.

Introduction

Apart from quantity, the quality of food is an essential component of pisciculture. According to Das *et al.* (2002) the technological advancements in fish culture practices have made supplementary feeding indispensable. Besides hygiene, a balanced nutritional supplementation is now being observed as key to profitable aquaculture. Consequently, new feed formulations are being worked out incorporating food commodities of animal and plant origins. However, the present scenario of aquaculture vis-a-vis fish feed availability in India is far from adequate and the small pisciculturists are dependent on local feed ingredients and formulations. Composition of such feeds essentially depends on easy availability of agricultural products or by-products. In India, the fish farmers usually utilize mustard oil cake, ground pulses mixture, wheat flour, rice flour, etc. alone or in combination to supplement the nutritional requirements of their standing fish crop. Problem arises with carnivore fishes in particular reference to suitable food having viability from both nutritional and commercial viewpoints. There is great paucity of knowledge regarding suitability of food for carnivore fishes in intensive farming.

Sabine (1978) and Yoshida and Hoshii (1978) have suggested that the possible substitution of earthworms as protein substitute in feed of pigs and poultry respectively. Arunachalam and Palanichamy (1984) have reported the improved growth rate of cat

fish *Mystus vittatus* when fed on earthworms. Dash *et al.* (1977) and Dash and Senapati (1984) have reported high protein content in earthworm. In terms of nutritional quality and quantity, earthworm protein has been valued equally important and useful as fish meal and meat meal (Veeresh, 1984; Lee, 1985).

Keeping the above facts in mind the present project was taken up to investigate the suitability of an earthworm *P. sansibaricus* as fish food for *C. batrachus* taking growth rate (mg g^{-1} wet weight day^{-1}) as a parameter.

Materials and Methods

Juveniles of *Clarius batrachus* in the weight group of 10.0 ± 1.00 g were collected from the reservoir near Ranchi, Jharkhand and were acclimated to laboratory conditions for 15 days. Fishes were divided into three groups and each group consisted of five sets (Five individuals in each set). Each set of individuals was introduced into rectangular glass aquaria (30×20 cm capacity) containing 5 litre of reservoir water. The first group was fed on an *ad libitum* diet of chopped muscle of earthworm (*P. sansibaricus*) twice a day for a period of two hours each. Prior to feeding, the gut of earthworms were evacuated by keeping 24 hrs in water (Dash and Patra, 1977) and then chopped into small pieces and then washed carefully in tap water to remove the sand particles present (if any). Similarly, second and third groups were fed on *ad libitum* diet of chopped foot muscle of *Pila bengalensis* and liver of goat respectively. The quantity of food to be fed was determined as 8% of body weight of fish per hour. Food remains were collected with least disturbance to the fish, using pipette and dried at 105°C for weight constancy. Thus, rearing experiment was carried out for 45 days clubbed at 15-day interval at 25±1°C. Aquarium water was aerated continuously and changed once in 3 days. Live weight of fishes was taken by electronic balance.

Table 1 : Growth rate (mg g^{-1} wet body weight day^{-1}) at 15-day interval and average ± SD.

15-day

S. No.	Earthworm meal (*P. sansibaricus*)	*Pila bengalensis*	Goat liver
1.	1.73	0.3	0.7
2.	1.99	0.37	0.91
3.	1.76	0.75	1.23
4.	2.22	0.51	1.44
5.	1.35	0.85	1.00
Average	1.81 ± 0.3244	0.556 ± 0.2378	1.056 ± 0.2867

30-day

S. No.	Earthworm meal	*Pila bengalensis*	Goat liver
1.	2.38	0.94	1.24
2.	2.68	0.98	1.22
3.	1.75	1.31	1.54
4.	2.93	1.11	1.9
5.	2.15	0.65	1.54
Average	2.378±0.4588	0.998±0.2422	1.488±0.2727

45-day

S. No.	Earthworm meal	*Pila bengalensis*	Goat liver
1.	2.98	1.03	1.78
2.	3.12	1.12	1.96
3.	2.85	1.20	1.73
4.	3.86	1.06	2.12
5.	2.35	1.18	1.45
Average	3.132 ± 0.5464	1.118 ± 0.0736	1.828 ± 0.2527

Observation

The data on growth of experimental fish as mg g^{-1} live body weight day^{-1} fed on three different types of food during the experiment have been presented in Table-1. The growth rates have been clubbed for 15 days interval depending upon range of variation and

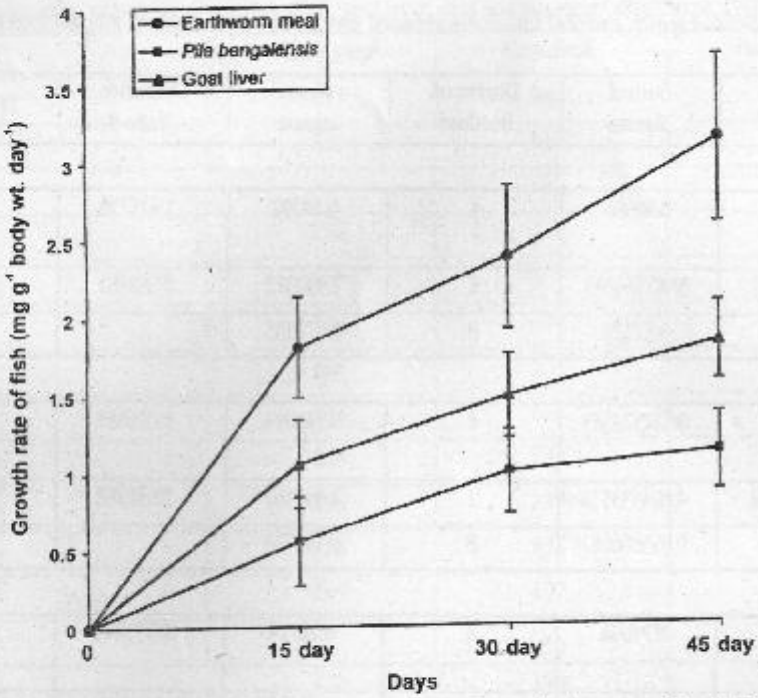

Fig. 1 : Growth rate of *C. batrachus* fed on three different types of food during 45 days averaged for 15 days.

Table 2 : t- test between growth rates of *Clarius batrachus* fed on vermi meal and goat liver meal as well as vermi meal and molluscan tissue meal with significance at different intervals.

15 -day

Type	df	Calculated 't'	Tabulated 't'		Significance
			0.01	0.001	
E-P	4	5.6055	4.604	8.610	$p < 0.01$
E-GL	4	5.355	4.604	8.610	$p < 0.01$

30 -day

Type	df	Calculated 't'	Tabulated 't'		Significance
			0.01	0.001	
E-P	4	5.6395	4.604	8.610	$p < 0.01$
E-GL	4	4.088	4.604	8.610	$p < 0.02$

45 -day

Type	df	Calculated 't'	Tabulated 't'		Significance
			0.01	0.001	
E-P	4	7.1909	4.604	8.610	$p < 0.01$
E-GL	4	8.8223	4.604	8.610	$p < 0.001$

Table 3 : Two way ANOVA of growth rate of *C. batrachus* obtained after feeding on earthworm, pila and goat liver at different intervals.

Source of variation	Sum of Square	Degree of freedom	Mean square	Variance ratio F	Significance
15th Day					
Replicates of same meal	0.40396	4	0.10099	1.411756	NS
Variation in meal	3.985053333	2	1.992527	27.85387	p < 0.001
Residual	0.57228	8	0.071535		
30th Day					
Repicates of same meal	0.531573333	4	0.132893	1.245097	NS
Variation in meal	4.894333333	2	2.447167	22.92786	p < 0.001
Residual	0.853866667	8	0.106733		
45th Day					
Replicates of same meal	0.74856	4	0.18714	2.071049	NS
Variation in meal	9.39612	2	4.69806	51.9927	p < 0.001
Residual	0.72288	8	0.09036		

Table 4 : Biochemical composition of earthworm *Perionyx sansibaricus* (three age groups). Ash content has not been presented (after Kumar, 2002).

Chemical components	Juvenile	Non clitellate	Mature
Water content (% of body wt.)	68.3 ± 7.84	82.6 ± 3.28	77.26 + 2.32
Protein (mg% dry wt)	46.21 ± 0.27	51.62 ± 0.18	47.23 ± 0.26
Fat (mg% dry wt)	13.62 ± 1.12	8.61 ± 1.92	12.28 ± 1.76
Carbohydrate (mg% dry wt)	0.931 ± 0.22	0.693 ± 0.21	0.853 ± 0.16

have been represented in Fig. 1. The analysis of the table reveals that the growth rate of the experimental fish is highest for earthworm (*P. sansibaricus*) fed group followed by goat liver meal and molluscan meal. The results indicate the suitability of verm meal over rest two types.

The statistical analysis of growth rates of earthworm fed group and molluscan meal fed group at all the three intervals showed significant ($p < 0.01$) difference. Similarly, growth rate of earthworm (*P. sansibaricus*) fed group and goat liver fed meal showed significant difference at 15-day ($p<0.01$), 30-day ($p<0.02$) and 45-day ($p<0.001$) intervals (Table-2). A two way ANOVA test (Table 3) of the generated data on growth rates at all the three intervals reveals no significant difference among the replicates of the samples while a highly significant difference has been produced (df-2, 8, F=27.85387; 22.92786; 51.9927; $p<0.001$) in growth rate of experimental fish due to variation in meal.

The observations show the superiority as well as suitability of verm meal over the other meals for growth

Table 5 : Percentage composition of amino acid in verm meal, meat meal and fish meal (after Sahine, 1978).

Amino acid	Worm meal	Meat meal	Fish meal
Arginine	4.13	3.48	3.9
Cystine	2.29	1.07	0.8
Glutamic acid	-	-	8.4
Glycine	2.92	7.09	4.4
Histidine	1.56	0.97	1.5
Isoleucine	2.58	1.33	3.6
Leucine	4.84	3.54	5.1
Lysine	4.33	3.08	6.4
Methionine	2.18	1.45	1.8
Phenylalanine	2.25	2.17	2.6
Serine	2.88	2.15	-
Threonine	2.95	1.77	2.8
Tryptophan	-	-	0.7
Tyrosine	1.36	1.29	1.8
Valine	3.01	2.22	3.5
Crude protein	61.0	51.0	60.9

and development. Further, the consumption of verm meal was higher than other meals, which was determined by left out food materials after feeding.

Discussion

Capacity of stomach, rate of digestion and gastric evacuation have been reported to influence the rate of food consumption (Pandian, 1967; Brett and Higgs, 1970), which in turn is dependent upon the nature of food material (Arunachalam and Palanichamy, 1984). Reimmers (1957) has reported a comparatively shorter period for gastric evacuation for meals of oligochaetes. Arunachalam (1978), while studying *Tubifex tubifex* and aquatic oligochaete and fish muscle of *Gambusia affinis* as food items of *M. vittatus*, has confirmed the findings of Reimmers (1957). The higher consumption of verm meal by the experimental fish *C. batrachus* in the present experiment might be due to the reasons mentioned above. The present finding is in conformity with the earlier reports of Vivekanand *et al.* (1976) and Arunachalam *et al.* (1984). The feeding behaviour and mechanism of feeding in fishes, however, have been reported to be very complicated. Several types of stimuli are usually linked with fish feeding (Langer *et al.*, 1977).

The present observations and associated statistical analysis indicate significantly influenced growth rates by the types of food used during experiment on *C. batrachus*. Growth rate was higher when fed on earthworm (*P. sansibaricus*). This may be attributed to higher food consumption as higher food consumption leads to maximisation of growth rate in one hand while on the other the nutritional value of the food consumed. Maximisation of food intake in

Table 6 : Amino acid composition of worm meal and fish meal (after Reinecke *et al.*, 1991).

Amino acid	*Eisenia foetida*	*Eudrilus eugeniae*	*Perionyx excavatus*	*Fish meal*	*Broiler starter*	*Lumbricus terrestris**	*Allolobophora longa**
Aspartic acid	-	-	-	-	-	9.35	11.35
Threonine	4.47	4.30	4.20	3.84	3.33	5.12	4.8
Serine	4.44	4.50	4.61	14.30	4.12	5.47	2.4
Valine	6.00	5.95	5.88	5.00	3.95	4.75	5.6
Methionine	1.80	1.75	1.90	2.66	2.08	2.29	1.14
Isoleucine	4.60	4.58	4.55	4.06	3.58	4.53	5.10
Leucine	9.80	9.60	9.85	7.80	6.42	8.48	8.13
Tyrosine	3.50	2.95	3.14	3.69	2.87	4.17	6.04
Phenylalanine	3.58	3.02	3.62	3.08	3.30	4.17	6.04
Histidine	3.37	3.10	3.22	2.23	0.19	2.85	2.30
Lysine	7.76	7.85	7.80	7.15	4.99	7.26	7.81
Arginine	9.56	9.20	9.33	4.62	6.24	6.54	7.17
Glutamic acid	17.70	13.80	-	-	-	17.56	13.66
Alanine	6.50	5.20	-	-	-	6.03	5.97
Cystine	6.70	1.60	-	-	-	0.66	0.68
% protein	66.13	53.38	61.63	61.00	22.00		

* After Veeresh (1984).

fishes by increasing the feeding frequency resulted in increased growth (Sampath and Pandian, 1984; Andrews and Page, 1975).

The nutritional value of the food is another important aspect to be evaluated to analyse the influence of food on growth. Thus, the nutritional composition may influence the growth i.e. the composition of food from carbohydrate, fat and protein content viewpoint. Garling and Wilson (1976, 1977) and Murray *et al.* (1977) have suggested an optimum level of protein, fat and carbohydrate component to promote growth in *Ictalurus punctatus* - a catfish. A biochemical analysis of earthworm tissue, hence, becomes an important aspect to show its suitability in promoting and maximizing the growth. Table-4 provides a picture of biochemical component in *P. sansibaricus* tissue in different age groups of earthworm showing high protein content. Table 5 contains a comparative account of percentage composition of different amino acids in verm meal, meat meal and fish meal as provided by Sabine (1978). The tables clearly show the superiority of verm meal over other meals.

Very high percentage of protein in earthworm tissue seems to be one of the reasons of suitability. Many workers (Dash *et al.*, 1977; Guerro, 1981; Lee, 1985) have also reported higher level of protein content in different earthworms.

Considering the protein content of other species of earthworm, for example, *Lumbricus terrestris* is

reported to contain 66.25% protein, *Apporectodea longa* 68.12%, *Octolasion cyaneum* 60% and *Eisenia foetida* 60-61% (Lee, 1985) and in terms of its nutritious quality, earthworm protein being valued as equally nutritious as fish meal or meat meal (Veeresh, 1984).

Dash *et al.* (1977) and Dash and Senapati (1984) have reported high protein, nitrogen and fat content in *Lampito mauritii*, a widely occurring worm in India. Guerro (1981) has reported a protein value of 54.77 and fat of 13.35% in *Perionyx excavatus*. Table 6 shows the amino acid composition of worm meals (different earthworms) and fish meals (different fishes). Considering the fact that the earthworm on an average, can convert 20-40% of their assimilated energy into high quality protein rich in most of the essential amino acids (Senapati, 1992) and going by the feeding trials in which growth, food consumption and efficiency of food conversion were estimated, the potential of earthworm meal as protein source in the diet of broilers was reported by Reinecke *et al.* (1991) and the feeding trials of Japanese quails and broilers by Das and Dash (1989). The present experimental results show the verm meal as ideal and suitable food for fishes too.

So far the economics of verm meal is concerned, it is easily available and affordable in Jharkhand. Sinha and Srivastava (2001) have reported a biomass of 328.38 g dry wt m^{-2} from a garbage site of Ranchi. The total population of the species has been found to be as high as 10,050 individuals m^{-2} (Sinha and Srivastava, 2001). This shows the abundance and easy availability of *Perionyx sansibaricus*. The earthworm *Perionyx sansibaricus* can be taken up as ideal fish food in commercial production.

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