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Nutritional potentiality of earthworm (*Perionyx excavatus*) for substituting fishmeal used in local feed company in Bangladesh

A.F.Md. Hasanuzzaman[1*], Sk.Z. Hossian[1] and M. Das[1]
[1] *Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna-9208, Bangladesh.*

**email: mhzaman.bd@gmail.com*

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Abstract - Nutritional composition of wild earthworm (*Perionyx excavatus*) and fishmeal used by local fish-feed industry in Bangladesh was determined to evaluate the nutritionally replacement potentiality of this earthworm species for fishmeal mostly used in feed for aquaculture and other animal production. Except for moisture content, the proximate chemical values in *P. excavatus* did not differ significantly ($P \geq 0.05$) from that in fishmeal. On an average, the earthworm had lower protein content (46.57 ± 0.97%) than fishmeal had (54.97 ± 7.49 %). On the other hand, the mean lipid content (8.03 ± 0.44 %) in this earthworm was found to be higher compared to fishmeal (7.97 ± 1.60 %). The average ash content in the earthworm and fishmeal were 24.26 ± 0.68 % and 24.13 ± 8.44 %, respectively. The results of the present study indicate that this earthworm species had almost similar nutritional values to the fishmeal, and thus would be a potential source of animal protein in supplementing fishmeal. In an implication, year-round production of this earthworm species through standard mass culture system, and its radical use could play a pivotal role in sustainable fisheries and aquaculture production.

Keywords: Earthworm, fishmeal, animal nutrition, sustainable aquaculture.

Introduction

In commercial aquaculture ventures, feeding high-value finfish and crustacean species is one of the most concerns focusing on availability of feed stuffs, their nutritional quality, cost and economic returns. Among fish-feed stuffs, trash fish/low-value fishes are used as whole or chopped in wet form, through fishmeal and fish-oil in commercial pelleted feed, and sometimes as live fish. Generally, feed and fertilizers account for about 40-60% of the total operational cost in semi-intensive aquaculture systems but feed accounts for 60-80 % (FAO, 2007), and fishmeal makes up a substantial stake of the cost. Traditionally fish meal is widely used as the commonest and most popular protein source for compound aquafeed production. About 3.06 million tones of fishmeal were consumed by aquaculture sector in 2006 (Tacon, 2007). It is estimated that an approximate 5 to 6 million tones of low-value/trash fish are used as direct

feed in aquaculture world-wide (Tacon *et al.*, 2006). Watanabe (2002) predicted that the demand for fish meal and fish oil would increase by more than 300% over the next 10 years. In Bangladesh, feed manufacture companies uses fishmeal collected locally and/or imported from China, Thailand, and India. It is now in question if fishmeal produced from dwindled capture fisheries would be sufficiently enough to supply the growing demand for increasing aquaculture production. Moreover, fishmeal is produced from low-value small fishes which are an important diet source for poor people, especially riverside and coastal communities in Asia and Africa. With taking into account of sustainable and ethical perspectives, it is very coherent to find alternative feed ingredients (especially protein sources) to make aquaculture economically viable and sustainable venture.

Earthworm has been found to be a good source of protein (Sogbesn and Ugwumba, 2008; Kostecka and Pączka, 2006; Guererro, 1983; Hilton, 1983; Tacon *et al.*, 1983), and its usage as fish bait is well known in fishing (Omorinkoba *et al.*, 1985; Segun, 1978). Earthworms with an important high protein component are used to feed chickens, pigs, rabbits, and as a dietary supplement for fish species (Mason *et al.*, 1992; Sabine, 1986; Stafford and Tacon, 1985; Akiyama *et al.*, 1984). Among 36 earthworm species available in Bangladesh, *Perionyx excavatus* - an epigeic earthworm, is almost found throughout the year, and is a suitably potential species for feeding roosters and fishes (Ali, 2002). The high reproductive rate and biomass production of this tropical earthworm species make it ideally suited to worm meal production (Edwards and Niederer, 1988).

Apart from availability, nutritional value of this earthworm is a major prerequisite in serving as fishmeal substitution in feed production. With a view to evaluating the nutritional suitability of *P. excavatus*, a comparative study was conducted focusing on the proximate chemical composition of wild *P. excavatus* and fishmeal used in local feed mill in Bangladesh.

Materials and Methods

A total of 90 wild earthworm species (*Perionyx excavatus)* was collected from Khulna University Campus in Bangladesh, and eight samples of fishmeal were colleted from two different animal feed companies, namely Bay Agro Industries Limited and Aman Feed Company Limited in Bangladesh. The proximate composition in content value of moisture, crude protein, crude fat, and crude ash in earthworm species and fishmeal samples was determined according to the methods of AOAC (2000). For statistical analysis, fishmeal samples from two different feed companies were pooled, and all data were subjected to two independent *t*-test at 5% significance level to figure out differences in mean proximate composition values between earthworm and fishmeal.

Results

The crude protein, lipid and ash content in *Perionyx excavatus* were recorded to be ranged from 45.60 to 47.53 %, 7.59 to 8.47 % and 23.54 to

24.88 %, respectively. On the other hand, fishmeal contained protein of 37.87 - 61.28 %, lipid of 4.13 - 8.88 % and 18.68 - 44.36 % ash (Table 1). The earthworm species had significantly ($P<0.05$) higher moisture (67.84 - 74.08 %) values compared to fishmeal containing moisture of 8.26 – 31.53 %. The mean crude protein content in the wild earthworm was found to be insignificantly lower than that in fishmeal. On the other hand, the lipid and ash values in the earthworm were close to the values recorded in fishmeal. Though there was no significant differences in protein, lipid and ash contents between the wild earthworm and the fishmeal, the nutritional values in fishmeal were rather inconsistent than in the earthworm.

Table 1. Proximate chemical composition of earthworm species (*Perionyx excavatus*) and fishmeal used in local feed mill in Bangladesh.

Groups	Moisture (%)	% Dry mater		
		Crude Protein (%)	Crude Lipid (%)	Crude Ash (%)
*Fishmeal				
Fishmeal (Emperic Int.)	9.20	56.71	8.63	20.00
Fishmeal (Karnafully Fish Products)	8.53	53.88	8.88	24.45
Fishmeal (Karnafully Fish Products)	8.75	53.54	9.15	23.83
Fishmeal (Emperic Int.)	8.95	56.32	8.56	22.28
Fishmeal (Emperic Int.)	8.60	60.45	8.30	18.68
Fishmeal (Tazan Agro Limited)	8.26	59.72	8.25	20.02
Fishmeal (Emperic Int.)	9.30	61.28	7.85	19.42
Fishmeal (Aman Feed Limited)	31.53	37.87	4.13	44.36
Mean ± SD	11.64^{a} ± 8.04	54.97^{a} ± 7.49	7.97^{a} ± 1.60	24.13^{a} ± 8.44
Earthworm (*Perionyx excavatus*) Wild-caught (mean ± SD)	71.53^{b} ± 3.27	46.57^{a} ± 0.97	8.03^{a} ± 0.44	24.26^{a} ± 0.68

* Supplier names in parentheses; Fishmeal and earthworm groups with different superscripts in the same column are significantly different ($P<0.05$).

Discussion

Recently, nutritional value of earthworms has considerably taken attention of fish nutritionists as they search for alterative animal protein source to fishmeal which is characterized by seasonal availability, and inconsistent supply from world's dwindled fisheries stock. Protein quality of earthworm has been reported at par with that of fishmeal (Sogbesan *et al.*, 2007; Kostecka and Pączka, 2006; Dynes, 2003). In the present research, the crude protein, lipid and ash values of *P. excavatus* were recorded not to be significantly different from that of fishmeal.

Though the crude protein content in *P. excavatus* was lower than 69.8 % (Guerrero, 1983) and 63.04 % for *Hyperiodrilus euryaulos* (Sogbesan *et al.,* 2007), the crude lipid value was higher than 5.8 % by Guerrero (1983), 7.8 % for *Eisenia foetida* (Tacon, 1994) and 5.9 % for *H. euryaulos* (Sogbesan *et al.,* 2007). The ash content was also found to be higher than 8.9 % for earthworm meal by Sogbesn and Ugwumba (2008) but lower than 45.7 % for wild *Lumbricus terrestris* (Barker *et al.*, 1998). These variations in proximate compositions are likely to be associated with specific-ecology, food, seasons, life stages, and reproductive states etc. reported by Mason *et al.* (1990) and Pennino *et al.* (1991).

The present work shows that fishmeal used in Bangladesh had almost similar values for protein, lipid and ash contents as to the report by Khatoon *et al.* (2006) and Sogbesan *et al.* (2007). But the quality of fishmeal is often questioned with the presence of sand, stone, heavy metals, antibiotics, fine sawdust, poultry byproducts and tannery wastes.

With considering the above facts, the present nutritional comparative study implies that *P. excavatus* could be an excellent protein source of substituting fishmeal used in fish-feed. The protein value of this earthworm species was found within range of the protein requirement (35 – 50 %) for aquaculture diets. The implicit significance of the present study is that *P. excavatus* can be used as live food for fish and as feed ingredients for fish-feed. In addition, the potential usage of earthworm in aquaculture and other animal production would contribute to the livelihoods of poor marginal farmers in developing countries. However, further research works on different contexts i.e. amino acid and fatty acid profile of this earthworm, cost-effective mass culture technology, as well as fishmeal replacement feasibility considering palatability, food conversion ratio (FCR) and processing techniques are recommended.

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