Journal of Aquaculture
Research & Development

Bag et al., J Aquacult Res Dev 2012, 3:8
DOI: 10.4172/2155-9546.1000154

Research Article | Open Access

Aquatic Weed as Potential Feed for Mozambique tilapia, *Oreochromis mossambicus*

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Abstract

A study was conducted to evaluate the nutritional potentials of three commonly available aquatic weeds namely, lemna (*Lemna minor*), water hyacinth (*Eichhornia crassipes*) and azolla (*Azolla pinnata*) for ascertaining their suitability in fish feed with the aim of reducing the cost of traditional feeds. Three isonitrogenous (30% crude protein approximately) and isocaloric (4.0 kcal g^{-1} approximately) diets were formulated including lemna, water hyacinth and azolla as principal ingredient. Three groups of juvenile tilapia fish (*Oreochromis mossambicus*) of thirty (30) number per group (Average weight 5.1 ± 0.15 g; length 4.5 ± 0.12 cm) were fed with three different types of feeds with lemna meal (LNM), water hyacinth meal (WHM) and azolla meal (AZM) for 90 days duration. Body weight gain, feed conversion ratio (FCR), protein efficiency ratio (PER) and gonadosomatic index (GSI) were significantly (P<0.05) high in LNM fed fish in comparison to the others. The lemna possibly contains superior quality of protein which in turn influenced growth, growth parameters and fecundity of cultured fish.

Keywords: Lemna; Isonitrogenous; Tilapia fish; Feed conversion ratio

Introduction

Fish feed generally constitutes 60-70% of the operational cost in intensive and semi-intensive aquaculture system [1]. The fish feed used in aquaculture is quite expensive, irregular and short in supply in many third world countries. These feeds are sometimes adulterated, contaminated with pathogen as well as containing harmful chemicals for human health. Naturally there is a need for the development of healthy, hygienic fish feed which influences positively the growth and quality of the cultured fish.

Considering the importance of nutritionally balanced and cost-effective alternative diets for fish, there is a need for research effort to evaluate the nutritive value of different non-conventional feed resources, including terrestrial and aquatic macrophytes [2-5]. Aquatic and terrestrial macrophytes have been used as supplementary feeds in fish farming since the early times of freshwater fish culture [6] and still play an important role as fish feed in extensive culture systems [7]. The aquatic weeds have been shown to contain substantial amounts of protein and minerals [8]. Valente et al. [9] reported clearly that macro algae such as *G. bursapastoris, U. rigida* and *G. cornea* have great potential as alternative ingredients in diets for European sea bass juveniles at dietary inclusion levels up to 10% with no adverse effects on growth performance and feed utilization efficiency. There is high competition for the same foodstuffs between man and his domestic animals. For both economic and practical reasons, fish feed should be prepared to be use locally available protein sources, preferably from those unsuitable for human consumption (Bag et al. 2012) [10]. It is, therefore, very crucial to find an alternative to reduce feeding cost, and to make aquaculture a viable and attractive venture. Mukherjee et al. [11] reinforced the utilisation of some aquatic weeds as promising sources of neutraceuticals in fish-feed.

Keeping the above in view, the main objective of the present study is to formulate feed incorporating the weeds as key ingredient and the effect of formulated feeds on yield and growth performances of Mozambique tilapia (*Oreochromis mossambicus*).

Material and Methods

Experimental set up

Thirty fingerlings in triplicate groups used in three different treatments. Altogether they are two hundred and seventy (270) in number. Nine groups of tilapia fingerlings comprising fifty (30) individuals each (average weight 5.0–5.5 g and length 4.0-4.5 cm) were obtained from Balarampur fish farm, 3 Km away from IIT-Kharagpur, West Bengal, India. The fish fingerlings were treated with potassium permanganate solution (1 mg $^{L-1}$) to remove any external parasites and were acclimatized in a tank for two days. Each group of fingerlings also were initially weighed to record the initial biomass. They were stocked in 9 rectangular cemented tanks (1000 L) and three different feeds were administered. The water system was static in nature and the bottom of the tank was filled with local agricultural inert soil (pH 6.6 ± 0.05). The experiment was conducted for 90 days. Dechlorinated well water (temperature 30 ± 4°C, pH 7.0 ± 0.05, free CO_2 0.6 ± 0.01 mg L^{-1},

Ingredient (%)	Lemna	Water hyacinth	Azolla
Dry matter	92.81 ± 1.50	92.68 ± 1.58	92.56 ± 1.52
Organic matter	82.92 ± 1.30	82.20 ± 1.40	82.80 ± 1.30
Crude protein	24.24 ± 0.50	19.70 ± 0.52	20.56 ± 0.54
Crude lipid	9.07 ± 0.09	7.98 ± 0.10	9.89 ± 0.09
Ash	9.89 ± 0.06	10.48 ± 0.07	9.76 ± 0.08
Nitrogen free extract	9.61 ± 0.05	36.81 ± 0.04	31.42 ± 0.06
Crude fibre	9.58 ± 0.03	9.58 ± 0.04	9.24 ± 0.04
Gross energy (Kcal g^{-1})	3.74 ± 0.02	3.70 ± 0.03	3.69 ± 0.04

Table 1: Biochemical composition (mean ± SD) of lemna, water hyacinth and azolla used for feed for tilapia (*O. mossambicus*).

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Received September 21, 2012; **Accepted** October 25, 2012; **Published** October 30, 2012

Citation: Bag MP, Mahapatra SC, Rao PS (2012) Aquatic Weed as Potential Feed for Mozambique tilapia, *Oreochromis mossambicus*. J Aquacult Res Dev 3:154 doi:10.4172/2155-9546.1000154

Sl. no	Name of feed	Ingredients	% of ingredient in formulated feed	% of crude protein	% of lipid	% of carbohydrate *	Calorific value of feed (kcal/g)
1	LNM	Lemna dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	46 09 34 10 01	30.10 ± 0.5	9.2 ± 0.05	11.2 ± 0.07	4.1 ± 0.05
2	WHM	Water hyacinth dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	47 10 32 10 01	29.70 ± 0.60	9.0 ± 0.05	12.3 ± 0.06	4.0 ± 0.03
3	AZM	Azolla dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	48 10 31 10 01	30.56 ± 0.60	9.1 ± 0.06	12.7 ± 0.05	4.1 ± 0.04

*Carbohydrates calculated by difference

Table 2: Formulation and composition of the experimental diets (%).

available nitrogen 0.5 ± 0.05 mg L^{-1} and dissolved oxygen (6.0 mg L^{-1}) was used in the experiment.

Feeding

The feed was offered twice a day, in a submerged feeding tray at 09.30 am and 4.30 pm on everyday for 1 h in each tank. Unconsumed feed was removed at 6.00 pm. and dried in a hot air oven at 100°C. Feed consumption was estimated by subtracting the weight of the unconsumed feed from the weight of the feed offered. Fish, feed samples, and unconsumed feeds were weighed on an electric balance to an accuracy of 0.1 mg.

Growth calculation

Growth and nutrient utilization were determined in terms of feed intake (FI), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), energy retention (ER) and hepatosomatic index (HSI) as follows (Bag et al., 2011) [12]:

FI (g $fish^{-1}$ day^{-1})=Total feed intake per fish/number of days

SGR (%day^{-1})=100×(ln[final body weight]- ln [initial body weight])/ no. of Days

FCR=feed intake/live weight gain

PER=live weight gain/crude protein intake

HSI (%)=100×(liver weight/total body weight)

GSI (%)=100×(weight of gonad /total body weight)

Analysis

Feeds and carcass samples were analyzed following standard procedures (AOAC, 1990) [13]: Dry matter (DM) after drying in a hot air oven at 105°C for 24 h; crude protein (CP) by Kjeldahl method (N×6.25) after acid hydrolysis, crude lipid (CL) after extraction with petroleum ether by Soxhlet method; total ash by igniting at 550°C for 3 h in muffle furnace. Organic matter (OM) was calculated by subtracting total ash from DM. Crude fibre was determined using a moisture free defatted sample which was digested by a weak acid HCl (0.1N) followed by a weak base NaOH (0.1N) using the Fibertec System 2021 (FOSS, Denmark). Nitrogen-free extract was determined by subtracting the sum of crude protein, crude lipid, crude fibre and ash from DM. Gross energy was determined using a Bomb Calorimeter Model-DFU 24by combusting sample in a chamber pressurized with pure oxygen and resulting heat measured by increase in the temperature of the water surrounding the bomb.

Statistical analysis

Data are presented as means ± SD. One-way ANOVA was used to find out the significant effects of feed on growth and growth parameters [14]. Duncan's new multiple range tests were also done to determine the differences of the results were significant or not [15].

Results and Discussion

The principal feed ingredients were collected from local pond at very low cost. These substances were economically cheap but contained significant amount of crude protein (above 20%). Biochemical composition of lemna, water hyacinth and azolla used in feed for tilapia are shown in table 1. Diets used for growth trial were prepared that feed formulations remain almost isonitrogenous (30 g 100 g^{-1}) and isoenergetic (4Kcal g^{-1}) in nature. Diet formulations are presented in table 2. Mustard oil cake, wheat flour, rice bran, egg shell dust and vitamin premix were common ingredient in every feed tested. These ingredients were used to compensate lipid, protein and calcium deficiency in formulated feed. Wheat flour was selected as binder. Each feed was fortified with egg shell dust which is available free of cost for calcium supplement. This was added keeping in mind that the developing fish needs huge quantity of calcium for its bone development. The different ingredients were thoroughly mixed using a food mixer (A200 Hobart Ltd). The proportion of different feed ingredients was determined by using Pearson's square method. The mixture was given the shape of pellets using a Pellet Mill (Model CL2) with a 12 mm die specification. The resulting pellets were dried under sun and then packed in polythene bags and kept in dry and cool place at 30°C.

The highest weight gain (83.33 g) was observed in the LNM applied feed series followed by WHM (64.66 g) and AZM (60.66 g) (Figure 1) applied feed series. The length of fish was maximum (12.9cm) in LNM fed treatment and minimum (10.9cm) in AZM fed treatment. The

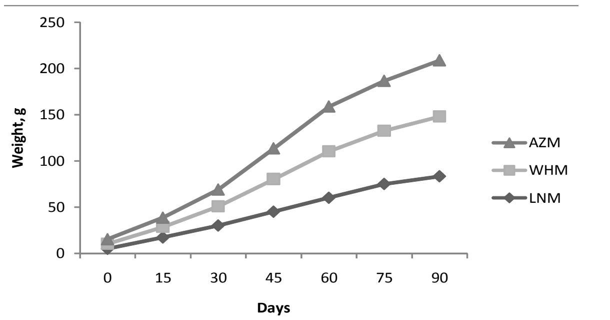

Figure 1: Mean body weight (g) evolution O. mossambicus fed LNM, WHM and AZM diets.

	LNM	WHM	AZM
Initial weight (g)	5.11 ± 0.12[a]	5.11 ± 0.11[a]	5.12 ± 0.10[a]
Final weight (g)	83.33 ± 0.89[a]	64.66 ± 0.75[b]	60.66 ± 0.73[c]
Initial length (cm)	4.5 ± 0.12[a]	4.6 ± 0.11[a]	4.5 ± 0.12[a]
Final length (cm)	12.9 ± 0.15[a]	10.1 ± 0.14[b]	9.9 ± 0.14[b]
Feed intake (g $fish^{-1}$ day^{-1})	2.12 ± 0.23[a]	1.80 ± 0.21[b]	1.72 ± 0.20[b]
Specific growth rate (% day^{-1})	1.01 ± 0.08[a]	0.78 ± 0.09[b]	0.74 ± 0.07[b]
Feed conversion ratio	2.30 ± 0.08[a]	2.40 ± 0.06[b]	2.45 ± 0.06[b]
Protein efficiency ratio	1.50 ± 0.05[a]	1.02 ± 0.06[b]	0.97 ± 0.05[b]
Hepatosomatic index	1.55 ± 0.03[a]	1.40 ± 0.02[b]	1.30 ± 0.03[c]
Gonado somatic index	1.64 ± 0.06[a]	1.04 ± 0.08[b]	1.01 ± 0.0[b]

Values are mean ± SD, n=3.
Values in the row superscripted by different alphabets are significantly different from each other (P<0.05).
Separate analysis was done for each row.

Table 3: Growth performance and nutrient utilization of *O. mossambicus* fed LNM, WHM and AZM diets (mean ± SD).

amount of feed intake was highest (2.12 g) in LNM provided treatment followed by WHM (1.80 g) and AZM (1.72 g) provided treatment. This was 15.09% higher than WHM and 23.25% higher than AZM and as expected the feed conversion ratio (FCR) was lowest (2.30) in LNM followed by WHM (2.40) and AZM (2.45) (Table 3).The specific growth rate was highest (1.01) in LNM fed treatment and lowest (0.74) in AZM fed treatment. The protein efficiency ratio (PER) was significantly differed (P<0.05) in different treatments. The PER value is highest (1.50) in LNM fed treatment and lowest (0.97) in AZM feed treatments. The hepatosomatic index (HSI) was highest (1.55) in LNM fed treatment series and lowest (1.30) in AZM feed treatment series (Table 3). The highest (1.64) value of gonadosomatic index (GSI) was observed in LNM feed treatment and the GSI values varied significantly (P<0.05) with WHM (1.04) and AZM (1.01) feed treatment (Table 3).

The highest weight gain was observed in the treatment administered with LNM feed. This indicates that fish can consume and assimilate the feed well. The results show high acceptability for the LNM among cultured tilapia. This was possibly due to their higher palatability and preference of the fish to take it as their potential food. The present result corroborates with findings of Sithara and Kamalaveni [16]. Moreover, mixing azolla with some agricultural byproducts such as wheat bran and rice bran can improve the digestibility and feed quality [16].

The low FCR of LNM indicates that fish can easily digest the feed and convert these feed into their body mass. The tested value of FCR showed a lower magnitude (2.30) indicating an encouraging effect on economic involvement in fish farming. The protein efficiency ratio was significantly (P<0.05) higher in LNM fed fish than WHM and AZM feed treatment indicating the better quality of protein in the feed produced from lemna (LNM). Kalita et al. [5] reported aquatic weeds such as *I. reptans* and *L. minor* could be important sources of proteins, vitamins and minerals, suitable for incorporation in fish diet. Though anti-nutritional factors were found to be present in these weeds, their levels were within tolerable limits and consumption of these plants would not result in any deleterious effect on the growth of fish.

The higher value of GSI indicates that the LNM has better impact on the reproductive function. The meal prepared from azolla has the lowest impact on reproductive function when compared to with other two meals. The mortality of fish was significantly (P<0.05) lower in LNM administered series than other two meals reflecting a better acceptance of the feed among the fish from beginning of the feed administration.

Conclusion

The feed prepared with lemna as principal source of protein enhanced growth significantly and thereby yield of Mozambique tilapia, *Oreochromis mossambicus*. Such improved quality of fish would claim higher economic return to the tilapia fish farmers. Use of locally available feed ingredient like lemna would reduce the cost of formulated feed and preparation of feed may be done at small scale level leading to employment generation in rural areas.

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