Potentials of castor seed meal (*Ricinus communis* L.) as feed ingredient for *Oreochromis niloticus*

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ABSTRACT

The potentials of castor seed (Ricinus communis) meal as feed ingredient for Oreochromis niloticus was determined by using boiled seeds to prepare five diets which were fed to the fish species. The effects of the experimental diets on the weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio, apparent net protein utilization, digestibility and carcass composition were investigated. The best of these growth factors were obtained with feed formulated from R. communis seeds boiled for 50 and 65 minutes. The highest carcass protein content was observed with fish fed with 65 minute-boiled seeds.

Key words: Ricinus communis seeds, experimental diets, growth, Oreochromis niloticus,

NTRODUCTION

Fish, unlike other groups of animals are less often kept life, reared or cultured in homes and more importantly in schools where they can be effectively used for biological investigations, skill acquisition and development (Blum, 1976). One of the most important limiting factors to fish production especially in culture fisheries is adequate food supply that is balanced in energy, protein, minerals and vitamins for healthy growth and reproduction (Ovie, 1986). The availability of cheap, steady supply of ingredients for fish feed formulation is essential in any intensive fish culture system. Scarcity of high quality conventional feeds and the high competition between man and animals for cereals, has necessitated the greater attention being received in research into unconventional feed resources in the developing nations including Nigeria. However, such unconventional feeds must be used with caution or backed up with published reports because some of them could contain toxic substances, the consumption of which could be harmful (Falaye *et al.*, 1998).

Conversion of feed stuffs into high quality protein by fish for human consumption at a profit for the farmer is the main objective of fish culture. The differences between artificial feeds and natural foods and the part that both play in the economics of fish production are been recognized by successful aquaculturists (Ipinjolu, 2000).

Oreochromis niloticus is widely cultured in Nigeria and they are readily available in most environments of the tropics. *Ricinus communis* is an exotic plant found growing everywhere in Nigeria, with tones of its' seeds being wasted every year underutilized, thus, this study was conducted to explore the feed potentials of *R. communis* in the culture of *O. niloticus*.

MATERIALS AND METHODS

Oreochromis niloticus fingerlings were obtained from Maigana Fish Farms in Kaduna State. They were transported in two large and open plastic water baths into the laboratory for two weeks acclimatization. During the period, they were fed with commercial diet (commercial feed-growers mash). Water parameters like temperature, pH and dissolved oxygen were monitored.

The healthy *O. niloticus* fingerlings with average body weight of 5.6 ± 0.15g were randomly distributed into 12 glass aquaria, each measuring 45cm x 30cm x 30cm, containing 25litres of de-chlorinated water. Feed stuffs or diets to be evaluated were raw and boiled-roasted *R. communis* seed meal, as source of protein, cassava and maize flour as energy source and coagulant (binder), red oil as source of fatty acids and vitamins A and C, blood meal (from cattle) and fish meal as supplementary protein source, growers vitamins and mineral premixes and chromic oxide as indicator for the digestibility tests. The formulations of the diets are shown in Table I.

Table I. Percentage composition of experimental diet fed *O. niloticus*.

	Boiling periods (minutes) of *R. communis*				
	I	II	III	IV	V
Ingredients	Raw	20	35	50	65
Castor seed	39	39	39	39	39
Blood meal	16.7	16.7	16.7	16.7	16.7
Fish meal	16.7	16.7	16.7	16.7	16.7
Cassava flour	11.3	11.3	11.3	11.3	11.3
Maize flour	11.3	11.3	11.3	11.3	11.3
Red oil	2.0	2.0	2.0	2.0	2.0
Vitamin/mineral premixes	2.5	2.5	2.5	2.5	2.5
Chromic oxide	0.5	0.5	0.5	0.5	0.5
Totals	100.0	100.0	100.0	100.0	100.0

Vitamin/mineral premixes contain: vitamin B12, riboflavin, vit. C. D3, K and E. Panthothenic acid, nicotinic acid, chloride, folic acid, selenium, phosphorus, calcium, iodine, copper, zinc, manganese, iron, terramycin, antioxidant and anticalling

Two aquaria were assigned for each diet of feedstuff to obtain duplicate results. The feeds mixture were ground and manually molded into balls and pelleted using local grater and sundried. Food given was at 4% body weight of fish per day. The food was served at 8.ooam, 1.00pm and 6.00pm daily. The time between feeding and first appearance of faeces was determined for each diet or feedstuff by observing the fish in the aquaria.

Feaces collected by individually stripping the fish were pooled for each aquarium, dried at 70° C and analysed for protein and nutrient digestibility, using methods of Furakawa and Tsukahara (1966). Each feed and feaces were analysed in triplicate. The crude protein was determined by methods of AOAC (1990), the carcass of fish was also analysed at the end of the experiment for crude protein, crude fibre, ash. Dry matter, lipid and moisture (AOAC, 1980, AOAC, 1990).

Apparent digestibility was calculated using the formula:

i. $$\% \text{ nutrient} = 100 - 100 \times \frac{(\%\, Cr_2O_3 \text{ in food})}{(\%\, Cr_2O_3 \text{ in feaces})} \times \frac{(\% \text{ nutrient in feaces})}{(\% \text{ nutrient in diet})}$$

ii. weight gain (wg) = Initial body weight – Final body weight of fish

iii. Specific Growth Rate (SGR) = Log e w2 – loge w1 (Brown, 1957)T-t

iv. Food Conversion Ratio (FCR) = weight gain x 100 weight of food consumed (Halver, 1972)

v. Protein Efficiency Ratio (PER) = $\frac{\text{\% Protein in diet x weight of diet consumed}}{100}$

vi. Net Protein Utilization (NPU) = $\frac{\text{Fish protein gain x 100}}{\text{Protein fed}}$

All data obtained were subjected to analysis of variance (ANOVA), means were separated using Duncan's new multiple range test (Steel and Torrie, 1981). Means and standard deviations were calculated following the established statistical procedures (Miller and Miller, 1986).

RESULTS AND DISCUSSION

For optimum growth to be achieved in juvenile fishes, there has to be appropriate water parameters such as temperature, pH and dissolved oxygen along with inherent factors of age and species differences (Milikin, 1982).

Table 2 shows the water parameters during the experimental period for *O. niloticus*. Temperature was in the range of 23 – 27 ° C, pH 6.3 – 7.8 and dissolved oxygen 6.3 – 9.6 respectively. These values were found to be within those recommended for culture of tropical fishes i e average temperature 28° C, dissolved oxygen 6.9ppm and pH of 7.3 (Mazid *et al.*, 1972).

Table II. Water parameter during the feeding experiment for *O. niloticus*

Diets	Temperature ° C	PH	Dissolved Oxygen DO(ppm)
1 (Raw)	23-27	6.4 - 7.5	6.5 – 9.0
II (20 min.)	23-27	6.4 – 7.8	6.4 – 9.5
III (35 min.)	23-27	6.5 – 7.8	6.5 – 9.6
IV (50 min)	23-27	6.3 – 7.9	6.3 – 9.4
V (65 min.)	23-27	6.4 – 7.0	6.4 – 9.0
VI (control)	23-27	6.5 – 7.0	6.5 – 8.9

The proximate composition of experimental diets were determined to ascertain the quantity of nutrient that may be available to the fish and subsequent effects on food conversion efficiency and apparent net protein utilization. The results of the determination are reported in Table 3.

Table III. Proximate composition of experimental diets (g/100g) fed *O. niloticus*

Components	Proximate composition of diets (g/100g)					
	I	II	III	IV	V	VI
Moisture	4.35	4.15	4.38	4.26	4.42	5.53
Crude protein	35.69	35.81	35.56	35.38	35.56	14.94
Crude fibre	2.44	3.24	2.08	2.44	2.17	7.96
Lipid	3.96	4.95	4.89	3.45	3.36	5.90
Ash	5.85	6.31	7.08	5.00	5.73	8.49
Sub total	55.94	50.31	49.61	46.27	46.82	37.29
NFE	44.06	65.85	50.39	53.73	53.18	62.71

Values with the same superscript in the same row are not significantly different (P > 0.05) Duncan's test.

There was no significant difference (P > 0.05) in the moisture content of treatments I, II, III, IV V and VI and the control. However; the crude protein contents (35.38 – 35.81g/100g) was unaffected by boiling.

The crude fibre, lipid, ash and NFE increased significantly (P < 0.05) after 20 minutes boiling but decreased significantly (P < 0.05) when boiling period gradually increased to 65 minutes. These decreases could be as a result of leaching of these nutrients from feeds with increase in temperature. These changes were similarly reported in corn and groundnut meals (Ufodike and Matty, 1983) and in Alfalfa, soya-bean and corn meals (Mgbenka and Lovell, 1987).

Weight gain is known to be the most important criterion for measuring fish responses to experimental diets and a very reliable indicator of growth (Lovell, 1989). Table 4 shows that the mean weight gain increased significantly (P < 0.05) with diet IV and decreased with diet VI.

Table IV. Growth performance of *O. niloticus* fed experimental diets

Diet	Initial mean wt. (g)	Final mean wt. (g)	Wt. gain (g)	Mean wt. gain (g)	Specific growth rate (SGR)	Feed conversion ratio (FCR)	Protein Efficiency ratio (PER)	Apparent Net protein utilization	Digestibility	Survival rate (%)
I	5.66	7.67	2.01	0.34	0.0036	0.74	0.017	24.78	60.64	80
II	5.68	7.67	2.01	0.34	0.0039	0.80	0.022	66.97	79.49	90
III	5.89	8.02	2.13	0.36	0.0037	0.76	0.021	65.43	78.80	90
IV	5.39	7.84	2.45	0.41	0.0040	0.62	0.026	56.19	80.00	95
V	5.57	7.88	2.31	0.39	0.0042	0.85	0.024	64.84	77.77	95
VI	5.64	7.72	2.08	0.35	0.0043	0.77	0.052	50.73	67.47	100
MSE	-	-	-	0.014	0.0012	0.062	0.0009	0.083	-	-

Values with same superscript on the same column are not significantly different (P > 0.05) Duncan's test

Table V. The proximate carcass composition (g/100g) of *O. niloticus* before and after feeding period

Components (g/100g dry wt.)	Initial composition	Final composition after feeding period I	II	III	IV	V	VI
Ash	28.3	21.41	25.26	21.59	20.11	17.62	18.55
Lipid	15.7	4.82	4.96	3.45	3.04	3.45	3.18
Protein	51.21	61.90	64.22	64.49	61.16	64.19	58.61
Carbohydrate	4.79	11.87	14.56	10.47	15.69	14.74	20.66

The decrease in weight gain with diets boiled up to 65 minutes may be attributed to heat denaturation and destruction of the plant protein. This was similarly reported in feed formulated for koi carp (*Cyprinus carpio*) Ipinjolu, 2000). The significantly higher (P < 0.05) specific growth rate (SGR) in fish fed experimental diets than that of control indicated that those diets contain more growth factors than the control diet. The feed conversion ratio (FCR). protein efficiency ratio (PER) and apparent net protein utilization (AppNPU) all three growth indices increase from the raw experimental diet to diet IV (boiled for 50 minutes). These increases reflect increase in the weight gains of the fish. Compared with other fishes. *O. niloticus* digest better nutrients in the experimental diets treated at the various temperatures up to 50 minutes boiling and the fish does not utilize crude protein in uncooked *R. communis*.

Apart from this reason, high level of anti-nutrient and low palatability could result in low consumption and utilization (NRC, 1981, Pompa, 1982). The gradual decrease in FCR, PER and AppNPU observed in diets from boiling *R. communis* above 50 minutes could be attributed to toxic effect of higher carbohydrate concentration and lower dietary protein resulting from heat denaturation and destruction (Cowey and Sargent, 1979).

There was clear correlation between digestibility and survival rate up to diet IV (boiling period of 50 minutes). The survival rate increased with increased digestibility. This could be attributed to gradual reduction in the activity of digestive enzyme inhibitiors (trypsin and chemotrypsin) which affect the utilization of amino acids in any diet (Jobling, 1981). The ricin content of seeds is to be responsible for low digestibility which is known to reduce with heat hence improved digestibility (Ravindran and Sivakanesan, 1996). The significantly higher ($P < 0.05$) fish carcass protein and carbohydrate (source of energy) at the end of the experiments clearly indicate that the fish growth could be associated with tissue-protein-carbohydrate synthesis arising from the higher digestibility of the diet (Gall. 1969). As the fish carcass protein and carbohydrate increases (Table 5), the lipid level decreases with the boiling periods of the diets. this showed that as the fish grows on the diet lots of lipids are utilized as source of energy for the deamination of the excess protein (Ufodike and Akombo, 1987).

Fish like any other animal, high intake of protein, lipid and fat conversely lead to a drop in the digestibility of these nutrients to maintain a relatively constant need for these nutrients (Cho *et al.*, 1976). These results conform in relation to *O. niloticus* fed artificial diets in aquaria. However *R. communis* have very high nutrient potentials as feed supplement after heat treatment to destroy the anti-nutrient contents. It goes to reduce the bottle-neck of high cost of fish feeds in the culture of *O. niloticus*.

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