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Utilisation of A Poultry Wastes Meal as A Replacement for Fishmeal in Diets of *Clarias gariepinus*

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Abstract

With increasing production from Nigeria's animal production sector and the attendant increased turnover in wastes generation from processing plants, there is the need to for effective utilization of wastes for a meal in animal production. The effect of replacing fishmeal with a newly available commercial poultry waste meal (PWM) in the diets of *Clarias gariepinus* was investigated. The proximate composition of PWM was determined using standard procedures. Five isonitrogenous diets (40% Crude protein) were produced using PWM to replace fishmeal at 0% (PW1), 25% (PW2), 50% (PW3), 75% (PW4) and 100% (PW5) levels. Diets were fed for 70 days at 3% body weight daily in two installments, to three hundred *C. gariepinus* (8.50±0.01g) randomly distributed into 15 plastic aquaria at 20 fish per 30L of water. Mean weight gain (MWG), Average daily weight gain (ADWG), Feed conversion ratio (FCR), Specific growth rate (SGR), Profit index (PI) and Incidence of cost (IC) were determined. Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell counts (RBC) were measured. MWG, ADWG, Feed intake, FCR and SGR showed no significant difference (P>0.05) in PW1, PW2, PW3 and PW4. Fish survival ranged from 77.77% in PW5 to 95.55% in PW3. Although PI and IC did not vary significantly in all treatments, PW4 recorded the highest PI (3.54) and least IC (0.26) values. PCV and Hb ranges between 22 to 28.01% and 4.34 to 5.62 g/dL^{-1} respectively. RBC and WBC were significantly higher (p<0.05) in PW4 and PW5 groups, while values for platelets did not show any significant variation (p>0.05) across treatments. Results of the polynomial regression reveal that the poultry waste meal can successfully replace 56% of fishmeal in the diet of *C. gariepinus* juveniles when growth is considered.

Keywords: Poultry by-product meal, fishmeal, African Catfish, wastes processing.

Introduction

Aquaculture has been described as probably the fastest growing in the food-producing sector and contributes 44.1% of total fish production globally (FAO, 2016). However, Sub-Saharan Africa aquaculture supplies only 3% of global fish production and this is largely due to the high cost of fish feed. Protein is the most expensive and important component in fish diet (Ngandzali *et al*., 2011) and is supplied mostly by fishmeal, which is highly relied upon as a good source of well-balanced amino acids in the fish diet. With a 7.05MMT annual fishmeal production globally, except in El Nino years (5-5.7MMT) depending on the severity (Hardy and Tacon, 2002), aquaculture growth exerts increasing pressure on the fishmeal industry, where increased production is unsustainable. Therefore, price of fishmeal will continue to increase, causing a further increase in the cost of fish production. This explains the concerted efforts at searching for alternative to fishmeal in fish diets; with adequate considerations given to the quality of alternative ingredients, the economic benefit, accessibility, availability, health implication to the cultured organism. Similarly, ingredients are fundamentally important in terms of both quality of resulting food products and potential effects on human health (Sapkota*et al,* 2007).

The processing of poultry generates waste in large quantities (Giri *et al*, 2000). Wastes include offal (feathers, entrails, and organs of slaughtered birds), processing waste and bio-solids. Though most of the by-products can provide organic and inorganic nutrients, however, they also give rise to potential environmental and human health concerns. Therefore, disposing these wastes is a challenge. However, finding an economical way of converting them to acceptable substitute to animal protein source has been a major challenge (Giri *et al*., 2000).

Though the replacement of fishmeal by single protein sources such as poultry by-product meal, poultry visceral and feather meals have been reported (Turker *et al*, 2005; Usman *et al*, 2007; Adewolu *et al*, 2010), none of them completely replaced fish meal. This may be attributed to nutritional restrictions associated with losses of essential amino acids during processing (Onifade *et al*, 1998) and the presence of insoluble proteins, for example in feather meal which provides mechanical resistance and impairs degradation by conventional proteolytic enzymes (Kornillowicz-Kowalska and Bohacz, 2011). However, Zhou *et al* (2004) reported that poultry by-product meal is suitable in the diet of carnivorous fish species due to its palatability, total digestible dry matter, protein content, and energy content similar to that of fishmeal. When the cost of the poultry waste meal and fishmeal are considered, then the former would seem to be a cost effective protein source in fish diet (Wang *et al*., 2006; Shapawi *et al*., 2007), and thus providing a substantial savings in production cost. This should however, be tested alongside the growth and health performance of the target species.

The introduction of a new poultry waste product into the Nigerian market thus requires some scientific testing for safety in investment of farmers and sustainable fish production. This study aims at investigating the effect of this processed poultry wastes meal as a replacement for fishmeal in the diet on the growth, haematological and economic performance of *Clarias gariepinus.*

Materials and methods

Study site and Experimental fish

The experiment was conducted at the Aquaculture Laboratory of the Department of Animal Sciences, Obafemi Awolowo. Three hundred and fifty *Clarias gariepinus* procured from a reputable hatchery were acclimatized to laboratory conditions for 14 days, during which they were fed a commercial diet (40% crude protein). After acclimatization, 300 fish (8.50±0.01g) were randomly distributed into 15 plastic aquaria at 20 fish/30Litres.

Experimental diet and schedule

Poultry waste meal (PWM) was procured from Zartech Limited Ibadan. Five isonitrogenous diets were produced with PWM replacing fishmeal at 0 (PW1), 25 (PW2), 50 (PW3), 75 (PW4) and 100% (PW5) levels (Table 1). Diets were fed to triplicate groups of fish at 3% body weight twice daily (900hr-930hr and 1600hr-1630hr) for 70 days. Fish were weighed bi-weekly for feed adjustment. Water quality parameters were monitored throughout the feeding trial.

Measurement and analysis

The proximate composition of diets and fish samples (before and after trial) was determined as described by A.O.A.C (2005). Weight gain, specific growth rate and feed conversion ratio were calculated from fish weights. Economic analysis was carried out using Profit index (PI) and Incidence of Cost (IC).

Table 1: Gross composition of PWM based diets fed to *C. gariepinus* for 70 days

Ingredient (%)	PW1	PW2	PW3	PW4	PW5
Fishmeal	22.33	18.24	13.40	7.47	-
PWM	-	6.08	13.40	22.37	33.62
Soybean Meal	22.33	22.33	22.33	22.33	22.33
GNC	22.33	22.33	22.33	22.33	22.33
Maize	14.51	13.51	12.28	10.76	8.86
Wheat offal	14.51	13.51	12.28	10.76	8.86
Lysine	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50
Dicalcium Phosphate	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
Premix	1.00	1.00	1.00	1.00	1.00
Starch	1.00	1.00	1.00	1.00	1.00
Total	100.01	100.00	100.02	100.02	100.00
Cost/Kg (N)	311.70	292.3	269.70	241.80	206.30
Calculated					
Crude protein (%)	40.01	40.00	39.98	39.99	39.97
Fat	4.70	5.97	7.51	9.40	11.75
Energy (Kcal/kg)	2770.80	2786.00	2805.70	2829.70	2852.50

Statistical analysis

Data resulting were subjected to one-way Analysis of Variance at $p<0.05$ (Using Statistical Package for Social Sciences Version 15, IBM corporation, New York, USA). Duncan's Multiple Range Test (DMRT) of the statistical package was used to compare differences between means.

Results and Discussion

Crude protein and ether extract contents of PWM presented in Table 2, falls within the range (41-53% and 12-25% respectively) reported by Fransen *et al* (1995). Ash content in the present study is however, lower than the 9-15% reported by the authors. The result of the proximate analysis of PWM shows a lower crude protein and ash contents than fishmeal, while ether extract is higher; almost thrice the value reported for fishmeal by Jensen (1990). This is reflected in higher values of calculated fat content in experimental diets with increasing level of PWM inclusion. Feed consumption was not significantly affected ($P>0.05$) by the inclusion of PWM up to 75%, but they however, vary significantly ($P<0.05$) with the PW5 groups and is reflected in the weight gain. FCR and SGR were inferior in PW5. Final weight in experimental fish ranged from 32.72g in PW5 to 58.87g in PW1. PW5 was significantly low ($P<0.05$) in final weight when compared with other treatments. Mean weight gained showed the same trend, with the highest value recorded in PW1 (50.37g).This value was however not significantly different from values recorded in PW2, PW3 and PW4.ADWG ranged from 0.34g in PW5 through 0.60g in PW4 to 0.71g in Pw1.

The lower weight gain recorded in fish fed diets containing over 75% PWM replacement of fishmeal, may be attributed to a shift in the nutrient balance in diets. In addition to the variation in the ether extract contents mentioned earlier, Adewumi *et al* (2011) reported lower lysine content in PWM compared to fishmeal and that diets containing over 75% poultry by-product meal would be deficient in this amino acid.

The relationship between the PWM levels of inclusion and the feed conversion ratio and mean weight gain are shown in Figures 1 and 2, with optimal inclusion levels 56 and 50% respectively. The relationships are best expressed by the following polynomial regression equations;

Y = -13867X3+1.0286X2+0.4181X+3.0506

RY = 3E– 0.06X^3– 0.0003X^2+0.0113X+1.2217 (R^2=0.989) *FCR*

Y = -0.0001X^3 + 0.0111X^2– 0.3528X+50.197 (R^2=0.9853) MWG

Table 2: Proximate composition of fishmeal and PWM

Ingredient	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Ash (%)	Moisture (%)
Fishmeal*	72.00	-	8-10	14.00	7.00
PWM	51.41	0.25	26.66	7.13	6.95

*According to Jensen (1990)

Table 3: Growth, nutrient utilization and economic performance of *C. gariepinus* juveniles fed Poultry waste meal based diets for 70 days

Parameter	PW1	PW2	PW3	PW4	PW5	SEM
Initial Wgt (g)	8.50	8.48	8.56	8.49	8.49	0.014
Final Wgt (g)	58.87[a]	54.49[a]	57.12[a]	50.94[a]	32.72[b]	2.963
MWG (g)	50.37[a]	46.01[a]	48.56[a]	42.45[a]	24.23[b]	2.952
ADWG (g)	0.71[a]	0.65[a]	0.69[a]	0.60[a]	0.34[b]	0.042
Feed consumed (g)	61.76[a]	62.05[a]	62.11[a]	56.91[a]	42.83[b]	2.145
FCR	1.22[b]	1.34[b]	1.27[b]	1.34[b]	1.76[a]	0.069
SGR	2.76[a]	2.65[a]	2.70[a]	2.55[a]	1.83[b]	0.109
PER	2.43[a]	2.20[ab]	2.32[a]	2.25[ab]	1.74[b]	0.089
Survival (%)	93.33[a]	86.66[ab]	95.55[a]	91.10[a]	77.77[b]	2.125
Profit Index	2.96	2.87	3.27	3.54	3.21	0.130
Incidence of cost	0.31	0.33	0.28	0.26	0.31	0.012

Values with different superscript along rows are significantly different (P<0.05)

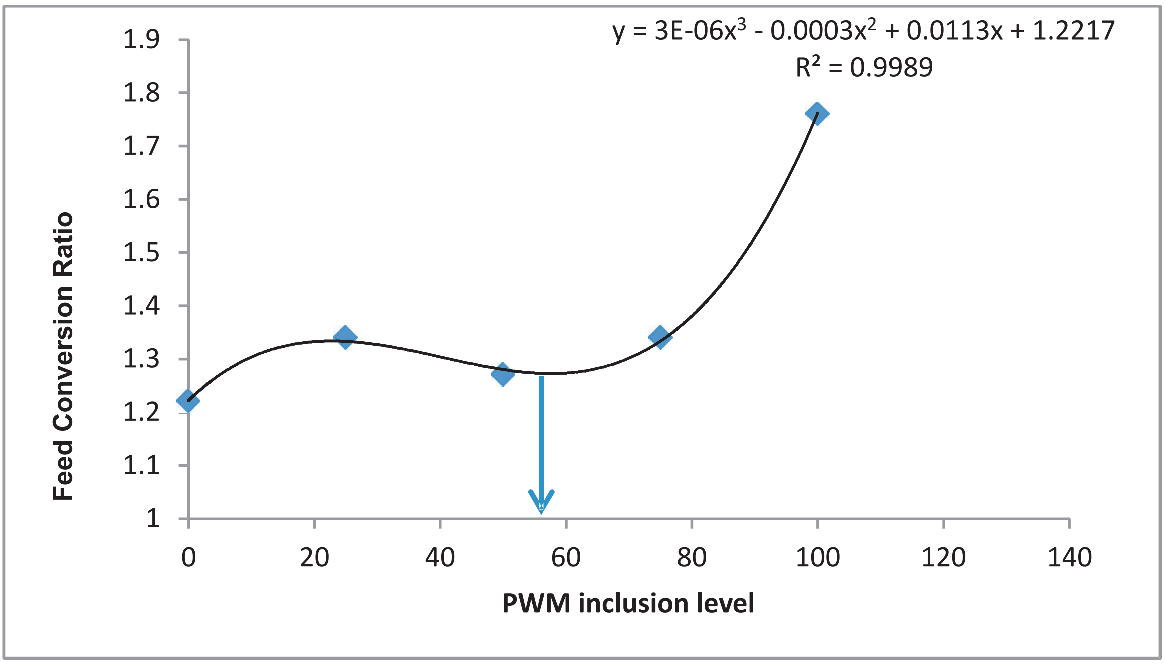

Figure 1: Relationship between inclusion levels of PWM and Feed Conversion Ratio

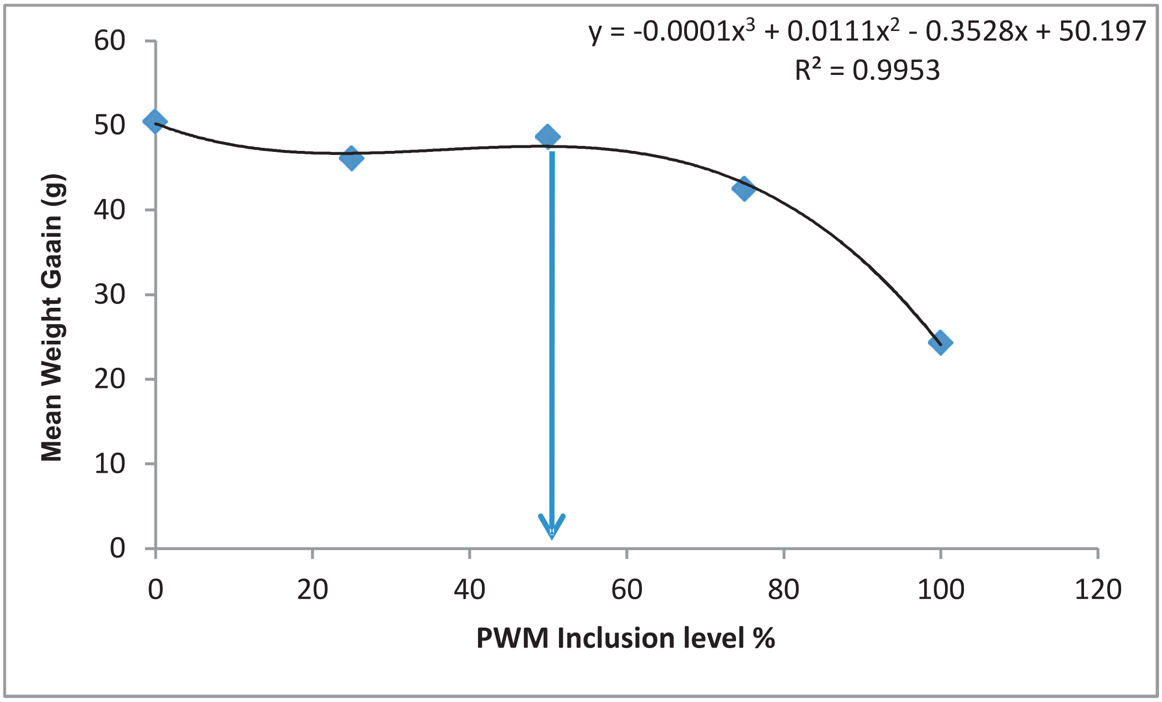

Figure 2: Relationship between inclusion levels of PWM and Mean Weight Gain in experimental fish

A case of decreased growth at inclusion levels higher than 75% was also reported in Nengas *et al* (1999); feeding gilthead sea bream with poultry by-product meal.

However, a complete replacement of fishmeal with PWM without affecting growth and nutrient utilization was reported by Yones and Metwalli (2015) and Takag *et al* (2000) in the diets of Nile tilapia and Red sea bream respectively. This is in contrast to the result in Fowler (1991), where weight gain in Chinook Salmon reduced with up to 50% replacement of fishmeal with poultry by-product meal. The result is attributed to a reduction in histidine, lysine and methionine contents of the diets. Variation in utilization observed between this present and other studies may be due to the differences in the feeding habit and nutritional requirements of the fish species. Although there was no significant difference (P>0.05) in Profit index and Incidence of cost between treatments, PW4 gave the best indices with the lowest IC and highest PI. Pooled mean water temperature, dissolved oxygen and pH in this present study are within the range recommended for freshwater fishes (El-Sayed, 2006).

The results of some haematological parameters in fish fed PWM based diets are presented in table 4. The PCV and Hb ranges between 22 to 28.01% and 4.34 to 5.62 g/dL^{-1} respectively. RBC and WBC were significantly higher (p<0.05) in PW4 and PW5 groups, while values for platelets did not show any significant variation (p>0.05) across treatments. According to De Pedro et al. (2005), haematological parameters have been used to evaluate the physiological state and immune response of fish. High values of Hb and RBC are always indicative as good health status of fish (Zhou *et al*., 2005). The white blood count of fish or any animal is a function of the immunity and the animal's resistance to some vulnerable disease, while high red blood cell count indicates high oxygen absorption and transportation capacity of the fish (Akinwande *et al*., 2004). In this present study, all monitored parameters fall within the range recommended for the culture of fish species (Clarks *et al*., 1979) showing that PWM did not negatively affect the health status of *C. gariepinus*.

Table 4: Haematological indices in *C. gariepinus* juveniles fed Poultry waste meal based diets for 70 days

Treatments	PCV	Hb (gdL^{-1})	RBC (cells x $10^6 mm^{-3}$)	WBC (cells x $10^3 mm^{-3}$)	Platelets
PW1	27.00 ± 1.00^b	5.62 ± 0.08^a	2.26 ± 0.34^d	8.13 ± 0.03^c	5.00 ± 0.00^a
PW2	22.00 ± 0.57^e	5.24 ± 0.05^a	2.16 ± 0.61^a	8.43 ± 0.06^c	5.00 ± 0.00^a
PW3	25.00 ± 0.57^d	4.34 ± 0.03^c	2.56 ± 0.00^c	9.14 ± 0.74^b	4.00 ± 0.00^a
PW4	26.03 ± 0.00^c	4.85 ± 0.26^b	3.01 ± 0.27^a	10.01 ± 0.15^a	5.00 ± 0.00^a
PW5	28.01 ± 0.10^a	4.67 ± 0.11^{bc}	2.97 ± 0.01^b	9.78 ± 0.02^a	4.00 ± 0.00^a

Conclusion

The results of this study suggest that the commercial poultry wastes meal can successfully replace up to 56% fishmeal in the diets of *C. gariepinus* juveniles, when growth and economic performances are considered. However, further study is required on the fish produced using this meal, considering the fat content in diet.

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