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Growth Performance of Broiler Chicken Fed Increasing Levels of *Limicolaria aurora* (Gardensnail) as Replacement for Fish Meal

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Authors' contributions

This work was carried out in collaboration between the three authors. All authors designed the study, wrote the protocol, supervised the conduct of the experiment and wrote the first draft of the manuscript. The three authors managed the analysis and statistical analysis. The three authors read and approved the manuscript

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ABSTRACT

The study was designed to investigate the response of broiler chickens to diets containing levels of *Limicolaria aurora* meal as replacement for fish meal. The experiment involved five treatments with three replicates per treatment in a Completely Randomized Design, and was carried out in the Teaching and Research Farm of the University of Calabar, Nigeria, between July, 2014 and Sept., 2014. A total of three hundred, one week old unsexed broiler chicks were randomly allotted to five dietary treatments consisting of three replicates of 20 birds each. Five experimental diets were formulated such that the control diet (Treatment 1 (T1)) contained 4% fish meal (FM), which was replaced with 25%, 50%, 75% and 100% of *Limicolaria aurora* meal for other treatments: T2, T3, T4 and T5 respectively. After 21 days of feeding the experimental (starter) diet, two hundred and forty of the birds were re-randomized and alloted to 5 finisher diet treatments, each with three replicates, and the same levels of replacement of FM with LM. The

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results of the proximate composition showed that ash content was higher in FM (14.39) than in LM (7.83), while ether extract content in LM (7.00) was higher than in fishmeal FM (5.11). Crude protein and crude fiber contents of LM and FM were not statistically different between treatments. Only crude fibre utilization showed significant (*P=0.05*) increase as the level of LM in the diet increased. Feed intake at both the starter and finisher phases did not differ significantly between diet groups. The final body weight, weight gain and feed conversion ratio were significantly (*P=.05*) superior at 50% replacement level, while differences between these parameters at the 50%, 75% and 100% replacement levels were not statistically significant. The results indicate that significantly (*P=.05*) lower performances in respect of the above parameters were observed in broilers in the control and the 25% replacement diet groups. The abdominal fat deposit did not differ across the treatment groups. Cost of feed per kg and cost of feed per kg weight gain (N) increased significantly as the level of LM increased in the diet. It was concluded that LM can replace FM in broiler chickens diet at the 50% replacement level with lower feed cost and improved growth performance.

Keywords: Limicolaria aurora; fish meal; broiler chickens.

1. INTRODUCTION

In poultry production, it is a known fact that feeding alone accounts for over 70 to 80 percent of the cost of production in developing countries including Nigeria [1]. High feed cost can be attributed partly to animal protein source of which fish meal is most common.

The importance of fishmeal in broiler production is immense; it is an ingredient with high amount of nutrients that are highly digestible. Fishmeal is the best suited animal source of protein utilized to attain the nutrient requirement of livestock and poultry, as it comprises high level of protein and appreciable quantity of fat and minerals [2]. Also, the protein content of fish meal has been assayed to be high in biological value due to the presence of limiting amino acids [2]. In addition, it supplements any deficiency of amino acids in soybean meal, groundnut cake and cotton seed cake [3].

In recent years, there have been several studies carried out to search for local alternative animal protein sources of feed ingredients to either partially or completely replace fishmeal so that so that feed cost in formulating poultry diets can be reduced [2]. By-products such as meat meal, silkworm pupae meal, liver residue meal and so on, thou available in minute quantities, have been used to bridge the gap in the supply of animal protein and lower feed cost [4]. Other unconventional protein sources that have been used include maggot from poultry droppings [5], waste products from poultry processing plants, offal meal, chicken offal meal [6,7], sundried shrimp waste meal [8-10] and termite meal [11]. These sources and more when used as substitute for fish meal, yielded remarkable results, reduced cost and increased profits with no negative effect on growth performance.

Snail species are suitable for studies due to the low cost of acquiring them [12]. There is a wide variety of this shell bearing invertebrate of either European or African origin having their habitats in either land or water [13].

Snail meat is rich in protein (56-60%), and iron (45-50 mg/kg), high in calcium, phosphorus, vitamin B-complex, vitamin C, contains almost all the amino acids required by humans, and is low in sodium, fat and cholesterol [14].

Snails are cheap to rear at both subsistent and commercial levels, while also yielding high returns [14]. Snail meat is a cheaper source of protein than conventional livestock protein sources such as beef, chicken, pork, mutton or chevron [15]. Snails are widely distributed throughout the world [16]. In some of these areas, snails are considered a pest to food crops [16]. It has been observed that *Limicolaria aurora* as well as the other land snails are found throughout the moist forest belts of Nigeria, Republic of Benin, Togo, Ivory Coast, Liberia and Sierra Leone [17]. Snails are sold live in Nigerian markets according to their sizes. The *Limicolaria* species is less in demand compared to rather the bigger sized snails such as *Archachatina marginata, Archachatina papyracea and Archachatina achatina*.

Studies involving the feeding of broilers and layers with snail meal have been reported [17]. It has been reported that broiler birds fed a diet with 15% inclusion of dried boiled snail meal had

similar weight gains as those fed the control diet [18,19]. It has also been shown that while it is less expensive raising broilers on diets containing snail meal than it is using diets containing fishmeal, bone meal and meat meal, snail meal can easily replace meat meal in broiler diets [20]. The studies concluded that snail meal is a suitable protein source in broiler diets as the final body weights were not affected by different protein sources (dried shelled snail meal, fish meal and meat meal).

Though there is scarcity of information on the use of *Limicolaria aurora* meal in broiler diets, available literature indicates that *Limicolaria aurora* meal will be a good source of protein and can replace the more expensive fishmeal in broiler diets.

2. MATERIALS AND METHODS

2.1 Location of Study

The experiment was conducted at the University of Calabar Teaching and Research Farm of the Department of Animal Science, Calabar, Nigeria, between June, 2014 and August, 2014.

2.2 Collection and Preparation of Samples

The test material *Limicolaria aurora* snails were gathered from different sources in Calabar, Cross River State, Nigeria. The snails were washed thoroughly and steamed for five minutes to ease separation of soft part (foot tissue) from the shell. The flesh was then oven dried at 70℃ after which they were ground and reduced to powdery form using an electric blender (National) and stored in an air tight container as *Limicolaria aurora* meal (LM) for use. The representative samples were analyzed for proximate and mineral content (Table 1).

2.3 Experimental Birds, Diets and Management

A total of 300 seven-day old broiler chicks of Elite strain were used in this study. They were balanced for weight and randomly divided into five groups of 60 chicks per group in a completely Randomized Design. Each group was further divided into three replicates of 20 birds each. Feed and water were provided *ad libitum*. The starter phase lasted for 28 days. Thereafter, 240 birds were re-randomized after weighing and re-distributed to the finisher treatment diets with each treatment having 48 birds. Each treatment was replicated thrice with 16 birds per replicate. The finisher phase lasted for 35 days; at the end of the experiment 6 birds per replicate were randomly selected and kept in metabolic cages for faecal collection. The birds were allowed 4 days of adaptation period to their different diets followed by 3 days of total collection of droppings. The droppings were collected every morning and stored at 18℃. Each treatment sample was pooled and representing samples analyzed for proximate components.

Five experimental diets were formulated for starter and finisher birds such that diet 1(T1) 4% fish meal was replaced by *Limicolaria aurora* meal(LM) at 25% (T2), 50%(T3), 75%(T4) and 100% (T5) levels.

2.4 Chemical Analysis

The proximate analysis [21] of the test ingredient *Limicolaria aurora*, the diets and faecal samples were determined.

2.5 Statistical Analysis

All the data collected were subjected to Analysis of variance (ANOVA) [22]) significant means were compared using Duncan's Multiple Range Test [23].

Table 1. Proximate composition of *Limicolaria aurora* meat meal

Proximate composition (%)			
Components	***Limicolaria aurora* meal**	**Fish meal**	**SEM**
Dry matter	86.36	92.28	1.18
Crude protein	65.08	62.06	2.14
Crude fibre	3.06	2.77	0.08
Ether extract	7.00^{a}	5.11^{b}	0.06*
Ash	7.83^{b}	14.39^{a}	1.24*
Nitrogen free extract	17.19	15.65	1.66

^{abcd}: Means on the same row having different superscripts are significantly different (P=.05)

Table 2. Gross composition of broiler starter diets containing *Limicolaria aurora* meal as replacement for fish meal

Levels of replacement of fish meal with *Limicolaria aurora* (Garden snail)					
Ingredients	**0%**	**25%**	**50%**	**75%**	**100%**
	T1	**T2**	**T3**	**T4**	**T5**
Maize	54.14	54.14	54.14	54.14	54.14
Wheat offal	5.86	5.86	5.86	5.86	5.86
Soybean meal	30.11	30.11	30.11	30.11	30.11
Palm Kernel meal	2.89	2.89	2.89	2.89	2.89
Fish meal	4.00	3.00	2.00	1.00	0.00
LM	0.00	1.00	2.00	3.00	4.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Vitamin premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
% CP	23.97	24.11	24.15	24.19	24.23
M.E.(Kcal/kg)	2890.40	2895.12	2900.07	2905.13	2910.00
Determined analysis					
Dry matter (%)	90.14	90.16	90.16	90.17	90.16
CP	23.23	23.27	23.31	23.33	23.41
CF	3.73	3.72	3.74	3.72	3.72
EE	4.33	4.40	4.56	4.69	4.80
Ash	6.21	6.32	6.35	6.36	6.39
Calcium	1.21	1.21	1.22	1.21	1.21
Phosphorous	0.61	0.63	0.64	0.67	0.68

Table 3. Gross composition of broiler finisher diets containing *Limicolaria aurora* meal as replacement for fish meal

Levels of replacement of fish meal with *Limicolaria aurora* (Garden snail)					
Ingredients	**0%**	**25%**	**50%**	**75%**	**100%**
	T1	**T2**	**T3**	**T4**	**T5**
Maize	58.22	58.22	58.22	58.22	58.22
Wheat offal	8.38	8.38	8.38	8.38	8.38
Soybean meal	20.00	20.00	20.00	20.00	20.00
Palm Kernel meal	5.00	5.00	5.00	5.00	5.00
Fish meal	4.00	3.00	2.00	1.00	0.00
LM	0.00	1.00	2.00	3.00	4.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Vitamin premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
% CP	20.65	20.69	20.73	20.77	20.81
M.E.(Kcal/kg)	3000.10	3005.55	3010.61	3015.43	3021.00
Determined analysis (%)					
Dry matter	90.16	90.21	90.20	90.14	90.11
CP	19.87	19.90	19.91	19.97	19.98
CF	5.43	5.44	5.45	5.44	5.46
EE	4.17	4.47	4.50	4.64	4.73
ASH	6.24	6.28	6.29	6.28	6.29
Calcium	1.20	1.21	1.20	1.20	1.22
Phosphorous	0.58	0.54	0.55	0.57	0.59

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Proximate composition of *Limicolaria aurora* (garden snail) meat meal and fish meal (Table 1) revealed that apart from Ash and ether extract that were significantly (*P=.05*) lower in LM than FM, both ingredients have statistically similar crude protein, crude fibre and nitrogen free extract levels. The high level of ash (14.00%) observed in fish meal is in accordance with the range of 10.00 to 25.00% [23] and 18.82 and 19.80% [24]. The high ash content in this study could be as a result of high level of mineral content noted in fish meals which is as a result of the presence of high level of calcium and phosphorus in fish meal [25].

The crude protein level of *Limicolaria aurora* meal (65.08) obtained in this study was within the levels of 60 to 70% [25], 62% [26], 62.4% [27] and 71.75% [28] and was higher than 47.89 [29]. The variation in values of crude protein could be as a result of differences in the processing methods used by the different authors. Drying of snail meat meal denatures certain proteins [27]. Differences in Crude protein levels could be due to differences in breed/strain of the snails [25-28]. This result however, confirms that snail meat is a good source of protein [30,28].

The ether extract of *Limicolaria aura meal* (7.00%) was very close to the 7.85% [24] but lower than 8.82% [31]. Variation in the diets and weather conditions may also affects the ether extract content of snail meat [32]. However these values are lower when compared to that of chicken egg 9.60%, mutton 21.40% and duck 23.00%, which means that snail meat could aid in the reduction of the high incidence of fat related diseases [33]. Other studies have reported that the right antidote for patients suffering from heart diseases, hypertension and diabetes is snail meat [34,35].

3.2 Starter Phase

3.2.1 Feed intake

At the end of the 28 days feed intake was not significantly affected by the replacement level of FM with LM. This is an indication that the test ingredient did not affect the flavor, palatability and fibre levels of the diets which are often responsible for a change in feed intake [34].

3.2.2 Feed conversion ratio

There was improvement in the feed conversion ratio, with birds on diets containing 50% LM and 50%FM having the most favorable than other treatments groups. This shows that the mixture of FM meal and LM meal in a ratio of 1:1 improves feed conversion to meat than any other ratio of combination. This could be due to effective augmentation of any deficiency that could have been associated with using either of the ingredients.

3.2.3 Final body live weight and weight gain

The final live weight and weight gain also showed similar trend as the FCR, as the best performance was obtained from birds in treatment diet 3 with 50% LM and 50% FM. The obtained values were better than that of the control diet, but was however, statistically similar to other levels of replacement of fish meal in the diet. This observed trend shows that LM is better than FM based on the broilers growth performance indices. The observed response coincides with the observed trend by other workers [36]. In addition the positive response of broilers as the level of LM inclusion in the diets could be due their higher requirement of amino acids than energy at this phase [27,37]. Another study [37] showed that increase in snail meal in broiler diet produce a corresponding increase in weight gain.

3.3 Finisher Phase

3.3.1 The mean daily feed intake

The mean daily feed intake (MDFI) of birds over the experimental period did not differ significantly among the dietary treatments. The observed similarity in the MDFI could be certified by the isocaloric and isonitrogenous feed in all the treatments and the uniformity in the age of the birds [38].

3.3.2 Feed conversion ratio

Feed conversion ratio showed better improvement with the use of LM diets. Birds on diets 3, 4 and 5 had better FCR than both the control and diet 2. The improvement in feed conversion showed better utilization of LM in broiler diets than FM. It is thus noteworthy that the use of LM to completely replace FM in broilers diets has a place in formulating feed for broiler birds especially in areas where there is

abundance of *Limicolaria aurora* which has been a nuisance (pest) to farmers as the feeds on foliage of crops.

3.3.3 Final body weight and weight gain

The final body weight and weight gain showed similar trend with birds in treatment diet 3, 4 and 5 having statistical similar values that were significantly (*P=.05*) higher than that of the control and birds in treatment diet 1. This affirms the report of other studies [18] that final body weight was not affected by feeding increasing levels of dried shelled snail meal. It has been reported that the weight of birds fed cooked giant snail meal was better due to increased palatability [37]. Other studies have recorded excellent performance with the inclusion of snail meal without shell either boiled or raw [19].

3.3.4 Abdominal fat deposit

The abdominal fat deposit was not affected by the varying dietary inclusion of LM. The lack of significant effect contradicts the findings [27] where abdominal fat level decreased from 1.8 to 0.6% as the level of snail meal increased from 60 to 100%. The discrepancy in these values could be due to differences in the snail breed/strain used as well as variation in the diet type [37].

3.3.5 Mortality

Mortality rate showed no significant difference, an indication that LM is a safe meal for birds.

3.3.6 Nutrient digestibility

The nutrient digestibility estimates (Table 4) revealed that the replacement levels of FM with LM in the diets had no significant (*P=.05*) effect on the Dry matter, crude protein, ether extract and nitrogen free extract, apart from crude fiber that tended to significantly (*P=.05*) improved as the level of LM increases in the diets. This is an indication that LM in broilers diets encourages utilization of Crude fiber than fish meal.

Table 4. Growth performances of broiler chickens fed diet containing different levels of *Limicolaria aurora* meal

	Replacement levels of fish meal with *Limicolaria aurora*					
Parameter	**0% (T1)**	**25% (T2)**	**50% (T3)**	**75% (T4)**	**100% (T5)**	**SEM**
Chick phase						
Initial live weight (g)	211.23	210.87	209.49	213.50	215.00	3.61
Final live weight (g) at 28 days	790.43^{d}	870.45^{c}	990.50^{a}	979.45^{b}	988.35^{ab}	6.22
Daily weight gain (g)	8.15^{d}	8.60^{c}	9.94^{a}	9.02^{b}	9.03^{b}	0.25
Daily feed intake(g)	43.50	44.19	44.45	45.09	45.16	3.11
Feed conversion ratio (FCR)	5.34a	5.14ab	4.47c	5.00b	5.00b	0.27
Mortality (%)	0	2	0	0	0	0
Finisher phase						
Initial live weight (g)	967.50	970.80	960.05	950.45	965.60	3.67
Final live weight (g)	2120.00^{b}	2130.25^{b}	2250.09^{a}	2270.60^{a}	2267.48^{a}	7.99
Daily weight gain (g)	46.89^{b}	47.14^{b}	58.98^{a}	59.62^{a}	59.24^{a}	2.36
Daily feed intake (g)	125.66	126.80	130.90	129.00	129.15	8.06
Feed conversion ratio(FCR)	2.68^{a}	2.69^{a}	2.22^{b}	2.13^{b}	2.18^{b}	0.18
Feed cost per kg (N)	96.55^{a}	94.12^{b}	92.05^{c}	90.50^{d}	88.88^{e}	2.44
Feed cost per kg weight gain(N)	258.75^{a}	253.18^{a}	204.35^{b}	192.77^{c}	193.76^{c}	5.71
Abdominal fat deposit	2.03	2.17	2.41	2.43	2.60	0.12
mortality	1.00	1.00	2.00	1.00	0.05	
Nutrient utilization (%)						
Dry matter	60.88	61.87	60.23	63.45	63.49	1.19
Crude protein	59.45	62.12	63.27	65.00	65.19	2.38
Crude fiber	30.88^{d}	36.45^{c}	39.38^{b}	41.72^{b}	46.05^{a}	2.14
Ash	55.34	54.12	57.97	51.32	50.33	7.98
Ether extract	55.85	54.68	57.12	58.90	60.32	4.07
Nitrogen free extract	67.43	65.12	63.65	62.05	62.00	2.12

^{abcd}: Means on the same row having different superscripts are significantly different (P=.05)

3.3.7 Cost of feed per kg (N)

The cost of feed per kg significantly (*P=.05*) improves as the level of LM increases in the diet. This is obvious as *Limicolaria aurora* during the onset of rain in the southern part of Nigeria is always available and cheap; refers to as a pest by farmers since the attack crops foliages.

3.3.8 Cost of feed per Kg live weight gain (N)

This also affected and tended to decline (*P=.05*) as the level of LM increased in the diet. This observation was obvious as the LM not only cheap but encourages weight gain, which revealed that it was cheaper to use LM in broilers diet than using fish meal.

4. CONCLUSION

It was concluded that *Limicolaria aurora* meal can replace Fish meal in broiler chickens diet at the 50% replacement level with lower feed cost and improved growth performance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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