

Growth performance and blood indices of Nigerian indigenous male turkey on diets containing shrimp waste meal

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Abstract

Protein ingredients represent substantial proportion of the cost of turkey ration. Fish meal (FM), a vital protein ingredient is expensive and scarce. Shrimp waste meal (SWM) shows a prospect as an alternative to FM. Effects of substituting FM with SWM in the diets of Nigerian indigenous turkeys (NIT) was determined in a 112-day feeding trial using eighty (80) four weeks old male NIT. The turkeys were allotted on weight equalization to four treatment groups replicated four times with five turkeys per replicate. Four starter and grower diets were formulated such that FM was substituted with SWM at 0, 150, 300 and 450 g/kg of diets. The experiment was arranged in a completely randomized design and data collected were analyzed using ANOVA. Means of significant results were compared by Duncan multiple range test. A probability of $p < 0.05$ was considered to be statistically significant. At starter phase, turkeys fed 0 g/kg SWM had ($p < 0.05$) higher cost of feed per kilogram. Other parameters were not significantly affected by the treatments. In the grower phase, the final liveweight and weight gain of the turkeys did not significantly differ between turkeys fed control diet (0 g/kg SWM) and those fed 150 g/kg SWM. However, they differ significantly from other treatments. Serum total protein reduced ($p < 0.05$) as the levels of SWM increased in the diets. However, albumin values increased with increased SWM. It was concluded that SWM can substitute FM at 150 g/kg in the diets of NIT without any adverse effect.

Keywords: Feed conversion ratio, feed intake, haematological, protein, serum, weight gain



Performances de croissance et indices sanguins d'un dindon mâle indigène nigérian soumis à des régimes contenant de la farine de déchets de crevettes

Résumé

Les ingrédients protéiques représentent une part importante du coût de la ration de dinde. La farine de poisson (FP), un ingrédient protéique vital, est chère et rare. La farine de déchets de crevettes (FDC) montre une perspective comme alternative à FP. Les effets de la substitution de FP par FDC dans l'alimentation des dindes indigènes nigérianes (DIN) ont été déterminés lors d'un essai d'alimentation de 112 jours utilisant quatre-vingt (80) DIN mâles âgés de quatre semaines. Les dindes ont été réparties sur l'égalisation du poids en quatre groupes de traitement répétés quatre fois avec cinq dindes par répétition. Quatre régimes de démarrage et de croissance ont été formulés de telle sorte que FP a été remplacé par FDC à 0, 150, 300 et 450 g/kg de régimes. L'expérience a été organisée selon une conception complètement randomisée et les données recueillies ont été analysées à l'aide d'ANOVA. Les moyennes des résultats significatifs ont été comparées par le test de gamme multiple de Duncan. Une probabilité de $p < 0,05$ a été considérée comme statistiquement significative. Lors de la phase de démarrage, les dindes nourries avec 0 g/kg de FDC avaient ($p < 0,05$) un coût d'alimentation plus élevé par kilogramme. Les autres paramètres n'ont pas été significativement affectés par les traitements. Dans la phase de croissance, le poids vif final et le gain de poids des dindes ne différaient pas significativement entre les dindes nourries avec un régime témoin (0 g/kg FDC) et celles nourries avec 150 g/kg FDC. Cependant, ils diffèrent considérablement des autres traitements. Protéines totales sériques réduites ($p < 0,05$) à mesure que les niveaux de FDC augmentaient dans les régimes. Cependant, les valeurs d'albumine ont augmenté avec l'augmentation

de FDC. Il a été conclu que le FDC peut remplacer le FP à 150 g/kg dans les régimes alimentaires des DIN sans aucun effet indésirable.

Mots-clés : Taux de conversion alimentaire, apport alimentaire, hématologique, protéines, sérum, prise de poids,

Introduction

The ban on importation of frozen chickens and turkeys by the government of Nigeria has stimulated increased turkey production. Indigenous turkeys are now being raised intensively on a large scale to meet the ever-growing demand especially during the festive seasons. We hypothesized that incorporation of SWM in the diet of NIT will stem the demand for fish meal as the sole animal protein source in poultry diets. Turkey production requires good quality feed with high level of energy, protein, vitamins and minerals to support maximum growth. The quality and quantity of dietary protein are major factors influencing growth and feed costs (Cuzon and Guillaume, 1997). Among the main dietary components, protein is considered very essential and of immense nutritional importance. The unique roles played by protein in tissue growth, tissue maintenance and in hormonal and enzymatic functions necessitate its inclusion in the diets of poultry.

Feed cost accounts for up to 80% of the cost of production in commercial poultry enterprise with protein ingredients (soybean meal, groundnut cake, fish meal, etc.) representing substantial proportion of the cost of composite ration (Kirkpinar and Acikgoz, 2018). Prices of poultry products in the country has become very high due to high cost of poultry feeds. According to Aktaret *et al.* (2011) fish meal (FM) is the conventional animal protein feed ingredient but it is of prime concern yet because of its scarcity as well as expensive value. Presently, the cost of fish meal in Nigeria is not affordable by majority of small to medium scale poultry practitioners, a situation which has forced many poultry farmers out of business. The prices of commercial poultry feed in Nigeria have risen astronomically with an associated problem of compromised nutritional quality.

In an attempt to solve these problems, shrimp waste meal (SWM) has been identified as a good potential alternative for fish meal (FM). Shrimp waste meal (SWM) is basically the dried waste of the shrimp industry, consisting of the heads, hulls (shell) and in some

instances, whole shrimp, and a certain percentage of fish and small crabs that are caught when shrimps are harvested (Ingweyeet *et al.*, 2008). According to Sánchez-Camargo *et al.* (2011) and Adeyeye *et al.* (2022) dried shrimp waste has high protein and ash contents. Mostly shrimp waste is disposed due to the lack of appropriate processing methods for utilization, which is not only a loss of potentially valuable industrial waste, but also environmental concerns and health challenges arising from the dumping and decomposition of the waste (Kaur and Dhilon, 2015).

Utilization of SWM as alternative protein source by egg and meat-type chickens is well documented (Oduguwaet *et al.*, 2004; Ojewola and Annah, 2006; Okonkwo *et al.*, 2012) in broiler chicken production. It was reported that SWM can be included up to 10% (Okoye *et al.*, 2005) and 15% (Khempakaet *et al.*, 2011) in the diet of starter and finisher broiler chickens. However, there is limited information on the utilization of SWM by turkeys. Therefore, this study seeks to find out the growth performance and blood indices of Nigerian indigenous growing turkeys fed diets containing SWM as substitutes for FM.

Materials and Methods

Study area

The experiment was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun-State, Nigeria. The farm is located in the tropical rainforest vegetation zone of South-Western Nigeria on latitude 7°10' N and longitude 3°02' E. The prevailing climate is tropical humid with an average annual rainfall of 1037 mm and a mean ambient temperature of about 34.7 °C (Federal University of Abeokuta Meteorological Station).

Ethical approval

Animal Ethics Committee guidelines of the Federal University of Agriculture, Abeokuta (FUNAAB, 2014) was strictly adhered to throughout the duration of the experiment.

Collection and processing of shrimp waste

Fresh shrimp waste was collected from a shrimp processing unit of Chi industry in

Lagos, South-West Nigeria and was immediately sun dried (till constant moisture of 10-11%). The sun-drying was done for 8 hours daily by spreading the shrimp waste thinly on a clean concrete slab for three consecutive days during afternoons/evenings. The dried shrimp waste was milled to 2 mm particles using a laboratory mill at Department of Animal Nutrition, FUNAAB and stored in air-tight container and kept in a cool, dry place till use.

It was therefore hypothesized in the present study that SWM can comfortably replace FM in practical diets for growing turkeys. Chitin content was determined on the acid detergent fibre (ADF) as organic residue according to the method described by Trung and Stevens (2010). The mineral content was assayed using the Buck Scientific Atomic Absorption/Emission Spectrophotometer (Perkin Elmer Optima 4300DV ICP Spectrophotometer, Beaconsfield, UK) while phosphorus was determined using the corning colorimeter according to the method of Fiske and Subbarow (1925). The amino acids content was determined by amino acid analyser (Model S433 (SYKAM) Eresing, Germany).

Experimental diets and design

Four iso-proteinous and iso-caloric starter and grower diets were formulated in line with the recommendation of NRC (1994), such that the FM was substituted by SWM (protein for protein). at 0, 150, 300 and 450 g/kg in diets 1, 2, 3, and 4, respectively Hence, the experiment was arranged in a completely randomized design. The crude protein (g/kg) and metabolizable energy (MJ/kg) contents of the diets were balanced within the recommended ranges (NRC, 1994). The gross composition of experimental diet is presented in Table 1.

Experimental birds and management

A total of 100 day-old, male turkey poults of Nigerian indigenous strain were obtained from Foresight hatchery in Ibadan, Oyo State, South West Nigeria, for the experiment. The turkeys were brooded on deep litter for a period of 28 days pre-experimental period. During brooding, the temperature of 35 °C was maintained for the first two weeks after which it was reduced by 2 °C every week. Routine medication and vaccination schedules were strictly adhered to. Pre-starter diet was formulated, compounded (11.93 MJ/kg, 28 % CP) and fed during this period. At 29th day, 80 turkeys were selected on weight equalization

basis and used for the study. Twenty turkeys were assigned to each dietary treatment and replicated four times with five turkeys per replicate. The turkeys were managed intensively with respective experimental diets and water given *ad libitum*. The study lasted 16 weeks expressed in starter and grower phases. The experiment terminated when the birds were 20 weeks old.

Experimental procedure and data collection

The performance of the turkeys was expressed by using growth rate (weight gain), feed intake and feed conversion ratio.

Weight gain: Weekly weight gain was obtained by subtracting previous weight from present week's weights with a sensitive measuring scale.

Feed intake and feed conversion ratio

Feed intake was obtained by feed-back mechanism on daily basis. Feed intake was determined by weighing the amount of feed offered and feed refusal in each pen (replicate) on a daily basis. Feed intake per pen was obtained by calculating the difference between the total weight of feed given and weight of the refusal feed (left over feed).

Feed conversion ratio (FCR) was obtained by dividing the total feed intake with total weight gain of all birds in each pen.

Protein efficiency ratio (PER): This was calculated by dividing the weight gain by the weight of total protein in the diet consumed. Mortality was recorded as the percentage of dead turkey(s) out of the total stocked.

Blood indices

At the end of the starter and grower phases, 6 mL of blood was aseptically collected through venipuncture, divided into two equal parts, and each deposited in ethylene-diamine-tetra-acetate (EDTA) and plain sample bottles for haematological and serum biochemical analyses respectively. Haemoglobin concentration (Hb) was estimated using the cyanmethaemoglobin method (Cannan, 1958). Packed Cell volume (PCV), red blood cell (RBC) and white blood cell (WBC) counts were determined using Wintrobehaematocrit tube according to the method of Schalm (1975). Total serum protein, serum albumin, and serum globulin (Varley, 1980), serum uric acid concentration (Wootton, 1964) and serum creatinine (Bonsnes and Taussky, (1945) were measured. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were

estimated with commercial Kits (Randox test Kits, Randox Laboratories, Antrim, UK).

Table1: Gross composition of experimental diets

Phases of growth Ingredients/Shrimp waste meal (g/kg)	Starter (days 29-56)				Grower (days 57-84)			
	0 (T1)	150 (T2)	300 (T3)	450 (T4)	0 (T1)	150 (T2)	300 (T3)	450 (T4)
Maize	465	465	465	465	564	564	564	564
Soybean meal	345	345	345	345	258	258	258	258
Shrimp waste meal	0	25	50	75	0	15	30	45
Fish meal (72%)	80	68	56	43	50	42	35	27.5
Wheat offal	60	47	34	22	62	54	47	39.5
Bone meal	33	33	33	33	32	32	32	32
Oyster shell	9	9	9	9	25	25	25	25
Vit./Min.Premix ^a	5	5	5	5	5	5	5	5
Salt	3	3	3	3	3	3	3	3
Lysine	-	-	-	-	0.5	0.5	0.5	0.5
Methionine	-	-	-	-	0.5	0.5	0.5	0.5
TOTAL	1000	1000	1000	1000	1000	1000	1000	1000
Determined values (g/kg)								
ME (MJ/kg)	11.78	11.80	11.80	11.82	11.87	11.88	11.90	11.95
Crude protein	262.7	260.7	258.7	256.2	206.4	205.3	205.0	204.1
Crude fat	34.1	35.0	36.0	36.9	34.3	34.9	35.4	36.0
Crude fibre	36.3	36.6	36.8	37.1	37.3	37.9	38.1	38.8
Mineral profile (g/kg)								
Phosphorus	7.0	6.8	6.6	6.4	6.2	6.1	6.0	5.9
Calcium	14.1	13.9	13.6	13.3	18.7	18.6	18.4	18.2

Vit/min premix contained per kg of diet: Vit A 11500IU, Vit D₃ 1600IU, Riboflavin 9.9mg, Biotin 0.25mg, Pantothenic acid 11.0mg, Vitamin K 3.0mg, Vit B₂ 2.5mg, Vit B₆ 0.3mg, VitB₁₂ 8.0mg, Nicotinic acid 8.0mg, Iron 5.0mg, Manganese 10.mg, Zinc 4.5mg, Cobalt 0.02mg, Selenium 0.01mg

Statistical analysis

Data obtained were subjected into one-way Analysis of Variance (ANOVA) using general linear model procedure of the Minitab version 17. Means of significant results were compared and separated with Tukey test of the same package. A probability of $p < 0.05$ was considered to be statistically significant.

Results and Discussion**Chemical composition of shrimp waste meal**

Table 2 shows the results of the proximate composition, mineral profile, fibre fractions and amino acid profile of the SWM. The sun dried SWM contains 367.4 g/kg crude protein, 8 g/kg and 16.6 g/kg methionine and lysine, respectively while the chitin content was 156 g/kg.

The proximate composition of the present sun dried SWM is at variance with some authors that had worked on SWM. The crude protein (39.5 and 49.0 %) reported by Yugandharkumaret al. (2017) and Sanchez-Camargo et al. (2011), respectively is higher than the value gotten in the present study. Nevertheless, the CP of this study is higher than 30.4% and 24.9% reported by Brito et al. (2020) and Bellaaj et al. (2012). The CF is higher than the value reported by Okonkwo et al. (2012) but lower than the value reported by Khempakaet al. (2011). However, ether extract (EE) of 1.31% recorded for the SWM was lower than the values reported by the aforementioned authors. The ash content (16.26%) was lower than values reported by Bellaajet al. (2012) and Brito et al. (2020) but higher than the value (10.5%) reported by Ehigiator and Nwangwu. (2011). The discrepancies in values obtained in this study when compared with values reported by various authors that had worked on SWM could be attributed to the sources of shrimp waste used, composition of shrimp waste, processing and storage method used. According to Yugandharkumaret al. (2017), the chemical composition of shrimp shell waste will vary significantly depending upon the nature of the processing operation. The most common methods of processing are hand de-heading and mechanical-peeling.

Growth performance

Performance characteristics of Nigerian indigenous turkeys fed SWM as partial replacement for FM at the starter phase is

presented in Table 3. There was no significant ($P > 0.05$) difference among the treatments for

Table 2. Chemical analysis of SWM

Variables	Values
Proximate (g/kg)	
Crude protein	367.40
Crude fat	13.10
Crude fibre	116.00
Ash	162.60
NFE	340.90
ME (MJ/kg)	11.24
Mineral profile	
Phosphorus (g/kg)	2.00
Calcium (g/kg)	90.60
Zinc (mg/kg)	45.10
Iron (mg/kg)	110.00
Manganese (mg/kg)	242.90
Fibre fraction (g/kg)	
NDF	427.00
ADF	402.70
ADL	Not determined
Amino acid profile (g/kg)	
Methionine	8.00
Lysine	16.60
Arginine	16.00
Tryptophan	4.00
Threonine	14.20
Chitin	156.00

NFE = Nitrogen Free Extract, ME = Metabolizable energy, NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, ADL = Acid Detergent Lignin. Metabolizable energy Shrimp waste meal (SWM) was calculated using Ponzenga formula ($37 \times \%CP + 81.8 \times \%EE + 35.5 \times \%NFE$)

all the parameters except the feed cost/kg. All the treatments varied among one another with the turkeys fed control (0 g/kg SWM) diet having ($P < 0.05$) highest feed cost/kg and tapered through 150, 300 and 450 g/kg ($P < 0.05$) SWM diets in descending order. There was no significant ($P > 0.05$) difference for feed conversion ratio (FCR) and protein efficiency ratio (PER) among the treatments

The results of the grower phase (Table 4) indicated that final weight (FW) and weight gain (WG) ($P < 0.05$) differed among the treatments. The 0 and 150 g/kg were similar ($P > 0.05$) but differed ($P < 0.05$) from 300 and 450 g/kg ($P > 0.05$). The highest numerical values for both indices were recorded for turkeys fed 0 g/kg SWM and the lowest was

300 g/kg SWM. The mortality percentage of turkeys fed 0, 150 and 300g/kg SWM were not significantly different from each other but differs from turkeys fed 450g/kg which recorded 0% mortality. Other parameters were not significant ($P > 0.05$) among the treatment groups.

The statistical similarity in feed intake and feed conversion ratio (FCR) for all the treatments at the starter phase is an indication that SWM can conveniently replace FM at this phase. Aktaret *et al.* (2011) reported that FCR did not differ among diets at 28 days of age ($P > 0.05$) in a broiler experiment. The non-significant difference ($P > 0.05$) in feed intake of turkeys fed diets SWM when compared with the control is in tandem with Ingweyeet *et al.*, (2008). They reported non-significance among broiler chickens fed SWM in replacement for FM. This could be attributed to the pleasant aroma of SWM, especially when promptly processed thereby reducing greatly the proliferation of micro-organism that could lead to compositional changes in the SWM and likely loss of quality and freshness (Fox *et al.*, 1994). It could also be to meet their energy need as reported by Fanimot *et al.* (2004). It has been reported that chitin reduces dietary energy (Gernat, 2001) and the chitin proportion in the diets will increase as the SWM levels increase.

The results of this study contradicted the findings of Okoye *et al.* (2005) who reported a reduced feed intake when FM was substituted with SWM in the diets of broiler chickens. On their part, Islam *et al.*, (2020) reported significant difference in cumulative feed intake among different treatment means from 5th to 18th weeks of age when pullet chickens were fed SWM in replacement for SBM. The numerical increase in the values of FCR and decrease in the values of PER as the level of SWM increased in the diets could be attributed

to the superiority of FM to SWM in terms of nutrients content (Oduguwaet *et al.*, 2004)

The result of cost of producing turkey on different diets is in line with the result of Aktaret *et al.* (2011). Cost of production reduced as the level of SWM in the diets increased. This was as a result of lower cost of SWM when compared with the cost of FM. At the grower phase, beyond 150 g/kg of SWM, growth response was declined. This could be due to accumulation of chitin because at that stage, they should be able to tolerate low profile feed than the starter phase. The decline in the growth performance of the turkeys as the level of SWM increased in the diets could be attributed to the reduced nutritional profile of SWM compared to FM (Oduguwaet *et al.*, 2004). The present finding is in line with the report of Ingweyeet *et al.* (2008) and Islam *et al.* (2020). They reported decline in growth indices when SWM substituted FM in the diets of broiler chickens. The lower body weight gain could also be attributed to accumulation effect of chitin (a non-digestible part of SWM) in the gastrointestinal tract which lower digestibility and utilization of nutrients in SWM thereby reduced body weight gain in the turkeys. The fibre in SWM is in the form of chitin, which is an N-acetylated glucosamine polysaccharide which forms part of protein complex and is considered to cause low digestibility especially in poultry (Ngoanet *et al.*, 2000). Chitin functions as structural polysaccharide like cellulose.

The mortality recorded had no defined pattern and could be attributed to outbreak of Newcastle disease at the grower phase as indicated by post-mortem findings and not due to the feeding of the test ingredient as mortality was recorded in the control. However, the mortality percentages were within acceptable limits.

Table 3: Performance characteristics of Nigerian indigenous Turkeys fed SWM as partial replacement for FM at starter phase (days 29-56)

Parameters	SWM LEVEL OF SUBSTITUTION (g/kg)				SEM	P-VALUE
	0	150	300	450		
Initial weight (g/b)	400	400	400	400	0.00	-
Final weight (g/b)	1512	1507	1433	1504	28.80	0.390
Weight gain (g/b)	1112	1107	1033	1104	28.80	0.390
Feed Intake (g/b)	3475	3530	3400	3548	70.80	0.608
Feed conversion ratio	3.13	3.19	3.29	3.21	0.04	0.199
Feed Cost/kg	440 ^a	438 ^b	435 ^c	433 ^d	0.38	0.000
Cost of feed consumed (₦/b)	1531	1546	1480	1535	8.92	0.236
Feed cost/Weight gain (₦/g)	1379	1397	1432	1389	5.48	0.196

Protein efficiency ratio	1.22	1.20	1.17	1.21	0.02	0.420
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SEM, pooled standard error of means; ^{abc} Means in the same row without common letter are different at P<0.05. ; g/b = gram per bird

Table 4: Performance characteristics of Nigerian indigenous Turkeys fed SWM as partial replacement for FM at grower phase (days 57-84)

Parameters	SWM LEVEL OF SUBSTITUTION(g/kg)				SEM	P-VALUE
	0	150	300	450		
Initial weight (g/b)	1512	1507	1433	1504	28.80	0.390
Final weight (g/b)	2625 ^a	2603 ^a	2275 ^b	2293 ^b	54.50	0.002
Weight gain (g/b)	1112 ^a	1095 ^a	841 ^b	789 ^b	52.10	0.006
Feed Intake (g/b)	5976	5046	5050	4873	457	0.371
Feed conversion ratio	5.37	4.60	6.00	6.17	0.56	0.226
Feed Cost/kg	384	382	380	378	0.00	0.123
Cost of feed consumed (₦/b)	2296	1931	1922	1845	51.00	0.256
Feed cost/Weight gain (₦/g)	2063	1761	2284	2337	60.70	0.306
Protein efficiency ratio	0.91	1.05	0.82	0.79	0.07	0.138
Mortality (%)	6.67 ^a	6.67 ^a	6.67 ^a	0.00 ^b	5.77	0.052

SEM, pooled standard error of means; ^{abc} Means in the same row without common letter are different at P<0.05. ; g/b = gram per bird

Blood indices

Table 5 shows the starter phase (days 29-56) blood indices of Nigerian indigenous turkeys fed SWM as partial replacement for FM. The results showed no difference ($P > 0.05$) for all the parameters except serum total protein (STP) and serum albumin (SA) ($P < 0.05$). Turkeys fed control diet (0 g/kg SWM) were similar to those on 150 and 300 g/kg SWM ($P = 0.05$) and statistically higher ($P < 0.05$) than those fed 450 g/kg with respect to STP and SA. Other parameters show no significance ($P > 0.05$) difference among the treatments. The result of the grower phase Table 6, showed that there was no difference ($P > 0.05$) among different treatment groups for all the parameters measured.

At starter phase, the reduction in the values of the STP as the levels of SWM in the diets progressively increased could be attributed to the reduced nutritional profile of SWM compared to FM. This observation agrees with the report of Oduguwa *et al.* (2004) where SWM was used to replace FM in the diets of broiler chickens. It is a known fact that STP and albumin are good indices of the quality of dietary protein. The result of STP at the grower phase deviate from this observation

which could be due to maturity and age as opined by Okoye *et al.* (2005). They reported that as the birds increase in age the gastrointestinal tract and absorption capacity becomes more efficient in carrying out digestive processes thereby utilize chitin more than younger birds. The non-significance effect of SWM in substitution for FM in the diet of NIT on majorly all the haematological and serum indices observed is an indication that SWM at the levels of replacement did not pose any threat on the health of the birds. This attest to the nutritional adequacy of SWM in meeting the protein needs of the turkeys and that SWM is not deleterious to the health of the birds at 450g/kg SWM replacement of FM. Values obtained for the parameters across dietary treatments were within the range for healthy birds. The values of packed cell volume (PCV) and haemoglobin recorded at both phases falls within recommended ranges (Oyewole and Ajibade, 1990 and Olayemiet *al.*, 2002 respectively). The results of haematology of this study are in line with the report of Oguntoye *et al.* (2018) in an experiment with broiler finisher fed maize-cassava diet supplemented with methionine and inorganic Sulphur.

Table 5. Blood indices of Nigerian indigenous turkey fed SWM as partial replacement for FM at Starter phase (days 29-56)

Parameters	SWM LEVEL OF SUBSTITUTION (g/kg)				SEM	P-VALUE
	0	150	300	450		
<i>n values</i>	8	8	8	8		
Glucose (mmol/l)	11.05	12.19	10.87	11.35	0.37	0.188
Total protein (g/l)	46.47 ^a	41.97 ^{ab}	41.87 ^{ab}	40.20 ^b	1.33	0.027
Albumin (g/l)	30.13 ^a	27.30 ^{ab}	26.30 ^{ab}	22.62 ^b	1.27	0.006
Globulin (g/l)	16.35	14.67	15.57	17.58	1.73	0.653
Uric acid (µmol /l)	343	284	318	312	31.1	0.617
Creatinine (µmol /l)	77.79	92.82	79.56	83.10	4.42	0.146
Cholesterol (mmol/l)	3.10	3.50	3.84	4.31	0.39	0.188
AST (µkat /l)	4.99	5.07	5.47	5.35	0.19	0.316
ALT (µkat /l)	0.68	0.51	0.55	0.61	0.07	0.356

	0	150	300	450	SEM	P-VALUE
PCV (l/l)	0.30	0.34	0.36	0.30	0.03	0.363
Haemoglobin (g/l)	101	113	123	102	8.70	0.331
White blood cell (10 ⁹ /l)	22.2	15.7	22.2	21.3	3.35	0.500
Red blood cell (10 ¹² /l)	2.49	2.82	2.90	2.56	0.18	0.364

AST =Aspartate aminotransferase; ALT=Alanine aminotransferase. SEM, pooled standard of means;

^{abc} Means in the same row without common letter are different at P<0.05

Table: 6. Blood indices of Nigerian indigenous turkey fed SWM as partial replacement for FM at Finisher phase (days 57-84)

Parameters	SWM LEVEL OF SUBSTITUTION (g/kg)				SEM	P-VALUE
	0	150	300	450		
<i>n values</i>	8	8	8	8		
Glucose (mmol/l)	18.5	17.3	20.1	19.3	1.08	0.380
Total protein (g/l)	49.7	49.3	53.2	55.5	2.20	0.219
Albumin (g/l)	36.5	32.3	36.1	36.9	1.34	0.134
Globulin (g/l)	13.3	16.9	17.1	18.6	1.48	0.155
Uric acid (µmol /l)	363	412	379	553	66.6	0.242
Creatinine (µmol /l)	97.2	97.2	106	112	6.19	0.350
Cholesterol (mmol/l)	5.32	5.81	5.79	6.44	0.46	0.435
AST (µkat /l)	4.10	4.47	4.07	3.42	0.57	0.377
ALT (µkat /l)	0.41	0.39	0.39	0.49	0.03	0.082
PCV (l/l)	0.32	0.40	0.39	0.35	0.04	0.458
Haemoglobin (g/l)	106	135	132	118	13.2	0.440
White blood cell (10 ⁹ /l)	24.2	30.9	24.1	25.1	5.04	0.740
Red blood cell (10 ¹² /l)	2.59	3.27	3.18	2.85	0.32	0.465

AST =Aspartate aminotransferase; ALT=Alanine aminotransferase. SEM, pooled standard of means. ^{abc} Means in the same row without common letter are different at P<0.05

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References

Adeyeye, E A., Jegede, A. V., Idowu, O. M. O., Oso, A. O and Ogunsola, I. A. 2022. Growth performance and blood indices of growing turkeys fed diets containing shrimp waste meal *AgriculturaTropica et Subtropica*, 55: 57–64.

Aktar, M., Rashid, M., Azam, M. G., Howlader, M. A. R and Hoque, M. A. 2011. Shrimp waste and marine waste as substitute of fish meal in broiler diet. *Bangladesh Journal of Animal Science*, 40:18-22.

Bellaaj, O. G., Younes, I., Maalej, H., Hajji, S. and Nasri, M. 2012. Chitin extraction from shrimp shell waste using bacillus bacteria. *International Journal of Biological Macromolecules* 51:1196-1201.

Bonsnes, R. W. and Taussky, H. H. 1945. On Colorimetric Determination of Creatinine by the Jaffe Reaction. *The Journal of Biological Chemistry*, 158:581-591.

Cannan, R. K. 1958. Proposal for a certified standard for use in hemoglobinometry; second and final report. *Clinical Chemistry*, 4:246-251.

Cuzon, G. and Guillaume, J. 1997. Energy and Protein: Energy Ratio. In: D'Abramo, L.R., Conklin, D.E. and Akiyama, D.M., Eds., Crustacean Nutrition, Advances in World Aquaculture Vol. VI, *World Aquaculture Society*, USA, 51-70.

Ehigiator, F. A. R and Nwangwu, I. M. 2011. Comparative studies of the proximate composition of three body parts of two freshwater prawns' species from Ovia River, Edo State, Nigeria. *Australian Journal of Basic and Applied Sciences*.5(12):2899-2903.

Fiske, C. H and Subbarow, Y. P. 1925. The colourimeter determination of phosphorus. *Journal of biological Chemistry* 66:373-400.

Fox, C. J., Blow, P., Brown, J. H and Watson, I. 1994. The effect of various processing methods on the physical and chemical properties of shrimp head meal and their utilization. *Fab Aquaculture*. 122:209-226.

Gernat. A. G. 2001. The effect of using different levels of shrimp meal in laying hen diets. *Poultry Science*.60:633-636.

Ingweye, J. N., Okon, B. I., Ubuja, J. A and Essien A I. 2008. Performance of broiler

- chickens fed fish and shrimp waste. *Asian Journal of Animal Science*, 2:58-63.
- Islam, S. S., Paul, C and Islam, Md B. 2020.** Substitution of soybean meal by shrimp head (*Penaeus monodon*) in poultry ration for the performance of growing pullets SAARC *Journal of Agriculture*, 18:125-137.
- Kaur, S and Dhillon, G. S. 2015.** Recent trends in biological extraction of chitin from marine shell wastes: A review. *Critical Review on Biotechnology*. 35, 44– 61.
- Kirkpinar, F and Acikgoz, Z. 2018.** Feeding. In: Animal Husbandry and Nutrition, (Yucel, B. and TurgayTaşkin, T. Editors). p. 97-113.
- Khempaka, S., Chitsatchapong, C., and Molee, W. 2011.** Effect of chitin and protein constituents in shrimp head meal on growth performance, nutrient digestibility, intestinal microbial populations, volatile fatty acids, and ammonia production in broilers. *Journal of Applied Poultry Research* 20: 1-11.
- Ngoan, L. D, Ogle, B and Lindberg, J. E. 2000.** Ensiling technique for shrimp by-products and their nutritive value for pigs. *Asian-Australian Journal of Animal Science*, 13:1278-1284.
- NRC, 1994.** National Research council. Nutrient requirement of poultry. 9th edition.
- Oduguwa, O. O., Fanimo, A. O., Olayemi, V. O and Oteri, N. 2004.** The feeding value of sun-dried shrimp waste meal-based diets for starter and finisher broilers. *Separata de Archivos de Zootecnia*, 53: 87-90.
- Ojewola, G. S and Annah, S. I. 2006.** Nutritive and economic value of Danish fish meal, crayfish dust meal and shrimp waste meal inclusion in broiler diets. *International Journal of Poultry Science*, 5 (4):390-394.
- Okonkwo, A. C, Akpan, I. P and Isaac, L. J. 2012.** Performance and carcass characteristics of finisher broilers fed shrimp waste meal. *Agricultural Journal*, 7 (4): 270-272.
- Okoye, F. C, Ojewola, G. S and Njoku-Onu, K. 2005.** Evaluation of shrimp waste meal as a probable animal protein source for broiler chickens. *International Journal of Poultry Science*, 4:458-461.
- Oguntoye, M.A., Idowu, O.M.O., Sogunle, O.M. Akintunde, A.R. and Danladi, Y. (2018).** Haematology and serum chemistry of finisher broiler chickens fed maize-cassava diet supplemented with methionine and inorganic sulphur. *Nigerian Journal Animal Science*. 20 (1): 152-162
- Olayemi, F. O., Alaka, O. O. and Sanni, A. A. 2002.** Effects of infectious coryzadisease in growing turkeys on some erythrocyte parameters. *African Journal of Biomedical Research*. 5:85-88.
- Oyewole, J. O. and Ajibade, H. A. 1990.** The osmotic fragility of erythrocytes of turkeys of two age groups. *Veterinary Arhivos*. 60:91-100.
- Schalm, O. W., Jain, N. C and Qureshi, M. Q. 1975.** *Veterinary Hematology*, 3rd Edition. Lea and Fibinger, Philadelphia.
- Sánchez-Camargo, A. P., Meireles, M. A. A., Lopes, M. B. L. F. and Cabral, F. A. 2011.** Proximate composition and extraction of carotenoids and lipids from Brazilian red spotted shrimp waste (*Penaeus paulensis*). *Journal of Food Engineering* 102: 87–93.
- Trung, T. S. and Stevens, W. F. 2010.** Recovery of chitin and protein from shrimp waste. *Journal of Fisheries Science and Technology* 2: 3–10.
- Varley, H., Gowenlock, A. H. and Bell, M. 1980.** *Practical Clinical Biochemistry. Clinical Chemistry*, Volume 1 pp 1277. Heinemann, London.
- Wootton, I. D. P. 1964.** *Micro analysis in medical biochemistry*, 4th ed., Churchill, London. Pp 409.
- Yugandharkumar, M., Ramana, J. V., Ravi, A., Suresh, J. and Sivakumar, A. V. N. 2017.** Effect of supplementation of Shrimp waste on the immune response, haematological characters and lipid profile in crossbred weaned piglets. *International Journal of Science, Environment and Technology*, 6: 2329-2334.

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