

Comparative assessment of Noiler chicks fed dietary of toasted bambara nut sievate-yam peel meal composite with or without Lactic Dry[®] as replacement for maize

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ABSTRACT: A 42-day feeding trial was conducted to assess the responses of Noiler chicks to dietary replacement of maize with toasted bambara nut sievate-yam peel meal composite (TBNS-YPMC), with or without Lactic Dry[®] (LD), using 180 14-day-old Noiler chicks. Birds were divided into two groups of 90 birds. Each group was subdivided into 3 subgroups of 30 birds and replicated 3 times with 10 birds. The experiment was a 2 x 3 factorial arrangement. The first group was offered diets: T1: 0, T2: 20 and T3:40% of TBNS-YPMC replacing maize, respectively, without LD, while the second group had the same diets with LD. Results revealed that birds on 20% TBNS-YPMC had the best FCR (3.63±0.11). The interaction effect revealed that birds fed a diet containing 40% TBNS-YPMC without LD had least DFI (48.26±3.90 g/bird). Birds fed the control diet without LD and the diet containing 40% TBNS-YPMC with LD had poor FCR (4.38±0.05). The diet containing 40% TBNS-YPMC without LD had the least cost per kg of diet (₦331.74) and the highest profit (₦425.32). Apparent digestibility/retention of Crude protein (CP), dry matter (DM), ether extract (EE) and ash were lowest for birds on the diet containing 40% TBNS-YPMC with LD. Results on the main effect of replacing maize with TBNS-YPMC revealed that lymphocytes were highest and similar (48.50±0.76%) in birds fed diet containing TBNS-YPMC. Birds on a diet containing 20% TBNS-YPMC without LD had least Aspartate Amino Transferase (AST) and Alkaline Phosphatase (ALP). It is concluded that replacing maize with 40% TBNS-YPMC in Noiler chicks' diets without LD did not affect growth, nutrient digestibility, blood profile, reduced cost per kg of diet and increased gross profit.

Keywords: Blood, Noiler, digestibility, growth, sievate and peel.

INTRODUCTION

There is a general crash in prices of agricultural produce in Nigeria due to massive importation of these products recently. However, the so-called hurried solution to skyrocketing prices of conventional feedstuffs would only provide a short-term solution; hence, there are no corresponding subsidies on the cost of crop farmers' inputs (Uza *et al.*, 2024). Thus, discouraging crop farmers from gainful engagement in farming activities. This will invariably lead to an increase in the cost of animal

production, which subsequently translates to high costs of animal protein sources in the country (Uza *et al.*, 2024). Therefore, the need for sustainable poultry meat and egg production to provide safe and quality dietary protein in human nutrition has been underscored in Nigeria (Nasiru *et al.*, 2023).

In an effort to overcome this challenge, research towards exploring alternative strains of birds, such as Noiler and feed ingredients like crop waste, among others, which are

available at relatively low cost to boost animal protein consumption among the populace by reducing production cost when incorporated in livestock feed, becomes indispensable (Uza *et al.*, 2025). It has been reported that average protein per capita daily consumption of most Nigerians is 45.4 g and below, compared with the global average of 64 g, while the value recommended by the Food and Agriculture Organisation (FAO) is 53.8 g per day per person (Okojie, 2021).

It has become important to use Noiler chickens due to their proven hardiness, activeness, ease to manage, dual-purpose nature, being less susceptible to diseases and ability to adapt to harsh conditions, just like the local chickens (Akinbola, 2023). According to Animashahun *et al.* (2022), noiler chickens are affordable, cheaper to maintain and capable of scavenging for feed and water, similar to our local chickens. Similarly, the crop waste of interest in this study is bambara nut sievate (BNS), a product obtained after milling bambara nut and sieving it using a 2 mm sieve (Uza *et al.*, 2021). It can be incorporated into the diets of livestock to boost their performance and reduce the cost of their edible products. Nutritionally, raw and toasted bambara nut sievate contains 93.21 to 98.83% dry matter, 10.98 to 13.13% crude protein, 25.38 to 27.62% crude fibre, 48.90 to 52.00% nitrogen-free extract, 2.66 to 4.60% ash and 2,260.87 to 2,625.94 Kcal/Kg of Metabolisable energy (Uza *et al.*, 2021). Yam peel is a by-product of yam processing obtained after peeling yam tubers. Adegun (2020) reported that the proximate nutrient composition of yam peel contains dry matter (82.3%), crude protein (10.2%), ash (7.2%), ether extract (1.2%), crude fibre (13.3%), NFE (68.1%) and metabolisable energy (3020 Kcal/Kg). Protein and sweet aroma contribution from toasted Bambara nut sievate would complement such deficiency in yam peel meal; hence the rationale for 1:1 combination. It is indispensable to assess the digestibility of nutrients in the feed offered to the experimental birds. Nutrient digestibility entails the amount of nutrients that have been efficiently utilised by the animal. It is therefore important to evaluate how well the birds have used the diets; hence, the presence of fibre and other anti-nutritional factors in unconventional feedstuffs could hamper adequate nutrient intake and utilisation by the birds (Uza *et al.*, 2025).

The need to evaluate haematological and serum biochemical constituents of livestock fed diets containing crop waste becomes very important; hence, it is considered a valuable tool for monitoring feed toxicity that could affect the health status of any farm animal fed such diets (Oyawole and Ogunkunle, 2004). This study evaluated the response of Noiler chicks, apparent nutrient digestibility, haematological and serum biochemical constituents fed dietary replacement levels of maize with toasted bambara nut sievate-yam peel meal composite with or without Lactic Dry®.

MATERIALS AND METHODS

Location of the study

The study was conducted at the Poultry Unit of the Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi, Nigeria. Makurdi lies at the geographical coordinates of latitude 7°44' north and longitude 8°22' east, with an ambient temperature range of 17.3-35.6°C and a relative humidity of 47-48% (Google Earth, 2026).

Collection and preparation of bambara nut sievate (BNS) and yam peel (YP)

BNS was purchased at Ushongo, Benue State. 5 kg of raw BNS was thoroughly mixed with 500 ml of water and toasted at a temperature of 70 to 80°C for 35 to 40 minutes using a big aluminium frying pan. The toasting material was turned frequently and cautiously to avoid charring until the material turned light brown with a sweet smell. Thereafter, the toasted material was allowed to cool to room temperature (25°C) before use. Fresh YP was collected from local farmers in Makurdi, washed and sun-dried to a constant weight. The dried yam peel was milled for use.

Experimental diets

Six (6) diets were formulated with toasted bambara nut sievate and yam peel meal (TBNS-YPM) mixed (1:1) to form a composite that replaced maize in the diets at 0, 20 and 40% with or without LD and denoted as T1, T2 and T3, respectively (Table 1). LD was supplemented in some diets at 25 g/100 Kg diet.

Experimental design and management of birds

A total of 180 14-day-old Noiler chicks were divided into 2 main groups of 90 chicks. Each group was further subdivided into 3 sub-groups of 30 birds and replicated thrice with 10 birds each. The first group was offered diets: T1: control, T2: 20% and T3:40% of TBNS-YPMC replacing maize, respectively, without Lactic Dry®, while the second received the same diets with Lactic Dry®. The experiment was a 2 x 3 factorial in a completely randomised design that lasted 42 days. Feed and water were offered to the birds *ad libitum* throughout the study. Gumboro, Newcastle "lasota" and Fowl pox vaccines were administered on the 7th and 14th day and at 8 weeks of age via drinking water and web puncture, respectively. Vitalyte was given after vaccination, during changes of litter materials, during handling and during weighing. Antibiotics

Table 1. Ingredients and nutrient composition of Noiler chicks' starter diets containing graded replacement of maize with TBNS-YPM Composite.

Ingredients (Kg)	Dietary replacement levels of Maize with TBNS-YPM Composite (%)					
	No Lactic Dry®			Lactic Dry® (25 g/100 kg)		
	0	20	40	0	20	40
Maize	31.33	25.06	18.80	31.33	25.06	18.80
TBNS-YPMC	00.00	6.27	12.53	00.00	6.27	12.53
FFSB	54.27	54.27	54.27	54.27	54.27	54.27
Maize Offal	10.00	10.00	10.00	10.00	10.00	10.00
Bone ash	3.50	3.50	3.50	3.50	3.50	3.50
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100
Analysed Proximate Nutrients Composition						
Crude protein	24.06	26.25	26.25	24.06	26.25	26.25
Crude fibre	3.99	5.62	6.89	3.99	5.62	6.89
Ether Extract	8.29	10.42	8.33	8.29	10.42	8.33
Ash	14.76	14.96	13.55	14.76	14.96	13.55
Moisture	4.21	4.15	4.15	4.21	4.15	4.15
ME (Kcal/Kg)	3,150.44	3,187.50	3,096.42	3,150.44	3,187.50	3,096.42

Vitamin and mineral premix contains vitamin B₁, 1.00 g; vitamin B₂, 6.00 g; vitamin B₁₂, 0.02 g; vitamin K₃, 3.00 g; vitamin E, 3.00 g; biotin, 0.05 g; folic acid, 1.50 g; choline chloride, 250.00 g; nicotinic acid, 30.00 g; calcium-pantothenate, 15.00 g; cobalt, 0.40 g; copper, 8.00 g; iron, 32.00 g; iodine, 0.80 g; zinc, 40.00 g; manganese, 64.00 g; selenium, 0.16 g, BHT, 5.00 g. Lactic Dry® contains per kg: *Saccharomyces cerevisiae*, 5,000.00 × 10⁹ cells; *Bacillus subtilis*, 2.20 × 10⁹ CFU; lactic acid bacteria, 77.00 × 10⁹ CFU; *Streptococcus faecium*, 44.00 × 10⁹ CFU; vitamins B₁ and B₆, 5.10 and 6.50 mg; carrier, distiller's grain (up to 1.00 kg). TBNS-YPMC - toasted bambara nut sievate-yam peel meal composite. Metabolizable energy was calculated using Ponzenga (1985).

and coccidian drugs were also administered when the birds were feeling sick and soft brownish faeces were seen on the litter materials.

Data collection

Growth performance

Feed intake: The birds were served a weighed quantity of feed, and the corresponding leftover feed was weighed and recorded at the end of the week. Daily feed intake was determined as the difference between the quantity of feed offered and the quantity of feed leftover, divided by the total number of birds alive and then by 42 days.

Weight gain: The birds were weighed at the beginning of the experiment and weekly thereafter. The body weight gain was calculated as the difference between initial body weight and final body weight divided by the total number of birds alive and then by 42 days.

Feed conversion ratio (FCR) was calculated as the ratio of feed intake to body weight gained in a specified period of time.

$$FCR = \frac{\text{Total feed intake}}{\text{Total weight gained}}$$

Percentage mortality rate was calculated as the ratio of the number of dead birds to the number of birds housed per treatment, expressed as a percentage.

$$\text{Mortality rate} = \frac{\text{Number of dead birds}}{\text{Total number of birds stocked}} \times 100$$

Cost-benefit analysis

Cost (₦) per kg diet was calculated as the aggregate of the individual cost contribution of feed ingredients used to formulate 100 kg diet divided by 100.

Cost (₦) of feed consumed was calculated as total feed consumed multiplied by their respective cost per kg of diet.

Feed Cost per Kg Gain was calculated as the product of the feed conversion ratio and feed cost per kilogramme.

Total production cost (₦) was calculated as the summation of the cost (₦) of the whole operation, including the cost (₦) of feed consumed and of birds.

Gross profit was calculated as the difference between price per bird and total production cost per bird.

Apparent nutrient digestibility/ retention by Noiler chicks

At the end of the feeding trial, three (3) birds were selected from each replicate across the treatments (representing the average live body weight of the treatment group) into individual metabolic cages constructed to allow faeces to pass through the floor for collection on polythene sheets. Each bird was allowed a 2-day acclimatisation period and then fed a known quantity of feed, and the corresponding faecal droppings were collected from individual birds for 5 days. The faecal samples were oven-dried at 62 °C until a constant weight was obtained, bulked, and representative weighed samples were taken alongside feed samples to the Laboratory for proximate analysis (AOAC, 2005). Thereafter, apparent nutrient digestibility of each nutrient was determined.

$$\text{Apparent nutrient digestibility} = \frac{\text{Nutrients in feed} - \text{Nutrients in faeces}}{\text{Nutrients in feed}} \times 100$$

Haematological indices

The blood collection site was sterilised with methylated spirit prior to collection. Five (5) ml sterilised disposable syringe fitted with a 24-gauge sterilised hypodermic needle was used to collect blood from the wing vein of one representative noiler bird per replicate between 7.00 and 9.00 am. Two (2) ml of blood samples from each bird were put in a labelled blood sample bottle containing ethylenediaminetetraacetic acid (EDTA) and 2 ml in a sample bottle without EDTA for haematology and serum biochemical assays, respectively. Haematological indices assessed were packed cell volume (PCV), red blood cell (RBC) count, haemoglobin (Hb) concentration and white blood cell (WBC) count determined according to the procedure of Coles (1986), while lymphocytes, heterophils, eosinophils, basophils and monocytes were determined using the procedures outlined by Jain (1986). Mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were calculated as follows: $MCV = PCV \times 10 / RBC$, $MCH = Hb \times 10 / RBC$ and $MCHC = Hb \times 100 / PCV$.

Serum biochemical constituents

Blood samples in EDTA-free sample bottles were used to determine serum biochemical indices. Total serum protein, albumin and globulin were determined using the Biuret method as described by Reinhold (1953).

Creatinine, uric acid and alkaline phosphatase (ALP) were determined using the method described by Coles (1986). Serum glucose was determined by the O-toluidine method using acetic acid (Cooper and McDonald, 1970).

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were determined as reported by Lindsley (1977). Serum cholesterol was determined by the use of the spectrophotometer using Commercial Diagnostic Kit (Fortress Diagnostic Ltd, UK) according to Gowenlock *et al.* (1988).

Statistical analysis

The data were analysed using analysis of variance (ANOVA) in SAS 2000 (version 9). Duncan Multiple Range Test (DMRT) was used to separate means that differed significantly ($p < 0.05$). The model used:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}$$

Where: Y_{ij} = individual observation, μ = general mean, A_i = effect of j^{th} Lactic Dry[®] supplementation (No Lactic Dry[®] and Lactic Dry[®]), B_j = effect of j^{th} replacement levels of maize with TBNS-YPMC ($i = 0, 20$ and 40%), $(AB)_{ij}$ = effect of interaction between Lactic Dry[®] supplementation and replacement levels of maize with TBNS-YPMC and ε_{ijk} = experimental error

RESULTS

Growth performance of Noiler chicks fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®]

The main effects of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®] on growth performance and economics of production of Noiler chicks are presented in Table 2. Results revealed that diets supplemented with or without Lactic Dry[®] had no significant ($p > 0.05$) influence on any growth performance indices. Feed conversion ratio (FCR) was significantly influenced ($p < 0.05$) by replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®] on the growth performance of the Noiler chicks. Noiler chicks fed diets containing TBNS-YPMC replacing maize at 20% had the best FCR (3.63 ± 0.11). The interaction effect of feeding Noiler chicks with diets containing replacement levels of maize with TBNS-YPMC, supplemented with or without Lactic Dry[®], on growth performance revealed that daily feed intake (DFI) and feed conversion ratio (FCR) were significantly ($p < 0.05$) influenced. Noiler chicks on other treatment diets recorded the highest and similar values (57.10 ± 1.58 g/bird) for DFI, while birds fed a diet containing 40% TBNS-YPMC as replacement for maize without Lactic Dry[®] supplementation recorded the least DFI (48.26 ± 3.90 g/bird).

Table 2. Effect of diets containing replacement levels of maize with TBNS-YPMC with or without LD on growth performance and economics of Noiler chick production.

Parameters	No Lactic Dry®	Lactic Dry®	Replacement levels of maize with TBNS-YPMC			
			0	20	40	
Main effect of the experimental with or without Lactic Dry®						
IBW (g/b)	188.33±0.44	190.00±0.00	188.50±0.67	190.00±0.00	189.00±0.45	
FBW (g/b)	758.37±13.82	774.38±13.01	758.61±18.92	788.76±11.48	751.76±16.06	
DFI (g/b)	52.35±1.52	52.25±0.94	54.39±1.77	51.59±0.72	50.92±1.63	
FCR	3.87±0.14	3.77±0.12	4.04±0.22 ^a	3.63±0.11 ^b	3.81±0.08 ^{ab}	
Mort. (%)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	
Interaction effect of the experimental with or without Lactic Dry®						
Parameters	No Lactic Dry® Supplementation			Lactic Dry® Supplementation		
	0	20	40	0	20	40
IBW (g/b)	187.00±0.00	190.00±0.00	188.00±0.00	190.00±0.00	190.00±0.00	190.00±0.00
FBW (g/b)	733.89±8.73	799.56±12.59	741.67±27.74	783.33±33.21	777.96±19.59	761.85±20.45
DBWG (g/b)	13.02±0.21	14.51±0.30	13.18±0.66	14.13±0.79	14.00±0.47	13.62±0.48
DFI (g/b)	57.10±1.58 ^a	51.69±0.55 ^{ab}	48.26±3.90 ^b	51.67±2.40 ^{ab}	51.48±1.51 ^{ab}	53.59±1.06 ^{ab}
FCR	4.38±0.05 ^a	3.57±0.09 ^b	3.67±0.11 ^b	3.69±0.34 ^b	3.69±0.22 ^b	3.94±0.06 ^{ab}
Mort (%)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Cost/Kg diet (₦)	369.54	358.26	331.74	369.56	358.28	331.76
Cost/Kg wt gain (₦)	1,618.59	1,278.99	1,217.49	1,363.68	1,322.05	1,307.13
Feed cons. cost (₦)	886.90	777.42	673.43	801.95	773.88	746.76
P. Cost (₦)	1,288.16	1,178.67	1,074.68	1,203.20	1,175.13	1,148.01
Gross profit (₦)	211.84	321.33	425.32	296.80	324.87	351.99

^{a,b} = Means in the same row with different superscripts are significantly different ($p < 0.05$). IBW= Initial body weight, FBW= Final body weight, DBWG= Daily body weight gain, DFI= Daily feed intake, FCR= Feed Conversion ratio, Mort= Mortality, Kg= Kilogram, Wt= weight, Cons. Consumption, P.= Production, g- gram, b= bird and ₦= Naira. Note: Each post-brooded Noiler bird was sold at ₦1,500.00

g/bird). Birds fed control diets without Lactic Dry[®] and diets containing 40% TBNS-YPMC with Lactic Dry[®] had the poorest and similar FCR (4.38 ± 0.05). Cost per kg of diet was highest (₦369.56) for the control diet supplemented with Lactic Dry[®], while the diet containing 40% TBNS-YPMC without Lactic Dry[®] supplementation recorded least (₦331.74) cost per Kg of diet. Cost per kg of weight gain (₦1,618.59), cost of feed consumed (₦886.59) and production cost of Noiler chick (₦1,288.16) were highest on bird fed control diet without Lactic Dry[®], while cost per kg of weight (₦673.43), cost of feed consumed (₦673.43) and production cost of Noiler chick (₦1,288.16) was least on birds diet containing 40% TBNS-YPMC replacing maize without Lactic Dry[®]. Birds fed the diet containing 40% TBNS-YPMC replacing maize without Lactic Dry[®] and the control diet without Lactic Dry[®] recorded the highest (₦425.32) and least (₦211.84) gross profit, respectively.

Apparent nutrient digestibility of Noiler chicks fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®]

Effect of diets containing replacement levels of maize with

TBNS-YPMC supplemented with or without Lactic Dry[®] on apparent nutrient digestibility of the Noiler chicks is presented in Table 3. Results on the main effect of diets supplemented with or without Lactic Dry[®] on apparent nutrient digestibility of the Noiler chicks showed that all apparent nutrient digestibility indices were significantly ($p < 0.05$) influenced. Noiler chicks fed diets without Lactic Dry[®] recorded the highest apparent nutrient digestibility values (%) for crude protein ($76.00 \pm 2.76\%$), dry matter ($76.08 \pm 2.41\%$), crude fibre ($49.78 \pm 6.61\%$), ether extract ($85.43 \pm 1.74\%$) and ash ($72.14 \pm 2.65\%$), while birds on diets with Lactic Dry[®] had the least values for all respective digestible or retention indices.

Results on the main effect of replacement level of maize with TBNS-YPMC on apparent nutrient digestibility by Noiler chicks revealed that crude protein, ether extract and ash were significantly ($p < 0.05$) influenced. Birds fed the control diet and the diet containing 40% TBNS-YPMC replacing maize recorded the highest and similar ($76.91 \pm 2.69\%$) digestible protein value, while birds fed the diet containing 20% TBNS-YPMC replacing maize recorded the least value ($66.92 \pm 3.75\%$) for digestible protein. Birds fed control diet recorded the highest values ($87.17 \pm 1.88\%$) for ether extract retention, while birds in other treatment groups had least and similar values ($73.47 \pm 5.39\%$) for ether extract retention. Noiler chicks fed

Table 3. Apparent nutrients digestibility of Noiler chicks fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry®

Parameters (%)	No Lactic Dry®	Lactic Dry®	Replacement levels of maize with TBNS-YPMC			
			0	20	40	
Main effect of the experimental with or without Lactic Dry®						
Crude protein	76.00±2.76 ^a	65.31±2.56 ^b	76.91±2.69 ^a	66.92±3.75 ^b	68.14±4.25 ^{ab}	
Dry matter	76.08±2.41 ^a	66.37±2.65 ^b	75.60±2.50	70.33±3.35	67.75±4.60	
Crude fibre	49.78±6.61 ^a	30.19±4.82 ^b	47.06±7.17	27.47±8.67	45.44±6.65	
Ether extract	85.43±1.74 ^a	72.68±3.97 ^b	87.17±1.88 ^a	73.47±5.39 ^b	76.53±4.02 ^b	
Ash	72.14±2.65 ^a	59.05±3.67 ^b	72.43±2.74 ^a	66.14±3.89 ^{ab}	58.21±5.66 ^b	
Interaction effect of the experimental with or without Lactic Dry®						
Parameters (%)	No Lactic Dry® supplementation			Lactic Dry® supplementation		
	0	20	40	0	20	40
Crude protein	81.29±0.80 ^a	71.24±6.66 ^{abc}	75.48±4.59 ^{ab}	72.53±4.05 ^{abc}	62.59±2.68 ^{bc}	60.81±3.93 ^c
Dry matter	78.35±2.82 ^a	74.17±6.07 ^a	75.71±4.55 ^a	72.85±3.97 ^{ab}	66.49±2.13 ^{ab}	59.79±4.63 ^b
Crude fibre	59.99±4.46 ^a	36.62±15.93 ^{ab}	52.75±10.35 ^a	34.13±8.38 ^{ab}	18.32±6.22 ^b	38.13±7.79 ^{ab}
Ether extract	89.09±1.83 ^a	84.25±4.08 ^a	82.94±2.39 ^a	85.25±3.26 ^a	62.68±3.54 ^b	70.12±5.81 ^b
Ash	76.26±0.94 ^a	72.60±4.73 ^{ab}	67.55±6.47 ^{ab}	68.60±4.68 ^{ab}	59.67±3.37 ^b	48.87±5.56 ^c

TBNS-YPMC= Toasted Bambara nut sievate- Yam peel meal composite. a,b,c = Means in the same row with different superscripts are significantly different (p<0.05).

the control diet and a diet containing 20% TBNS-YPMC replacing maize recorded the highest and similar values (72.43±2.74%) for ash retention, while birds fed a diet containing 40% TBNS-YPMC replacing maize recorded the least (58.21±5.66%) ash retention.

Results on the interaction effect of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry® on apparent nutrient digestibility by Noiler chicks revealed that all apparent nutrient digestibility indices were significantly (p<0.05) influenced. Noiler chicks fed diets without Lactic Dry® supplementation and the control with Lactic Dry® had the highest and similar (81.29±0.80%) crude protein digestible value, while birds fed a diet containing 40% TBNS-YPMC replacing maize with Lactic Dry® recorded the least (60.81±3.93%) crude protein digestible value. Dry matter digestibility values were highest and similar (78.35±2.82%) for Noiler chicks on all experimental diets except birds fed a diet containing 40% TBNS-YPMC replacing maize with Lactic Dry®, which had the least (38.13±7.79%) dry matter digestibility value. Crude fibre digestibility values were highest and similar (59.99±4.46%) for Noiler chicks on all experimental diets except birds on the diet containing 20% TBNS-YPMC replacing maize with Lactic Dry®, which had least (18.32±6.22%) crude fibre digestible value. Highest and similar (89.09±1.83%) ether extract retention values were recorded for birds fed diets without Lactic Dry® and the control diet with Lactic Dry®, while birds in other treatment groups had least and similar values (70.12±5.81%) for ether extract retention. Birds fed a diet containing 40% TBNS-YPMC with Lactic Dry® recorded the least (48.87±5.56%) ash retention value.

Haematological Indices of Noiler chicks fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry®

Effects of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry® on haematological indices of Noiler chicks are presented in Table 4. Results on the main effect of diets supplemented with or without Lactic Dry® revealed no significant (p>0.05) influence on all haematological indices of noiler chicks. Meanwhile, the main effect of diets containing replacement levels of maize with TBNS-YPMC revealed that lymphocytes differed significantly (p<0.05). Noiler chicks on diets containing TBNS-YPMC as a replacement for maize recorded the highest and similar lymphocyte values (48.50±0.76%), while birds on the control diet had the least (45.17±0.07%) lymphocyte. Results on the interaction effect of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry® on haematological indices of Noiler chicks showed that all haematological indices were not significantly (p>0.05) influenced.

Serum biochemical constituents of Noiler Chicks fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry®

Effects of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic

Table 4. Main effect of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®] on haematological indices of Noiler chicks.

Parameters	No Lactic Dry®	Lactic Dry®	Replacement levels of maize with TBNS-YPMC			
			0	20	40	
Main effect of the experimental with or without Lactic Dry®						
PCV (%)	28.56±1.12	26.89±0.86	28.83±1.45	26.83±0.79	27.50±1.43	
RBC (x10 ¹² /L)	2.43±0.05	2.30±0.05	2.32±0.54	2.37±0.08	2.42±0.06	
WBC (x10 ⁹ /L)	6.27±0.17	5.82±0.20	5.73±0.11	6.33±0.21	6.07±0.31	
Hb (g/dL)	9.52±0.37	8.96±0.29	9.61±0.48	8.94±0.26	9.17±0.48	
MCV (fL)	118.75±3.27	115.76±4.38	124.42±5.13	113.90±4.62	113.45±3.16	
MCH (pg)	39.95±1.24	38.57±1.47	41.52±1.72	38.52±1.87	37.75±1.07	
MCHC (g/dL)	33.27±0.02	33.36±0.07	33.32±0.04	33.38±0.10	33.25±0.02	
Lymphocyte (%)	47.56±0.77	46.33±0.82	45.17±0.70 ^b	48.50±0.76 ^a	47.17±1.01 ^{ab}	
Heterophil (%)	46.22±0.80	46.56±0.53	47.17±0.48	45.67±0.71	46.33±1.11	
Eosinophil (%)	2.00±0.24	2.44±0.38	2.67±0.33	2.00±0.44	2.00±0.37	
Basophil (%)	0.22±0.15	0.33±0.17	0.33±0.21	0.17±0.17	0.33±0.21	
Monocytes (%)	4.00±0.29	4.22±0.36	4.67±0.21	3.67±0.33	4.00±0.52	
Interaction effect of the experimental with or without Lactic Dry®						
Parameters	No Lactic Dry® supplementation			Lactic Dry® supplementation		
	0	20	40	0	20	40
PCV (%)	29.00±3.21	27.33±1.45	29.33±1.20	28.67±0.33	26.33±0.88	25.67±2.33
RBC (x10 ¹² /L)	2.40±0.06	2.43±0.15	2.47±0.03	2.23±0.07	2.30±0.06	2.37±0.12
WBC (x10 ⁹ /L)	5.73±0.18	6.47±0.29	6.60±0.12	5.73±0.18	6.20±0.35	5.53±0.44
Hb (g/dL)	9.67±1.07	9.11±0.49	9.78±0.40	9.56±0.11	8.78±0.29	8.55±0.78
MCV (fL)	120.34±10.45	117.05±3.99	118.87±0.77	128.51±2.41	110.76±9.00	108.03±4.45
MCH (pg)	40.15±3.53	40.12±2.44	39.58±0.25	42.88±0.71	36.91±2.99	35.91±1.53
(g/dL)	33.30±0.06	33.27±0.03	33.27±0.03	33.33±0.07	33.50±0.21	33.23±0.03
Lymphocyte (%)	45.33±1.45	49.00±0.58	48.33±0.88	45.00±0.58	48.00±0.53	46.00±1.73
Heterophil (%)	47.33±0.88	45.33±1.20	46.00±2.08	47.00±0.58	46.00±1.00	46.67±1.33
Eosinophil (%)	2.33±0.33	1.67±0.33	2.00±0.58	3.00±0.58	2.33±0.88	2.00±0.58
Basophil (%)	0.33±0.33	0.33±0.33	0.00±0.00	0.33±0.33	0.00±0.00	0.67±0.33
Monocytes (%)	4.67±0.33	3.67±0.33	3.67±0.67	4.67±0.33	3.67±0.67	4.33±0.88

TBNS-YPMC= Toasted Bambara nut sievate- Yam peel meal composite. a,b,c = Means in the same row with different superscripts are significantly different (p<0.05).

Dry[®] on serum biochemical constituents of Noiler chicks are presented in Table 5. Results on the main effect revealed that all serum biochemical constituents of Noiler chicks were not significantly (p>0.05) influenced by supplementation of diets with or without Lactic Dry[®]. Replacement levels of maize with TBNS-YPMC significantly influenced (p<0.05) AST and ALP values. Birds fed the control diet and the diet containing 40% TBNS-YPMC as a replacement for maize had the highest and similar AST (101.64±5.56 U/L) and ALP (114.67±3.70 U/L) while birds fed the diet containing 20% TBNS-YPMC as replacement for maize had the lowest AST (89.97±8.40 U/L) and ALP (102.53±8.73 U/L), respectively.

The interaction effect of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®] on serum biochemical constituents of Noiler chicks revealed that AST and ALP were significantly

(p<0.05) influenced. Birds on all experimental diets had the highest and similar AST (102.92±3.57 U/L) and ALP (116.00±3.72 U/L) values, while Noiler chicks fed a diet containing 20% TBNS-YPMC as a replacement for maize without supplementation of Lactic Dry[®] recorded the lowest AST (76.00±3.49 U/L) and ALP (88.00±3.63 U/L) values, respectively.

DISCUSSION

Growth performance of Noiler birds fed diets containing replacement levels of maize with TBNS - YPMC supplemented with or without Lactic Dry[®]

Results on growth performance of starter Noiler chicks showed that the final body weight of Noiler chicks in the

Table 5. Effect of diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry® on haematological indices of Noiler chicks.

Parameters	No Lactic Dry®	Lactic Dry®	Replacement levels of maize with TBNS-YPMC			
			0	20	40	
Main Effect of the experiment with or without Lactic Dry®						
Protein (g/dL)	4.94±0.40	4.93±0.48	4.88±0.65	4.60±0.55	5.32±0.40	
Albumin (g/dL)	2.77±0.16	2.62±0.14	2.63±0.18	2.78±0.12	2.67±0.25	
Globulin(g/dL)	2.19±0.46	3.33±0.56	2.31±0.72	1.83±0.59	2.64±0.57	
Creatinine (mg/dL)	0.85±0.06	0.84±0.04	0.86±0.05	0.84±0.08	0.86±0.17	
Cholesterol (mg/dL)	71.98±3.13	81.99±7.25	70.60±2.93	75.78±4.49	84.58±10.78	
Glucose(mg/dL)	83.37±3.63	94.96±8.40	81.78±3.39	87.77±5.20	97.96±12.49	
AST (U/L)	91.51±5.16	96.51±3.69	97.41±4.79 ^a	82.99±5.13 ^b	101.64±3.56 ^a	
ALT (U/L)	38.61±3.30	37.87±2.32	37.16±2.20	38.10±4.43	39.47±3.76	
ALP (U/L)	104.13±5.36	109.33±3.83	110.27±4.98 ^a	95.27±5.33 ^b	114.67±3.70 ^a	
Interaction effect of the experiment with or without Lactic Dry®						
Parameters	No Lactic Dry® supplementation			Lactic Dry® supplementation		
	0	20	40	0	20	40
Protein (g/dL)	4.20±0.48	5.07±1.08	5.54±0.15	5.55±1.20	4.14±0.32	5.10±0.86
Albumin (g/dL)	2.83±0.33	2.79±0.03	2.70±0.43	2.43±0.06	2.76±0.27	2.65±0.35
Globulin(g/dL)	1.45±0.75	2.28±1.11	2.84±0.47	3.17±1.14	1.38±0.55	2.45±1.17
Creatinine (mg/dL)	0.90±0.07	0.91±0.15	0.75±0.06	0.81±0.07	0.77±0.01	0.96±0.09
Cholesterol (mg/dL)	69.98±4.31	71.84±8.27	74.12±5.15	71.22±4.88	79.71±4.08	95.03±21.10
Glucose(mg/dL)	81.06±4.99	83.21±9.58	85.85±5.97	82.50±5.66	92.33±4.72	110.07±24.44
AST (U/L)	95.62±10.01 ^{ab}	76.00±3.49 ^b	102.92±3.57 ^a	99.21±3.33 ^a	89.97±8.40 ^{ab}	100.36±6.99 ^a
ALT (U/L)	35.26±4.43	34.21±6.76	46.37±4.47	39.06±1.01	41.99±6.11	32.57±1.74
ALP (U/L)	108.40±10.41 ^{ab}	88.00±3.63 ^b	116.00±3.72 ^a	112.13±3.47 ^a	102.53±8.73 ^{ab}	113.33±7.27 ^a

TBNS-YPMC= Toasted Bambara nut sievate- Yam peel meal composite. a,b,c = Means in the same row with different superscripts are significantly different (p<0.05).

present study was lower compared to the final body weights of FUNAAB Alpha chicks (840.39±12.71 g) and Noiler chicks (871.46±13.60 g) reported by Sanda *et al.* (2022) when they conducted heritability and repeatability estimates of growth traits in FUNAAB Alpha and Noiler chicken genotypes fed commercial diets. However, the final body weight range of 481 to 597 g of pullet chicks fed diets containing graded levels of bambara nut offal as a replacement for soybean meal and maize reported by Amaefule and Osuagwu (2005) is lower compared to the final body weight (733.89±8.73 to 799.56±12.59 g) of Noiler chicks in the present study. This could be due to variation in strain and feed used in the two studies. Sirovnik *et al.* (2021) reported no effect of probiotic supplementation on broiler chicken body weight gain, which agrees with the findings on Noiler chicks fed diets supplemented with Lactic Dry® in this study. Contrarily, Nalunga *et al.* (2021) reported that inclusion of probiotics in broiler chickens' diets promotes growth, which contradicts the findings of the present study. Similarly, Glombowsky *et al.* (2020) found that supplementing broiler chicken diets with probiotics improves body weight gain, which disagrees with the findings of the present study.

Low feed intake of birds fed a diet containing 40% TBNS-YPMC replacing maize without Lactic Dry® may be due to the high fibre content of the diet, which could not be handled efficiently by the young birds, possibly due to secretion of insufficient endogenous enzymes that could not facilitate the breakdown of complex and macro feed molecules for subsequent digestion by the birds. High feed intake of birds fed control diets in the present study could be due to low dietary fibre content and the ability of beneficial bacteria present in Lactic Dry® to dislodge harmful microbes which secrete poisonous substances that affect birds' health, according to Mirsalami and Mirsalami (2024). In addition, birds on a high-fibre diet which contains 40% TBNS-YPMC, replacing maize with Lactic Dry® supplementation, recorded high feed intake due to the beneficial influence of harmless bacteria in the feed, which corroborates the findings of Mirsalami and Mirsalami (2024), who reported that beneficial microflora present in the host intestine play a vital role in digestion by secreting digestive enzymes, promoting production of digestive enzymes, inhibiting growth and adhesion of pathogens, and preserving the integrity of gut flora and the epithelial barrier. In the same vein, Mirsalami and

Mirsalami (2024) found that amylase, protease, lipase, trypsin, lactase, maltase and sucrase are usually higher in the duodenum and jejunum of chickens fed diets containing probiotics, which aids in the digestion of feed. Colonisation of the intestinal wall by beneficial bacteria improves birds' gut health with subsequent improvement in feed intake and growth performance (Mirsalami and Mirsalami, 2024).

FCR and percentage mortality of birds in the present study are comparable with the values of FCR (3.85 to 4.75) and percentage mortality (0.00%) of pullet chicks reported by Amaefule and Osuagwu (2005). The absence of mortality buttressed the findings of Nalunga *et al.* (2021), who found out that inclusion of beneficial microbes regulates the immune reaction and anti-oxidative status to boost the host's immunity to infections.

Poor FCR recorded for birds on a control diet without Lactic Dry[®] supplementation could be attributed to lower crude fibre content, which was easily digestible with attendant short transit time in the digestive tract that enables the birds to consume large quantities of feed. Similarly, poor FCR of birds on a diet containing 40% TBNS-YPMC replacing maize with Lactic Dry[®] supplementation could be attributed to the ability of the beneficial bacteria in Lactic Dry[®] to displace and dislodge harmful bacteria, which subsequently improved birds' gastrointestinal tract and general health, thus encouraging feed intake as well as possible production of enzymes that aid in the breakdown of fibrous feed components (Mirsalami and Mirsalami, 2024). This implies that incorporating a composite of TBNS-YPMC provided the required nutrients the birds need for proper tissue accretion and also promoted good health of Noiler chicks. The slight variation in the parameters among these studies could be attributed to the differences in the breed of birds, nutrient composition of the test ingredients, feed consumed and duration of the studies.

Results on economics of production of Noiler chicks revealed that feed cost per kilogram in the present study agrees with the report of Amaefule *et al.* (2011), who observed a reduction in feed cost due to inclusion of bambara groundnut offal (BGO) that subsequently increased farmers' income. According to Amaefule and Osuagwu (2005), inclusion of BGO in pullets' diets considerably reduced feed cost per kg of diet, which is in harmony with the findings of the present study. Also, a report by Ukpabi *et al.* (2008) observed a reduction in feed cost of broiler chickens due to the inclusion of BGO, which will go a long way to boost farmers' profit margin, buttressing the findings of the current study. Tuleun *et al.* (2020) opined that inclusion of 30% BGO in enzyme-supplemented broiler chickens' diets reduce feed cost per kg weight gain of broiler finisher chickens, which is in consonance with the findings of this study. In the same vein, Ezieshi and Olomu (2011) reported that a reduction in the cost of production is enhanced when 50% YPM replace maize in broiler chickens' diets at both starter and

finisher phases. Similarly, Akinmutimi and Onen (2008) reported that yam peel meal (YPM) can replace up to 15% of maize in diets to reduce the cost of broiler chickens' production, which aligns with the findings of the present study. Furthermore, Oguntoye *et al.* (2018) reported that broiler chickens fed diets containing graded levels of YPM (0, 15 and 30%) with or without enzymes (50 g/100 Kg diet) as a replacement for maize improved farmers' profit due to reduction in the cost of production. This implies that replacement of maize and/or any other conventional expensive feedstuff using agricultural waste will definitely go a long way to reduce production cost and boost producers' profit.

Apparent nutrients digestibility/ retention by Noiler birds fed diets containing replacement levels of maize with TBNS-YPMC supplemented with or without Lactic Dry[®]

Results on apparent nutrient digestibility of Noiler chicks in the present study are in line with the findings of Tuleun *et al.* (2020), who reported significant differences in all apparent nutrients digestibility/ retention indices of finisher broiler chicken fed diets containing graded levels of bambara groundnut offal (0, 10, 20 and 30%) with or without enzyme fortification as replacement for maize. Dry matter digestible, crude protein, crude fibre, ether extract and ash values in the present study are lower compared to their respective values of 95.50 ± 0.29 to 97.10 ± 0.34 , 95.29 ± 0.16 to 96.96 ± 0.41 , 84.71 ± 1.20 to 92.77 ± 0.55 , 95.88 ± 0.28 to 97.83 ± 0.38 and 88.47 ± 1.13 to $95.49 \pm 0.43\%$ reported by Tuleun *et al.* (2020). A reduction in crude protein digestible values of Noiler chicks fed diets containing 40% TBNS-YPMC replacing maize, supplemented with or without Lactic Dry[®], implies that the young birds could not handle protein from high TBNS-YPMC replacement levels efficiently, possibly due to its poor-quality nature or the inability of the bird's digestive system to secrete sufficient protein-degrading enzymes that would have further aided such protein digestion. Supplementation of the experimental diets with Lactic Dry[®] could not improve protein, dry matter, or other nutrient digestion, especially poor-quality protein or protein and other nutrients bound by strong molecules in unconventional feedstuffs. Hence, birds fed diets without Lactic Dry[®] supplementation recorded improved values on all apparent nutrient digestibility values across the treatment groups.

Haematological and serum biochemical constituents of Noiler birds fed diets containing replacement levels of maize with TBNS -YPM composite with or without Lactic Dry[®]

Results on haematological indices of Noiler chicks

revealed significantly higher values of lymphocytes for birds fed diets containing 20 and 40% TBNS-YPMC replacement levels of maize. Lymphocytes are mobile units of the body's protection system; after formation, they are conveyed via the blood to a site of urgent need for rapid and potent defence (Etim *et al.*, 2014). Similarly, Soetan *et al.* (2013) confirmed that animals with high lymphocyte counts are able to produce sufficient antibodies capable of carrying out phagocytosis, have a high degree of resistance to diseases and enhance adaptability to local environmental and disease-prevalent conditions. This implies that birds with higher levels of lymphocytes could have had a stronger immune response compared to birds on control diets, which could be due to the presence of anti-nutritional factors in TBNS-YPMC that might have triggered certain physiological reactions in the body of these birds to produce more lymphocytes.

However, these values fall within a normal range of reference values of 45.00 to 70.00% reported by Banerjee (1998) for a healthy chicken. This shows that feeding Noiler chicks with diets containing 20 and 40% TBNS-YPMC replacing maize, with or without Lactic Dry[®] supplementation, had no negative impact on the immune status of the birds but showed a propensity to improve the birds' immune systems. PCV, RBC, haemoglobin, MCV, MCH and MCHC of birds in the present study fall within the respective normal reference ranges of 25.00 to 45.00%, 2.00 to 4.00 $\times 10^{12}/L$, 7.00 to 13.00 g/dL, 90.00 to 140.00 fl, 33.00 to 47.00 pg and 26.00 to 35.00 g/dL for a healthy chicken reported by Banerjee (1998). Isaac *et al.* (2013) reported that PCV is involved in the transport of oxygen and absorption of nutrients. Therefore, increased PCV shows better transportation and thus results in increased primary and secondary polycythemia. This implies that adequate transport of gases such as oxygen and carbon dioxide, among others, between the birds and their surroundings was not impaired. Haemoglobin physiologically transports oxygen to tissues of the animal for oxidation of ingested food so as to release energy for the other body functions, as well as transport carbon dioxide out of the body of animals (Isaac *et al.*, 2013; Soetan *et al.*, 2013). Hence, there was sufficient diffusion of oxygen from the blood to the metabolising cells and also carbon dioxide from these cells to the blood with the aid of the haemoglobin it contains. Therefore, there was absolutely no health challenge among the birds. MCH and MCHC values of birds in this study were comparable with the respective range of 36.00 to 41.50 pg, and 33.57 to 35.10 g/dL for broiler chickens fed diets containing replacement levels (0, 5, 10, 15 and 20%) of maize with toasted bambara nut waste reported by Oyewole and Omeje (2022). MCH is a major index for evaluating erythrocyte colour, diagnosis of anaemia and also serves as a useful index of the bone marrow capacity to produce red blood cells (Etim *et al.*, 2014). MCH and MCHC indicate blood level conditions. A low level is an indication of anaemia (Etim *et al.*, 2014).

Similarly, eosinophils of birds in this study fall within the normal reference range of 1.50 to 6.00% eosinophils for a healthy chicken reported by Banerjee (1998).

The levels of WBC and monocytes of birds obtained in the present study are lower compared to their respective reference range of 9.00 to 31.00 $\times 10^{12}/L$ and 5.00 to 10.00% for a healthy chicken reported by Banerjee (1998). These lower levels of WBCs and monocytes in the blood of the birds imply possible lower presence of pathogenic microbes in the body system of the experimental birds, which could otherwise have elicited a response in terms of massive production of defence mechanisms such as excessive production of lymphocyte, monocytes to tackle the problem. The birds could have been subjected to minimal stress, and the feed offered provided adequate nutrients for body nourishment and tissue accretion. The differences in these results could be attributed to genetic variation among breeds of chickens used in different studies, as reported by Peeters *et al.* (2012) and Etim *et al.* (2014).

Results on serum biochemical constituents of Noiler chicks significantly reflected similar variation in AST and ALP, which did not follow a specific pattern. All AST values of birds reported here fall within a normal reference range of 88.00 to 208.00 U/L for a healthy chicken reported by Banerjee (1998). Animashahun *et al.* (2022) reported lower AST values of 50.00 ± 2.89 to 66.67 ± 4.41 U/L compared to AST values of Noiler chicks in this study. However, there was a drastic reduction in AST compared to the normal range (88.00 to 208.00 U/L) for a healthy chicken when these birds were fed a diet containing 20% TBNS-YPMC as replacement for maize without Lactic Dry[®] supplementation, which could be attributed to lower incidences of liver, kidney and heart-related diseases, physiological growth, physical activities, among other factors.

Generally, higher levels of ALP in the experimental birds across the treatment groups in the present study, compared to a reference range of values of 25.00 to 44.00 U/L for a healthy chicken according to Banerjee (1998), could be due to the breed of chicken used (Noiler) and not the effect of diets, stress or diseases; hence, birds fed control diets with or without Lactic Dry[®] supplementation also had high ALP values.

ALT of birds in the present study is comparable with the range of 10.00 to 37.00 U/L for a healthy chicken reported by Banerjee (1998). The release of large amounts of AST, ALT and ALP in the blood is due to ailments that affect the kidney, liver and heart. The liver possesses the ability to carry out detoxification and elimination of harmful substances from the body and, as such, aids in assessing normal functioning of the liver according to Animashahun *et al.* (2022). Pathological, impaired cells or tissue may also increase the concentration of liver enzymes according to Giannini *et al.* (2005). Total protein of birds in this study falls within the normal reference range of 3.50 to 5.50 g/dL for healthy chickens, as reported by Peter (2002) when he

evaluated avian blood in the laboratory. Animashahun *et al.* (2022) reported lower total protein values of 4.01 ± 0.01 to 4.25 ± 0.07 U/L when Noiler chickens were fed diets containing *Parkia biglobosa* as a partial replacement (0, 5, 10 and 15%) for soybean meal compared to total protein values in the present study. Albumin values of these experimental birds fall within a normal reference range of 2.00 to 3.50 g/dL for a healthy chicken reported by Banerjee (1998). Albumin values of birds in the present study are lower compared to the values of 3.11 ± 0.07 to 3.55 ± 0.23 g/dL reported by Animashahun *et al.* (2022). Globulin values of birds in the present study are higher compared to the values of 1.33 to 1.67 g/dL reported for broiler chicks by Oyewole and Omeje (2022).

Higher globulin values of birds in the present study could be attributed to the slow-growth nature of Noiler chicks compared to broiler chicks, which place high demand and utilisation on blood protein for rapid growth, thus leaving a little amount in the bloodstream.

Creatinine values in the present study fall within the reference values of 0.50 to 1.50 mg/dL for a healthy chicken reported by Levey *et al.* (2006) when they worked on standardising serum creatinine values in modification of diet in renal disease study equation for estimating glomerular filtration rate. The present creatinine values are higher compared to values of 0.47 to 0.73 mg/dL for broiler chicks reported by Oyewole and Omeje (2022). High creatinine values in the present study could be attributed to high muscle activity of the experimental birds; hence, Noiler chicks are more active compared to broiler chicks. Similarly, elevated creatinine values are associated with body weight; hence, birds in this study had higher body mass compared to the body weight of broiler chicks reported by Oyewole and Omeje (2022). According to Oyewole and Omeje (2022), an elevated level of creatinine usually indicates a muscular condition due to poor quality of protein in the diets, which was not so with the birds in this study; hence, the values fall within the acceptable range.

Cholesterol values of birds in the present study fall within the normal range of reference values of 52.00 to 148 mg/dL reported by Banerjee (1998). Animashahun *et al.* (2022) reported cholesterol values in the range of 79.54 ± 3.67 to 95.37 ± 2.31 mg/dL, which is comparable to cholesterol values of birds in the present study. High cholesterol levels in the body of animals is risky and a predisposing factor to cardiovascular disease. Hence, cholesterol values obtained in this study show that replacing maize with TBNS-YPMC with or without Lactic Dry® supplementation could not have impaired other physiological activities like reproduction, adrenal and tissue function, among others. Despite the fact that it is a vital component of many tissues, its role as a vital constituent of adrenal hormones and the pituitary gland cannot be overemphasised (Animashahun *et al.*, 2022).

Glucose levels of birds in this study are lower compared to the normal range of reference values of 125.00 to

200.00 mg/dL reported by Banerjee (1998). These lower values of glucose could be attributed to the genetic constitution of this breed; hence, birds fed control diets also recorded higher and similar values across the treatment groups. A persistent elevation in blood glucose levels leads to glucose toxicity, which contributes to cell dysfunction. This implies that TBNS-YPMC may not have had adverse effects on the Noiler chicks.

Conclusion

It was concluded that replacement of maize with TBNS-YPMC up to 40% of the maize component did not adversely affect the measured growth-performance variables, while reducing feed cost. However, nutrient digestibility responses varied with replacement level and Lactic Dry® supplementation, with the most pronounced reductions observed in selected nutrient digestibility indices at 40% replacement with Lactic Dry®.

Recommendation

It is recommended that 40% TBNS-YPMC can efficiently replace maize without LD in Noiler chicks' diets.

CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

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