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Haematological and Serum Biochemistry Indices of Starter Turkeys Fed Diets Containing Graded Levels of Flashed-Dried Cassava Pulp

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Abstract

The use of flash-dried cassava pulp as a feed ingredient in poultry production is limited by concerns about its impact on animal health, necessitating an evaluation of its effects on haematological and serum biochemistry indices of turkey starters. One hundred and twenty (120) day-old British United Turkey (BUT) poults were sourced from a reputable farm in Nigeria. Poults were brooded for 28 days, during which pre-starter diet was offered. Thereafter, starter turkeys (29-56 days) were randomly assigned into four (4) dietary treatments in a completely randomized design (CRD). Thirty (30) turkey starters were assigned in each treatment and replicated six (6) times with five (5) birds per replicate. The test feeds were formulated so that flashed-fried cassava pulp (FDCP) partially replaced maize at level of 0, 5, 10 and 15% in starting phase. Water and feed were supplied ad-libitum. At the 7th week, 3 mls blood samples were collected via the wing vein into vials containing ethylene diamine tetra-acetic acid (EDTA) as an anti-coagulant for the determination of haematological indices. Another set (3 mls) of blood samples were collected into heparinized tubes for serum biochemistry analysis using standard procedures. Results showed that mean corpuscular volume (MCV), mean cell haemoglobin (MCH), white blood cells (WBC), lymphocytes, monocytes, hemoglobin, cholesterol, alkaline phosphate (ALP) and density bilirubin were significantly affected ($p<0.05$). MCV significantly ($p<0.05$) ranged between 94.07 and 127.32 (fl),MCH ranged between 31.27 and 41.27 (pg), WBC ranged between 12.13 and 13.87 (x 10^9/l), lymphocytes between 67.67 and 71.00 (%), monocytes between 0.00 and 1.67 (%), haemoglobin between 11.10 and 12.50 (g/l), 93.57 and 139.53 (mg/dl), cholesterol between, ALP between 13.00 and 42.00 (U/L) and density bilirubin between 0.02 and 0.06 (mg/dl). Conclusively, up to 15% flashed-dried cassava pulp did not pose negative effects on haematological and serum biochemistry indices of turkey at starting phase.

Key words: Haematological indices, serum biochemistry, turkey starter, flashed-dried cassava pulp and maize.

Introduction

Maize, an energy ingredient in domesticated animal feed is expensive due to high demand for human consumption and commercial use (Bot *et al.,* 2013). Consequently, the advantage of cassava as a main ingredient in both small-scale and commercial livestock production has recently increased over the use of maize (Otekunrin., 2024). Cassava is a perennial, tuberous woody plant from the Euphorbiaceous family. There are two types of cassava; the sweet type, which is consumed by humans and animals, and the bitter type, which has high levels of hydrogen cyanide (HCN) and is not suitable for human consumption (Ogbuewu *et al.,* 2017). In 2021, global cassava production reached 315 million tonnes, with Africa accounting for approximately 204 million tonnes (Otekunrin., 2024).

The large amount of waste produced during the processing of cassava greatly contaminates the environment (Olukannai and Olatunji, 2018). Aro *et al.* (2010) studied a Nigerian starch factory and found that 120 tons of tubers were processed daily into starch, 17 tons of leftover starch, 5 tons of peels, 15.04 tons of wastewater, 8 tons of stumps and 1.15 tons of whey was produced every day as waste. According to PWC (2020), the supply and demand for cassava starch and high quality cassava flour in Nigeria is 290,000 tonnes annually. This corresponds to an annual production of 485,000 tonnes of cassava pulp and an estimated 870,000 tonnes of waste. Undoubtedly, this poses a serious environmental risk to the communities surrounding the production sites. Developing appropriate technologies to integrate cassava starch by-products into livestock feeding programs are therefore essential (Aro *et al.,* 2010).

Numerous processing methods have been tested and proven to work well in lowering the concentration of cyanogenic glycoside present in cassava products (Okoli *et al.,* 2012). Physical processing methods such as peeling, boiling, drying, pounding or milling and sieving (Ogbuewu *et al.,* 2017) and fermentation (Aladi, 2016) are efficient means in reducing the content of cyanogenic glycoside in cassava. Consequently, many reports have demonstrated the effectiveness of including cassava in poultry feed. Diarra and Devi (2015) stated that by efficiently utilizing their by-products, cassava producers and processors can generate additional revenue streams and reduce feed costs for chicken production. Ten to fifteen percent of the initial root weight used to produce cassava starch is made up of the solid, moist residue known as cassava pulp (Khampaka *et al*., 2014). Cassava pulp is abundant and high in starch. Due to its high starch and moisture content (75-80% w/w dry weight), cassava pulp deteriorates rapidly and causes environmental problems, including a severe and offensive putrefaction and local water contamination. Fresh cassava pulp is usually dried in the sun to achieve a moisture content of 10-13% and is commonly used as animals feed. Adeyeye *et al.,* (2024) reported that flashed-dried cassava pulp contained 91.00 % dry matter (DM), 3.25 % crude protein (CP), 9.00 % ether extract (EE), 8.00 % crude fibre (CF), 68.25 % nitrogen free extract (NFE), 1.3 % calcium, 0.60, phosphorous, 3279.00 MJ/kg metabolizable energy (ME) and 33.75 mg/kg hydrocyanide acid. The nutritional quality of cassava pulp depends on several factors, including the starch extraction process, cassava variety and cultivation practices used by farmers (Bede, 2010). As an ingredient, dried cassava pulp can help broilers meet some of their energy needs, but its use in diets should be restricted to 8% (Khempaka, *et al.,* 2009). It can also promote the intestinal health of broilers and reduce the amount of fat that accumulates in their abdomens (Khempaka *et al.,* 2009**)**. Raji *et al.* (2020) found that serum enzyme levels of broiler chickens were not affected when sun-dried cassava starch pulp was added to their diets in place of maize as an energy source.

Flashed-dried method is a continuous mass production, yield good quality and climatic conditions did not affect the production and it occupied a small area than sun drying method. Therefore, the need for alternative energy sources like flash-dried cassava pulp needs to be researched upon. Therefore, this research was investigated the effect of flashed-dried cassava pulp on haematological and serum biochemistry indices of exotic turkeys.

Materials And Methods

Location of the study

The study was conducted at the Federal University of Agriculture, Abeokuta, Ogun, State, Nigeria, at the Poultry Unit of the Directorate of University Farms (DUFARM). The farm is located at an elevation of 415 feet and eye altitude of 700 feet, on Latitude $7^{o}13^{1}35.48''$ N and longitude $3^{0}\ 26^{1}\ 12.38''$E respectively. The latter is at Latitude 7^0 13^1 57.53'' N., at an elevation of 1141 feet and longitude 3^0 26^1 12.38''E (Google Earth, 2022). The climate is humid with an average annual rainfall of 1,037 mm, a mean temperature and humidity of 43.7°C and 83%. It is situated in the rainforest vegetation zone.

Sourcing of test ingredient

The test ingredient i.e flashed-dried cassava pulp (FDCP) was obtained from Psaltry industry, a starch processing industry along Maya Ado-Awaye Road, Iseyin Local government area, Oyo-State, Nigeria. Iseyin geographical coordinates are latitude 7^0 58' 0'' North and longitude 3^0 36' 0'' East. Cassava pulp was subjected to flash drying, a process that involves high temperatures (150^0C) for a short minutes (5 -10 minutes), resulting in a product called flashed-dried cassava pulp (FDCP).

Experimental diets

The test feeds were formulated so that FDCP partially replaced maize at levels of 0, 5, 10 and 15% in starter, as shown in the Table 1. Iso-proteinous and iso-caloric diets were formulated in compliance with the NRC 1994 guideline.

Table 1: Gross composition (%) of experimental diets for starting turkeys (5– 8 weeks)

	FDCP levels of replacement			
Ingredients (%)	**0%**	**5%**	**10%**	**15%**
Maize	42.50	37.50	32.50	27.50
FDCP	0.00	5.00	10.00	15.00
Full fat soybean meal	13.50	15.00	16.50	18.00
Soybean meal	24.00	24.00	24.00	24.00
Wheat offal	7.80	6.30	4.80	3.30
Fish meal (72 %CP)	6.50	6.50	6.50	6.50
Lime stone	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50
Lysine	0.20	0.20	0.20	0.20
Methionine	0.50	0.50	0.50	0.50
Vitamin/mineral Premix	0.25	0.25	0.25	0.25
NaCl	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated values				
ME (MJ/kg)	11.53	11.52	11.50	11.49
Crude protein (%)	26.12	26.08	26.05	26.02
Calcium (%)	2.04	2.04	2.04	2.04
Phosphorous (%)	0.78	0.77	0.77	0.76
Lysine (%)	1.33	1.31	1.28	1.25
Methionine (%)	0.87	0.85	0.84	0.82

FDCP = Flash Dried Cassava Pulp ME = Metabolizable Energy NaCl = Sodium Chloride

** Vitamin/mineral premixes: Vitamin A – 13.340 iU., Vitamin E – 105 mg, Vitamin K3 – 3 mg, Vitamin B2 – 5 mg, Vitamin B6 – 4 mg, Ethoxyquin – 100 mg, Vitamin B1 – 3 mg, Vitamin D3 – 3,260 iU., Vitamin B12 – 0.04 mg, Niacinamide – 40 mg, Folic acid – 1.5 mg, Ca pantothenate – 12 mg, Biotin – 0.15 mg, Choline-Cl – 250 mg, Copper- 3.3 mg Zinc – 60 mg, Iron – 50 mg, manganese – 80 mg, iodine – 1 mg, and silicon – 0.25 mg*

Experimental design and turkeys' management

One hundred and twenty (120) day-old British United Turkey (BUT) poults were sourced from a reputable farm in Nigeria and were brooded for twenty eight (28) days by using commercial pre-starter turkey diet. At the end of 28-days brooding period, turkey starters were randomly assigned into four (4) dietary treatments in a completely randomized design (CRD). A total of thirty (30) turkeys were used in each treatment and replicated six (6) times with five (5) birds per replicate. A standard deep litter system was used to rear from four (4) to eight (8) weeks of the experiment (starting phase). Prior to the arrival of turkey poults, brooding pen, environment, facilities and equipment were thorough cleaned and properly disinfected. Brooding was done on deep litter pens, each pen (dimension 2.0m x 1.5m) containing 5 birds. Electricity and charcoal pots were the sources of heat. Birds were provided water and feed *ad libitum.* The vaccination and medication protocols for the poultry birds were adhered to strictly, following. established guidelines (Nwosu and Okonkwo 2017)

Data collection

Haematological indices

At the 7th week of the experiment, 3 ml blood sample was collected via the wing vein into vials containing ethylene diamine tetra-acetic acid (EDTA) as an anti-coagulant for the determination of haematological parameters (packed cell volume, haemoglobin, white blood cells, red blood cells and differential counts to determine neutrophil, eosinophil and basophil counts) as described by Owen, (2011)

Serum biochemistry

Another set of (3 mls) blood sample was collected into heparinized tubes for serum biochemistry measurement (total serum protein, serum albumin, serum globulin, serum uric acid, serum creatinine, serum glucose, aspartate aminotransferase, alanine aminotransferase and alkaline phosphate) using standard procedures Owen, (2011).

Statistical analysis

Using SPSS (2021), a one-way analysis of variance (ANOVA) was performed on all collected data. Duncan's multiple range test (Duncan, 1955) was used to differentiate significant ($p<0.05$) means between variables.

Statistical models

$Yij = \mu+T_i+\varepsilon_{ij}$

where:

Yij = Observed value of dependent variable

μ = Population mean

Ti = Effect of treatment (0, 5, 10, 15%)

ε_{ij} = Random residual error

Results and Discussion

Haematological indices of starter turkeys fed experimental diets (5-8 weeks)

The results of haematological indices of starter turkeys fed diet containing varying levels of flash-dried cassava pulp are presented in Table 2. Mean corpuscular volume (MCV), mean cell haemoglobin (MCH), white blood cells, lymphocytes, monocytes and hemoglobin were significantly affected ($p<0.05$) while packed cell volume, red blood cells, neutrophils, basophils and MCHC were not significantly affected ($p>0.05$) by the experimental feeds. Haemaglobin significantly ($p<0.05$) ranged from 11.10 to 12.50(g/dl), with the higher $p<0.05$ value of 12.50g/dl observed from turkeys fed 15% FDCP while the lowest (11.10g/dl) was noticed from birds fed 0% FDCP. White blood cells ranged from 12.13 to 13.87 (x 10^{12L}) and the highest (13.87 x10^{12L}) significance ($p<0.05$) was obtained from turkeys fed 15% FDCP while the lowest (12.13 x10^{12L}) was obtained from 10% FDCP. Lymphocytes showed significant ($p<0.05$) difference between 67.67(%) and 71.00 (%), Birds on 15% FDCP gave the highest (71.00%) significance value ($p<0.05$) while the least (67.67%) value ($p<0.05$) was observed on turkeys fed 5% FDCP. Monocytes showed that 5% FDCP had the highest (1.67%) value while 0% FDCP had 0.00(%). MCV revealed a level of significance between 94.07(fl) and 127.32(fl). Turkey on 15% FDCP had the highest MCV (127.32 fl) while turkeys on 5% FDCP had the lowest MCV (94.07 fl). The mean cell hemoglobin (pg) varied between 31.27 and 31.27 with the highest (41.27 pg) value ($p<0.05$) obtained from turkeys fed 15% FDCP and the lowest (31.27pg) obtained from turkeys fed 5% FDCP.

Table 2: Haematological indices of starter turkeys fed experimental diets (5-8 weeks)

	FDCP Levels of replacement					
Parameters	**0%**	**5%**	**10%**	**15%**	**SEM**	**P–value**
PCV (%)	34.00	34.67	35.33	38.67	0.63	0.320
Haemoglobin(g/l)	11.10^{b}	11.53^{b}	11.90^{ab}	12.50^{a}	0.18	0.030
RBC ($x10^{12}$/l)	3.40	3.73	3.60	3.10	0.10	0.153
WBC ($x10^{9}$/l)	13.53^{a}	12.70^{ab}	12.13^{bc}	13.87^{a}	0.22	0.010
Neutrophils (%)	29.67	30.33	30.33	28.33	0.31	0.063
Lymphocytes (%)	70.00^{a}	67.6^{b}	68.3^{b}	71.00^{a}	0.36	0.001
Basophils (%)	0.33	0.33	0.33	0.33	0.10	1.000
Monocytes (%)	0.00^{c}	1.67^{a}	1.00^{ab}	0.33^{c}	0.17	0.000
MCV (fl)	101.68	94.07^{b}	99.30^{b}	127.32^{a}	3.98	0.006
MCH (pg)	33.15^{b}	31.27^{b}	33.35^{b}	41.27^{a}	1.21	0.008
MCHC (g/dl)	32.65	33.33	33.70	32.37	0.22	0.123

^{a,b,c} Means within the same row with different superscripts are significantly different ($P<0.05$). SEM = Standard error of the mean, PCV = Packed cell volume, RBC = Red blood cell, WBC = White blood cell, MCV = Mean corpuscular volume, MCH = Mean corpuscular haemoglobin MCHC = Mean corpuscular haemoglobin concentration

The haemoglobin concentrations were significantly increased as the levels of FDCP in the diets increased up to 15% inclusion levels. This finding confirmed report of Oyegunwa *et al.* (2021) who noticed an increased in haemoglobin levels. Increased haemoglobin concentration is related with a better ability to fight against infections and poor nutrition (Cheesbrough, 2004). All values recorded however are within normal ranges reported by Adediran and Omojola (2021). Turkeys on 15% FDCP had slightly higher value than 12.13g/dl reported by Ukoha *et al.* (2022). Therefore, turkeys fed on FDCP diets had good quality protein. The haematological levels of the parameters revealed the nutritional state and metabolic efficiency of the birds (Alabi *et al.* 2015). Results observed inferred that starter turkeys with varied FDCP diets had good nutritional status and metabolic performance like turkeys on control diets.

White blood cells (WBC) and their differentials play a crucial role in the immune response by distributing antibodies, engulfing foreign organisms through phagocytosis and transport, thereby fighting infection and protecting the body system (Soetan *et al.,* 2013). Significantly higher WBC observed in turkey's starter fed diet containing 15% FDCP is an indication that FDCP boost immunity of the turkeys at starting phase which was in accordance with the report of Isaac *et al.* (2013) who found that animals with elevated WBC counts have highest levels of disease resistance and can produce antibodies during phagocytosis.

Lymphocytes level at starting phase were significantly ($p<0.05$) improved as FDCP level in diets increased. The values obtained (67.67 -70.10%) fell within the ranged of 69.00–70.67% for healthy birds as established by Ukoha, *et al.,* (2022). According to Guryton and Hall (2006), an increase in lymphocytes in the blood indicates improved immunological well-being of the turkey starter. The results of lymphocytes obtained inferred that FDCP has nutrients and ability to fight against diseases infection and improve the health status of the turkeys at starting phase. Improved monocytes observed from turkeys fed varied FDCP diets from this study suggest that inclusion of FDCP enhanced the immune cell response to invading germs i.e FDCP diets had better resistance against protozoa, virus and bacteria that might invade starter turkeys.

The three indicators of the immune system (MCV, MCH and MCHC) are crucial for diagnosing anemia and serve as an effective indicator ability of the bone marrow to produce red blood cells (Awodi *et al.,* 2005; Esiegwu and Obi, 2019). The values of MCV and MCH observed from this finding were significantly increased across dietary treatment groups as levels of FDCP diets increased. The value of mean corpuscular volume (MCV) fell within ranged reported by Ijeh and Ejike, (2011). It aids in determining presence of shortage of blood that affect an animal. Low MCV may show shortage of iron, prolonged (chronic) disease, haemoglobin syndrome like anaemia due to blood cell destruction or bone marrow disorder (Ukoha, *et al.,* 2022). Insignificant differences were observed for MCH between turkeys fed 0-10%FDCP while the value was significant at 15% FDCP. The values obtained ranged from 31.27pg–41.27pg. These values were above the range of 32.23pg-35.56pg for healthy birds as established by Utoka *et al.* (2022) but fell within the established values of 33.0 – 47pg reported by Ijeh and Ejike. (2011). The MCV and MCH values recorded contradict the report of Esiegwu, (2021) who observed non-significant effect on all treatments when birds were subjected to the experimental diets.

Table 3: Serum biochemistry of starter turkeys fed experimental diets (5-8 weeks).

	FDCP Levels of replacement					
Parameters	**0%**	**5%**	**10%**	**15%**	**SEM**	**P – value**
Total protein (g/dl)	4.77	6.20	5.57	5.30	0.32	0.476
Albumin (g/dl)	2.60	2.80	3.10	2.57	0.14	0.525
Globulin (g/dl)	2.17	3.40	2.77	2.70	0.26	0.479
Glucose (g/dl)	152.00	112.10	109.13	147.63	9.08	0.159
Triglyceride(mg/dl)	79.20	60.37	62.07	64.37	2.51	0.090
Cholesterol (mg/dl)	93.57^{b}	139.53^{a}	124.60^{a}	126.23^{a}	4.70	0.001
Uric acid (mg/dl)	8.60	8.90	7.63	8.10	0.36	0.849
AST (U/L)	76.33	85.00	76.00	77.67	1.50	0.317
ALT (U/L)	15.33	15.67	17.33	15.33	0.53	0.190
ALP (U/L)	42.00^{a}	32.00^{ab}	29.00^{ab}	13.00^{b}	3.60	0.027
TB (mg/dl)	0.32	0.25	0.27	0.38	0.03	0.325
DB (mg/dl)	0.05^{ab}	0.06^{a}	0.02^{c}	0.03^{bc}	0.00	0.043
Creatinine (mg/dl)	1.44	1.35	1.27	1.27	0.09	0.948

[a,b,c] Means within the same row with different superscripts are significantly different (P<0.05). SEM = Standard error of the mean, NA = Not available, AST = Aspartate transaminase, ALT = Alanine transaminase, ALP = Alkaline phosphate, TB = Total bilirubin, DB = Density bilirubin,

Serum biochemistry of starter turkeys fed experimental diets (5-8 weeks)

Table 3 displays serum biochemistry results for starter turkeys given diets with different levels of flash-dried cassava pulp. Triglycerides, total protein, albumin, globulin, uric acid, alanine transferase (ALT), aspartate transferase (AST), total bilirubin, and creatinine were not significantly different (p>0.05); However, cholesterol, alkaline phosphate (ALP) and density bilirubin differed significantly (p<0.05). Cholesterol showed a non-significant (p>0.05) value on 5% FDCP, 10% FDCP and 15% FDCP with the highest value of 139.53mg/dl) obtained from the turkey starter fed 5% FDCP and the least (93.57mg/dl) significant (p<0.05) difference observed from the turkey starters placed on 0%

FDCP. AST ranged from 76.33 (U/L) to 85.00 (U/L), and turkeys placed on 5% FDCP and 15% FDCP had similar significant ($p<0.05$) values, with the highest (85.00U/L) value from turkey starters placed on 5% FDCP and the lowest (77.6U/L) value obtained from turkeys on 15% FDCP diets. Turkeys fed with 0% FDCP and 10% FDCP showed comparable statistical results. Turkeys on 0% FDCP had the highest (42.00U/L) alkaline phosphate (ALP) significantly ($p<0.05$), while 15% FDCP had the lowest (13.00U/L) significant effect ($p<0.05$). Density bilirubin showed significant effects ($p<0.05$) between 0.02 (mg/dl) and 0.06 (mg/dl), with the highest value (0.06mg/dl) found in turkeys fed with 5% FDCP while turkeys fed with 10% FDCP had the least (0.02 mg/dl) significant effect ($p<0.05$).

The values of the total protein, albumin, globulin, glucose, uric acid, ALT, total bilirubin as well as creatinine observed in turkey starters fed varied FDCP diets compared favourably with the control diet, which indicated that the experimental turkeys in this finding did not compromise immune status. Triglycerides are broken down into fatty acids and glycerol as a source of metabolic energy (Santo *et al.,* 2006). However, triglyceride levels obtained (62.07–79.20mg/dl) were lower than those (80.30–121.00mg/dl) reported by Odutayo *et al.* (2021). Cholesterol is required by the body to produce hormones, vitamin D and other constituents that are involved in food digestion (Adeniyi *et al.,* 2016). Adeniyi *et al.* (2016) submitted that the body system can manufacture cholesterol needed to carry out various functions, but too much consumption and storage could predispose the body to illness. The starting turkeys in this study that were fed different FDCP diets fell within the normal range (129-297 mg/dl) that Church *et al.* (1984) had reported, however, those given the control diet (0% FDCP) had 93.57 mg/dl, which below suggested levels.

The study of different enzyme activities such as alanine aminotransferase (ALT), aspartate aminotransferase (AST) and total protein have been found to be of great value in the assessment of clinical and experimental liver damage (Olawale, 2019). High levels of ALT indicate liver injury while an increase in ALT levels coincided with an increase in AST, which is essential for converting amino acids into keto acids (Dash *et al.,* 2007). Kende, (2006) reported that alkaline phosphatase (ALP) results from increased infectious disease states. The turkeys on control diet had higher ALP therefore required more bone in their diet to meet up to form notable bone in the body. Statistical similarity of ALT in varying inclusion levels of FDCP in this finding showed that FDCP diets had no negative effects on liver functions and turkey health status at starting stage.

Conclusion and Recommendation

Based on the outcome of this finding, flashed-dried cassava pulp did not pose any adverse effect on blood profiles of turkeys at starting phase. Further research is needed to explore the feasibility of using flash-dried cassava pulp as a maize substitute at levels above 15% in turkey starter diets.

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