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| RESEARCH ARTICLE

Paper Title:

EFFECT OF FLASHED-DRIED CASSAVA PULP ON SERUM BIOCHEMICAL AND HAEMATOLOGICAL INDICES OF BROILER CHICKS

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| ABSTRACT

The effects of dietary inclusion of flashed-dried cassavapulp (FDCP) on serum biochemical and haematological indices were investigated in a study involving two hundred and forty (240) day-old unsexed Cobb 500 broiler chicks. The broiler chicks were randomly assignedinto four dietary treatment groups and replicated six (6) times, with 10 birds per replicate in a completely randomized design. FDCP substituted for maize at 0, 5, 10 and 15% levels. The feeding trial lasted for 28-days.

| KEYWORDS

Brioler chicks, flashed-dried cassava pulp, serum biochemical, haematological and maize.

| ARTICLE INFORMATION

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The effects of dietary inclusion of flashed-dried cassavapulp (FDCP) on serum biochemical and haematological indices were investigated in a study involving two hundred and forty (240) day-old unsexed Cobb 500 broiler chicks. The broiler chicks were randomly assignedinto four dietary treatment groups and replicated six (6) times, with 10 birds per replicate in a completely randomized design. FDCP substituted for maize at 0, 5, 10 and 15% levels. The feeding trial lasted for 28-days. On the 28-days of the study, 3mls blood was randomly withdrawn from wing web by using a disposable needle and syringe from a bird per replicate into a bottle that contained no anticoagulant and another 3mls per replicate was obtained from another bird into bottle that containing anticoagulant and transferred to the laboratory for assay. Laboratory results were analyzed by using SPSS version 27.

The dietary treatments showed a significant influence ($p<0.05$) on albumin, cholesterol and creatinine levels. Broiler chicks fed on 10% FDCP had the highest (3.85 g/dl) albumin, which was statistically comparable to the values found from broiler chicks fed with 15% FDCP while the least (3.25 g/dl) was recorded from chicks fed with 0% FDCP. The highest (99.50 mg/dl) cholesterol was obtained from birds placed on 15% FDCP while the lowest (46.45 mg/dl) was obtained from birds fed 0% FDCP. Broiler chicks fed 10% FDCP had higher significant ($p<0.05$) creatinine of 1.91 mg/dl while control birds had the lowest significant ($p<0.05$) creatinine (1.11mg/dl). White blood cells (WBC) showed significant values ($p<0.05$) from 11.85 to 17.10 (x 10^6/l). Mean corpuscular volume (MCV) significantly ($p<0.05$) ranged from 119.25 to 118.35 (fl). The mean corpuscular hemoglobin values ranged from 37.40 to 40.35%. Conclusively, varied FDCP can be used up to 15% level of inclusion in the broiler chicks without posing negative impacton serum biochemical and haematological indices of broiler chicks. Therefore, 15% inclusion level of FDCP is recommended to replace maize in broilerchicks.

Introduction:-

Cassava is a perennial woody shrub, is a resilient crop well-suited to tropical and subtropical regions, especiallyin the developing nations (Onyenwoke and Simonyan,. 2014). Nigeria leads global cassava production with over 34 million tonnes annually (FAO and IFAD, 2005). Cassava is a promising ingredient for animal feeds due to its high starch content, cost effectiveness, and adaptability. Cassava has been studied as an alternative energy source in poultry diets(Eruvbetine, 1995). Cassava roots can replace maize, improving poultry energy source, while its protein content is lower, it can be balance with protein-rich grains and methionine additive (Chimeremeze Emeh, 2025). Its leaves and stems have important roles in animal feeds, providing essential nutrients and promoting growth. It contains minerals and vitamins in macro quantities.Incorporating cassava and its by-products like cassava pulp, cassava peels, cassava leaves etc in animal feeds enhances digestion, performance and reduces reliance on conventional feed sources. Cassava pulp is the left over obtained after starch extraction, is typically underutilized, posing environmental disposal challenges.Transforming it into a poultry feed ingredient introduces a novel, sustainable approach. It contains 50-60% carbohydrates, 10-15% fibreand 2-5% protein, making it an energy-dense, cost-effective alternative to maize.

It holds strong potential in animal feed due to its high energy and fiber content. Its availability in cassava producing area also ensures local supply, making it a practical and sustainable option for animal nutrition (Chimeremeze Emeh, 2025).Studies show that dried cassava pulp can help broilers meet some of their energy needs, but its use in diets should be restricted to 8%. It can also promote the intestinal health of broilers and reduce the amount of fat that accumulates in their abdomens (Khempaka et al., 2009**)**. However, its impact on the health and well-being of broiler blood indices is not well exploited. To address this scanting information, an experiment was conducted to evaluate the effects of dietary inclusion of flashed-dried cassava pulpon the serum biochemical and haematological indices of broiler chicks.

Materials and Methods:-

Experimental site

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, 2020). 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 the flashed-dried cassava pulp (FDCP)

Test ingredient used for this study was flashed-dried cassava pulp (FDCP). Flashed-dried cassava pulp was obtained from the starch processing industry (Psaltry International) along Maya, Ado-Awaye road, Iseyin Local government, Oyo State, Nigeria. Iseyin geographical coordinates are latitude 7^{0} 58' 0'' North and longitude 3^{0} 36' 0'' East.

Chemical analysis

The AOAC (2022) standard procedures were followed for the determination of crude protein (CP), crude fibre (CF), ether extract (EE), ash, calcium, and phosphorous in flash-dried cassava pulp (FDCP) while metabolizable energy (ME) was calculated using the Pauzenga formula (1985) as follows: ME = (37 X CP) + (81.8 X EE) + (35.5 X NFE) where NFE is Nitrogen Free Extract. NFE = 100 - CP – EE - ASH – MC – CF, where MC = Moisture Content.

Experimental diets

The test diet was formulated such that FDCP was partially replaced maize at 0, 5, 10 and 15% levels at starting phase as shown in Tables 1. The formulated diets were iso-proteinous and iso-caloric, in line with the recommendation of (NRC 1994).

Experimental design and birds' management

Two hundred and forty (240) day-old unsexed Cobb 500 broiler chicks were placed in a completely randomized design (CRD) with four (4) dietary treatments. Each dietary group contained sixty (60) broiler chicks per treatment; each group was subdivided into six (6) replicates, with a total of ten (10) broiler chicks per replicate. Prior to the arrival of the chicks, brooding pen, environment, facilities, equipment were thoroughly cleaned and properly disinfected. Brooding was done on deep litter pens. Electricity and charcoal pots were the sources of heat. Birds were provided water and feed ad libitum. Vaccination and medication protocols were strictly followed. Management was firmly monitored to prevent build up pathogens.

Table 1: Gross composition (%) of experimental diets for broiler starters (0 – 4 weeks)

Ingredients (kg)	0%	5%	10%	15%
Maize	50.50	45.50	40.50	36.00
FDCP	0.00	5.00	10.00	15.00
Full fat soybean	15.00	16.50	18.00	19.00
Ground nut cake	20.00	20.00	20.00	20.00
Wheat offal	6.00	4.50	3.00	1.50
Fish meal (72%CP)	3.50	3.50	3.50	3.50
Lime stone	1.50	1.50	1.50	1.50
Bone meal	2.50	2.50	2.50	2.50
Lysine	0.20	0.20	0.20	0.20
Methionine	0.30	0.30	0.30	0.30
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)	11.95	11.83	11.75	11.66
Crude protein (%)	23.22	23.17	23.12	23.07
Calcium (%)	1.67	1.67	1.67	1.68
Phosphorous (%)	0.58	0.58	0.57	0.57
Lysine (%)	0.88	0.85	0.82	0.80
Mthionine (%)	0.57	0.56	0.54	0.53

*** Vitamin/mineral premixes: - Vitamin A 10,000,000 (IU), Vitamin D3 2,000,000 (IU), Vitamin E 23,000 mg, Vitamin, K3 20,000 (mg), Vitamin B1 1,800 (mg),Vitamin B2 5,500 (mg), Niacin 27,500 (mg), Pantothenic acid 7,500 (mg), Vitamin B6 3,000 (mg), vitamin B12 15 (mg), folic acid 750 (mg), biotin H2 60 (mg), chlorine chloride 300,000 (mg), cobalt 200 (mg), copper 3,000 (mg), iodine 1,000 (mg), iron 20,000 (mg), manganese 40, 000 (mg), selenium 200 (mg), zinc 30,000 (mg), and antioxidant kI 250 (mg). FDCP = Flash Dried Cassava Pulp; ME = Metabolizable Energy; NaCl = Sodium Chlorid.**

Data collection

Serum biochemical

At the end of the 28-day (starting phase) feeding trial, a sterile needle and syringes were used to draw blood from one bird per replicate through the wing web vein. Three milliliters (3mls) blood sample was withdrawn from each bird into the vials that did not contain ethylene diamine tetra-acetic acid (EDTA) to measure serum biochemical (alanine aminotransferase, creatinine, uric acid, albumin, globulin, glucose, cholesterol, and total protein). After allowing the blood samples to clot, they were refrigerated for six hours, and then centrifuged for twenty minutes at 900 rpm. The blood sera of each bird were separated labeled and store in the freezer at 20°C before analysis.

Haematological indices

Another three milliliters (3mls) blood sample was withdrawn from one birdper replicate into the vials that contained ethylene diamine tetra-acetic acid (EDTA) as an anticoagulant for determination of heamatological indices. Haemoglobin concentration was estimated by using Cyanmethaemoglobin method (Cannan, 1958), and red blood cell (RBC) count, packed cell volume (PCV), as well as white blood cell (WBC) counts of the blood samples were analyzed in Wintrobe haematocrit tubes according to the method of Schalm et al. (1975). Mean corpuscular volume (MCV) was calculated by dividing hematocrit by the total red blood cell (RBC) i.e MCV= $\frac{\text{Hct } \% \times 10}{\text{RBC count (millions /mm 3}}$

Mean corpuscular hemoglobin (MCH) was calculated by multiplied heamoglobin (Hb g/dl x 10 and divided by thr RBC count i.e $\text{MCH} = \frac{\text{Hb}\left(\frac{g}{dL}\right) \times 10}{\text{RBC count (millions /mm 3}}$

Mean corpuscular hemoglobin concentration (MCHC) i.e $\text{MCHC} = \frac{\text{Hb}\left(\frac{g}{dl}\right) \times 100}{\text{Hct } \%}$

Statistical analysis

Data obtained were subjected to one-way analysis of variance by using SPSS (2021). Means were separated using Duncan's multiple range test (Duncan, 1955) of the same software package to determine significant differences ($p<0.05$) among treatment groups.

Statistical model

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

where Y_{ij} = Observed value of dependent variable

μ = Population mean

T_i = Level of FDCP (i= 0, 5, 10, 15%)

ε_{ij} = Random residual error.

Results and Discussion:-

Results:-

Table 2 shows the serum biochemistry of broiler starter chicks fed varied FDCP. The dietary treatments showed a significant influence ($p<0.05$) on albumin, cholesterol and creatinine levels. However, no significant effect ($p>0.05$) was observed on total protein, globulin, uric acid, total bilirubin, aspartate transferase (AST), alanine transferase (ALT), triglyceride, glucose, and density bilirubin. Albumin concentration ranged from 3.25 to 3.85 (g/dl). The birds fed 10% FDCP had the highest value (3.85 g/dl), which was statistically comparable to the values found from starting broilers fed with 15% FDCP. The least value (3.25 g/dl) was recorded in the starting broiler fed on 0% FDCP and was statistically similar ($p>0.05$) to the starting broiler placed on 5% FDCP. The values of cholesterol ranged between 46.45 and 99.50 mg/dl, and the highest value (99.50 mg/dl) was obtained in the starting broiler fed 15% FDCP while the lowest value (46.45 mg/dl) was obtained in the starting broiler fed 0% FDCP (control). Birds placed on 0% FDCP (control) differed significantly ($p<0.05$) from birds on 5% FDCP. Correspondingly, birds on 5% FDCP were significantly ($p<0.05$) similar to those chicks fed on 10% FDCP and 15% FDCP. The starting broilers fed FDCP had creatinine values ranging from 1.11 mg/dl to 1.91 mg/dl, birds fed 10% FDCP had the highest significant value ($p<0.05$) of 1.91 mg/dl while birds fed 0% FDCP (control) diet had the lowest significant ($p<0.05$) creatinine values (1.11mg/dl), birds fed 10% and 15% FDCP showed significant ($p<0.05$) creatinine similarities between treatment groups.

Table 2: Serum biochemistry of broiler starter fed experimental diets (0-4 weeks)

Parameters	0%	5%	10%	15%	SEM	P-value
Total Protein (g/dl)	5.85	6.95	5.40	6.70	0.34	0.376
Albumin (g/dl)	3.25^{b}	3.30^{b}	3.85^{a}	3.75^{a}	0.10	0.019
Globulin (g/dl)	2.55^{ab}	3.65^{a}	1.50^{b}	2.95^{ab}	0.34	0.146
AST (U/L)	99.00	113.00	99.00	97.50	3.36	0.353
ALT (U/L)	35.00	38.50	38.00	36.50	0.60	0.143
Triglyceride (mg/dl)	129.20	125.45	108.25	94.35	6.84	0.258
Cholesterol (mg/l)	46.45^{b}	71.15^{ab}	78.70^{a}	99.50^{a}	6.85	0.018
Glucose (mg/dl)	129.40	114.65	150.90	237.70	22.12	0.200
Uric Acid (mg/dl)	6.85	8.40	8.10	4.10	0.71	0.105
Total Bilirubin	0.07	0.44	0.25	0.14	0.03	0.128
Density Bilirubin	0.40	0.09	0.70	0.11	0.01	0.282
Creatinine (mg/dl)	1.11^{c}	1.36^{b}	1.91^{a}	1.79^{a}	0.10	0.000

^{a,b,c}Means on the same row with different subscripts are significantly different at P < 0.05. SEM = Standard error of the mean AST= Aspartate transaminase ALT= Alanine transaminase NA = Not available

Table 3 shows effect of experimental diets in haematological indices of broiler starters.

Significant ($p<0.05$) differences were found in white blood cells (WBC), mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) but no significant effect ($p>0.05$) in

packed cell volume (PCV), hemoglobin (Hb), red blood cells (RBCs), mean corpuscular hemoglobin concentration (MCHC), heterophils, lymphocyte, basophils and monocytes. The WBC showed significant values ($p<0.05$) from 11.85 to 17.10 (x 10^6/l), with the highest value (17.10 x 10^6/l) at 15% FDCP while the least (11.85 x 10^6/l) was obtained from 0% FDCP. MCV of broiler chicks from 5% FDCP gave the highest significantly ($p<0.05$) difference of 119.25 (fl) while those on 10% FDCP recorded the least significant value of 109.85 (fl). The mean corpuscular hemoglobin values ranged from 37.40 to 40.35%, with the highest (40.35%) significant value ($p<0.05$) obtained in starting broilers with 15% FDCP, while the lowest significant value ($p<0.05$) of 37.40% recorded from broilers fed with 10% FDCP.

Table 3: Haematological indices of broiler starter fed experimental diets (0-4weeks)

Parameters	0%	5%	10%	15%	SEM	P-value
PCV (%)	32.00	31.00	34.50	35.50	0.76	0.104
Haemaglobin (g/dl)	10.70	10.45	11.75	12.10	0.27	0.053
RBC (10^2/l)	2.70	2.60	3.15	3.00	0.08	0.055
WBC(x 10^6/l)	11.85^c	14.00^b	15.00^b	17.10^a	0.67	0.001
MCV (fl)	118.75^b	119.25^a	109.85^d	118.35^c	1.17	0.001
MCH (%)	39.75^b	40.20^a	37.40^c	40.35^a	0.36	0.001
MCHC (%)	33.45	33.70	34.00	34.05	0.11	0.145
Heterophils (%)	36.50	32.00	29.00	24.00	1.95	0.123
Lymphocyte (%)	63.50	67.50	70.5076.00		2.00	0.147
Basophil (%)	0.00	0.50	0.00	0.00	0.00	0.095
Monocytes (%)	0.00	0.00	0.50	0.00	0.09	0.095

[a,b,c] Means on the same row with different subscripts are significantly, different at $P < 0.05$, 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 cell hemoglobin concentration

Discussion:-

Blood type and quality are influenced by serum albumin levels, which reflect nutritional status and overall health. The serum albumin levels in this study contradict the findings of Sugiharto et al. (2019), who reported no significant differences in serum albumin levels of broiler chicks fed fermented cassava pulp as a substitute for corn. Serum albumin concentrations of broiler broiler chicks fed 10% FDCP were similar to those fed 15% FDCP, suggesting that the protein content in the experimental diets (FDCP) is sufficient to maintain the health status and support the nutritional needs of the birds during the starter phase. The globulin values (1.50-3.65g/dl) were within the values of 2-3.50g/dl reported by Marieb and Hoehn (2007), but were higher than 1.86-2.66g/dl established by Sugi

harto, (2019), who fed broiler chickens with dried fermented cassava pulp. In this study, birds fed graded levels of FDCP showed the highest globulin levels at the bigining of the experiment, suggesting improved disease resistance.

Cholesterol is a key intermediate in the biosynthesis of related sterols; therefore, a significant increase in cholesterol as FDCP diets increased across treatments groups might lead to increased low-density lipoprotein. Adeniyi et al. (2016) opined that excessive consumption and storage of cholesterol could predispose bird to illness. The cholesterolvalues (46.45 – 99.50 mg/dl) in this study fell below the range of (87-192 mg/dl) reported by Meluzzi et al. (1992). An elevated risk of cardiovascular disease is indicated by high cholesterol levels. This suggests that the cholesterol content of broiler starter diets in this finding had no negative effects on the health status of broilers.

Kidneyfunction is assessed using creatininelevles. According to Ileke et al. (2014), creatinine serves as a maker forthe excretion of waste products produced during the metabolism and the contraction.The creatinine values (1.11–1.91mg/dl) obtained in this study was higher than reference values (0.90mg/dl–1.85mg/dl) reported by Mitruka and Ranwnsley (1977). Thehigh creatinine level (1.91mg/dl) found in broiler chicks fed 10% FDCP suggests that kidney function may be impaired.However, the creatinine values observed in this research indicate no muscular wastage in broiler starters.

Rajman et al. (2006) opined that a direct correlation between creatinine levels, muscle volume and activity explains why blood levels of the protein are lower in both young and old chickens. Total protein, glucose, uric acid, triglyeride, aspartate transferase (AST), alanine transferase (ALT), total bilirubin and density bilirubin levelsin starting broilers fed varied FDCP diets compared favourably with the control diet. It suggeststhat the FDCP diets had no negative impact on the birds' health during the starting phase.

Haematological indices are commonly used to identify nutritional stressors and other factors (Afolabi et al., 2010). The white blood cellcount (WBC) of 11.85-17.10 (x$10^{6}/^{l}$) obtained from this research was within the range of 12.00 – 30.00 (x$10^{6}/^{l}$) reported by Bounous and Stedman (2000). White blood cells are known to fight against foreign bodies and contribute to immunity (Osman et al., 2004). The result of this study indicates that broiler starter fed with FDCP showed comparable immunity status, which is better than that of broiler starters fed with 0% FDCP. The control broiler starters in this study were more susceptible to disease dueto their low WBC counts.However, birds with high WBC counts are more resistant to illness and have the ability to produce antibodies during the phagocytocis process (Soetan, et al., 2013). Therefore, birds on varied FDCP diets from this study had higher resistance to diseases.

The mean corpuscular hemoglobin (MCH) values obtained (37.40-40.35%) fell within the normal range for broilers, as suggested by Adekunle and Omoh (2014). Thissuggests that the FDCP is adequate for starter broiler nutrition. MCH is an indicator of the ability of red blood cells to transport oxygen, implying that broiler chicks fed FDCP diets at an early stage have improved respiratory function, as reported Abdulazeez et al. (2016). In all dietary treatments, mean corpuscular volume (MCV) and MCH showed the same pattern.

The packed cell volume (31-35.50 %), red blood cell (2.70-3.10 x 10^6/l), lymphocytes (63.50-76.00 %) and basophils (0.00-0.50%) values obtained from this study fell within the standard ranges of 22-35, 2.81 to 3.42 x (10^6/ul), 40-80(%) and 0.00-1.00 (%) respectively, as recommended for healthy chickens by Sembulingam and Sembulingam (2002), Jain, (1993), Ijaduola et al. (2018),Kalio and Ingweye (2018), Yasim et al. (2017) and Alade (2018). This suggests that broiler chicks fed varied FDCP diets had improved immunological well-being, as they maintained normal blood count andweresufficiently nourished tomeet their dietary requirements.

The red blood cell count, MCV, and MCHC values were within the recommended ranges of 1.58–3.82 (x10^3/mm^3), 38.44–43.04% and 32.90-33.80% respectively, for healthy broiler chicks, as reported by Madubuike and Ekenye (2006), Banerjee (2008), Amao and Siyanbola (2013), Adekunle and Omoh (2014) and Kalio and Ingweye (2018). Inadequate protein and energy intake generally affects PCV and Hb, with lower values indicating anaemia (i.e shortage of redblood cells) (Muhammad and Oloyede, 2009). This observation is consistent with research conducted by Alade (2018), who fed diets containing both treated and untreated cassava sifting diet to finisher broiler chickens, with values within the standard range. The results observed from the broiler starters suggested the nutritional adequacy of the FDCP. MCV and MCH are indicatorsof red blood cell status, not specifically " signs of immune system''(Esiegwu and Obi, 2019). The lack of significant differences in this finding suggests that the experimental chickens' immune system and overall health were not negatively impacted during the final phase of the experiment.

Conclusion:-

It can be concluded that flashed-dried cassava pulp can be used to replac maize in broiler chick diets at inclusion level up to 15% without adverse effects on health.

Recommendation:-

15% level of inclusion of flashed-dreid cassava pulp is recommended in the broiler chick diets.

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Conflict Of Interest Statement

The authors declare no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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