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Haematology, Organ Weight, And Carcass Characteristics of Broiler Finishers Fed Varying Levels of Bread Waste as Partial Replacement for Maize

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Abstract

This study investigated the effects of varying levels of bread waste (0%, 5%, 10%, 15%, and 20%) as partial substitute for maize, on the haematology, organ weight, and carcass characteristics of broiler finishers. The experiment was conducted at the University of Port Harcourt Teaching and Research Farm, over a period of eight weeks, using 120 mixed-sex broiler finishers randomly allocated to five dietary treatments in a Completely Randomized Design. Blood samples were collected to analyze haematological parameters, while organs and carcass characteristics were measured at the conclusion of the experiment. Results revealed no significant differences (p>0.05) in haematological parameters including Packed Cell Volume, Haemoglobin, Red Blood Cell, White Blood Cell counts, Platelets, and other blood indices across all treatment groups. Similarly, no significant differences were observed in organ weight (liver, heart, spleen, etc.) or carcass characteristics (live weight, dressed weight, dressing percentage, and primal cuts). These findings suggest that bread waste can be effectively incorporated into broiler diets up to 20% inclusion level as a partial replacement for maize without adversely affecting the birds' physiological status, organ development, or carcass quality. The study demonstrates that bread waste represents a viable alternative feed ingredient that could potentially reduce production costs in broiler farming without compromising the health and performance of the birds.

Keywords: *Bread waste, Haematology, Organ weight, Carcass, Broiler, Chickens.*

INTRODUCTION

Poultry production represents one of the fastest-growing segments of the agricultural sector worldwide, with broiler production being a significant contributor to global protein supply. The intensification of poultry farming has led to increased demand for conventional feed ingredients, particularly energy sources such as maize (corn), which constitutes approximately 50-60% of commercial broiler diets (Ravindran, 2013). However, the rising costs of conventional feed ingredients, coupled with competition between humans and livestock for these resources, has necessitated the exploration of alternative feed ingredients to ensure sustainable poultry production (Makinde *et al*., 2019).

Bread waste, a by-product from bakeries, supermarkets, and food processing industries, represents a potential alternative energy source in poultry nutrition. It contains appreciable amounts of carbohydrates, proteins, and fats that could potentially replace portions of maize in broiler diets (Omole *et al*., 2013; Faddle *et al*., 2019). The utilization of bread waste in animal feeds not only provides a cost-effective alternative to conventional energy sources but also contributes to reducing environmental pollution associated with improper disposal of food waste (Al-Tulaihan *et al*., 2004).

Despite the potential of bread waste as an alternative energy source in broiler diets, there is insufficient information regarding its optimal inclusion levels and effects on the physiological and carcass characteristics of broiler chickens (Ayanrinde *et al.*, 2014). The present study therefore aims to investigate the effects of partial replacement of maize with varying levels of bread waste on the haematological parameters, organ development, and carcass characteristics of broiler finishers.

MATERIALS AND METHODS

The experiment was carried out in the University of Port Harcourt Teaching and Research Farm, Choba, Port Harcourt, Rivers State, which lies on latitude 40 53' 30'' N and longitude 40 53' 30'' and 60 54' 45'' E (Ayeloja and Adedeji, 2015). A total of 120 mixed sex broiler finishers were randomly allotted to five (5) dietary treatments (T1, T2, T3, T4, and T5), comprising twenty-four (24) birds per treatment, distributed across three replicates of eight (8) birds each, in a Completely Randomized Design (CRD). The birds were housed in a deep litter system, in an open poultry house demarcated with wire mesh and wooden frame. The birds were managed under strict hygiene conditions where daily routine practices associated with poultry production were observed. Bread waste was purchased from Ochuko Sweet Bread Bakery, located at No 2 Uniport road, Owhipa, Choba, Port Harcourt, Rivers state. The waste was dried, milled into powder and incorporated into the formulated broiler finisher diet at inclusion levels of 0%, 5%, 10%, 15% and 20%, corresponding to treatments T1 through T5, respectively. Water and experimental diet were provided *ad-libitum* throughout the experimental duration of eight (8) weeks.

Table 1: Experimental Feed Composition

Ingredients	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)
Yellow maize	59.06	56.12	53.15	50.2	47.25
Soya bean	24.1	24.1	24.1	24.1	24.1
Palm kernel cake	6.56	6.56	6.56	6.56	6.56
Groundnut cake	3.19	3.19	3.19	3.19	3.19
Bone meal	2.85	2.85	2.85	2.85	2.85
Fish meal	3.0	3.0	3.0	3.0	3.0
Vitamins/Minerals	0.46	0.46	0.46	0.46	0.46
Methionine	0.18	0.18	0.18	0.18	0.18
Lysine	0.14	0.14	0.14	0.14	0.14
Salt	0.46	0.46	0.46	0.46	0.46
Bread Waste	0	2.95	5.91	8.86	11.81
Total	**100**	**100**	**100**	**100**	**100**
Nutrient Composition of Feed					
Energy (kcal)	2908.83	2815.77	2725.81	2632.75	2542.79
Protein (%)	20.42	20.45	20.49	20.52	20.55
Fat & Oil (%)	3.31	3.19	3.07	2.95	2.84
Crude Fiber (%)	4.28	4.19	4.10	4.01	3.92
Lysine (%)	1.03	1.02	1.01	1.00	0.99
Methionine (%)	0.40	0.39	0.39	0.38	0.38
Calcium (%)	1.30	1.29	1.29	1.29	1.29
Phosphorus (%)	0.89	0.88	0.87	0.86	0.85

Data Collection and Analysis

At the end of the feeding trial, blood, organ and carcass samples were collected from replicates representing each treatment, and evaluated for haematology, organ weight and carcass parameters respectively. Blood samples were collected from the wing vein using 2ml syringes, and transferred into Ethylene Diamine Tetra acetic Acid (EDTA) bottles, to prevent clotting. Blood samples were sent to the laboratory for evaluation of haematological parameters such as haemoglobin concentration (Hb), packed cell volume (PCV), erythrocyte (RBC) count, leukocyte (WBC) count, thrombocyte concentration, and erythrocytic indices comprising mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular hemoglobin (MCH). Additionally, differential leukocyte counts were performed, quantifying neutrophils, lymphocytes, monocytes, and eosinophils. Also, visceral organs such as the crop, gizzard, liver, kidney, spleen, intestines, heart, lungs, etc. were harvested from humanely slaughtered birds and weighed with the use of a digital scale. Overall carcass weight, including dressed weight (after removal of feathers, head and feet) and eviscerate weight (after removal of internal organs) were determined using a digital weighing scale. Dressing percentage, the ratio of dressed carcass weight to live weight was calculated thus; Dressing percentage (%) = (Eviscerated weight/Live weight) × 100. Subsequently, the carcass was cut into different significant commercial cuts such the breast cut, thigh, drumstick, back cut and wing and weighed using a digital scale.

Statistical Analysis

All data obtained were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980) and their means were separated using Duncan Multiple Range Test (DMRT) according to Duncan (1955), using the Statistical Package for Social Science (SPSS) software.

RESULTS

Table 2 below shows the influence of bread waste on haematological parameters of broiler finishers. The result from the study revealed that there was no significant ($p>0.05$) difference in haemoglobin (Hb), packed cell volume (PCV), Red blood cell (RBC), white blood cell (WBC), Platelets, mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), Neutrophil, Lymphocytes, Eosinophil and Monocytes among the treatment groups.

Table 2: Influence of bread waste on haematological parameters of broiler finishers

Parameters	T1(0%)	T2(5%)	T3(10%)	T4(15%)	T5(20%)
Packed Cell Volume (%)	24.33 ± 2.02	27.67 ± 1.20	32.33 ± 1.45	29.33 ± 1.85	29.33 ± 2.96
Haemoglobin (g/100ml)	8.10 ± 0.66	9.23 ± 0.39	10.80 ± 0.49	9.76 ± 0.62	9.76 ± 1.00
Red Blood Cell ($\times 10^6$)	4.16 ± 0.37	4.73 ± 0.14	5.43 ± 0.29	5.00 ± 0.36	4.96 ± 0.53
White Blood Cell (×103/l)	6.43 ± 0.57	7.00 ± 1.36	8.56 ± 0.57	9.10 ± 1.17	8.33 ± 1.43
Platelets (%)	178.33 ± 7.79	197.33 ± 8.87	193.33 ± 13.44	198.33 ± 20.18	203.33 ± 18.77
Mean Corpuscular Haemoglobin Concentration (%)	32.67 ± 0.33	32.67 ± 0.33	33.00 ± 057	32.00 ± 0.57	33.00 ± 0.57
Mean Corpuscular Haemoglobin (%)	19.33 ± 0.33	18.67 ± 0.33	19.00 ± 0.57	20.33 ± 0.88	19.33 ± 0.88
Mean Corpuscular Volume (%)	58.33 ± 0.88	58.33 ± 0.88	59.33 ± 0.88	59.33 ± 0.88	62.33 ± 2.00
Neutrophil (%)	41.67 ± 2.02	36.67 ± 4.46	44.33 ± 1.85	41.00 ±4.58	40.00 ± 4.04
Lymphocytes (%)	51.00 ± 2.08	53.33 ± 3.75	44.00 ± 2.08	49.33 ± 4.70	53.33 ± 4.41
Eosinophil (%)	2.33 ± 0.33	3.67 ± 0.66	4.00 ± 0.57	3.00 ± 0.57	2.33 ± 0.33
Monocyte (%)	5.00 ± 0.00	6.33 ± 0.66	7.67 ± 0.33	10.00 ± 3.00	4.33 ± 0.66

Table 3 shows the Influence of bread waste on the organ weight of broiler finishers fed varying levels of bread waste. The result showed no significant difference ($p>0.05$) in crop, proventiculus, gizzard, small intestine, large intestine, caecum, liver, heart, pancreas, kidney and spleen weight across all treatment groups.

Table 3: Influence of bread waste on organ weight of broiler birds

Parameter	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)
Crop (g)	11.00 ± 2.00	13.00 ± 1.00	11.00 ± 1.00	11.50 ± 0.50	11.50 ± 1.50
Proventiculus (g)	12.50 ± 2.50	13.50 ± 0.50	15.00 ± 1.00	14.00 ± 4.00	13.50 ± 2.50
Gizzard (g)	54.00 ± 9.00	58.00 ± 4.00	59.50 ± 3.50	64.50 ± 0.50	32.50 ± 16.50
Small intestine (g)	30.00 ± 3.00	31.00 ± 7.00	30.50 ± 9.50	41.00 ± 4.00	37.50 ± 10.50
Large intestine (g)	51.00 ± 3.00	53.50 ± 4.50	49.50 ± 3.50	40.00 ± 12.00	56.00 ± 4.00
Caecum (g)	16.50 ± 4.50	17.00 ± 8.00	16.50 ± 7.50	22.00 ± 2.00	21.00 ± 2.00
Liver (g)	43.00 ± 5.00	48.50 ± 2.50	42.00 ± 13.00	49.00 ± 6.00	46.50 ± 11. 50
Heart (g)	8.50 ± 1.50	9.50 ± 1.50	11.50 ± 1.50	10.50 ± 0.50	12.00 ± 2.00
Pancreas (g)	6.50 ± 1.50	7.50 ± 0.50	7.00 ± 2.00	5.50 ± 2.50	6.50 ± 3.50
Kidney (g)	2.50 ± 0.50	3.50 ± 0.50	3.00 ± 1.00	3.00 ± 0.00	3.50 ± 1.50
Spleen (g)	5.00 ± 0.00	6.50 ± 1.50	5.00 ± 1.00	6.50 ± 1.50	9.00 ± 2.00

The result on carcass characteristics of broiler finishers fed varying levels of bread waste is shown in Table 4. The table reveals that no significant ($p>0.05$) difference was observed on live weight, dressed weight, dressing percentage, and Individual cut weights (breast, thigh, drumstick, back, and wing) in response to the graded level of the treatment diet.

Table 4: Influence of bread waste on carcass parameters of broiler birds

Parameters	T1(0%)	T2(5%)	T3 (10%)	T4 (15%)	T5 (20%)
Live weight (g)	1800.00 ± 0.00	1750.00 ± 50.00	1850.00 ± 50.00	1950.00 ± 50.00	2050.00 ± 50.00
Dressed weight (g)	1472.00 ± 77.00	1400.00 ± 3.00	1486.00 ± 18.00	1560.50 ± 40.50	1642.50 ± 37.50
Dressing percentage (%)	81.77 ± 4.27	80.06 ± 2.46	80.37 ± 3.17	80.13 ± 4.13	80.20 ± 3.80
Breast cut (g)	331.50 ± 27.50	296.00 ± 5.00	338.00 20.00	338.50 ± 13.50	372.00 ± 32.00
Thigh (g)	219.00 ± 19.00	218.50 ± 16.50	222.00 ± 33.00	246.00 ± 22.00	256.50 ± 23.50
Drumstick (g)	158.50 ± 13.50	141.00 ± 34.00	148.00 ± 33.00	176.50 ± 20.50	193.50 ± 15.50
Back cut (g)	308.00 ± 30.00	285.00 ± 6.00	293.50 ± 15.50	251.00 ± 54.00	306.50 ± 4.50
Wing (g)	153.00 ± 5.00	149.00 ± 8.00	163.50 ± 16.50	175.00 ± 22.00	178.50 ± 21.50

DISCUSSION

Haematological indices are valuable indicators of physiological, pathological, and nutritional status in animals (Etim *et al.*, 2014), and the normal haematological profile across treatment groups may be attributed to the nutritional composition of bread waste, which contains appreciable amounts of carbohydrates, proteins, and certain micronutrients (Faddle *et al.*, 2019). The packed cell volume (PCV), haemoglobin (Hb), and red blood cell (RBC) counts are primary indicators of the oxygen-carrying capacity of blood and overall health status (Onu *et al.*, 2021). The non-significant differences in these parameters across treatment groups suggest that bread waste did not interfere with erythropoiesis or induce anaemia, which aligns with findings by Adeyemo (2022), who reported similar results when evaluating alternative feed ingredients in broiler diets. Similarly, the consistent white blood cell (WBC) counts and differential leukocyte parameters (neutrophils, lymphocytes, eosinophils, and monocytes) across treatments suggest that bread waste did not trigger an immune response or inflammatory reaction in the birds. According to Sugiharto (2016), elevated WBC counts often indicate infection, inflammation, or stress in poultry. The comparable WBC values observed in this study indicate that bread waste did not contain anti-nutritional factors or toxins that would stimulate the immune system, which is consistent with findings by Olugbemi *et al.* (2021a) when evaluating bakery by-products in broiler nutrition. The stability in platelet counts further supports the safety of bread waste inclusion, as platelets play a crucial role in hemostasis and blood clotting (Oyinloye *et al.*, 2023). Fluctuations in platelet counts can indicate disease conditions or nutritional deficiencies (Chen *et al.,* 2022), but the consistent values observed across treatments suggest that bread waste maintained normal platelet production and function. The erythrocyte indices, including mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC), provide information about the size and haemoglobin content of red blood cells (Tian *et al.*, 2020). The non-significant differences in these parameters suggest that bread waste did not affect erythrocyte maturation or haemoglobin synthesis. These findings corroborate the work of Al-Sagan *et al.* (2020), who reported that bakery waste could replace up to 75% of corn in broiler diets without affecting haematological parameters. It is worth noting that the present findings contradict some earlier reports, such as Hassan *et al.* (2018), who observed slight reductions in RBC counts and haemoglobin levels with high inclusion rates of bakery waste.

The absence of significant differences in organ weights among broilers fed varying levels of bread waste as partial replacement for maize indicates that bread waste inclusion did not adversely affect the physiological development and function of vital organs. Organ weights serve as reliable indicators of physiological adaptations, toxicological responses, and overall health status in poultry (Schmidt *et al.*, 2023). The comparable gizzard weights across treatment groups suggest that bread waste did not necessitate increased muscular activity for grinding and processing, unlike some fibrous alternative feedstuffs that can induce gizzard hypertrophy (González-Alvarado *et al.*, 2020). According to Svihus (2022), gizzard development is highly responsive to dietary physical characteristics, particularly particle size and fiber content. The similar gizzard weights observed in this study indicate that bread waste likely had physical properties comparable to maize or that any differences were insufficient to trigger adaptive changes in the gizzard musculature. The non-significant differences in crop weights further support the nutritional adequacy of bread waste-containing diets. The crop serves as a temporary storage organ, and its size can be influenced by feed intake patterns and dietary bulk (Classen *et al.*, 2020). According to Liu *et al.* (2023), significant alterations in crop size often reflect changes in feeding behavior or digestive efficiency. The comparable crop weights across treatments suggest that bread waste did not adversely affect feed palatability or necessitate compensatory storage mechanisms. Liver weights are particularly important indicators of metabolic status and potential toxicity in nutritional studies (Wang *et al.*, 2022). The liver plays a central role in nutrient metabolism, detoxification, and protein synthesis, making it highly responsive to dietary changes and potential toxins (Jahanian *et al.*, 2023). The similar liver weights observed across treatment groups indicate that bread waste did not contain hepatotoxic compounds or impose unusual metabolic demands that would trigger liver hypertrophy. This aligns with findings by Hassan *et al.* (2021), who reported no adverse effects on liver morphology or function when bakery by-products partially replaced conventional energy sources in broiler diets. Heart weights also remained consistent across treatment groups, suggesting that bread waste did not induce cardiovascular adaptations or stress. According to Olatunji *et al.* (2023), significant increases in relative heart weight often indicate physiological responses to increased metabolic demands or specific nutritional deficiencies. The stability in heart weights observed in this study indicates that bread waste provided adequate nutrients for normal cardiovascular development and function, corroborating findings by Adeyemo and Longe (2022) when evaluating alternative energy sources in broiler diets. According to Sugiharto (2022), intestinal morphology and size can be influenced by various dietary factors, including nutrient density, anti-nutritional factors, and fiber content. The similar intestinal weights observed in this study suggest that bread waste did not contain significant levels of anti-nutritional factors that would trigger intestinal adaptations such as hypertrophy or atrophy. This is consistent with findings by Olugbemi *et al.* (2021b), who reported normal intestinal development in broilers fed bakery waste-based diets. These findings however, contradict some earlier reports, such as Alagbe *et al. (*2019), who observed slight increases in liver weight at high inclusion rates of bakery by-products.

The comparable final weights across treatment groups suggest that bread waste provided adequate energy and nutrients to support growth performance similar to conventional maize-based diets. This aligns with findings by Faddle *et al*. (2021), who reported that bakery by-products could replace up to 75% of maize in broiler diets without negatively affecting growth performance. The non-significant differences in dressing percentages observed across treatments indicate that bread waste did not cause excessive development of non-carcass components or reduce muscle deposition. This corroborates findings by Hassan *et al.* (2020), who observed that bakery waste could replace up to 50% of maize without affecting dressing percentage in broilers. The uniform development of these high-value cuts (breast, thigh, and drumstick) across treatment groups suggests that bread waste supported balanced nutrient partitioning similar to conventional maize-based diets. This is consistent with findings by Adeyemo and Longe (2022), who reported no adverse effects on primal cuts when alternative carbohydrate sources replaced maize in broiler diets. These results are in contrast with some earlier reports, such as Alagbe *et al.* (2019), who observed reduced breast meat yield at high inclusion rates of bakery by-products. The discrepancies in findings between this study and previous research may be attributed to differences in the composition of bread waste, processing methods, overall diet formulation, or experimental conditions (Sugiharto, 2022).

Conclusion

Findings from this study suggest that poultry producers can incorporate bread waste as a partial replacement for maize without concerns about negative impacts on blood parameters, vital organ development and carcass yield and quality. This could result in significant cost savings given the generally lower price of bread waste compared to conventional maize. Furthermore, the utilization of bread waste in poultry feeds contributes to sustainable animal production by reducing food waste and the environmental impact associated with conventional feed ingredient production

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