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INFLUENCE OF RUMEN DIGESTA SUPPLEMENTED WITH ENZYMES ON THE CARCASS COMPOSITION AND BLOOD PROFILE OF BROILER CHICKENS

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ABSTRACT

This study investigated the effects of varying levels of cattle rumen digesta supplemented with 0.025% Fullzymes on carcass characteristics and blood profile of broiler chickens. A total of 180 unsexed day-old Cobb chicks were randomly assigned to five dietary treatment groups, each comprising 36 birds with four replicates of nine birds per replicate, in a Completely Randomized Design (CRD). The experimental diets included 0% (T1), 5% (T2), 10% (T3), 15% (T4), and 20% (T5) inclusion levels of rumen digesta. Data were collected on carcass yield, internal organ characteristics, hematological parameters, and serum biochemical indices. Results showed no significant differences ($p > 0.05$) in overall carcass traits and most internal organ weights across treatment groups, except for the heart and gizzard, which exhibited significant variation ($p < 0.05$). Hematological indices, including packed cell volume (PCV), red blood cell count (RBC), hemoglobin concentration (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), were not significantly affected ($p > 0.05$) by dietary treatments. Similarly, biochemical parameters such as glucose, albumin, cholesterol, creatinine, and urea remained statistically unchanged ($p > 0.05$), while total protein levels showed a significant difference ($p < 0.05$) among treatment groups.
In conclusion, the inclusion of up to 20% cattle rumen digesta supplemented with 0.025% Fullzymes in broiler diets had no adverse effects on carcass quality or blood parameters. Therefore, it is recommended as a viable alternative feed ingredient in broiler production.

Keywords: Blood, Broiler Chicken, Carcass and Rumen Digesta

INTRODUCTION

The rising cost of conventional feed ingredients has become a major concern for animal scientists and nutritionists, particularly in tropical regions. In Africa, and especially in Nigeria, the escalating prices are driven not only by competition between human and livestock consumption but also by socio-political factors such as ethno-religious conflicts, natural disasters, political instability, and poor implementation of agricultural policies (Anoh and Akpet, 2013). Feed costs typically account for 65% to 75% of the total expenditure in poultry production, significantly hindering the growth of the industry and contributing to the persistently low animal protein intake among the population (Bamgbose *et al*., 2004; Adeniji and Jimoh, 2007). Currently, animal-derived protein contributes only 15–20% of the total dietary protein intake of the average Nigerian, which is well below the 33% recommended by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) (Taiwo *et al*., 2004). This substantial gap underscores the urgent need to boost animal protein production by promoting the rearing of animals with short generation intervals and relatively low production costs, particularly at the household and commercial levels (Onu *et al*., 2007).

El-Deek *et al*. 2008 previously reported that broiler chicken production is widely recognized as one of the most efficient and cost-effective methods of addressing the growing demand for animal protein. Broilers offer advantages such as rapid growth, excellent feed conversion efficiency, ease of management, and a quick return on investment. Despite these benefits, the high cost and limited availability of conventional protein and energy feedstuffs pose significant challenges to broiler production in many tropical and subtropical regions (Onu, 2007; Atawodi *et al*., 2008; El-Deek *et al*., 2008). These challenges contribute to the underperformance of poultry farms and the resulting protein deficiency in human diets (Adeniji and Jimoh, 2007).

To mitigate the high cost of feed and reduce dependence on conventional ingredients, there is growing interest in exploring alternative, locally available agro-industrial by-products particularly those that do not compete with human food resources and have little or no nutritional value for human consumption (Esonu *et al*., 2006; Oladunjoye and Ojebiyi, 2010). One such by-product is rumen content, a waste material generated daily at abattoirs (Odunsi *et al*., 2004). Rich in energy and B-complex vitamins, rumen content holds promise as a sustainable and cost-effective feed ingredient. Its inclusion in poultry diets could also provide an environmentally friendly solution for abattoir waste disposal (Esonu *et al*., 2006).

MATERIALS AND METHODS

Experimental Location

The experiment was conducted at the Poultry Research Farm of the Department of Animal Science and Range Management, Modibbo Adama

University of Technology, Yola, located in Girei Local Government Area of Adamawa State, Nigeria. The study area lies within the Guinea Savannah ecological zone, between latitudes 9° and 11° North and longitudes 10° and 12° East. The region experiences a tropical climate characterized by distinct wet and dry seasons. The rainy season typically begins in April and ends in late October, while the dry season spans from November to April. The area receives an annual rainfall ranging from 700 mm to 1600 mm, with relative humidity levels between 5% and 42%. The average maximum temperature is approximately 39°C (Adebayo and Tukur, 1999).

Source of rumen Digesta and Processing Methods

Fresh cattle rumen digesta was sourced from the Yola abattoir in Adamawa State. It was sun-dried on a clean cement floor for five days, with regular turning to facilitate even drying, and subsequently ground into a fine powder.

Experimental Diets, Design and Animal Management

Cattle rumen digesta was incorporated into both the starter and finisher diets at inclusion levels of 0%, 5%, 10%, 15%, and 20%, corresponding to treatments T1, T2, T3, T4, and T5, respectively. Treatment T1 served as the control. The experiment was arranged in a Completely Randomized Design (CRD) and involved one hundred and eighty (180) day-old broiler chicks. After a two-week brooding period, the chicks were individually weighed and randomly assigned to the five dietary treatments, with 36 birds per treatment. Each treatment was replicated four times, with nine birds per replicate. The feeding trial lasted for 42 days (6 weeks), during which the birds were housed on a deep litter system. During the brooding phase, the chicks were fed a commercial broiler starter feed, after which the experimental diets were introduced (table 1). Clean drinking water and feed were provided ad libitum throughout the trial. Routine management practices, including vaccination and medication, were carried out in accordance with the recommendations of Oluyemi and Roberts (2000).

Procedure for Blood Collection

On the final day of the experiment (day 42), blood samples were collected from randomly selected birds - eight per treatment group, with two birds from each replicate. Using sterile disposable needles and syringes, blood was drawn from the wing vein of each bird and transferred into labeled specimen tubes. A 5 ml portion of the blood was placed into tubes containing heparin as an anticoagulant for hematological analysis, while an additional 2 ml was transferred into plain tubes (without anticoagulant) for serum biochemical analysis.

Table 1: Composition of Broiler Starter and Finisher Diets at 23% and 20% Crude Protein

	Starter					Finisher				
Ingredient	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T1 (0%)	T2 (5%	T3 (10%)	T4 (15%)	T5 (20%)
Maize	53.9	48.9	45.9	41.9	37.9	56.175	53.175	50.175	47.175	45.175
GNC	30.0	30.0	28.0	27.0	26.0	30.0	28.0	27.0	27.0	26.0
Maize Offal	7.0	7.0	7.0	7.0	7.0	10.0	10.0	9.0	7.0	5.0
Rumen Digesta	0.0	5	10	15	20	0	5	10	15	20
Fish Meal	6.175	6.175	6.175	6.175	6.175	-	-	-	-	-
Enzymes	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Bone Meal	2.0	2.0	2.0	2.0	2.0	2.9	2.9	2.9	2.9	2.9
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3Methiomine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Salt	0.025	0.025	0.025	0.025	0.025	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis										
Metabolizable Energy (Kcal/Kg)	2995	2993	2972	2923	2873	3066	3017	2968	2918	2868
Crude Protein	23.53	23.74	23.31	23.30	23.29	20.69	20.68	20.67	20.66	20.65
Crude Fiber	4.47	5.22	6.11	7.19	8.27	4.15	5.23	6.31	7.39	8.47
Ether Extract	4.34	4.37	4.29	4.18	4.08	4.48	4.38	4.27	4.17	4.06
Calcium	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95
Phosphorous	0.75	0.75	0.73	0.72	0.70	0.77	0.76	0.74	0.72	0.71
Methionine	0.56	0.56	0.55	0.54	0.53	0.48	0.46	0.45	0.44	0.43

Lysine	1.02	1.02	0.99	0.97	0.94	0.77	0.75	0.72	0.70	0.67

Vitamin premix 1.25kg contains ; Vitamin A,10,000,000 IU; Vitamin D_3, 2,000,000 IU; Vitamin E,10,000mg; Vitamin K_3,2,000mg; Folic Acid, 1,000mg; Niacin, 20,000mg; Calpan, 8,000mg; Vitamin B_2, 5,000mg; Vitamin B_{12},15mg;Vitamin B_1, 1,500mg; Vitamin B_6, 3,000mg; Biotin, 50mg; Antioxidant, 125,000mgVitamin premix 1.25kg contains ; Cobalt, 200mg; Selenium, 200mg; Iodine, 1,000mg; Iron, 20,000mg; Manganese, 60.000mg; Copper, 5000mg; Zinc, 50,000mg; Choline Chloride, 100,000mg. Name of Enzymes and web site: Fullzymes , www.@biofeed.ca Feeding Direction: 200 - 250g/tone of feedManufacturer and E-mail: by Biofeed Tech Inc Canada, Info@biofeed.ca, Ingredient Statements: Fungal protease, Alpha amylase, Cellulase, Lipase, B-glucane, Phytase, Pectinase, Lactase, Guaranteed Analysis : Crude protein -20% , Crude fat- 1.40% , Crude fibre -100%

Data Analysis

All data generated from experiment were subjected to one way analysis of variance (ANOVA) in a completely randomized design (CRD) according to Steel and Torrie (1980). Treatment means were separated using Duncan's multiple range test (DMRT) (Duncan, 1995).

RESULT AND DISCUSSION

Chemical Composition of Rumen Digesta

The proximate composition of rumen digesta (RD) is presented in Table 2. The analysis revealed the following values: moisture content – 6.13%, dry matter (DM) – 93.87%, crude protein (CP) – 16.69%, crude fiber (CF) – 13.32%, ash – 9.21%, nitrogen-free extract (NFE) – 38.39%, and ether extract (EE) – 8.79%.

Table 2: Proximate Composition of Rumen Digesta

Nutrient	Percentage composition
Moisture	6.13
Dry matter (DM)	93.87
Crude protein (CP)	16.69
Crude fiber (CF)	13.32
Ash	9.21
Nitrogen free extract (NFE)	38.39
Ether extract (EE)	8.79
Metabolizable energy (ME)	2666.02

Metabolizable Energy (ME) = 35 x CP% + 81.8 x EE% + 35.5 x NFE

The proximate composition of rumen digesta is presented in Table 2. The crude protein (CP) content was 16.69%, which is consistent with the 16.23% reported by (Maidala *et al*., 2009), but slightly lower than the values of 17.13% and 18.20% reported by (Dairo *et al*., 2005) and Esonu (2006), respectively. The crude fiber (CF) content was 13.32%, which is also lower than the 15.30% and 24.58% reported by (Esonu, 2006; Dairo *et al*., 2005). These variations in crude protein and fiber content may be attributed to factors such as the age of the animals, seasonal differences, and the diversity of vegetation consumed. The ether extract (EE) content was 8.79%, aligning with the value reported by Esonu (2006), but significantly lower than the 23% and 24% recorded by (Maidala *et al*., 2009; Dairo *et al*. 2005), respectively. The nitrogen-free extract (NFE) content was 38.39%, which is also lower than the 59% and 40.82% reported by (Maidala *et al*., 2009; Dairo *et al*., 2005). These lower values may result from differences in the composition of the rumen digesta and the methods used during processing.

Effect of Enzyme Supplemented Rumen Digesta on Carcass Yield and Internal Organs Characteristics of Broiler Chicken

The results for live weight, slaughter percentage, plucked percentage, eviscerated percentage, carcass percentage, and dressing percentage showed no significant differences ($p > 0.05$) across all treatment groups. This suggests that the inclusion of rumen digesta had minimal or no toxic effects on the broiler chickens. Numerically, carcass percentage values ranged from 69.69% in the control group (T1 – 0%) to 71.75% in T5 (20% inclusion), indicating a slight improvement in birds fed higher levels of rumen digesta. Although birds on T5 recorded the highest carcass percentage, the value was still lower than the 92.06–97.64% reported by Esonu *et al*. (2006). The improved carcass percentage observed in T5 could be attributed to the higher fiber content of the rumen digesta, which may have enhanced growth and weight gain, resulting in a better yield. Similar findings were reported by Abd-ElGalil and Khider (2001), who observed increased feed intake and body weight gain in birds fed diets containing dried rumen digesta. This performance boost may be due to the presence of microbial protein, long-chain fatty acids, and partially digested feed components (Okorie, 2005). Additionally, adequate dietary crude fiber levels may stimulate intestinal activity, enhance peristalsis, promote enzyme secretion, and improve nutrient digestion, as noted by (Esonu *et al*., 2001, 2004).

Dressing percentages showed an increasing trend across treatment groups: 69.65% (T1), 71.10% (T2), 69.44% (T3), 71.67% (T4), and 71.74% (T5). The highest value was recorded in T5, followed closely by T4 and T2. These values fall within the range of 66.44–71.74% but are slightly lower than the 72.92–77.39% reported by Mahmoud et al. (2015) and Esonu et al. (2006). This supports the assertion by Oluyemi and Roberts (2000) that dressing percentage is influenced by both carcass yield and live weight. Regarding internal organs, no significant differences ($p > 0.05$) were observed in the weights or lengths of the lungs, liver, spleen, kidneys, small intestine, large intestine, and caeca. However, significant differences ($p < 0.05$) were observed in the heart and gizzard percentages. The highest heart weight (0.479%) was recorded in T5, followed by T4 (0.434%), T2 (0.409%), T3 (0.385%), and T1 (0.376%). These values were lower than the 0.64–0.74% range reported by (Mahmoud *et al*., 2015). According to Njidda and Isidahomen (2011) and Bone (1979), organ weight abnormalities can indicate the presence of toxins or anti-nutritional factors in feed. The variation in heart weight might suggest a metabolic response to potential stressors in the diet. However, the absence of clinical signs of illness in the birds indicates that there were no adverse health effects.

Gizzard weight was significantly affected ($p < 0.05$) by the inclusion of rumen digesta. The highest relative gizzard weight (2.44%) was observed in birds fed T5, while the lowest values were recorded in T2 (1.69%) and T1 (1.79%). These values are lower than the 2.61-3.89% and 3.17-4.10% ranges reported by (Esonu *et al*., 2006) and (Mahmoud *et al*., 2015), respectively. The increased gizzard weight in birds fed higher levels of rumen digesta may reflect increased muscular activity required to process the fibrous content of the feed, supporting observations by (Mahmoud *et al*., 2015).

Table 3: Carcass Yield and Internal Organ Characteristics of Broiler Chicken Fed Various Inclusion Levels of Enzyme Supplemented Rumen Digesta

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	T_5 (20%)	SEM
Live weight (g)	2323.88	2445.25	2330.00	2527.50	2404.50	86.4^{ns}
Slaughter (%)	96.042	97.357	96.912	97.234	96.547	0.14^{ns}
Plucked (%)	91.617	93.017	92.743	93.036	92.892	0.64^{ns}
Eviscerated (%)	75.830	77.302	77.490	77.542	78.082	0.10^{ns}
Carcass (%)	69.685	71.132	71.750	71.648	71.752	0.18^{ns}
Dressing percentage (D %)	69.65	71.10	69.44	71.67	71.74	1.7^{ns}
Internal Organs						
Lung (%)	0.504	0.519	0.471	0.466	0.473	0.25^{ns}
Heart (%)	0.376^{b}	0.409^{b}	0.385^{b}	0.434^{ab}	0.479^{a}	0.13^{*}
Liver (%)	1.759	1.858	1.861	1.696	1.972	0.14^{ns}
Kidney (%)	0.337	0.427	0.387	0.425	0.388	0.10^{ns}
Spleen (%)	0.058	0.065	0.064	0.059	0.079	0.13^{ns}
Gizzard (%)	1.793^{ab}	1.677^{b}	2.077^{ab}	1.990^{ab}	2.214^{a}	0.09^{*}
Large intestinal length (cm)	13.25	11.31	10.75	11.38	10.63	0.8^{ns}
Large intestinal (%)	0.115	0.120	0.117	0.121	0.118	0.6^{ns}
Small intestinal length (cm)	214.25	229.25	211.63	209.38	210.88	8.5^{ns}
Small intestinal (%)	4.174	4.609	5.050	3.812	3.939	0.17^{NS}
Ceacal length (cm)	38.13	40.88	39.63	38.50	42.25	1.7^{NS}
Ceacal (%)	0.441	0.441	0.445	0.371	0.401	0.24^{NS}

[a,b,c]Means within in the same row bearing different superscripts differ significantly ($p<0.05$), *=significant ($p<0.05$), NS = Not significant, SEM = Standard Error of Mean

Heamatology and Biochemical Indices of Broiler Fed Various Inclusion Level of Enzyme Supplemented Rumen Digesta

The results of the hematological and biochemical indices are presented in Table 4. There were no significant differences ($p > 0.05$) observed across all treatment groups for the hematological parameters assessed. White blood cell (WBC) counts ranged from 2.28×10^9/L to 2.36×10^9/L, with the highest value recorded in birds fed T5 (20% rumen digesta inclusion), followed closely by T1 (control, 0%) at 2.35×10^9/L. The lowest WBC count was observed in T4 (2.28×10^9/L). Although these differences were not statistically significant, the values were higher than the reference range of $1.9–9.5 \times 10^9$/L reported by Samour (2013). The elevated WBC levels could indicate an adaptive immune response, reflecting the birds' ability to resist potential pathogens or foreign substances in the diet. Nonetheless, all values remained within physiologically acceptable limits, suggesting that the birds maintained a healthy immune status.

Red blood cell (RBC) counts ranged from 2.08×10^{12}/L to 2.57×10^{12}/L, with the highest value observed in the control group (T1) and the lowest in T4. These values fall within the normal range of $2.5–3.9 \times 10^{12}$/L for chickens, as reported by Samour (2013), indicating that dietary inclusion of rumen digesta had no adverse effect on erythropoiesis.

Packed cell volume (PCV) values ranged from 30.16% to 32.28%, while hemoglobin (Hb) concentrations ranged from 8.52 to 9.53 g/dL. Both parameters were within the normal physiological ranges of 22–35% for PCV and 7.0–13.0 g/dL for Hb (Samour, 2013). According to Oyawole and Ogunkunle (1998), PCV is an important indicator of toxicity and blood health, with reductions often signifying the presence of toxic substances that impair hematopoiesis. Similarly, Adejumo (2004) noted that PCV and Hb are correlated with the nutritional status of animals. The results of this study, therefore, confirm that the inclusion of rumen digesta at levels up to 20% had no negative impact on the hematological health of the birds. Biochemical parameters also showed no significant differences ($p > 0.05$) among treatment groups, except for total protein, which was significantly affected ($p < 0.05$). The values for total protein were not consistent with the range of 6.16 to 7.14 g/dL reported by (Mahmoud *et al*., 2015). Serum cholesterol levels ranged from 169.3 to 195.0 mg/dL, which are lower than the values of 207.11 to 209.13 mg/dL reported by (Mahmoud *et al*., 2015). These discrepancies may be attributed to differences in the levels of rumen digesta inclusion, as the referenced studies used lower inclusion levels (5–10%).

Overall, the findings suggest that the dietary inclusion of rumen digesta up to 20% did not adversely affect the hematological or most biochemical parameters of broiler chickens, further supporting its potential as a viable alternative feed ingredient.

Table 4: Hematology and Biochemical Indices of Broiler Chicken Fed Various Inclusion Level of Enzymes Supplemented Rumen Digesta

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	T_5 (20%)	SEM
Hematological Indices						
WBC x 10^9/L	2.35	2.28	2.29	2.28	2.36	0.2^{NS}
RBC x 10^{12}/L	2.57	2.16	2.20	2.08	2.41	0.2^{NS}
HB g/dl	9.10	8.79	8.90	8.53	9.54	0.3^{NS}
PCV %	31.16	30.64	31.41	30.16	32.29	0.9^{NS}
MCV fl	138.68	143.15	143.30	145.00	139.06	2.5^{NS}
MCH pg	40.09	40.85	40.51	40.85	41.05	0.7^{NS}
MCHC g/dl	28.96	28.56	28.29	28.23	28.54	0.3^{NS}
Biochemical Indices						
Glucose mmol/l	12.43	12.36	12.19	12.44	11.98	0.2^{NS}
Total Protein g/l	30.63^{ab}	27.50^{b}	33.25^{ab}	34.50^{a}	30.88^{ab}	1.8^{*}
Albumin g/l	23.50	24.13	23.38	23.75	23.63	0.6^{NS}
Cholesterol mg/dl	195.00	175.63	169.38	182.25	187.88	8.9^{NS}
Creatinine mmol/l	193.50	188.63	197.75	175.00	180.50	11.1^{NS}
Urea mm/l	11.26	11.38	11.89	10.34	11.45	1.3^{NS}

a,b.c= Means within the same row bearing different superscripts differ significantly ($p<0.05$), *=significant ($p<0.05$), NS= Not significant, SEM= Standard Error of Mean, WBC= white blood cell, RBC= red blood cell, HB= hemoglobin, PCV = packed cell volume, MCV = mean corpuscular volume, MCH= mean corpuscular hemoglobin, MCHC= mean corpuscular hemoglobin concentration.

CONCLUSION

The results of this study demonstrate that dried rumen digesta can be included in broiler diets at levels up to 20% without adverse effects on growth performance, carcass characteristics, hematological profiles, or most biochemical indices. The slight improvements observed in carcass yield and dressing percentage at higher inclusion levels suggest a potential nutritional benefit, possibly due to the fiber and microbial protein content of rumen digesta. Furthermore, the lack of significant differences in key hematological and biochemical parameters across all treatments confirms the safety and physiological tolerance of the birds to rumen digesta. Given its availability as a slaughterhouse by-product and the rising cost of conventional feed ingredients, rumen digesta presents a cost-effective and sustainable alternative feedstuff for poultry production. Its utilization not only supports animal growth and productivity but also contributes to environmental waste management. Therefore, incorporating dried rumen digesta into broiler diets can be a practical strategy to enhance feed resource efficiency and reduce feed costs in tropical poultry production systems.

RECOMMENDATION

Based on the result of these findings, enzyme supplemented rumen digesta could be used by farmers to formulate diets for broiler chicken. It is a cheap and available alternative source of feed all year round.

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