Vol. 5 No. 1, June, 2025

FUAM Journal of Pure and Applied Science

Available online at
www.fuamjpas.org.ng

An official Publication of
College of Science
Joseph Sarwuan Tarka University,
Makurdi.

FUAM Journal of Pure and Applied Science
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https://fuamjpas.org.ng/
Vol.5 No. 1 June, 2025

Responses of Feedlot Bunaji Bulls to Concentrate Diets Containing Different Levels of Ensiled Cage Layer Chicken Droppings

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Received: 30/10/2024 **Accepted**: 06/12/2024 **Published online**: 08/12/2024

Abstract
The experiment assessed the potential of using cage layer chicken droppings in the diets of feedlot Bunaji bulls. The droppings were ensiled for 21 days, dried (test ingredient) and incorporated in the diets at 0, 10, 20 and 30% denoted as T_1, T_2, T_3 and T_4, respectively. Twelve (12) intact Bunaji bulls with average weight of 130.17±2.56 kg was divided in four groups (3 animals each) and allotted among the four treatment diets, in a Completely Randomized Design. Data were collected and subjected to a one-way analysis of variance using SPSS (version 23). Results reveal that feed intake, weight changes, feed conversion ratio, haematological, serum and oxidative biomarkers were not affected ($p>0.05$) by the experimental diets. There was increase ($p<0.05$) in the rumen pH of bulls in T_4 compared to T_2. Total volatile fatty acids, acetic acid, and propionic acid increased ($p<0.05$) in all the animals fed diets with test ingredient. The inclusion of cage layer chicken droppings in the diets of the bulls at 30% resulted in a reduction ($p<0.05$) in total bacteria count, amylolytic bacteria and an increase ($p<0.05$) in lipolytic and proteolytic fungi, compared to control. Feeding test ingredient to feedlot Bunaji bulls resulted in a reduced average unit cost of production with higher revenue and subsequently gross profit margin. It is recommended that cage layer chicken droppings can be incorporated in the diets of feedlot Bunaji bulls at 20% optimum performance and profitability of the feedlot operation.
Keywords: Bunaji cattle, Feedlot, Poultry droppings, Processed, Ensilage

Introduction

Improving livestock production in many developing countries is militated against by a myriad of problems including the inadequacy and expensive nature of animal feed resources. In general, the animal feed base is insufficient, especially feed ingredients that are high in protein content to meet animal requirements. Interestingly, there is an abundance of crop residues from crop farming activities, and ruminants rely heavily on them (primarily rice straw, maize stover, among others.) and natural grass hay, especially during dry seasons [1]. These feed resource bases for ruminants are usually low in nitrogen content. The low nitrogen content in crop residue may not support the proper functioning of rumen microbes which require crude protein of at least 7%, thus limiting the effective utilization of crop residue as feed for livestock. Under protein-deficient diets, dry matter intake and digestibility in turn fall below the requirement for maintenance leading to reduced milk or meat yield and weight losses. It is, however possible to minimize these losses through protein or non-protein nitrogen (NPN) supplementation.

Uses of urea and urea molasses have been introduced as an alternative means of improving the nitrogen supply to the rumen [2,3]. However, these sources are equally expensive to most farmers and they, in addition, impose danger of toxicity, especially the use of urea. This calls for alternative protein sources to optimize protein supply for proper function of rumen microbes and subsequently, production efficiency.

A potential protein resource is cage layer chicken droppings. Most cage layer chicken droppings contain about 25% crude protein on a DM basis, about half of it derived from uric acid, which can be efficiently used by rumen for protein production [4]. In addition, cage layer chicken droppings contribute significant amounts of Ca, P, K, and Mg [5]. If the diet consists of at least 20% cage layer chicken droppings, no additional mineral supplementation is needed [6].

Even though layer chicken droppings have a valuable role as a source of NPN for ruminants [7] it is important to process them to destroy potentially harmful microorganisms which may be present in them. Drying has been reported to be one way of processing for safe use and it also makes handling easy [8]. Drying with heated air offers several advantages over unheated air drying including a higher rate of oxidation and pathogen destruction [4]. This is supported by other researchers who reported that solar drying offers several advantages over other energy sources because it is available in abundance all year round, it has a higher rate of oxidation and it results in good waste stabilization, odor control and pathogen destruction [9,10,11]. Solid state

ensiling is one other way of providing heat during the fermentation of cage layer chicken droppings and may be an alternative source of heat to destroy potential pathogenic microorganisms from the poultry dropping.

Processed cage layer chicken droppings may be an effective and economical protein and mineral supplement in smallholder farms and feedlot systems. With the use of processed cage layer chicken droppings alongside low-quality crop residues, it is possible to develop a feeding regime that will support efficient performance in cattle production systems at a reduced cost. Cage layer chicken droppings can be combined in complete diets containing other low-quality feedstuff such as rice straw, cassava peels, maize stover among others for supplementation in feedlot systems. In this regard, this research was designed to assess the response of feedlot Bunaji cattle to concentrate diets containing different levels of processed cage layer chicken droppings.

Material and Methods

Descriptions of the study area

The study was conducted at the Cattle Unit of the Livestock Teaching and Research Farm of the Joseph Sarwuan Tarka University, Makurdi. Makurdi is located on latitude 7^0 14^1 N and longitude 8^031^1 E and a height of 90 meters above sea level in the Southern Guinea Savannah ecological zone of Nigeria. Makurdi is characterized by about 6-7 months of rainy season ranging from 1317-1323 mm annually, between April to October and 5 months of dry season (November-March). The temperature ranges from 17.58-38.44 °C and it is highest in the month February and March [12]

Collection and processing of poultry droppings

Chicken droppings were obtained from a chicken layer farm where birds were reared in cages. On bringing the droppings, they were checked for possible foreign material and subsequent removal. The droppings were ensiled by deep stacking in a silage pit at 20% moisture (w/w) for 21 days. At the end of the fermentation period, the droppings were dried again and packed in sacks for inclusion in the diets of the animals.

Experimental Animals, housing and Management

A total of twelve (12) Bunaji yearling bulls were purchased from the Aramis International Cattle Market, Lafia, Nasarawa State and taken to the experimental site. The bulls were treated for internal and external parasites using Tridox®, ivermectin® and pour on. The animals were quarantined for a period of 21 days after which they were weighed and allotted to the four treatments. Each of the bulls was housed in a pen measuring 3.6 m X 2.5 m (Length and width) constructed of wood and roofed using corrugated iron sheets. Each animal received a known quantity of experimental concentrate diet (3% of body weight) in troughs made from metal drums that had been cut into two along the length and fitted with metal rods to enable them remain in standing position. Forages (*Pennisetum purpureum*) were provided *ad libitum* in the afternoon as basal diet. The animals were allowed access to drinking water *ad libitum* and this was served in plastic basins provided in the individual pens.

Experimental design and diets

The experimental design was a completely randomized design. Four (4) animals each were balanced for weight and randomly allotted to four dietary treatments (Experimental diets). Each animal served as a replicate. Four dietary treatments (Table 1) were denoted as T1 (Control: no inclusion of poultry droppings), T2 (Inclusion of poultry droppings at 10%), T3 (Inclusion of poultry droppings at 20%) and T4 (inclusion of poultry droppings at 30%).

Sampling Procedures

Growth performance

Data were collected on weight changes, dry matter intake and feed conversion ratio. A weighing balance was used to determine the weight of the animals on a weekly basis. Feed intake was determined by the difference between the quantity offered and the quantity left over. Feed conversion ratio (FCR) was calculated as the ratio of feed intake to live weight gain.

Collection and sampling of blood samples

Approximately, 2 mL blood was collected in heparinized vacutainer for haematological studies, while another 3 mL was collected in plain vacutainer. Samples in plain vacutainer were allowed to clot at room temperature after 3 hours of collection. Serum samples were separated following the centrifugation at 3000 g for 5 min and stored at -20 °C for biochemical studies.

Blood profile analysis

The procedures outlined in the report of [13] was adopted for determination of haemoglobin (Hb), Packed Cell Volume (PCV), White blood cells (WBC), red blood cells (RBC), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean

Table 1. Gross composition of experimental diets

Ingredient (%)	T1	T2	T3	T4
Maize offal	35	35	35	35
Palm kernel cake	36	26	16	6
Rice offal	15	15	15	15
Cassava peels	10	10	10	10
Poultry droppings	-	10	20	30
Bone meal	3	3	3	3
Salt	1	1	1	1
Total	100	100	100	100
Nutrient analysis				
Crude protein	11.85	12.15	12.49	12.81
Fibre	17.43	16.67	15.91	15.15
Ether extract	8.92	8.80	8.32	7.84
Nitrogen free extract	44.36	47.80	51.24	54.68

corpuscular haemoglobin concentration (MCHC) and serum indices including total proteins, glucose, cholesterol, AST, ALT triglyceride, HDL and LDL.

Oxidative biomarkers determination

The various methodologies described in the work of [14] were adopted to obtain data on serum bilirubin, glutathione peroxidase (GSHPx), malondialdehyde (MDA), superoxide dismutase (SOD), nitric oxide (NO) uric acid and serum albumin concentration

Collection and sampling of rumen samples

After 90 days of feeding trial, rumen samples were collected using a suction tube as described by [15] from all animals in each treatment for sampling. 6-hours post feeding. At collection, the rumen samples were immediately assessed for rumen pH using a pH meter. The rumen samples were subsequently filtered using a four-layer cheese cloth and divided into two portions for determination of volatile fatty acids and rumen microbial count and identification, respectively.

Determination of volatile fatty acids and methane output

The first portion of the filtered rumen sample was used for analyses of total volatile fatty acid (VFA) and the proportions of acetate, propionate, and butyrate as illustrated by [16].

Rumen microbial count and identification

The second portion of the rumen filtrate was used for microbial count and identification. For protozoa count, the procedure of [17] was adopted by direct observation using a microscope at 10× magnification. In the case of bacteria and fungi, colony-forming units/ml (CFU/ml) methodology was adopted with the pour plate technique using nutrient algae (NA) and potato dextrose agar (PDA), for bacterial and fungi, respectively. The plates were incubated for 24 hours at 37 °C. All colonies appearing at the end of the incubation period were counted using a digital illuminated colony counter. Colonies grown on nutrient agar plates were suspected to be either gram-positive or gram-negative thus; all colonies found on each plate were used for gram staining as described by [18]. Colonies grown on the PDA were further incubated for three days after the first 24 hrs to check for morphology and isolation of fungi.

Economics of production

Parameters that were measured include cost of purchasing animals, concentrate feed cost/animal, forage cost/animal**,** total cost of production**,** revenues and profit margin. The prevailing market prices of the ingredients and other variable inputs at the time of the study was used to calculate the cost of 1 kg feed for all the experimental diets. The economics of production was determined by computing the following:

$$feed\ intake$$
$$= Feed\ intake\ X\ feed\ cost\ per\ kiligram profit\ margin$$
$$= Revenue - total\ cost\ of\ production$$

Statistical analysis and model

The data obtained on growth, blood and rumen profile were subjected to one-way analysis of variance using [19]. Where significant differences in means occurred, they were separated using Duncan's Multiple Range Test as contained in the statistical software.

Results

The results of growth indices of feedlot Bunaji bulls in feedlot system fed concentrate diets with varying levels of cage layer chicken droppings are presented in Table 2. All the growth parameters measured were not affected by the inclusion of varying levels of cage layer chicken droppings in the diets of the Bunaji bulls. Daily forage intake was 10.96 kg in T1, 11.63 kg in T2, 11.85 kg in T3, and 11.18 kg in T4. Daily concentrate intake ranged between 2.59 kg in T1 and 2.84 kg in T2. Total feed intake ranged from 13.55 kg (T1) to 14.66 kg (T3). Daily average water intake was 7.07, 8.32, 8.00 and 7.55 liters for T1, T2, T3 and T4, respectively. Daily weight gain ranged from 0.42 kg in the control diet to 0.73 kg in T3. The daily weight gain in T2 was 0.64 kg and that of T4 was 0.53 kg. The feed conversion ratio ranged from 22.26 in T3 to 26.36 in T4. The FCR in T1 and T2 was 25.85 and 25.13, respectively.

Table 3 represents the results of haematological parameters of Bunaji bulls in feedlot systems fed concentrate diets with varying levels of cage layer chicken droppings. Red blood

cells were reduced ($p<0.05$) in T2 (5.05×10^{12} /L), compared to T1 (control) (6.00×10^{12} /L). Similar ($p>0.05$) values of red blood cells were obtained in T1 (6.00×10^{12} /L), T3 (5.75×10^{12} /L), and T4 (5.60×10^{12} /L). All other haematological parameters measured were not affected ($p>0.05$) by feeding varying levels of cage layer chicken droppings to feedlot Bunaji bulls. Packed cell volume (PCV) ranged from 32.50% (T2) to 37.33% (T1). White blood cells were 5.67×10^{9} /L for T1, 5.50×10^{9} /L for T2, 5.40×10^{9} /L for T3 and 5.60×10^{9} /L for T4. Haemoglobin concentration was 12.44 g/dl for T1, 10.84 g/dl for T2, 11.00 g/dl for T3 and 11.22 g/dl for T4. Mean corpuscular haemoglobin was 20.72, 21.38, 18.95, and 20.29 fl for T1, T2, T3, and T4, respectively. The mean corpuscular haemoglobin concentration was 33.27, 33.35, 33.30and 33.33 g/dl in T1, T2, T3, and T4, respectively. Lymphocytes ranged from 65.00 and 65.67% across the various treatment groups

Table 2. Growth Performance of Bunaji Bulls in Feedlot System fed Concentrate Diets with Varying Levels of Cage layer chicken droppings

Parameter	T1	T2	T3	T4	SEM	p-Value
Initial weight (kg)	131.67	132.33	125.67	131.00	2.56	0.84
Daily forage intake(kg)	10.96	11.63	11.85	11.18	0.30	0.77
Daily concentrate intake (Kg)	2.59	2.84	2.81	2.69	0.07	0.60
Total feed intake (kg)	13.55	14.47	14.66	13.87	0.37	0.75
Daily water intake (l)	7.07	8.32	8.00	7.55	0.26	0.41
Daily weight gain (kg)	0.42	0.64	0.73	0.53	0.06	0.33
Total weight gain (kg)	37.32	57.84	66.00	47.76	5.62	0.33
Final weight (kg)	168.99	190.17	191.67	178.76	4.89	0.35
Feed conversion ratio	25.85	25.13	22.26	26.36	3.04	0.48

SEM=Standard error of mean

T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings

while Heterophil was 26.67% for T1, 27.50% for T2, 25.50% for T3, and 25.67% for T4. Eosinophil ranged from 2.33% in T1 to 3.33% in T4. Basophil was 0.33, 0.00, 0.50, and 0.33% for T1, T2, T3, and T4, respectively. Monocyte was 5.33, 4.50, 4.00 and 5.33% in T1, T2, T3, and T4, respectively.

The serum indices of feedlot Bunaji bulls fed concentrate diets with varying levels of cage layer chicken droppings are presented in Table 4. Total protein concentration reduced ($p<0.05$) in T4 (7.15 g/dl) compared to control (8.76 g/dl). Total protein levels in T1 were compared to those in T2 and T3 (8.03 and 8.47 g/dl, respectively). Other serum indices measured in this experiment were not affected ($p>0.05$) by the inclusion of cage layer chicken droppings in the diets of feedlot Bunaji bulls. Albumin was 4.82, 4.69, 3.76and 4.04 g/dl for T1, T2, T3 and T4, respectively. Aspartate transaminase was 106.36, 87.39, 113.54and 113.54 U/L for T1, T2, T3and T4, respectively. Alanine transferase was 29.24 U/L for T1, 29.56 U/L for T2, 29.74 U/L for T3 and 27.81 U/L for T4. Alanine phosphate (ALP) ranged from 54.40 U/L for T2 to 68.00 for T3. Glucose concentration ranged from 37.77 mg/dl for T4 to 50.60 mg/dl for T1. Cholesterol was 69.64 for T1, 59.91 mg/dl for T2, 58.91 mg/dl for T3 and 51.98 mg/dl for T4. Triglyceride ranged from 47.30 mg/dl for T4 to 63.36 mg/dl for T1. High-density lipoprotein was 22.50 for T1, 21.30 mg/dl for T2, 23.45 mg/dl for T3, and 23.95 mg/dl for T4. Low-density lipoprotein in the blood was 34.46 mg/dl for T1, 27.71 mg/dl for T2, 24.74 mg/dl for T3 and 18.58 mg/dl for T4.

The result of oxidative biomarkers of feedlot Bunaji bulls fed diets containing varying levels of cage layer chicken droppings is presented in Table 5. All oxidative biomarkers measured were not influenced ($p>0.05$) by the different levels of cage layer chicken droppings in the diets of feedlot Bunaji bulls. Superoxide dismutase ranged from 14.11 IU/L for T1 to 16.94 IU/L for T2, Glutathione peroxidase was 0.06 IU/L for T1, 0.08 IU/L for T2, 0.04 IU/L for T3 and 0.05 IU/L

Table 3 Haematological Parameters of Feedlot Bunaji Bulls fed Concentrate Diets Containing Varying Levels of Cage layer chicken droppings

Parameter	T1	T2	T3	T4	SEM	p-value
Packed cell volume (%)	37.33	32.50	33.00	33.67	1.10	0.42
RBC (x 10^{12} /L)	6.00[a]	5.05[b]	5.75[ab]	5.47[ab]	0.15	0.04
WBC (x 10^{9} /L)	5.67	5.50	5.40	5.60	0.18	0.98
Haemoglobin (g/dl)	12.44	10.84	11.00	11.22	0.37	0.42
MCH (g/dl)	20.72	21.38	18.95	20.29	0.39	0.23
MCHC (g/dl)	33.27	33.35	33.30	33.33	0.02	0.66
Lymphocyte (%)	65.33	65.00	65.00	65.67	0.73	0.99
Heterophil (%)	26.67	27.50	25.50	25.67	0.60	0.73
Eosinophil (%)	2.33	3.00	2.50	3.33	0.29	0.64
Basophil (%)	0.33	0.00	0.50	0.33	0.15	0.83
Monocyte (%)	5.33	4.50	4.00	5.33	0.43	0.73

[a,b] Means with different superscripts along the row are significantly ($p<0.05$) different
SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)
RBC- Red blood cells; WBC- White blood cells; MCV- Mean corpuscular volume
MCH- Mean corpuscular haemoglobin; MCHC- Mean corpuscular haemoglobin concentration

Table 4 Serum **Indices of Feedlot Bunaji Bulls Fed Diets Containing Varying Levels of Cage layer chicken droppings**

Parameter	T1	T2	T3	T4	SEM	p-value
Total protein (g/dl)	8.76[b]	8.03[ab]	8.47[ab]	7.15[b]	0.26	0.04
Albumin (g/dl)	4.82	4.69	3.76	4.04	0.22	0.28
AST (U/L)	106.36	87.39	113.54	113.54	5.22	0.33
ALT (U/L)	29.24	29.56	29.74	27.81	1.04	0.95
ALP (U/L)	64.27	54.40	68.00	68.00	2.71	0.33
Glucose (mg/dl)	50.60	43.53	42.81	37.77	2.57	0.37
Cholesterol (mg/dl)	69.64	59.91	58.91	51.98	3.54	0.57
Triglyceride (mg/dl)	63.36	54.50	53.60	47.30	3.22	0.37
High-density lipoprotein (mg/dl)	22.50	21.30	23.45	23.95	0.53	0.42
Low-density lipoprotein (mg/dl)	34.46	27.71	24.74	18.58	3.25	0.40

[a,b] Means with different superscripts along the row are significantly ($p<0.05$) different

SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)
AST- Aspartate transaminase; ALP- Alanine phosphate; ALT- Alanine transferase

For T4. Uric acid ranged from 6.10 mg/dl for T3 and 6.81 mg/dl for T1. Nitric oxide was 5.14 µm/mlfor T1, 4.81 µm/ml for T2, 4.80 µm/ml for T3and 4.50 µm/ml for T4. Malondehyde ranged from 0.87 mmol/L for T4 to 0.99 mmol/L for T2.

Table 6 shows the result of rumen pH and metabolites of feedlot Bunaji bulls fed diets with varying levels of cage layer chicken droppings. The pH of rumen of bulls on T4 (6.47) were higher ($p<0.05$) compared to those in T2 (5.80), while the pH values observed in T1 and T3 (6.00 and 6.10, respectively) were comparable ($p>0.05$) to both T2 and T4.

The total volatile fatty acids (TVFa) in all the bulls supplemented with diets containing cage layer chicken droppings (0.29, 0.27, and 0.27 mmol/100mol for T2, T3and T4, respectively) were higher ($p<0.05$) compared to control (0.19 mmol/100mol). The acetic acid concentration in the rumen was 0.06 mmol/100mol in T1, which increased ($p<0.05$) to 0.13, 0.12and 0.12 mmol/100mol for T2, T3and T4, respectively. Propionic acid was 0.04 mmol/100mol in T1, with higher ($p<0.05$) values of 0.09, 0.08, and 0.08 mmol/100mol observed for T2, T3and T4, respectively. Butyric acid was 0.01 mmol/100mol for T1, T2and T4, while T3 had a value of 0.04 mmol/100mol.

The results of the rumen microbial population of feedlot Bunaji bulls fed diets with varying levels of cage layer chicken droppings is presented in Table 7. Bacteria count, amylolytic bacteria, lipolytic fungiand proteolytic fungi were significantly ($p<0.05$) affected by the inclusion levels of cage layer chicken droppings in the diets of feedlot Bunaji bulls, while protozoa count, fungi count, lipolytic bacteria count, proteolytic bacteria count and amylolytic fungi count were not affected ($p>0.05$) by the inclusion of different levels of cage layer chicken droppings in the diets of the bulls. Bacteria count reduced ($p<0.05$) in T4 (74.33 x10^5 cfu/ml) compared to 201.67, 186.00 and 168.00 x10^5 cfu/ml observed for T2, T3and T4, respectively. Amylolytic bacteria reduced ($p<0.05$) in T4 (36.67 x10^5 cfu/ml) compared to T1 and T2 only (90.00 and 84.50 x10^5

Table 5. Oxidative Biomarkers of Feedlot Bunaji Bulls Fed Diets Containing Varying Levels of Cage Layer Chicken Droppings

Parameter	T1	T2	T3	T4	SEM	p-value
Superoxide dismutase (IU/L)	14.11	16.94	14.21	13.21	1.20	0.82
Glutathione peroxidase (IU/L)	0.06	0.08	0.04	0.05	0.01	0.64
Uric acid (mg/dl)	6.81	6.20	6.10	6.42	0.14	0.28
Nitric oxide (µm/ml)	5.14	4.81	4.80	4.50	0.12	0.23
Malondehyde (mmol/l)	0.94	0.99	0.98	0.87	0.08	0.97

SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)

Table 6. Rumen pH and Metabolites of Feedlot Bunaji Bulls Fed Diets Containing Varying Levels of Cage Layer Chicken Droppings

Parameter	T1	T2	T3	T4	SEM	p-value
PH	6.00^{ab}	5.80^{b}	6.10^{ab}	6.47^{a}	0.11	0.05
TVFA (mmol/100mol)	0.19^{b}	0.29^{a}	0.27^{a}	0.27^{a}	0.02	0.05
Acetic acid (mmol/100mol)	0.06^{b}	0.13^{a}	0.12^{a}	0.12^{a}	0.01	0.05
Propionic acid (mmol/100mol)	0.04^{b}	0.09^{a}	0.08^{a}	0.08^{a}	0.01	0.05
Butyric acid (mmol/100mol)	0.01	0.01	0.04	0.01	0.01	0.39

^{a,b} Means with different superscripts along the row are significantly ($p<0.05$) different
SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)

cfu/ml), but similar ($p>0.05$) to the value observed for T3 (45.00 x10^5 cfu/ml). Lipolytic fungi increased ($p<0.05$) in T4 (6.33 x10^5 cfu/ml) compared to T1, T2and T3 (2.67, 3.50 and 2.50 x10^5 cfu/ml, respectively). Also, proteolytic fungi increased ($p<0.05$) in T4 (6.00 x10^5 cfu/ml) compared to T1 and T2 only (0.67 and 1.00 x10^5 cfu/ml), but not T3 (2.00 x10^5 cfu/ml). Protozoa count was 116.33 for T1, 142.00 for T2, 58.50 for T3 and 100.67 for T4. Fungi count ranged from 3.50 x10^5 cfu/ml for T2 to 8.33 x10^5 cfu/ml for T4. Lipolytic bacteria was 34.00 x10^5 cfu/ml in T1, 36.50 x10^5 cfu/ml for T2, 21.50 x10^5 cfu/ml for T3 and 16.33 x10^5 cfu/ml for T4. Proteolytic bacteria ranged from 11.00 x10^5 cfu/ml for T2 to 188.00 x10^5 cfu/ml for T1. Amylolytic fungi were 2.33 x10^5 cfu/ml for T1, 2.50 x10^5 cfu/ml for T2 and T3, respectivelyand 3.33 x10^5 cfu/ml for T4.

Table 8 represents the economics of production of feedlot Bunaji bulls fed diets with varying levels of cage layer chicken droppings. The cost of purchasing animals varied across the treatment groups and was within the range of ₦125,666.67 and ₦132,333.33. Total cost of forage intake was ₦7,309.20 in T1, ₦7,755.90 in T2, ₦7,902.90 in T3 and ₦7,458.30 in T4. The total cost of concentrate intake was higher in T2 (₦33,767.70) and least in T4 (₦27,714.90). Concentrate intake cost was ₦33,475.20 in T1 and ₦30,741.30 in T3. Other cost which is a product of labour and health management was ₦10,462.50 across all the treatment groups. Total cost of production ranged from ₦174,773.37 (T3) to ₦184,319.43 (T2) across the treatment groups, with T1 and T4 having ₦182,913.57 and ₦176,635.70. The revenue from sales of the cattle ranged between ₦253480.00 in T1 to 287500.00 in T3. Other revenues were ₦285,260.00 in T2 and ₦268,140.00 in T4. Profit margin was highest in T3 (₦112,726.63) and least in T1 (₦70,566.43). The profit margin in T2 and T4 was ₦100,940.57 and 91,504.30, respectively.

Table 7. Rumen microbial dynamics of Feedlot Bunaji Bulls fed Concentrate Diets Containing Varying Levels of Cage Layer Chicken Droppings

Parameter	T1	T2	T3	T4	SEM	p-value
Protozoa Count (cells/ml)	116.33	142.00	58.50	100.67	19.51	0.66
Bacteria count (X 10^5 CFU/ml)	201.67^{a}	186.00^{a}	168.00^{a}	74.33^{b}	20.08	0.02
Fungi count (X 10^5 CFU/ml)	6.67	3.50	7.00	8.33	0.88	0.34
Amylolytic bacteria (X 10^5 CFU/ml)	90.00^{a}	84.50^{a}	45.00^{ab}	36.67^{b}	9.50	0.04
Lipolytic bacteria (X 10^5 CFU/ml)	34.00	36.50	21.50	16.33	3.72	0.13
Proteolytic bacteria (X 10^5 CFU/ml)	18.00	11.00	17.00	15.33	2.02	0.75
Amylolytic fungi (X 10^5 CFU/ml)	2.33	2.50	2.50	3.33	0.52	0.92
Lipolytic fungi (X 10^5 CFU/ml)	2.67^{b}	3.50^{b}	2.50^{b}	6.33^{a}	0.61	0.01
Proteolytic fungi (X 10^5 CFU/ml)	0.67^{b}	1.00^{b}	2.00^{ab}	6.00^{a}	0.93	0.04

^{a,b} Means with different superscript along the same row are significantly ($p<0.05$) different SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)

Table 7. Economics of Production of Feedlot Bunaji Bulls Fed Diets Varying Levels of Cage Layer Chicken Droppings

Parameter	T1	T2	T3	T4	SEM
Cost of Purchase (₦)	131,666.67	132,333.33	125,666.67	131,000.00	2560.40
Total Cost of forage intake (₦)	7,309.20	7,755.90	7,902.90	7,458.30	201.71
Total cost of concentrate (₦)	33,475.20	33,767.70	30,741.30	27,714.90	1512.39
Other cost (₦)	10,462.50	10,462.50	10,462.50	10,462.50	0.00
Total cost of Production (₦)	182,913.57	184,319.43	174,773.37	176,635.70	3554.03
Revenue (₦)	253,480.00	285,260.00	287,500.00	268,140.00	7334.22
Profit (₦)	70,566.43	100,940.57	112,726.63	91,504.30	7876.58

SEM=Standard error of mean
T1=Control diet (no inclusion of cage layer chicken droppings)
T2= (10% inclusion of cage layer chicken droppings)
T3= (20% inclusion of cage layer chicken droppings)
T4= (30% inclusion of cage layer chicken droppings)

Discussion

Growth performance indices are a measure of diet appreciation and valuable tools in assessing the nutritional potentials of feedstuff. The non-significant differences observed for growth indices of Bunaji feedlot bulls fed diets with varying levels of cage layer chicken droppings compared to control in this current study suggest that experimental diets compared favorably with control and that the test material can be a valuable feed resource for cattle fattening. Similar to this, feeding poultry litter did not affect the feed intake, weight changes and feed conversion ratio of Savanna Brown goats [20]. Also, the use of poultry manure in steer finishing rations did not affect the performance of the animals [21]. In a similar report, dry matter intake and daily weight gains in lambs were not influenced by including broiler chicken litter in their diets [22,23]. Also, [24] observed that Poultry litter included up to 56% in diet did not cause a reduction in dry matter intake, digestibility and milk production. On the other hand, cattle-supplemented cage layer chicken droppings in concentrate diets gave higher weights than non-supplemented groups [25,26]. The differences between this report and that of others could be due to the amount of cage layer chicken droppings used and the source of the cage layer chicken droppings. The non-significant difference in water intake in this present study also corroborates the findings of [27] that broiler chicken litter-containing diets did not reduce dry matter and water intake in Holstein and Jersey cows. Contrary to findings on water intake in this present study, feedlot Bunaji bulls on melon husk-based diets and biodegraded rice offal diets experienced a reduced water intake [28,29]. The observed differences in the various reports on water intake can be attributed to the types of diets in the different experiments.

Haematological parameters are a veritable tool to assess the health status of animals in response to dietary regimes. A good haematological composition in animals may likely cause the animals to exhibit good performance and productivity [30]. The reduction in red blood cells observed in bulls on 10% cage layer chicken droppings in the concentrate diet compared to control may have occurred due to individual animals' differences and not inclusion of cage layer chicken droppings in the diets of feedlot Bunaji bulls. This is so because bulls on diets containing 20 and 30%

inclusion of cage layer chicken droppings had similar results with both control and those on 10% cage layer chicken droppings. Similar values of red blood cells of bulls fed diets containing cage layer chicken droppings in some poultry-dropping diets compared to control indicate that utilization of cage layer chicken droppings in diets of feedlot Bunaji bulls may not have distorted the quality of the diets across the treatment groups. Report of [31] has explained that the quality and amount of red blood cells in the animal's body depends on nutrient availability, state of health and physiological status of the animal. This supports the assertion that diets containing cage layer chicken droppings provided adequate nutrients and maintained the health and physiological status of the animals compared to control. The packed cell volume (PCV) observed in this current study across the treatment groups fell within the range values for cattle (24-48%) as provided in [32]. These values were also closely related to that of 32.60 - 36.00%) reported by [33] for grazing Bunaji bulls grazing natural pastures and supplemented concentrate diets with sweet orange peels. Non-significant differences in haematological parameters in the current study show the healthy state of the animals as well as the physiological status. On the contrary, West African dwarf goats on processed poultry litter diets showed a significant difference in haemoglobin, packed cell volume, white blood cells, neutrophils and lymphocytes [34]. The species differences between cattle and goats may have accounted for the differences in the two reports.

Like the actions of cage layer chicken droppings on total protein concentration, the protein content of fish has been reportedly affected by incorporating cage layer chicken droppings in fish diets. Therefore, the consumption of cage layer chicken droppings by Bunaji bulls could lead to changes in their nutrient intake and metabolism, potentially resulting in decreased total protein levels in the blood. In another research, the addition of cage layer chicken droppings in the diets of West African dwarf bucks affected the urea levels in the animals, possibly due to the slow release of ammonia from non-protein nitrogenous compounds present in the droppings [34]. The presence of cage layer chicken droppings in the diets of cattle is likely to influence the microbial composition of the gut, which may potentially affect serum parameters through interactions with gut microbiota. [35] has reported that gastrointestinal bacterial communities play critical roles in the functioning and health of their hosts, including metabolism and immune programming. In this report, the reduction in total protein corresponds with a reduction in amylolytic bacteria populations in the rumen of the animals feeding 30% inclusion levels of cage layer chicken droppings. Like this research, serum total protein in lambs decreased when they were fed poultry litter-based silage [36].

Assessing the oxidative status of animals following certain feeding regimes is important for the development of sustainable feeding systems. The non-significant differences for all the oxidative biomarkers of Bunaji bulls fed up to 30% inclusion level of cage layer chicken droppings in the current study is an indication that there was no cellular damage or health challenges in the animals. This may be because the cage layer chicken droppings were ensiled, likely, some of the challenges associated with the use of cage layer chicken droppings in ruminant diets including the presence of pathogens that could cause health challenges and cellular damage in the animals may have been addressed during fermentation while ensiling. Research has shown that the supplementation of fermented feed resources can effectively help maintain the stability of the intestinal environment and reduce the adverse effects of oxidative stress [37,38]. [39] found that fermentation could lead to a significant increase in antioxidant activities.

Rumen fermentation parameters are used to measure diet appreciation and the health of the rumen. Increased rumen pH in animals on 30% inclusion of cage layer chicken droppings in diets of Bunaji bulls compared to those on 10% only may have occurred not necessary because of the use of cage layer chicken droppings. This is because rumen pH of animals in control and 20% inclusion of cage layer chicken droppings were comparable with 30% inclusion. Except for the pH value observed for Bunaji bulls on 10% cage layer chicken droppings, those obtained in control, 20 and 30% cage layer chicken droppings were closely related to values of 6.80 and 6.64 found in sheep and goats, respectively fed poultry litter in their diets as reported by [40]. In addition, the pH from the rumen of bulls on control, 20 and 30% was within a range of 6-7 as reported in the work of [41]. The increase in total volatile fatty acids propionic acid and acetic acid in bulls on poultry litter may be explained by the presence of non-protein nitrogen (NPN) which may serve as a substrate to rumen microorganisms for rumen fermentation. This may increase the activities of the microorganism in the rumen, especially leading to higher rumen metabolites in the rumen. In this report, compared to the control, lipolytic and proteolytic fungi increased especially when the Bunaji bulls were supplemented with diets with 30% cage layer chicken droppings. The increase in total volatile fatty acids and the various proportions in the rumen of bulls on cage layer chicken droppings compared to control in this current study is in contrast with the submission of [41] that total fatty acids in the rumen of sheep-fed deep stack broiler chicken litter reduced. The differences observed for total volatile fatty acids in the two different reports may be due to the type of poultry material utilized from the two experiments (cage layer chicken droppings and the deep stack poultry litter).

The observed decrease in total bacteria count and amylolytic bacteria at 30% inclusion levels of cage layer chicken droppings compared to control and some of the other poultry dropping levels is indicative that such action is dose-dependent. However, this may not be the same for fungi counts as both proteolytic and lipolytic fungi were observed to increase when cage layer chicken droppings were included in the diets of Bunaji bulls at 30%.

Sustainable feeding systems must consider the cost of feeding for optimum profitability. The higher cost of production found in cattle on diets containing 10% cage layer poultry droppings in this study is because of a higher concentrate intake in the cattle on the treatment diet. This higher cost of production however, gave higher revenue

when the animals were sold, compared to control. However, compared to control, cattle feeding on 20 and 30% cage layer poultry droppings in diets gave lower cost of production. Like this result, the average cost of production unit was reduced when broiler chicken litter replaced soybean meal in the diets of fattening lambs [23]. The revenue and profit margin in all cage layer poultry droppings diets was superior to the animals on control diets, with gross profit margin in animals on diets with 20% cage layer poultry droppings providing highest profit margin. This establishes the fact that inclusion of cage layer poultry droppings in diets of feedlot Bunaji bulls will enhance profit margin for farmers, especially at 20% inclusion level. To support this claim, the report of [41] has established that the performance and economic efficiency of the cow were improved with the consumption of diets containing broiler chicken litter.

Conclusions

The inclusion of ensiled cage layer chicken droppings in the diets of feedlot Bunaji bulls up to 30% did not affect the growth haematological, serum and oxidative biomarkers of the animals. The use of ensiled cage layer chicken droppings in diets of feedlot Bunaji bulls resulted in improved pH in the rumen, decrease in total bacteria and amylolytic bacteria counts, while proteolytic and amylolytic fungi counts increased. Consequently, the energy supply for the animals increased with the inclusion of cage layer chicken droppings in the diets of feedlot Bunaji bulls as total volatile fatty acids, propionic acid, and acetic acid increased in animals feeding diets with cage layer chicken droppings. Feeding ensiled cage layer chicken droppings in the diet of feedlot Bunaji bulls resulted in a reduction in the cost of production, and increased profit margin ensuring more profitability of the enterprise when using cage layer chicken droppings in the diets of the animals.

Acknowledgements

The authors acknowledge the support of the College and Department of Animal Production, Joseph Sarwuan Tarka University, Makurdi for providing an enabling environment for this research. The support of Mr. Iyoryisa Terungwa and others students during the field work is also appreciated.

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Cite this article

Wuanor A.A., Ata C.M., Ikyume T.T. (2025). Responses of Feedlot Bunaji Bulls to Concentrate Diets Containing Different Levels of Ensiled Cage Layer Chicken Dropping. FUAM Journal of Pure and Applied Science, **5**(**1**):106-115