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Evaluation of Ensiled Corncob-Poultry Dropping as Ruminant Feed Using *in Vitro* Gas Production Technique

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Feed availability, during the dry season has been major factor limiting the expansion of ruminant production in Nigeria. Utilization of crop residues had been suggested, although of low nutritive value. The study was carried out to evaluate the silage quality, microbial characteristics, chemical and mineral composition and the nutritive value of ensiled corncob-poultry droppings using in-vitro gas production techniques. Corncob, an agro-industrial by product and poultry dropping were used in this study. The treatment comprised of T1: (Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%), T2: (Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%), T3: (Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%), T4: (Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%).The silage physical characteristics, pH, temperature, microbial analysis, mineral composition, chemical composition and in-vitro gas production were determined. The colour varied from dark brown to light brown for corncob with varying poultry dropping. The aroma varied from almost pleasant to very pleasant; the pH ranged from 4.25 to 4.75. The dry matter (DM) was not significantly affected by the different combination of the silage while crude protein (CP), Crude fibre (CF), Ether extract (EE) and ash differed significantly among the treatments. However, the highest (P<0.05) CP value of 8.83% was obtained for silage T2. Mineral compositions; Sodium (Na) ranged from 0.144 – 0.210%, copper obtained was similar for all the treatments which is an indication that percentage copper composition for all the treatments were not significantly (p<0.05) different from one another. Lactic acid bacteria count which ranged from 2.30-3.02 log10 cfu/g with T2having the highest value (3.22log10cfu/g) and the lowest value 2.3log10cfu/g at T1. Total aerobic bacteria ranged from 6.90 to 5.95log10 cfu/g with T2 having the highest value (6.90 log10 cfu/g) and T1had the lowest value (5.95log10cfu/g). No significant difference (P>0.05) was observed on the values obtained for Propionic bacteria count and mould. The Enterobacteria bacteria count ranged from 1.57-2.06 log10 cfu/g with the highest obtained at T2. The cumulative gas produced ranged between 17. 67 and 20.83 ml/200mg DM. Methane (ml 200mg/DM) production ranged from 7.50 to 8.75 ml/200mg DM. The values for the ME, OMD and SCFA ranged from 5.12 to 5.36 MJ/Kg DM; 34.77 to 37.47% and 0.36 to 0.44 µmol respectively. It was therefore concluded that ensiled corncob poultry dropping could be an effective way of enhancing the nutritive value of corncob and also resulted in improved CP and digestibility, hence its potential in ruminant nutrition.

Key words: Corncob, Poultry dropping, Silage and *in-vitro* gas production technique.

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INTRODUCTION

Nutrition has been identified as a major problem in ruminant production in the tropics particularly during the dry season. The season is characterizedwith scarce fresh fodder and abundance of roughages consisting mainly of highly lignified grasses, crop residues, and agro industrial wastes. These roughages are coarse, fibrous, less digestible low in protein and other essential nutrients. The shortage in feed supply due to high cost and seasonality, have caused ruminant livestock farmers to search for alternative feed sources that are inexpensive and readily available.These sources are not directly required as component of human diets and can economically supplement the feed ingredients in rations without adverse effects on the rumen microbial fermentation and performance of the animals [1,2,3 and 4]. The inclusion of agro-industrial by product based diet had resulted in improved animal performance in terms of production and weight gain.

Poultry dropping, although not aesthetically pleasing, has been recognized as a safe, nutritionally valid and environmentally friendly animal feed, especially when combined with other feed sources as supplements.It refers to pure excreta from layers in batteries and poultry litter to the mixture of excreta and bedding material obtained largely from broiler houses and also from houses where pullets and layers are kept on deep litter systems. A small amount of feed spillage may be present in the material[5].

Corncob is the maize harvest by-product obtained following shelling and it is readily available. A major use of corn-cob to date has been a source of fuel energy for cooking. Its use as a feed has been restricted to ruminant because of its high fibre content. Corncob contains about 3.40% crude protein and 48.70% crude fibre. [6].However, corncob has low feeding value because of its poor protein content, energy, minerals and vitamins. It is also unpalatable and easily contaminated by toxic fungi such as *Aspergillusflavus*. Ensiled corncob is very palatable as shown by a higher feed consumption by sheep fed on ensiled corn cob basal diet than that fed on grass basal diet. Although it is palatable, the fibre content of corn cob silage was found to be high [7], which is important for methane production in rumen fermentation.

Ensiling has been proved to be a potential general method of preserving crop residues for better acceptability and degradability, and also a way to make feed available during forages off-season, [8]. The *in-vitro* gas production techniqueis simple, cheap, fast, reliable and allows a large number of samples to be handled at a time [9]. It is based on the fact that the anaerobic digestion of carbohydrates by rumen or caecal micro-organisms produces gas (carbon (IV) oxide, methane and traces of hydrogen) and volatile fatty acids (acetate, propionate, and butyrate); gas production can be measured to estimate the rate and extent of feed degradation. The *in-vitro* gas production technique needs feeds (substrates), an anaerobic medium and a representative sample of the micro-organism population present in the rumen or caecum (inoculum). For ruminant animals, proximate analysis, fibre constituents and *in-vitro* gas production is important to delineate its nutrient value.

Utilization of agricultural by-product as silage during the critical period of feed shortage will go a long way in reducing feed shortage. This study therefore focused on the evaluation of physical, microbial and mineral characteristics of corncob-poultry dropping mixture silage and its nutritive quality using *in-vitro* gas production method.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the small ruminant unit of the Ladoke Akintola University of Technology, Ogbomosho. The area is situated in derived savannah zone of Nigeria and lies on Longitude4°15 East of Greenwich meridians and Latitude 5°15 north of the equator. The altitude is between 300m-600m above sea level while the mean temperature and annual mean rainfall are 27°C and 1247mm respectively [10].

Source and Preparation of Test Ingredients

Poultry dropping was collected from the poultry unit of LAUTECH Teaching and Research Farm, Ogbomoso, Oyo State. The poultry dropping was sundried to reduce the moisture content and it was sieved to remove unwanted particles. Fresh pineapple pulp was gotten from a nearby processing industry and corncob was purchased from Odo Oba market about 17.4km to the Teaching and Research Farm, LAUTECH, Ogbomoso, Oyo State.

Silage Preparation

Silage was prepared in mini silos **(**60Litres plastic drums).The poultry dropping, corncob and pineapple pulp were mixed homogeneously in a varying proportion. Treatment 1: Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%); Treatment 2: Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%); Treatment 3: Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%) and Treatment 4: Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%). Each mixture was packed in the plastic drums and compressed with heavy stones and sand bags to eliminate air and it was immediately sealed. All materials were allowed to ferment for 28 days.

Silage quality determination

After 28 days, the fermentation was terminated and the silage was opened for physical quality assessment. The appearance, smell, texture, and pH of the silage were judged using the criteria below.

	0	1	2	3	4	5
Observation	Very bad	Bad	Going bad	Moderate	Good	Excellent
Colour	Very dark	Dark	Dark brown	Deep brown	Brown	Light brown
Smell	Offensive	Poor	Almost pleasant	Fairly pleasant	Pleasant	Very pleasant
Texture	Slimy	Very soft	Soft	Moderately firm	Firm	Very firm
pH	>6.5	6.1 – 6.5	5.6 – 6.0	4.6 – 5.5	4.0 – 4.5	< 4.0

[11]

On opening the silage, a thermometer was inserted to determine the temperature. Sub-samples from different points and depth were taken and mixed together to determine the dry matter. The samples were oven dried at $65^{0}C$ until a constant weight was achieved. The samples were stored in an air-tight container until it was ready for chemical analysis. The pH meter was used to measure the pH of the sub-samples in each of the treatments. Colour assessment was determined using visual observation with the aid of colour charts. The odour or smell of thetreatments was assessed as to whether it is nice or pleasant or fruity [12].

In-vitro Gas production Technique

Rumen fluid was collected from four West African dwarf ram using oesophageal technique, by using suction tube prior to morning feeding. The method of collection was as described by [12]. After collecting a sumptuous amount needed for the analysis, the rumen fluid (liquor) was poured in thermo flask that has been pre-warmed (sterilized) with hot water to a temperature of 39°C, in order to maintain the temperature and was taken into the laboratory.The samples, each weighing 200mg (n=3) was carefully dropped into the syringes and thereafter, filled with 30ml inoculum (incubation medium) containing cheese-cloth strained rumen liquor and buffer. The rumen liquor and buffer solution was mixed in ratio 1:4 (v/v) under continuous flushing with carbon dioxide (CO_2) to maintain anaerobic condition of the liquor; this is to keep the needed microbes alive and to perform optimally by total expulsion of oxygen gas, because methanogens cannot function in an oxygen (O_2) environment and also to avoid the death of anaerobes in the liquor.

The buffer solution prepared was the McDougall's buffer adapted from [13] which consisted of sodium bicarbonate ($NaHCO_3$), sodium phosphate dibasic ($NaHPO_4$), potassium chloride (KCl), Sodium chloride (NaCl), Magnesium sulphur ($MgSO_4$. $7H_2O$) and calcium chloride ($CaCl_2$. $2H_2O$). The buffer solution was freshly prepared and store in a dark bottle. The following were the quantity of reagents used in preparing the buffer: 9.80g$NaHCO_3$ + 2.77gNa_2HPO_4 + 0.57g KCl + 0.47gNaCl + 2.16g$MgS0_4.7H_2O$ + 0.16g CaCl2.2H2O +1g urea [14]. The reagents were dissolved in distilled water. The calcium chloride was added only after the other reagents were completely in solution. Prior to use, a volume of buffer was warmed at 30°C and reduced with a stream of CO_2. During the warming and reducing step, urea was added to the McDougall's buffer at the rate of 1.0gm/litre.

Incubation was carried out according to [15], using 100ml calibrated transparent plastic syringes with fitted silicon rubber tubes and clipped. 200mg (0.2g) each feed sample was carefully weighed into the 100ml syringes in triplicates (three replicates), in which one of the weighed sample (replicate) was contained in fibre cloth/ sack prior to deposition into the syringe for degradability evaluation. Each syringe was fitted with a plunger that has been lubricated with vaseline to facilitate easy aspiration and expiration[16]. Then, using 50ml plastic calibrated syringes, 30ml of prepared incubation medium (inoculum) was injected into substrate in each syringe via the silicon tube. The syringe was tapped and pushed upward by the piston in order to eliminate air completely in the inoculums. The silicon tube in the syringe was then tightened by a metal clip (Hoffman clip) as to prevent escape of gas. The syringes were thereafter placed in an incubator at 38-39°C for incubation within 24hours. Three syringes without any substrate (blanks) which contain only the inoculums and buffer were incubated at the same time, the volume of gas production was measured at 3,6,9,12,15,18,21, 24 (hours) of incubation. The average of volume of gas produced from the blanks was deducted from the volume of gas produced per sample [16].

The volume of methane gas produced from each sample was determined by dispensing 4ml of 10 molar NaOH to the sample at the end of 24 hours of incubation. The tip of 5ml syringe capacity that contained the 4ml of NaOH was introduced into the incubated syringe through the silicon tube just above the metal clip. The clip was carefully unscrewed and the reagent introduced. NaOH was added to absorb carbon dioxide (CO_2) produced during the process of fermentation and the remaining gas was recorded as methane according to [17] and [18]. A pop sound was heard given rise to jacking upward of the piston, which was suggested the absorption of CO_2 by the sodium hydroxide (NaOH) .The syringe was turned upside down for the reading of methane (CH_4) level.

The volume of the gas produced at interval was plotted against the incubation time and from the graph, the gas production characteristics were estimated using the linear equation: $Y= a + b (1- ^{ect})$ described by [19], where Y =volume of gas produce at time (t), a= intercept (gas produced from the soluble fraction), b= gas produced from the insoluble fraction, c= gas production rate constant for insoluble fraction (b), t= incubation time.

The predicted metabolizable energy (ME, MJ/KgDM) and organic matter digestibility (OMD, %) were estimated as established by [15] and short chain fatty acid (SCFA) was calculated as reported by [20].ME=2.20 + (0.136GV) + (0.057CP) + (0.0029C); OMD=14.88 + (0.88GV) + (0.45CP) + (0.651XA); SCFA=0.0239GV – 0.0601. Where GV is the net gas production (ml/200mg DM), CP iscrude protein,CF is crude fibre and XA is the ash of the incubated samples respectively.

Chemical and Mineral Analysis

Samples of the experimental treatments were analyzed for microbial characteristics. Dried samples of the experimental treatments were analyzed for crude protein (N× 6.25), dry matter, ether extract and ash contents as described by [21]. The Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL) were determined using the method of [22].Mineral content of silage treatments were determined by wet digestion method using concentrated nitric acid and perchloric acid. The concentrations of sodium (Na), copper (Cu), manganese (Mn) and zinc (Zn) were determined by using an atomic absorption spectrophotometer [21].

Statistical Analysis

Data generated from this experiment was subjected to analysis of variance (ANOVA) for a completely randomized design using the procedure of [23]. Significant differences between the means was separated using the Duncan's multiple range test at 5% probability level.

RESULTS AND DISCUSSION

Results

Table 1 presents the physical characteristics of the silage treatments. The characteristics measured include colour, smell and texture of the silages which differ slightly from light brown to deep brown. Treatment 1 (Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%),–T1) had a deep brown colour,Treatment 2 (Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%), T2 had a brown colour while T3Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%)and T4 Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%)had light brown colour. The slight difference in colour is as a result of varying composition of corncob and poultry dropping in each treatment. T2 had a fairly pleasant smell, T1 andT3 produced pleasant smell while that of T4 was very pleasant smell. There is similarity in texture because all the treatments are moderately firm.The temperature ranged from 28.5^{o}C to 29.5^{o}C across all the treatments (Figure I). T1 had a significantly high temperature of 29.5^{0}C. T3 and T4 had a similar temperature of 28.5^{o}C. The pH values of the experimental treatments are presented in figure 2. The pH values ranged from 4.25 in T4 and 4.75 in T1.There were significant differences ($P< 0.05$) in the pH values across the treatments. T4 had the lowest pH value. It was also observed that the pH value reduced as corncob content increased and as poultry dropping content reduced (Figure 2).

Table1: Physical characteristics of corncob-poultry dropping silage

TREATMENT	COLOUR	SMELL	TEXTURE
T1	Deep brown	Pleasant	Moderately firm
T2	Brown	Fairly pleasant	Moderately firm
T3	Light brown	Pleasant	Moderately firm
T4	Light brown	Very pleasant	Moderately firm

T1: Corncob 40% + Poultry Dropping 40% + Pineapple Pulp 20%
T2: Corncob 50% + Poultry Dropping 30% +Pineapple Pulp 20%
T3: Corncob 60% + Poultry Dropping 20% + Pineapple Pulp 20%
T4: Corncob 70% + Poultry Dropping 10% + Pineapple Pulp 20%

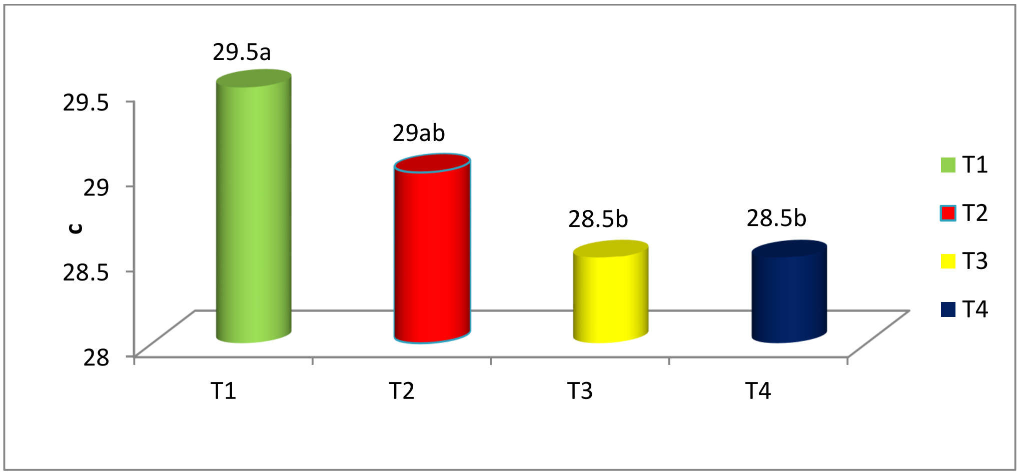

Figure 1: Temperature of ensiled Corn cob - poultry dropping silage

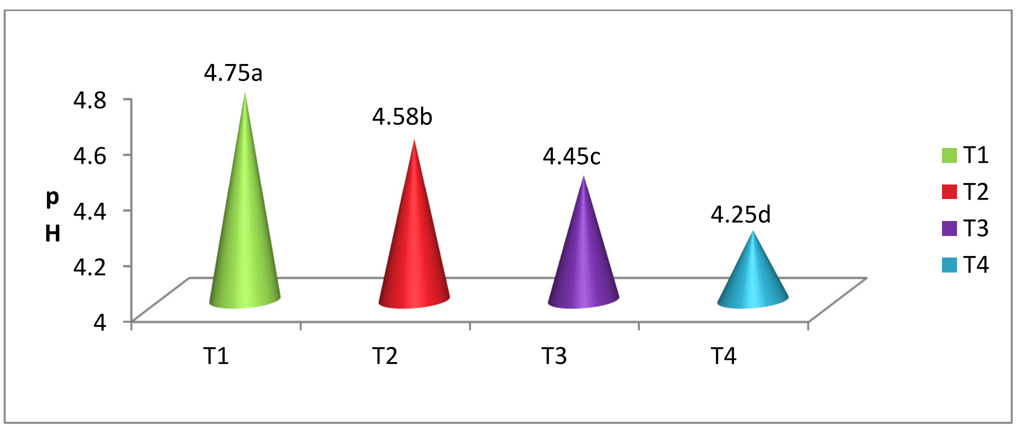

Figure 2: pH values of Corn cob- poultry dropping silage

Table 2: Microbial composition of Corncob-poultry dropping silage

PARAMETERS (Log10(cfu/g))	TREATMENTS				SEM
	T1	**T2**	**T3**	**T4**	
TABC	5.95	6.90	6.35	6.60	0.35
PBC	1.92	2.29	2.07	2.25	0.14
LABC	2.3^{b}	3.02^{a}	2.48^{b}	2.65^{b}	0.11
EBC	1.60^{bc}	2.06^{a}	1.57^{c}	1.74^{b}	1.45
FUNGI	2.05^{a}	2.00^{a}	2.14^{a}	1.74^{b}	0.04
MOULD	1.31	1.30	1.33	1.45	0.04

^{abc}-means on the same row with different superscripts are significantly different (P<0.05).
TABC= Total aerobic bacteria count, PBC= Propionic bacteria count, LABC= Lactic acid bacteria count, EBC= Enterobacteria count.
Treatment 1: Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%)
Treatment 2: Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%)
Treatment 3: Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%)
Treatment 4: Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%)
SEM- Standard error of mean.

Table 2 revealed the silagemicrobial counts, in colony forming unit (cfu)/g of the microbes in the varied combination of corncob-poultry dropping silage. Total aerobic bacteria count (TABC) ranged from 5.95 log_{10}cfu/g to 6.90 log_{10}cfu/g. The highest value of 6.90log_{10}cfu/gwas found at T2 while the least value (5.95log_{10}cfu/g) was at T1. There was no significant difference (P>0.05)for propionic bacteria count (PBC) in all the treatments. The highest PBC value of 2.29 log_{10}cfu/g was recorded in T2 and the lowest value (1.92 log_{10}cfu/g) in T1. Lactic acid bacteria count (LABC) which ranged from 2.30-3.02 log_{10}cfu/g had the highest LABC value of 3.02log_{10}cfu/g) at T2 and had it least value of 2.3log_{10}cfu/g at T1. The Entero bacteria count (EBC) ranged from 1.57-2.06 log_{10}cfu/gwith the highest value of 2.06log_{10}cfu/g obtained at T2 and the least value of 1.57log_{10}cfu/g at T3. The highest valueof 2.14log_{10}cfu/gobtained for fungi was found at T3and the lowest value of 1.74log_{10}cfu/g at T4.The mould count shows that the treatment did not induce significant effect on them as those values obtained were not significantly different (P>0.05).

Table 3: Chemical composition of Corncob-poultry dropping silage

PARAMETERS (%)	T1	T2	T3	T4	SEM
Dry matter	55.64	54.89	56.11	56.76	1.17
Crude protein	5.28^{bc}	8.83^{a}	6.27^{b}	4.00^{c}	0.42
Ether extract	2.80^{a}	1.05^{b}	1.45^{b}	3.05^{a}	0.15
Crude fibre	16.83^{c}	31.17^{a}	23.69^{b}	32.45^{a}	0.62
Ash	37.45^{a}	18.55^{b}	11.85^{c}	9.65^{c}	1.06
NDF	55.60^{c}	53.10^{a}	56.90^{bc}	58.50^{b}	0.74
ADF	35.50^{b}	39.78^{a}	29.75^{c}	24.55^{d}	0.84
ADL	16.95^{b}	22.45^{a}	17.10^{b}	16.50^{b}	1.09
Hemicellulose	20.10^{d}	23.32^{c}	27.16^{b}	33.95^{a}	0.16
Cellulose	18.55^{a}	17.33^{a}	12.65^{b}	8.05^{c}	0.46

^{abcd} means on the same row with different superscripts are significantly different (P<0.05). NDF- Neutral detergent fibre;ADF- Acid detergent fibre; ADL- Acid detergent lignin.
Treatment 1: Corncob (40%), Poultry Dropping (40%), Pineapple waste (20%)
Treatment 2: Corncob (50%), Poultry Dropping (30%), Pineapple waste (20%)
Treatment 3: Corncob (60%), Poultry Dropping (20%), Pineapple waste (20%)
Treatment 4: Corncob (70%), Poultry Dropping (10%), Pineapple waste (20%)
SEM- Standard error of mean.

Table 3 showed the chemical composition of the experimental silages. The results revealed significant differences (P<0.05) in the values obtained for the chemical composition except for dry matter (DM).The highest value of 56.76% for DM was observed in silage combination of T4 while the least value (54.89%) was observed in T2. The crude protein (CP) ranged from 4.00% - 8.83% with T4 having the lowest (4.00%) value while the highest crude protein value of 8.83% was observed in T2. Ether extract (EE in %) was observed to have its highest value 3.05% at T4 while the least value 1.05% was observed in T2.The highest value for crude fibre (CF %) was observed in T2 (31.17%) while the least value 16.83% was observed in T1. The Ash content of silages ranged from 9.65%- 37.45% with the highest value 37.45% in silage combination of T1while the least value of 9.65% was observed in T1. Neutral detergent fibre having the highest value (58.50%) in T4 with the least value (53.10%)at T2. Acid detergent fibre (ADF) was observed to have its highest value (39.78%) inT2 while the least value (24.55%) was in T4. Acid detergent lignin(ADL) ranged from 22.45%-16.50% highest value (22.45%) was recorded at T2 and lowest value (16.50%) was recorded at T4. Hemicellulose value at its peak (33.95%) was found in T4 and its lowest value (20.10%) at T1.Cellulose ranged from 8.05%- 18.55% having the highest value (18.55%) at T1while the least value (8.05%) was at T4.

The selected mineral compositions of the experimental treatments were presented in Table 4. The selected minerals were Sodium (Na), Copper (Cu), Manganese (Mn) and Zinc (Zn). It was revealed that T3 recorded the highest sodium content; T2 had a close value to T3while T1 had an improved value to T2 and T3 while T4 had the least value.Also, quantity of copper obtained in this present study was similar for all the treatments which is an indication that percentage copper composition for all the treatments were not significantly (P<0.05) different from one another. The table also revealed that T2 had highest value, T1 had relative high value and T3 and T4 had close values. T1 and T2 had the same value, T3 had an improved value and T4 had low value.

Table 4: Mineral composition of corncob poultry dropping silage

Treatment	T1	T2	T3	T4	SEM
Sodium	0.173^{bc}	0.204^{ab}	0.210^{a}	0.144^{c}	0.009
Copper	0.001	0.001	0.001	0.001	0.00001
Manganese	0.010^{b}	0.012^{a}	0.006^{c}	0.005^{c}	0.0004
Zinc	0.007^{a}	0.007^{a}	0.006^{ab}	0.005^{b}	0.0005

^{abc}means with different superscript along the same column differ significantly (P<0.05).
Treatment 1: Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%)
Treatment 2: Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%)
Treatment 3: Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%)
Treatment 4: Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%)
SEM: Standard Error of Mean

The gas volumes (ml/200mg DM) of ensiled corncob-poultry dropping silage are shown in Table 5 and figure 3. The gas produced ranged between 17.67 and 20.83 ml/200mg DM. Gas production was not significantly (P<0.05) affected by the experimental treatments at all incubation intervals. The gas produced increased with increasing incubation time. Rate of gas volumes production increased rapidly up to 12 hours and thereafter steadily increased til the 24th hour (Figure 3). Among the treatments, least gas volumes at 24hours (17.67 ml/200mg DM) was recorded for treatment (T2). Significantly (P<0.05) highest gas volume (20.83 ml/200mg DM) at the end of the incubation period was recorded for treatment (T4). This was followed by a value of 20.00 ml/200mg DM) obtained for treatment (T1).

Table 5: Gas volumes (ml/200mg DM) of ensiled corn-cob poultry dropping silage.

Treatment	3hrs	6hrs	9hrs	12hrs	15hrs	18hrs	21hrs	24hrs
T1	4.50	8.67	11.67	15.00	16.83	18.00	18.83	20.00
T2	4.50	8.33	11.83	14.12	15.67	16.50	17.00	17.67
T3	3.67	7.67	11.00	14.00	15.17	16.33	17.50	18.33
T4	5.00	9.50	13.33	16.50	18.67	19.50	19.83	20.83
SEM	0.70	0.82	0.95	1.25	1.14	1.15	1.03	0.99

[abc] means with different superscript along the same column differ significantly (P<0.05).
T1= Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%)
T2= Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%)
T3= Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%)
T4= Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%)
SEM = Standard Error of the Mean

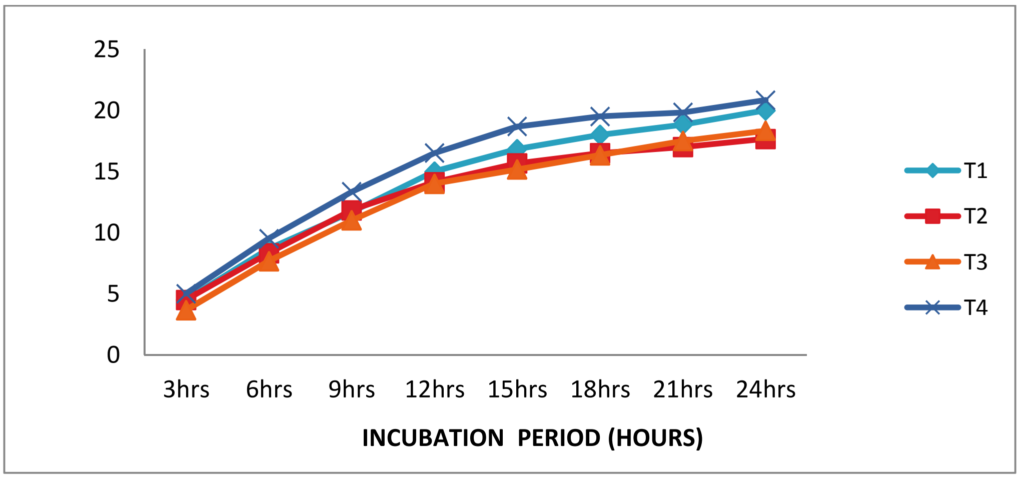

Figure 3: *In-Vitro* Gas Production of Corn Cob-Poultry Dropping Silage

The methane production volume of ensiled corncob-poultry dropping silage is shown in Figure 4. Methane (ml/200mg DM) production ranged from 7.50 to 8.75ml/200mg DM among different silages, the least (7.50ml/mg) was obtained from treatment (T3) and the highest (8.75ml/mg) from treatment (T2). The difference were all significant (P<0.05)

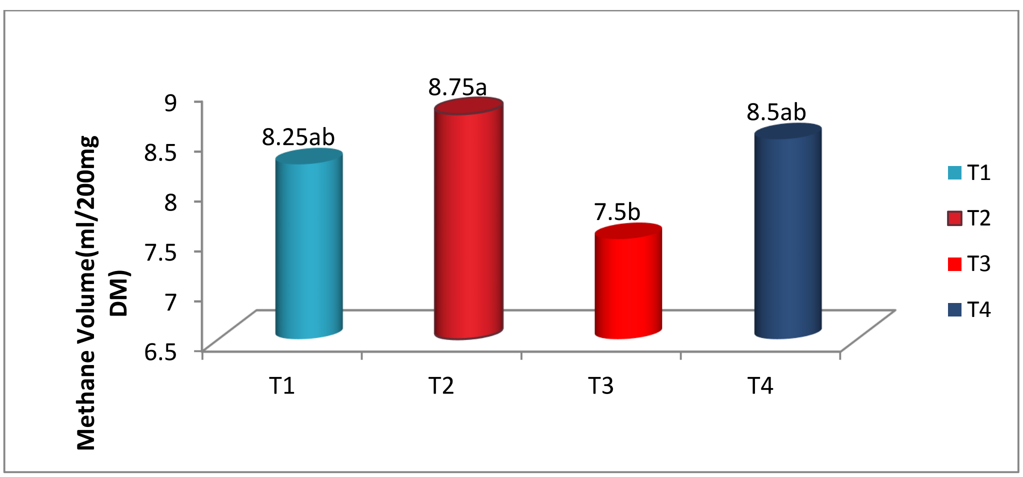

Figure 4: methane production of corncob -poulttry dropping Silage

Table 6 showed the *in-vitro* gas production characteristics, Metabolizable energy (ME, MJ/Kg DM), organic matter digestibility (OMD, %) and short chain fatty acids (SCFA µmol) of ensiled corncob-poultry dropping with different mixtures. Gas production (a+b) (ml/200mg DM) ranged from 17.67 to 20.83 ml/200mg DM. Gas production increased as incubation progressed and there were significant differences ($P<0.05$) in the gas production characteristics of all the treatments. The highest ($P<0.05$) potential gas production (a+b) value of 20.83 ml/200mg DM was recorded for treatment T4 while the lowest potential gas production (a+b) value of 17.67 ml/200mg DM was recorded for treatment T2. The values of the ME, OMD and SCFA ranged between 5.12 and 5.36 MJ/Kg DM; 34.77 and 37.47%; and 0.36 and 0.44 µmol respectively. T4 was observed to have the highest values of gas produced from soluble fraction, insoluble fraction potential gas production, gas volume, ME and SCFA.

Table 6: *In-vitro* gas production characteristics and metabolizable energy (MJ/Kg DM), organic matter digestibility (%) and short chain fatty acids (µmol) of corncob-poultry dropping silage.

Treatment	a	b	a+b	C	t	Y	ME	OMD	SCFA
T1	4.50	15.50a	20.00	0.05	6.00	8.67	5.27	37.47	0.42
T2	4.50	13.17b	17.67	0.07	6.50	9.00	5.20	35.77	0.36
T3	3.67	14.67ab	18.33	0.05	6.00	7.67	5.12	34.77	0.38
T4	5.00	15.83a	20.83	0.06	6.00	9.50	5.36	35.83	0.44
SEM	0.70	0.67	0.99	0.01	0.25	0.88	0.14	0.94	0.02

^{abc} means with different superscript along the same row differ significantly ($P<0.05$).
OMD- organic matter digestibility, ME- metabolisable energy, SCFA - short chain fatty acid, a (ml) = gas produced from the soluble fraction, b (ml) = gas production from the insoluble but degradable fraction, C (h^{-1}) = rate of gas production , a + b (ml) = potential gas production, t = Incubation time, y = gas volume.
T1= Corncob (40%), Poultry Dropping (40%), Pineapple Pulp (20%)
T2= Corncob (50%), Poultry Dropping (30%), Pineapple Pulp (20%)
T3= Corncob (60%), Poultry Dropping (20%), Pineapple Pulp (20%)
T4= Corncob (70%), Poultry Dropping (10%), Pineapple Pulp (20%)
SEM= Standard Error of the Mean.

DISCUSSION

The characteristics of good silage are usually determined by colour, smell and texture. The colour obtained in this present work was generally brown. This is an indication that the original colour of the corncob and poultry dropping was well preserved and could be identified as good silage. The result is in conformity with the previous reports [24 and 25] which claimed that good silage preserves the original colour of the standing plant. The colour of silage is often influenced by temperature. The lightcolour of the silage suggests a better quality [26].

The smell of all the experimental treatments was generally pleasant except for T2. The smell of the silage is a good indicator of the quality of silage. Pleasant smell will stimulate and facilitate feed intake and better performance of livestock. In line with this present finding, [25] confirmed that good silage has a mild, slightly acidic and fruity smell resembling that of cut bread and of tobacco due to the presence of lactic acid. It was reported by[27] also that pleasant smell is accepted for good or well-made silage. Moreover, all the test ingredients had moderately firm texture.Ensiling is a preservation method for moist forage crops. It is based on lactic acid bacteria (LAB) converting water soluble carbohydrates (WSC) into organic acids, mainly lactic acid, under aerobic conditions. Tropical forages are reportedly [28] difficult to ensile because of their high buffering capacity hence the addition of a fermentable substrate at ensiling in order to enable a more satisfactory fermentation. The presence of readily fermentable carbohydrates for the metabolism of lactic acid producing bacteria has also been reported to prevent to some extent the activities of clostridia which spoil silages and cause pH to be low, As a result, pH decreases and the moist forages are preserved from spoilage microorganisms [26].

Temperature is one of the factors affecting silage colour. The lower the temperature; the better the silage and the less the change in colour. The temperature of fermenting forage varying from 27-38^{O}C was presumed to produce excellent silage [29].The temperature of the experimental silage ranged from 29^{O}C- 29.5^{O}C which is higher than the range (25^{O}C- 27^{O}C) obtained by [18] in silage of guinea grass. The pH values revealed the measure of the acidity of the silage. And it is the simplest and quickest way of evaluating silage quality [25]. If the pH is too high, it indicates poor preservation and if the pH is too low, it can reduce intake.[11].The observed pH values (4.35-4.73) were lower than the range of 4.5 to 5.5 considered by [30] which was acceptable for good silage. Meanwhile, [31] reported that the attainment of low pH as 4.0 resulted in successful silage preparation. However, pH may be influenced by the moisture content and the buffering capacity of the original materials. Silage that has been properly fermented will have a much lower pH (but more acidic) than the original forage.

The presence of readily fermentable carbohydrates for the metabolism of lactic acid producing bacteria has been reported to prevent to some extent the activities of clostridia which spoil silages and cause pH to be low, As a result, pH decreases and the moist forages are preserved from spoilage microorganisms [26]. The lactic acid bacteria (LAB) are mainly responsible for the reduction in pH that occurs in properly fermented silages. The ensiling process is the fermentation of sugars by lactic acid bacteria .Once the environment is anaerobic, lactic acid bacteria grow rapidly and quickly become, in most cases, the dominant microorganisms in the silage ingredients. Lactic acid bacteria cover bacteria from a number of genuses (*Lactobacillus*, *Pediococcus*, *Lactococcus*, *Enterococcus, Streptococcus* and *Leuconostoc)* are found in silage [32]. The lactic acid bacteria generally need various amino acids and vitamins for growth [32]. However in this study, lactic acid bacteria count of the ensiled corncob poultry dropping had its highest significantly at T2 (6.90 log10 (cfu/g)).The production of the desirable acids – total aerobic bacteria count (TABC), Propionc bacteria count (PBC) and lactic acid bacteria count (LABC) in significant values in all the silage treatments revealed that the pH of the ensiled material decreased and thus spoilage organisms were inhibited. The highest values of TABC, PBC and LABC across all the treatments were observed in T2 with 6.90 log_{10}cfu/g, 2.29 log_{10}cfu/g and 3.01 log_{10}cfu/g. Enterobacteria, fungi, yeasts, molds and clostridia bacteria are undesirable organisms that are present in ensiled plant material. Excessive proliferation of these organisms has negative effects on silage quality [26]. Enterobacteria produce lactic acid but are undesirable in the silage because they compete with lactic acid bacteria for sugars and have acetic acid as a major end product. The enterobacteriacount obtained in this study had its highest value at T2 (2.06 log10 (cfu/g).Mould count obtained from this study ranged from 1.31-1.45 log10cfu/g with the highest value (1.45 log10cfu/g) observed at T4.Fungi count ranged from 1.74-2.14log10cfu/g with the highest observed significantly (P<0.05) at T3. The enterobacteria count(EBC), fungi and mould values which are the undesirable ones, in all the treatments were negligible when compared with the required minimum level of 300 – 1,000,000 log_{10}cfu/g [32]. The microbial activities from each treatment showed that the silage does not have any hazardous effect on the animal and the handler used in the study. Ensiled 50% corncob + 30% poultry dropping + 20% pine apple waste (T2) had the highest lactic acid bacteria count of 3.02log10 (cfu/g) and pH of 4.73 which indicates it had a stable and well established anaerobic fermentation condition.Therefore, all the treatments have good feed value, insignificant level of toxins and would not be hazardous to animal health and the handler.

The Dry Matter (DM) contents of the treatments were observed to lie within 54.89% to 56.76%. The DM contents of the ensiled corncob poultry dropping were not significantly different (P>0.05), but had its highest value (56.76%) at T4. However, the DM range of 54% to 56% is within the reported range for silages. The highest DM value of 56.76% at T4 is lesser than that reported by[33]. The higher DM in the previous study may be due to the inclusion of cassava peel to the silage. The crude protein values obtained from the silages were below the minimum recommended range of 7.0 - 8.0 % for efficient functioning of rumen microorganisms [22] except for T2 and lower than 10-12% recommended by [34] for moderate level of ruminants production. However, the CP value of T2 (8.83%) was within the above mentioned required limits and above the critical value of 7.7% or 70g/Kg recommended for small ruminants [35].

The higher (P<0.05) CP content in T2 (8.83%) when compared with that of T1 (5.28%) might be due to the percentage inclusion of poultry dropping in the treatments and solubility in the rumen. Uric acid is the principle nitrogen (N) component of poultry excreta which degrades more slowly than urea [36] creating a favourable ammonia pattern for efficient utilization in ruminants. If in excess higher concentrations of ammonia limit the growth of cellulolytic microorganisms and reduce rumen fibre digestion and hence microbial protein production [37 and 38]. It implies, the higher the poultry dropping, the more of ammonia to be produced. The lower amount of protein in this study showed that it is limiting in corncob and therefore suggests a supplementation with richer protein sources. However, CP in corncob can be enhanced by ensiling with urea molasses to obtain 9.96-12.81%CP [39] and by treating with fungi to obtain 10.05-10.37%CP [40]. High proportion of corncobs poultry dropping silage T2(ensiled 50% corncob + 30%Poultry Dropping+20%Pineapple waste) was observed to result in increasing crude protein content. All the silage combinations (T1 T2, T3 and T4) with crude protein (CP) values 5.28%, 8.83%, 6.27% and 4.00% respectively could serve as diets to improve the low protein in ruminant diet. Although the minimum crude protein requirement range of 10-12% is recommended for ruminants by [41].

Ether Extract (EE) ranged significantly from 3.05% T4to 1.05% T2. The values were lower when compared with 3.58% EE content observed in the study of [33]. It was stated by [12] that low ether extract content of a diet could imply that the incubated diets were low in energy sources, which connotes that other silage treatments except T4 must be supplemented with high energy sources.Ash value of the experimental silages ranged significantly from 9.65% (T4) to 37.45% (T1).Ash content signifies the mineral level and was observed to decrease as the proportion of poultry dropping decreased in each of the treatments. T1 had the highest ash content; this might be due to the high proportion of poultry dropping in it.

Crude fibre measures the cellulose, hemicellulose and lignin content of forages. High fibre content in diets have been reported to result in increased removal of carcinogens, potential mutagens, steroids, bile acids and xenobiotics by binding or absorbing to dietary fibre components and be rapidly excreted, hence these diets will have health promoting benefits for the ruminants and non-ruminants [42].However, high levels of crude fibre affect the digestibility of diets. Neutral detergent fibre (NDF) is a measure of the total fibre in the plant which gives a guide to plant maturity. NDF level increases as plant matures and therefore high level suggest fibrous silage. The NDF contents of the silage ranged between 53.10% and 58.50% while the acid detergent fibre (ADF) contents ranged between 24.55% and 39.78%. The silage NDF and ADF values represent a great reduction from the corresponding respective values of the original silage material, probably due to the action of cellulolytic microorganism during the ensilage process. The resultant silage ADF and NDF values could be regarded as low to moderate when compared with low quality roughages which ruminants can readily degrade [43]. The hemicellulose content increased with reduced proportion of the poultry dropping, while the cellulose content reduced as the proportion of the poultry dropping increased.

The mineral analysis of a plant gives the idea of possibility either or not to be used for any feeding trial purpose. Sodium plays a fundamental role in the absorption of sugar and amino-acids from the intestine and in the transmission of nerve impulses [41]. In this study, sodium level fell between the range of 0.144 - 0.210%. The value of sodium obtained in this study is within the range (0.01-0.25g/100g) recommendedfor ruminants [44].The manganese content was significantly different ($P<0.05$) in all the treatments. The values in this study ranged from 0.005- 0.012). These ranked higher than the 0.002 -0.004% recommended for critical level by [45]. The zinc content was significantly different in all the treatments. The values were between 0.005% and 0.007%). This range is higher than that recommended at critical level of 0.002-0.003% by [45].It could be deduced from this study that the mineral contents were adequately sufficient to promote growth in ruminants. The sodium, manganese and the zinc content of the experimental diets are high; therefore, there is no need for provision of supplemental diets to boost the mineral contents fed to the animals.

The final gas produced ranked from the highest to the lowest were T4, T1, T3 and T2 and were not significantly different ($P<0.05$). It was suggested by [46] that gas volume is a good parameter to predict digestibility, fermentation end-product and microbial protein synthesis of the substrate by rumen microbes in the *in-vitro* system. Although gas production is regarded as nutritionally wasteful [47], it however provides a useful basis from which metabolizable energy, organic matter digestibility and short chain fatty acid can be predicted [12]. It was reported by [9 and17] that*in-vitro* gas production is synonymous with feed digestibility, that the higher the gas production, the higher the digestibility.

Gas production rate constant (c, h^{-1}) ranged from 0.05 (T1 and T3) to 0.07 (T2). The amount of gas released when feeds are incubated *in-vitro* showed a close relationship to digestibility of feed for ruminants [48]. The higher gas production observed for T1 and T4 suggested a higher nutrient digestibility compared to T2 and T3. This observation could be a reflection of a higher proportion of carbohydrate available for fermentation [20]. The gas volume produced at the 24th hour at T4 (20.83 ml/200mg DM) was low when compared with the 30.33 ml/200mg DM produced at the same hour for corncob only reported by [49]. The metabolizable energy (ME), organic matter digestibility (OMD) and the short chain fatty acid (SCFA) values obtained in this study across all the treatments were found to be low when compared with the corresponding of corncob alone reported by [49]. The poultry dropping and the pineapple pulp could have been responsible for this difference. Poultry dropping has been recognized as a suitable alternative to urea in treating crop residues and thus reduce the problem of disposing animal waste [50]. The potential extent of gas production (a+b) recorded that treatment T4 (20.83%) had the highest value. It implies that T4 wasreadily available in the rumen.The estimated ME (MJ/Kg DM) for this study ranged between 5.12 (T3) and 5.36 (T4). The values obtained were lower than 5.49 to 6.04 and 11.76 to 14.47 recorded by[40 and 39]. It was suggested by [51] that *in-vitro* gas production technique should be considered for estimating ME in tropical feedstuffs. No variations observed in the OMD content of the different silages. The improved value observed in T1 for OMD implies that the microbes in the rumen of the animal have high nutrient uptake [52]. The SCFA predicted from gas production were 0.36µmol (T2) to 0.44µmol (T4). It was reported by [53] that there is a close association between SCFA and gas production, which is an indicator of energy availability to animal. T4 recorded higher value of SCFA which indicates that more energy is likely to be available to the animal fed on the treatment. The nutritive quality of corncob has therefore been improved by ensiling it with poultry dropping and pineapple pulp at 60:10:20 ratio mix.

The methane production of the ensiled corncob poultry dropping is shown in Figure 2. The highest methane production was at T2 (8.75 ml/200mg DM) while the least was at T3 (7.50 ml/200mg DM). The dietary energy loss in this study is minimal when compared with the range of 26.31 – 33.49 ml/200mg DM produced in *in-vivo* study involving lambs fed ensiled corncob basal diet supplemented with complete rumen modifier [54].

CONCLUSION

This study revealed that ensiling improved the nutritive value of crop residue and poultry dropping. The colour obtained was generally brown with pleasant smell and firm texture which indicate good quality silage.The use of crop by-products as additives in silage can be employed to enhance good silage fermentation. The result obtained in the study indicated that poultry dropping with corncob silage improved the crude protein content and also enhanced the breakdown of fibre, reduced dietary energy loss and provided a better atmosphere for the rumen microbes to operate effectively. Ensiling poultry dropping with corncob would improve productivity of ruminants in Nigeria especially during the dry season.

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