In Vitro Gas Production Assessment of Ensiled *Brachiaria Decumbens* with Different Additives as Animal Feed During the Dry Season

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**ABSTRACT**

Scarcity of forages during the dry season in Nigeria has lingered. This study therefore assessed the nutritive quality of *Brachiaria decumbens* with additives prepared as silage using in-vitro gas production technique. *Brachiaria decumbens* was ensiled with four different additives. T1: 90% *Brachiaria decumbens*+ 10% Yellow corn residue; T2: 90% *Brachiaria decumbens*+ 10% White maize residue; T3: 90% *Brachiaria decumbens* + 10% Guinea corn residue; T4: 90% *Brachiaria decumbens* + 10% Soy bean residue; T5: 100% *Brachiaria decumbens* and were incubated for in vitro gas production for 24 hours. Cumulative gas production was recorded at 3, 6, 9, 12, 15, 18, 21 and 24 hr of incubation periods and the organic matter digestibility (OMD), short chain fatty acid (SCFA) and metabolisable energy (ME) were estimated. Results showed that the dry matter content of the silages ranged from 26.35 to 37.57%, the crude protein ranged from 7.30 to 10.00%, the ether extract ranged from 3.60 to 4.27%, The NDF, ADF and ADL were significantly (p<0.05) different among the different silages. The cumulative gas produced ranged between 13.00 and 18.67 ml/200mg DM. There were no significant difference in ME, OMD and SCFA of the silages. The estimated ME (MJ/Kg DM) for the silages ranged from 4.33 MJ/Kg DM to 5.19 MJ/Kg DM. The highest OMD (45.27%) was observed in T2 (*Brachiaria decumbens* ensiled with white maize residue) and the lowest (41.45%) value in T4 (*Brachiaria decumbens* ensiled with soy bean residue). The SCFA estimated from gas production were 0.35, 0.50, 0.37, 0.33 and 0.45 μMol. All the silages under the study revealed that feeding ensiled *Brachiaria decumbens* with or without different additives will be of great use for ruminant productivity during dry season when there is scarcity of forages.

**Keywords**: *Brachiaria decumbens*, Silage quality, treatments, Metabolizable energy, microbial degradation

**I. INTRODUCTION**

The shortage of good quality forage needed to sustain livestock growth especially during the dry season has been a perennial problem in Nigeria. Various attempts have been made to ensure availability of feed especially in the dry season. One of such attempts is ensiling. It has been found to be cost effective, highly nutritious, feasible and effective in terms of high moisture content of stored fodder which can be fed to ruminant animals. McDonald *et al.* (1995) also identified ensiling as a promising alternative. It is a forage preservation method based on spontaneous lactic acid fermentation under anaerobic condition. The goal in silage making is to stop enzymatic reactions (which could come from the plant itself) and minimize loss of energy, protein and other nutrients (Broderick, 1995). Feed evaluation using *in vitro* gas production technique has been widely used as it cheaper, less time consuming and allows for more control of experiments (Blummel *et al.*, 1997). Fermentation of substrate by rumen microorganisms...
results in production of short chain volatile fatty acids (VFAs) and microbial protein (MP) and gases (Blummel et al., 1997). The microbial protein produced in the rumen by micro-organisms is the major source of protein for the ruminants and the prediction of efficiency of microbial protein production is very important in ruminant nutrition (Leng, 1993).

*Brachiaria decumbens* generally referred to as signal or palisade grasses, originated from East Africa and is a forage resource for grazing by sheep, cattle and wildlife. The erect, semi-erect and stoloniferous growth habit in *Brachiaria decumbens* is strongly associated with good production and adaptation. *Bracharia* species show rapid re-growth and good persistence under heavy frequent defoliation (Rika et al., 1990). It is valuable forage used in permanent pastures. It is high yielding and forms low leafy stands that do well in infertile soils. It is palatable to all classes of livestock and withstands heavy grazing (Cook et al., 2005). Signal grass can be grazed, cut to be fed fresh or to be made hay. Signal grass (*Brachiaria decumbens*) has been introduced into many tropical countries including tropical and sub-tropical areas of Africa; *Brachiaria* species have been planted on more than 80% of improved farming pastures with *B. decumbens* as the most favoured species (Ndikumana et al., 1996). The limited commercial use of Brachiaria in Africa is due to availability of other forages which could be more appropriate to the prevailing livestock production systems (Ndikumana and de Leeuw, 1996). *Brachiaria decumbens* is tropical forage that produces high nutritive quality for ruminants. The crude protein content of *Brachiria decumbens* from previous research work ranged from 7.6 to 15.5% (Ortega-Gomez et al., 2011). The authors reported neutral detergent fibre of 74.3%, acid detergent fibre of 42.4% and lignin of 6.7%.

Previous reports revealed that signal grass resulted in high live weight gains in grazing livestock (Susan, 2015); although some reported low weight gains (Wasinghe et al., 1987 and Opasina, 1996). Meanwhile, its use as livestock feed is being compromised by presence of steroidal saponins which makes it toxic to ruminants at certain stages of growth (Susan, 2015). However, Hasiah et al. (2000) reported that *Brachiaria decumbens* is highly nutritious when treated with phenobarbitone. It helped to reduce its toxicity in sheep. Also, ensiling reduced the concentrations of steroidal saponin in *Brachiaria decumbens* (Flavia et al., 2015).

Crop residues have been proved to be good additives in silages prepared from grasses. This has improved the taste, palatability and nutritive quality of the ensiled grass. Chung et al. (2018) observed that the ensiling of *Brachiaria decumbens* was effective in removing toxic and undesirable compounds. Previous research work revealed that inclusion of millet additive in *Brachiaria brizantha* silage provided good nutritional values in terms of high total digestible nutrient content, low neutral detergent fibre and lignin (Costa et al., 2011). Information on quality of *Brachiara decumbens* as silage with additives is missing. Thus, the need to assess the quality of ensiled *Brachiaria decumbens* when prepared with different additives.

## II. MATERIALS AND METHOD

### Experimental site

The experiment was carried out at the Teaching and Research Farm, Ladoke Akintola University of technology (LAUTECH), Ogbomosho located in the derived savanna zone in Nigeria.

### Sampling collection

Signal grass was collected from already existing paddocks within the Teaching and Research Farm and the additives were purchased from a nearby market within Ogbomosho environment.
Preparation for silage

The harvested grass was weighed in order to determine the expected amount for the making of silage. Samples of known weight were taken for dry matter analysis by drying in the oven. There were five treatment comprised mixture of *Brachiaria decumbens* with different additives. Signal grass was chopped into 2-3 cm lengths for ease compaction for silage. Plastic was lined internally by polythene sheets. Each layer of the grass was compacted manually to displace the air until the container is filled. The final compaction was made after the polythene sheet was used to cover the material. Sand bag was used as weight which was put on the filled materials and was left to ferment for 75 days.

Experimental treatment
There were five treatment diets used for the experiment, designated as T1, T2, T3, T4 and T5. The content of the treatment were as follows:

- **T1**: 90% *Brachiaria decumbens* + 10% Yellow corn residue
- **T2**: 90% *Brachiaria decumbens* + 10% White maize residue
- **T3**: 90% *Brachiaria decumbens* + 10% Guinea corn residue
- **T4**: 90% *Brachiaria decumbens* + 10% Soy bean residue
- **T5**: 100% *Brachiaria decumbens*

Determination of silage quality
After 75 days, the fermentation was terminated and the silage was being opened for silage quality assessment. The assessed quality characteristics were color, smell texture, taste, pH and temperature according to Babayemi and Igbekoyi (2008). Sub-samples from different points and depth were later taken and mixed together for dry matter determination by oven drying at 65°C until a constant weight is achieved. The samples were later milled and stored in an air tight container until chemical analysis.

*In-vitro* gas production
Rumen fluid was obtained from three West African Dwarf female goats through suction tube described by Babayemi (2007) before the morning feed. The animals were fed with 40% concentrate and 60% Guinea grass. Incubation was carried out using 120 ml calibrated syringes in three batches at 39°C (Menke and Steingass, 1988). To 200 mg sample in the syringe was added 30 ml inoculum that contained cheese cloth strained rumen liquor and buffer (9.8 g NaHCO3 + 2.77 g Na2HPO4 + 0.57 g KCL + 0.47 g NaCl + 0.12 g MgSO4. 7H2O + 0.16 g CaCl2. 2H2O) in a ratio (1:4 v/v) under continuous flushing with CO2. The gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24 h. After 24 hours of incubation, 4 ml of NaOH (10 M) was introduced to estimate the amount of methane produced (Fievez et al., 2005). The average volume of gas produced from the blanks was deducted from the volume of gas produced per sample. The volume of gas production characteristics were estimated using the equation \( Y = a + b \left(1 - e^{-ct}\right) \) (Ørskov and McDonald, 1979), where \( Y \) = volume of gas produced at time \( t \), \( a \) = intercept (gas produced from the soluble fraction), \( b \) = gas production from the insoluble fraction, \( (a+b) \) = final gas produced, \( c \) = gas production rate constant for the insoluble fraction (\( b \)), \( t \) = incubation time. The post incubation parameters such Metabolizable energy (ME, MJ/Kg DM) and organic matter digestibility (OMD, %) were estimated as established (Menke and Steingass, 1988) and the value of short chain volatile fatty acids (SCFA) was calculated as reported (Getachew et al., 1998):

\[
\text{ME} = 2.20 + 0.136 \cdot \text{Gv} + 0.057 \cdot \text{CP} + 0.0029 \cdot \text{CF}; \\
\text{OMD} = 14.88 + 0.889 \cdot \text{Gv} + 0.45 \cdot \text{CP} + 0.651 \cdot \text{Xa}; \\
\text{SCFA} = 0.0239 \cdot \text{Gv} - 0.0601; \\
\]

where Gv, CP, CF and Xa are net gas production (ml/200 mg DM), crude protein, crude fibre and ash of the incubated samples respectively.

Chemical analysis
Crude protein, crude fiber, ether extract, ash were determined using standard methods (AOAC, 2005). Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) was also determined using the standard method (Van Soest et al., 1991). Hemicellulose was calculated as the...
difference between NDF and ADF while cellulose is the difference between ADF and ADL.

### Statistical Analysis

Data obtained were subjected to analyses of variance using general linear model of SAS, (2000). The significant means were separated using Duncan multiple range test sample package.

#### III. RESULTS AND DISCUSSION

### Silage Quality Characteristics

The smell, colour, and texture are presented in Table 1. The colour of the silages was olive green. These physical qualities especially colour which is similar to those obtained by (Man and Wilktorsson 2001). All the silages ensiled are close to the original fresh forage assessing its quality (Oduguwa et al., 2007). All the silage prepared with different residues produces a very pleasant smell except for T4 (ensiled 90% BD +10 % SBR) which had a pleasant smell. It was noticed that the additives added to *Brachiaria decumbens* made it more attractive. The result of the present study shows that all the silage treatments exhibit fruity to pleasant aroma which is an indication of well-made silage (Kung and Shaver 2002). The entire silage gives fruity aroma except the one ensiled with soyabean residue which produced a pleasant aroma. All the silages ensiled with additives including 100% BD were firm in texture. The texture of the silages was firm which was expected to the best texture of good silage in silage (Kung and Shaver, 2002).

Figure 1 and 2 shows the temperature and pH of ensiled *Brachiaria decumbens* with different additives. T1 to T3 has temperature of 27.50°C and T4 and T5 had temperature of 28.00. The temperature of the fermented silage varied from 27-29°C which was presumed to produce excellent silage (Muck, 1996). It has also been observed that the temperature is one of the essential factors affecting silage colour, the lower the temperature, the better the silage and the lesser the colour of silage. If the temperature obtained for the present silages was above 30°C the grass silage would have become dark yellow or brown due to caramelization of sugars in the forage (McDonald et al., 1995). The pH of the silages in the present study is within the range of 4.20 to 4.75 and *Brachiaria decumbens* with yellow maize residue had the highest pH of 4.75.

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 that is, more acidic than the original forage. Kung and Shaver (2002) suggested that a good quality grass and legume silage-pH values in the tropics should range between 4.3 and 4.7. The pH value of silage obtained in this study ranged between (4.3 to 4.8) which is in agreement with pH of 4.2 -5.0 reported by Babayemi (2009).

Silage additives were used in order to enhance silage fermentation and their nutritional quality. They are classified according to their function as fermentation inhibitors, fermentation stimulant, deterioration inhibitors, nutrients and absorbents (McDonald et al., 1991). It was emphasized that additives can improve silage quality and minimize losses, but cannot compensate for poor silage making and management.

### Table 1: Colour, smell and texture of *Brachiaria decumbens* with different additives

| TREATMENT | COLOUR     | SMELL    | TEXTURE |
|-----------|------------|----------|---------|
| T1        | OLIVE GREEN| Very Pleasant | Very firm |
| T2        | OLIVE GREEN| Very Pleasant | Very firm |
| T3        | OLIVE GREEN| Very Pleasant | Very firm |
| T4        | OLIVE GREEN| Pleasant   | Very firm |
| T5        | OLIVE GREEN| Pleasant   | FIRM     |
The chemical composition of *Brachiaria decumbens* ensiled with different additives and 100% *Brachiaria decumbens* shows that DM ranges from (26.35 to 37.57%). Silage with DM content between 25-35% are considered to be good (Petterson, 1988). CP ranges from (7.30 to 10.00%) and was lower than 11–12% suggested by NRC (1985,2001) as adequate to meet requirements of growing sheep, and was below the level at which it could be considered deficient (Norton, 1994) This implies that the voluntary dry matter intake, as well as the rumen efficiency may be negatively affected as to reduce protein and energy availability to the animal. The CP content of the various silages studied were all above 8% CP required to satisfy maintenance requirement of ruminant animals (Norton, 2003) and above the minimum level necessary to provide sufficient nitrogen required by rumen microorganisms to support optimum activity (Mc Donald et al., 2002) and for adequate intake of forages. (Ranjhan, 2001) have shown that intake of forages is limited when their CP content is less than 10%. Voluntary feed intake also rapidly falls if CP content of forages is below 6.2% (Nasrullah et al., 2003). The optimum concentration level of rumen bacteria is reached at a CP level of 13.0% CP in the diet.

Ether extract ranges from (3.60 to 4.27%). Ether extract is the lipid fraction, which is a major form of...
energy storage in the plant. The energy derivable from the plant is what the animal uses for its body maintenance and production. The low EE in the present study connotes that the forage is low in energy and therefore, must be supplemented with high energy sources. The ash content represents the inorganic (mineral matter) content in a feed. Its value is mainly in the contents phosphorus, calcium, or potassium and large amounts of silica. Since ash content signifies the mineral levels, it then implies that when supplying this silage to ruminants, the diets may have to be fortified with mineral supplements.

NDF was lowest (60.75%) in T4 (Brachiaria decumbens ensiled with soyabean residue) but highest (71.44%) in T1 (silage with yellow maize residue). ADL was also lowest (15.05%) in T4 (Brachiaria decumbens ensiled with soyabean residue) but highest (20.70%) in T5 (100% Brachiaria decumbens). Cellulose of the silage ranges from 20.39 to 28.89 and T2 (Brachiaria decumbens ensiled with white maize residue) had the highest (28.89%) value while T3 (Brachiaria decumbens ensiled with Guinea corn residue has the lowest value. Hemicellulose value ranges from 20.26 to 27.48 and Brachiaria decumbens with guinea corn additives has the highest value while that of T2 has the lowest value. NDF and ADF concentrations of the forage were much higher than recommended values of 25% for ruminants (NRC, 2001). The neutral detergent fibre (NDF) was above the range of 24 – 61% and 17 – 61% documented for forages by Topps (1992) and Budi and Wina (1995) respectively. However, their concentrations were not too high to hinder intake and animal production (Meissner et al., 1991; Buxton, 1996). ADF or acid detergent fiber is correlated with the digestibility of a feed; the lower the ADF, the higher the digestibility. NDF or neutral detergent fiber is correlated with the level of dry matter intake by ruminant; the lower the NDF, the higher the level of intake. The NDF reported in this experiment was higher than results from Oduguwa et al. (2007), but ADF was in the range reported. Ensilage had average effect on the structural carbohydrate. Stage of Maturity is the major factor contributing to the variability in fibre content. The chemical composition of the silage suggests that any of the additives could be used but this will depend on the availability and cost of the additive. The difference between NDF and ADF is hemicellulose, which is degradable by rumen microbes. The higher the hemicellulose fraction, the higher is the feed value (Humphreys, 1991). High ADL can limit voluntary feed intake, digestibility and nutrient utilization

| Table 2: Chemical composition (%) of Brachiaria decumbens ensiled with different additives |
|-------------------------------|---|---|---|---|---|---|
| TREATMENT                      | T1  | T2  | T3  | T4  | T5  | SEM  |
| Dry Matter                     | 33.82<sup>c</sup> | 26.35<sup>d</sup> | 36.56<sup>b</sup> | 37.57<sup>a</sup> | 34.55<sup>c</sup> | 0.76  |
| Crude Protein                  | 8.25<sup>b</sup> | 10.00<sup>a</sup> | 8.25<sup>b</sup> | 7.94<sup>b</sup> | 7.30<sup>b</sup> | 0.29  |
| Crude Fibre                    | 27.72<sup>b</sup> | 25.52<sup>b</sup> | 28.40<sup>b</sup> | 30.28<sup>b</sup> | 26.05<sup>c</sup> | 0.28  |
| Ether Extract                  | 4.27<sup>a</sup> | 4.11<sup>a</sup> | 3.60<sup>b</sup> | 4.22<sup>a</sup> | 4.11<sup>a</sup> | 0.09  |
| ASH                            | 18.28<sup>bc</sup> | 17.27<sup>cd</sup> | 18.50<sup>b</sup> | 20.32<sup>c</sup> | 16.60<sup>d</sup> | 0.37  |
| NDF                            | 71.44<sup>a</sup> | 67.15<sup>b</sup> | 63.92<sup>c</sup> | 60.75<sup>d</sup> | 71.34<sup>a</sup> | 0.72  |
| ADL                            | 16.05<sup>d</sup> | 18.00<sup>c</sup> | 19.15<sup>b</sup> | 15.05<sup>c</sup> | 20.70<sup>a</sup> | 0.26  |
| ADF                            | 46.76<sup>z</sup> | 46.89<sup>a</sup> | 50.80<sup>a</sup> | 38.71<sup>b</sup> | 48.29<sup>b</sup> | 1.23  |
| CELLULOSE                      | 27.62<sup>a</sup> | 28.89<sup>a</sup> | 20.39<sup>c</sup> | 23.66<sup>b</sup> | 27.59<sup>a</sup> | 0.68  |
| HEMICELLULOSE                  | 24.68<sup>ab</sup> | 20.26<sup>c</sup> | 27.48<sup>a</sup> | 22.05<sup>bc</sup> | 23.05<sup>bc</sup> | 0.89  |
abc means with different subscript along row differ significantly (p<0.05). NDF(neutral detergent fibre), ADF(acid detergent fibre), ADL(acid detergent lignin), SEM(standard error of mean).

TD1:(90%Brachiaria+10%Yellow maize residue);
TD2:(90%Brachiaria+10%White maize residue)
TD3:(90%Brachiaria+10%Guinea corn residue);
TD4:(90%Brachiaria+10%Soyabean milk residue)
TD5:(100%Brachiaria)

Table 3 shows the gas production volumes (ml/200 mg samples) of the Brachiaria decumbens with additives. The cumulative gas produced ranged between 13.00 and 18.67 ml/200mg DM. Gas production was significantly (p<0.05) affected by the experimental treatments at all incubation intervals.

For gas volume and in vitro gas production characteristics, Menke et al. (1979) suggested that gas volume at 24h after incubation is an indirect relationship with metabolisable energy in feedstuffs.

Gas production can be regarded as an indicator of carbohydrates degradation and good parameter to predict digestibility, fermentation end product and microbial protein synthesis of the substrate, by rumen microbes in the in vitro system.

Thus, the gas volume can be considered a good reflection of substrate fermentation to VFAs and an estimate of potential digestibility in the rumen. It can also be said that when the amount of substrate is increased, a slight depression in the amount of gas will be produced by the silage. Therefore, the higher gas production observed for T2 and T5 suggested a higher nutrient digestibility of these silage compared T2, T3 and T4 This result nonetheless, could be a reflection of a higher proportion of carbohydrate available for fermentation (Getachew et al., 1999).

Since the utilization of forages is largely dependent on microbial degradation, the extent of degradation, GV, suggested that for T2 and T5 possessed more degradable and fermentable carbohydrates than T2, T3 and T4. The existence of the negative correlation between methane production and energy utilization implies that silage having a lower methane production would possibly indicate a better utilization of dietary energy from the species when fed to ruminants.

IN VITRO GAS PRODUCTION VOLUME OF BRACHIARIA DECUMBENS WITH DIFFERENT ADDITIVES

In-vitro gas production techniques, digestibility has been reported to be synonymous to in vitro gas production (Fievez et al 2005), so that the higher the gas production, the higher the digestibility. Fermentation characteristics are directly proportional to the volume of gas produced. Gas production after incubation ranges from 11.67 to 18.33 per 200ml of substrate. In-vitro gas method primarily measure digestion of soluble and insoluble carbohydrates (Menke and Steingass, 1988) and the amount of gas produce from a feed on incubation reflects production of VFA which are a major source of energy of ruminant. Gas arises directly from microbial degradation of feed and indirectly from buffering of acids generated as a result of fermentation.

Generally, gas production is a function and a mirror of degradable carbohydrate and therefore, the amount depends on the nature of the carbohydrates (Demeyer and Van Nevel, 1975; Blummel and Becker, 1997). The presence of FA in silages may also affect gas volume measurements in carbonate buffered in vitro measures, where about half of the gas volume is accounted for by CO2 released upon buffering SCFA (Blümmel and Ørskov, 1993). The fermentation is relatively intensive during the first 24 hours of incubation, after which it reaches a stationary phase. The kinetics of gas production appears to be determined by two distinct phases; the first one corresponds to the degradation of the soluble fraction of the tested mixtures and the second to the insoluble but potentially fermentable fraction. The same profile in the gas production kinetics between the 2 mixtures is probably due to their chemical composition.
GAS PRODUCTION OF *BRACHIARIA DECUMBENS* WITH DIFFERENT ADDITIVES

There are many factors that may determine the amount of gas to be produced depending on the nature and level of fibre, the secondary metabolites (Babayemi *et al.* 2004) and the potency of the rumen liquor for incubation (Babayemi, 2007); which are found applicable to the presence study. Therefore the high gas production recorded for T2 and T5 suggested a higher nutrient digestibility of the silages compared to others.

It is possible to attain potential gas production of a feedstuff if the donor animal from which rumen liquor for incubation was collected got the nutrient requirement met. This observation could be a reflection of a higher proportion of carbohydrate available for fermentation (Getachew *et al.* 1999). Generally, gas production is a function and a mirror of degradable carbohydrate and therefore, the amount depends on the nature of the carbohydrates (Beaker, 1996; Cone and Anthonie, 1998). Guinea grass is high in crude fibre and this may reduce its digestibility. Digestibility has been described to be synonymous to *in vitro* gas production (Fievez *et al.*, 2005). From the present study, the higher the gas production, the higher was the digestibility.

*Table 3: In-Vitro Gas Production Volume Of Brachiaria decumbens Ensiled With different Additives*

|          | 3HRS | 6HRS | 9HRS  | 12HRS | 15HRS | 18HRS | 21HRS | 24HRS |
|----------|------|------|-------|-------|-------|-------|-------|-------|
| T1       | 2.67 | 7.33 | 8.67b | 10.33b| 10.00b| 11.33ab| 11.67ab| 12.33  |
| T2       | 6.37 | 12.67a| 13.33a| 15.33a| 15.57a| 16.33a| 17.33a| 18.33  |
| T3       | 2.00 | 6.67b | 9.00b | 9.67b | 10.69b| 11.67ab| 12.00ab| 13.00  |
| T4       | 3.33 | 6.67b | 7.33b | 8.00b | 9.00b | 9.33b | 10.00b| 11.67  |
| T5       | 3.00 | 7.33a | 8.67b | 10.67b| 11.67b| 12.00b| 15.33ab| 16.33  |
| SEM      | 1.26 | 1.26 | 1.62  | 1.89  | 1.63  | 1.87  | 1.95  | 2.30   |

abc mean with different superscripts along the same column differ significantly (p<0.05). SEM: standard error of the mean; T1: (90%Brachiaria+10%Yellow maize residue); T2: (90%Brachiaria+10%White maize residue); T3: (90%Brachiaria+10%Guinea corn residue); T4: (90%Brachiaria+10%Soya bean residue) T5: (100%Brachiaria).

The methane gas (Table 8) of ensiled *Brachiaria decumbens* with different additives was not significantly affected. Methane gas was highest (11.50 ml/200mg DM) in T2 (*Brachiaria decumbens* with white maize residue) and lowest (7.50ml/200mg DM) was recorded from T3 (ensiled *Brachiaria decumbens* with guinea corn). In most cases feedstuffs that show high capacity for gas production are also observed to be synonymous for high methane production. Methane production indicates an energy loss to the ruminant and many tropical feedstuffs have been implicated to increase methanogenesis (Babayemi *et al.*, 2004a; Babayemi and Bamikole, 2006a; Babayemi and Bamikole, 2006b) as an integrated part of carbohydrate metabolism (Demeyer and Van Nevel, 1975). It is metabolic component of anaerobic fermentation in the rumen. It represents a significant energy loss to ruminant. Methane production in the rumen is an energetically wasteful process, since the portion of the animal’s feed, which is converted to CH4, is eructated as gas. It is an energy loss to ruminant and also has environmental implication on the greenhouse gas contributing to global warming (Johnson and Johnson, 1995). The end product of feed fermentation in ruminant is carbon(iv) oxide (CO2) and methane (CH4). Digestibility has been reported to be synonymous to *in vitro* gas production (Fievez *et al.*, 2005). Mostly the
portion of animal’s feed which are converted to CH4 is eructed as gas, therefore high methane production has a negative effect on ruminants (Yusuf et al., 2013).

Table 4: Methane production volume of ensiled Brachiaria decumbens with different additives

| Treatments | Methane |
|------------|---------|
| T1: (90%Brachiaria+10%Yellow maize residue); T2: (90%Brachiaria+10%White maize residue); T3: (90%Brachiaria+10%Guinea corn residue); T4: (90%Brachiaria+10%Soya bean residue); T5: (100%Brachiaria). SEM: Standard error of mean |
| T1         | 9.50    |
| T2         | 11.50   |
| T3         | 7.50    |
| T4         | 8.50    |
| T5         | 10.67   |
| SEM        | 1.35    |

The in-vitro gas production characteristics, soluble gas fraction, potential degradable fraction, potential gas production, and gas production rate constant, volume of gas production and time of incubation are shown in Table 5. Gas production (a+b) (ml/200mg DM) ranges from 11.67 to 18.33 ml/200mg DM among different silages. The highest (18.33ml/200mg) potential gas production (a+b) value was recorded T2 which is the potential degradable fraction. Gas production rate constant (h⁻¹) ranged from 0.07 in T2 to 0.13 in T5. The amount of gas released when the silages are incubated in vitro showed a close relationship to digestibility of feed for ruminants (Mebrerrahtu and Tenayo, 1997). Thus the gas volume can be considered a good reflection of substrate fermentation to VFAs and an estimate of potential digestibility in the rumen (Isah et al, 2012). The potential extent of gas production (a+b) expressed in ml showed that T2 recorded the highest. It implies that T2 were readily available in the rumen.

The rate of gas production (c) ranged from 0.07 to 0.13 h⁻¹. The fastest rate of gas production was observed in T5 (100% brachia decumbens), possibly influenced by the soluble carbohydrate fraction readily available to the microbial population. Slower rates were observed in T4 (Brachia decumbens ensiled with soy bean residue) indicating that these residues were less readily available to the microbes in the rumen. The b fraction represents the diet that potentially may escape rumen degradation but absorbed in the rumen. The low b value obtained is an indication of the fibrous nature of the feedstuffs incubated.

Table 5: Fermentation characteristics of Brachiaria decumbens ensiled with different additives

| Treatment | a | a+b | B | C | ‘t’ | Y |
|-----------|---|-----|---|---|-----|---|
| T1        | 2.67 | 12.33 | 9.67 | 0.11 | 6.00 | 7.33ᵇ |
| T2        | 6.33 | 18.33 | 12.00 | 0.13 | 6.00 | 12.67ᵃ |
| T3        | 2.00 | 13.00 | 11.00 | 0.09 | 6.00 | 6.67ᵇ |
| T4        | 3.33 | 11.67 | 8.33 | 0.09 | 7.00 | 7.00ᵇ |
| T5        | 3.00 | 16.33 | 13.33 | 0.07 | 6.00 | 7.33ᵇ |
| SEM       | 1.26 | 2.30 | 2.13 | 0.02 | 0.45 | 1.12 |

ᵃMeans different superscript in a column differ significantly (P<0.05) Y = Volume of gas produced, t = time of incubation, a = gas produced from the soluble fraction, b = gas produced from insoluble fraction, c = gas production rate for the insoluble fraction (b). a+b = potential degradable fraction. T1: (90%Brachiaria+10%Yellow maize residue); T2: (90%Brachiaria+10%White maize residue); T3: (90%Brachiaria+10%Guinea corn residue); T4: (90%Brachiaria+10%Soya bean residue); T5: (100%Brachiaria). SEM: Standard Error of Mean

The metabolizable Energy (MJ/Kg DM), Organic Matter digestibility (%) and Short chain Fatty Acids (µ mol) of the ensiled Brachia decumbens with
different additives (Table 6) had no significant differences in all the silages. The estimated ME (MJ/Kg DM) for the silages ranged from 4.33 MJ/Kg DM (T4) to 5.19 MJ/Kg DM (T5). The observed value in T2 and T5 were higher than the values estimated for energy feedstuffs (et al., 2007) reported a strong correlation between ME values measured in vivo and predicted from 24h in vitro gas production and chemical composition of feed. Krishnanmoorthy, et al., (1995) suggested that in vitro gas production techniques should be considered for estimating ME in tropical feedstuffs. Using the in vitro gas measurement and chemical composition in multiple regression equation (Sallam, 2005) found a high precision in prediction of in vivo OMD. This group further used a correlative approach to predict the ME content of feed by in vitro gas volume measurement and chemical constituents and concluded that the prediction of ME is more accurate when based on gas and chemical constituents only(Sallam,2005).

Brachiaria decumbens ensiled with white maize residue has the highest ME with (5.07MJ/Kg DM).

Variations observed in the organic matter digestibility (OMD) % were not significant. The highest (45.27%) was observed in T2 (Brachiaria decumbens ensiled with white maize residue) and the lowest (41.45%) value in T4. The values observed in T2 and T5 fod OMD implies that the microbes in the rumen of the animal have high nutrient uptake (Chumpawadee et al., 2007). The higher crude fibre content of T4 probably resulted in lower OMD, since high NDF and ADL contents in feedstuffs resulted in lower fibre degradation. (Van Soest 1994). The SCFA estimated from gas production were 0.35 (T1), 0.50 (T2), 0.37 (T3), 0.33 (T4) and 0.45 μMol (T5). There were no significant differences among the silages. The least SCFA observed in T4 (Brachiaria decumbens ensiled with white maize residue) had the highest level and highest estimated SCFA compared with other silages, suggests a potential to make energy available to the ruminants. Getachew, et al (2002) reported a close association between SCFA and gas production in vitro. SCFA is an indication of energy availability to the animal. Since T2 and T5 recorded higher values of SCFA, which indicate the more energy are likely to be available to the animal fed on those silages (Babayemi, 2007).

Table 6: Metabolizable Energy(MJ/Kg Dm), Organic Matter Digestibility (%) And Short Chain Fatty Acids(μmol) of Brachiaria decumbens Ensiled With Additives

| Treatment            | ME   | OMD  | SCFA |
|----------------------|------|------|------|
| (90%B D+10%YMR)      | 4.43 | 42.05| 0.35 |
| (90%BD+10%WMR)       | 5.19 | 45.27| 0.50 |
| (90%BD+10%G.CR)      | 4.52 | 42.19| 0.37 |
| (90%BD+10%SBR)       | 4.33 | 41.45| 0.33 |
| (100%BD)             | 5.07 | 45.14| 0.45 |
| SEM                  | 0.97 | 6.09 | 0.17 |

IV. CONCLUSION

It has been experimented that silage making is an important tool in preserving and storing forages for months or years and also helps to retain its nutritive value. Brachiaria decumbens ensiled with different additives indicated well preserved silage except that ensiled with soy bean residue. It is therefore
recommended that feeding ensiled Brachiaria with or without additives are of great use for ruminant animal could enhance productivity during dry season when there is scarcity of forages.

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