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# 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, 21and 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 2-3cm 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 ware later taken and mixed together for dry matter determination by oven drying at 65$^{o}$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 120ml calibrated syringes in three batches at 39$^{0}$C (Menke and Steingass, 1988). To 200mg sample in the syringe was added 30ml inoculum that contained cheese cloth strained rumen liquor and buffer (9.8g NaHCO3 + 2.77g Na2HPO4 + 0.57g KCL + 0.47g NaCL + 0.12g MgSO4. 7H20 + 0.16g CaCI2 . 2H20 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 24h. After 24 hours of incubation, 4ml of NaOH (10M) 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 $Y = a + b (1 – e^{ct})$ (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) : ME = 2.20 + 0.136*Gv + 0.057*CP + 0.0029*CF; OMD = 14.88+0.889Gv + 0.45CP + 0.651 XA; SCFA = 0.0239*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* a*l.,* 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, 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 $p^H$ 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

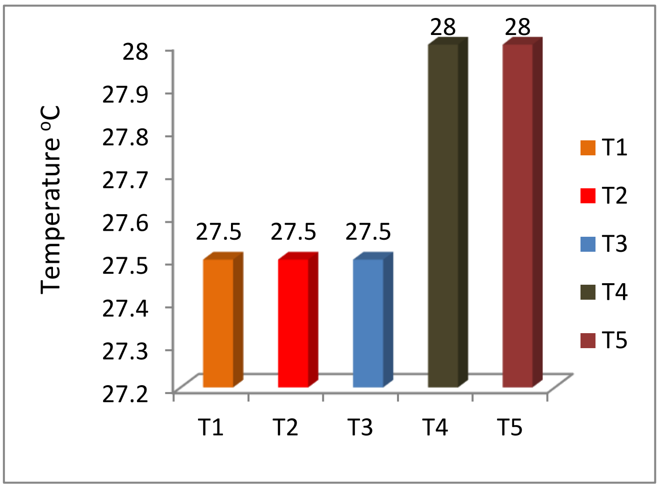
pH may be influenced by the moisture content and the buffering capacity of the original materials. Silage that has been properly fermented will have a much lower pH that is, more acidic than the original forage. Kung and Shaver (2002) suggested that a good quality grass and legume silage-pH values in 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 |

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*).

**Fig 2 :** TEMPERATURE OF BRACHIARIA DECUMBENS ENSILED WITH DIFFERENT ADDITIVES

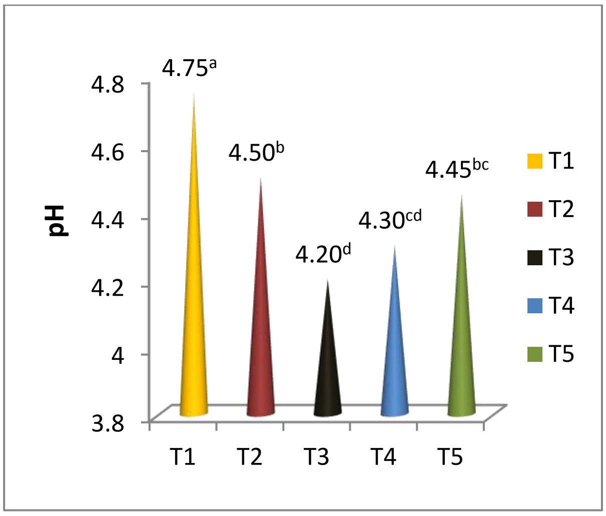



**Fig 2 :** pH OF ENSILED *Brachiaria decumbens* WITH DIFFERENT ADDITIVES

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%Soya bean residue*) TD5:(*100%Brachiaria*).

## CHEMICAL COMPOSITION OF *BRACHIARIA DECUMBENS* WITH DIFFERENT ADDITIVES

Table 2 below shows the chemical composition (g/kg DM) of the silages. The dry matter content of the silages ranges from 26.35 to 37.57%, the crude protein ranges from 7.30 to 10.00%, the ether extract ranged from 3.60 to 4.27%, the crude fibre ranged from 25.52 to 30.28%, the ash content ranges from 16.60 t0 18.50%, the NDF ranges from 60.75 to 71.44%, the ADL ranges from 15.05 to 20.70%, the ADF ranges from 38.71 to 189.80%. DM was lowest in T2 (*Brachiaria decumbens* ensiled with white residue (26.35%) but highest inT4 ( B*rachaiaria decumbens* ensiled with yellow maize residue(92.20%). CP was lowest (7.30%) in T5 (100% BD) and highest (10.00%). in T4 (B*rachaiaria decumbens* ensiled with white maize residue).

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. (Ranjhnan, 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 (B*rachaiaria decumbens* ensiled with soyabean residue) but highest(20.70%) in T5 ( 100%*brachaiaria 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[c] | 26.35[d] | 36.56[b] | 37.57[a] | 34.55[c] | 0.76 |
| Crude Protein | 8.25[b] | 10.00[a] | 8.25[b] | 7.94[b] | 7.30[b] | 0.29 |
| Crude Fibre | 27.72[b] | 25.52[c] | 28.40[b] | 30.28[a] | 26.05[c] | 0.28 |
| Ether Extract | 4.27[a] | 4.11[a] | 3.60[b] | 4.22[a] | 4.11[a] | 0.09 |
| **ASH** | 18.28[bc] | 17.27[cd] | 18.50[b] | 20.32[a] | 16.60[d] | 0.37 |
| **NDF** | 71.44[a] | 67.15[b] | 63.92[c] | 60.75[d] | 71.34[a] | 0.72 |
| **ADL** | 16.05[d] | 18.00[c] | 19.15[b] | 15.05[c] | 20.70[a] | 0.26 |
| **ADF** | 46.76z | 46.89[b] | 50.80[a] | 38.71[b] | 48.29[b] | 1.23 |
| **CELLULOSE** | 27.62[a] | 28.89[a] | 20.39[c] | 23.66[b] | 27.59[a] | 0.68 |
| **HEMICELLULOSE** | 24.68[ab] | 20.26[c] | 27.48 [a] | 22.05 [bc] | 23.05 [bc] | 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%Soyabeanmilkresidue*)
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 (Bl¨ummel 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$^{a}$ | 8.67$^{ab}$ | 10.33$^{b}$ | 10.00$^{b}$ | 11.33$^{ab}$ | 11.67$^{ab}$ | 12.33 |
| T2 | 6.37 | 12.67$^{a}$ | 13.33$^{a}$ | 15.33$^{a}$ | 15.57$^{a}$ | 16.33$^{a}$ | 17.33$^{a}$ | 18.33 |
| T3 | 2.00 | 6.67$^{b}$ | 9.00$^{ab}$ | 9.67$^{ab}$ | 10.69$^{ab}$ | 11.67$^{ab}$ | 12.00$^{ab}$ | 13.00 |
| T4 | 3.33 | 6.67$^{b}$ | 7.33$^{b}$ | 8.00$^{b}$ | 9.00$^{b}$ | 9.33$^{b}$ | 10.00$^{b}$ | 11.67 |
| T5 | 3.00 | 7.33$^{a}$ | 8.67$^{ab}$ | 10.67$^{b}$ | 11.67$^{b}$ | 12.00$^{ab}$ | 15.33$^{ab}$ | 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$CH_4$, 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 ($CO_2$) and methane ($CH_4$). 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 | 9.50 |
| T2 | 11.50 |
| T3 | 7.50 |
| T4 | 8.50 |
| T5 | 10.67 |
| SEM | 1.35 |

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 *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 (Mebrrahtu 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% *bracharia decumbens)*, possibly influenced by the soluble carbohydrate fraction readily available to the microbial population. Slower rates were observed in T4 *(Bracharia 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 | 7.33[b] |
| T2 | 6.33 | 18.33 | 12.00 | 0.13 | 6.00 | 12.67[a] |
| T3 | 2.00 | 13.00 | 11.00 | 0.09 | 6.00 | 6.67[b] |
| T4 | 3.33 | 11.67 | 8.33 | 0.09 | 7.00 | 7.00[b] |
| T5 | 3.00 | 16.33 | 13.33 | 0.07 | 6.00 | 7.33[b] |
| SEM | 1.26 | 2.30 | 2.13 | 0.02 | 0.45 | 1.12 |

[ab]Means 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 B*rachairia 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 *e.t al.,* 2007). The higher crude fibre content of T4 peobably 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 soy bean residue) was due to a lower gas production which was evident in the first 24h of incubation (Blummel, and. Orskov,1993). Since SCFA is based on carbohydrate fermentation, T5 (100%*Brachiaria decumbens*) and T2 (*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 |

ME:Metabolizable Energy, OMD:Organic Matter digestibility SCFA: Short chain Fatty Acids (micro mole) of the brachairia *decumbens* 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 milk residue*)T5:(*100%Brachiaria*)SEM: Standard Error of Mean

## 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.

## V. REFERENCES


[1]. AOAC. (2005). Official Methods of Analysis. AOAC International. 18th ed. Assoc. Off. Anal. Chem, Airlington, USA

[2]. ARC (1980). The nutrient requirement of ruminant livestock. CAB Farnham Royal, U.K.

[3]. Budi, T. and E. Wina, (1995). Chemical evaluation of shrub legumes. Indonesia Ag. Res. Diet. J., 17: 147-158

[4]. Bolsen, K.K.,. Ashbell G. Weinberg, Z.G (1996). Silage fermentation and sillage additives.Rev. Asian-Aust. Journal. Animal. Science. 9: 483-493.

[5]. Babayemi, O. J. and Bamikole, M. A. (2006a). Supplementary value of Tephrosia bracteolata, Tephrosia candida, Leucaena leucocephala and Gliricidia sepium hay for West African dwarf goats kept on range. Journal of Central European Agriculture 7 (2): 323-328

[6]. Babayemi, O.J., Bamikole, M. A. (2006b). Effects of Tephrosia candida DC leaf and its mixtures with Guinea grass on in vitro fermentation changes as feed for ruminants in Nigeria. Pakistan J. Nutr. 5 (1):14- 18

[7]. Babayemi, O.J., Bamikole, M.A., Daniel, I.O., Ogungbesan, A. and Babatunde, A. (2003). Growth, nutritive value and dry matter degradability of three tephrosia species. Nigerian Journal of Animal Production 30 (1): 62 - 70.

[8]. Babayemi, O. J., Demeyer, D. and Fievez, V. (2004) Nutritive value and qualitative assessment of secondary compounds in seeds of eight tropical browse, shrub and pulse legumes. Communications in Agricultural and Applied Biological Sciences, Ghent University 69 [1]: 103- 110

[9]. Babayemi, O.J. (2007). In-vitro fermentation characteristic and acceptability by West Africa Dwarf goat of some dry season forages. Afri. J. Biotech., 6(10):1260-1265.

[10]. Babayemi, O.J. (2009). Silage quality, dry matter intake and digestibility by WAD sheep fo guinea grass (Panicum Maximum CV Ntchisi) harvested at 4 and 12week regrowths. African Journal of biotechnology Vol. 8 (16), pp. 3983-3988.

[11]. Babayemi, O.J., Igbekoyi, J.A., (2008). In Eric Tielkes (ed). Competition for resources in a changing world: New drive for rural development. Conference of the International Research on Food Security, Natural Resource Management and Rural Development, Tropentag

[12]. Bamikole, M.A., Ikhatua, U.J. Ajulo M.T.. Osuji, A.C (2004). Feed utillisation potential of west African dwarf goats fed different proportions of Ficus thonningii and Panicum maximum. Proceedings of the 29th Annual conference of Nigeria society of Animal Production, Vol., 29, pp: 336 -340.

[13]. Becker, K. (1996). Studies on utilization of Moringa oleifera leaves as animal feed. Institute for Animal production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, 480:1.

[14]. Blummel, M. and Ørskov, E. R. (1993). Comparison of in vitro gas production and nylon bag degradability of roughages in predicting feed intake in cattle. Anim. Feed Sci. Technol. 40:109 - 119.

[15]. Blummel, B and Becker, K. (1997). The digestibility characteristics of Fifty-Four roughages and Roughages Neutral Detergent Fiber as described in In Vitro Gas Production and their Relationship to voluntary Feed Intake. Britian. Journal Nutrition, 77:757-768

[16]. Broderick, G. A. (1995). Desirable characteristics of forage legumes for improving

protein utilization in ruminants. J. Anim. Sci. 73:2760-2773.

[17]. Buxton, D.R., (1996). Quality-related characteristics of forages as influenced by plant environment and agronomic factors. Anim. Feed Sci. Technol., 59: 37-49

[18]. Cheeke, P.R(1995). Endogenous toxins and mycotoxins in forage grasses and their effects on livestock. Journal on. Animinal. Science., 73, 909-918.

[19]. Chumpawadee, S. ; Chantiratikul, A. ; Chantiratikul, P., (2007). Chemical compositions and nutritional evaluation of energy feeds for ruminants using an in vitro gas production technique. Pak. J. Nutr., 6 (6): 607-612 http://www.pjbs.org/pjnonline/ab749.htm

[20]. Chung, E.L.T. Michael, P. Nobilly, F., Samsudin, A.A. Firdaus, F. and Loh, T. (2018) Can treatment of Brachiaria decumbens improve its utilization in the diets of small ruminants? - a Review. Animal Health and Production . https://doi.org/10.1007/S11250-018--1641-4

[21]. Cone, J.W., Anthonie, H.G. (1998).Influence of protein fermentation on gas production profiles. Animal Feed Science and Technology 76:251 - 264

[22]. Cook B.G., Pengelly B.C., Brown S.D., Donnelly J.L., Eagle D.A., Franco M.A., Hanson J., Mullen B.F., Partridge I.J., Peters M., Schultze-Kraft R.(2005). Tropical forages. CSIRO, DPI and F(QID), CIAT and ILRI, Brisbane, Australia

[23]. Costa, K.A.P, Asis, R.L., Guimaraes, K.C., Sevearino , E.C., Assis-Neto, J.M., Crunivel, W.S, Garcia,J.F. and

[24]. Santos, N.F. (2011) Quality of Brachiara brizantha cultivars ensiled with different levels of millet meal. Arquivo Brasiliero Med. Vet. Zoote. Vol 63 no 1. https://dx.doi.org/10.1590/S0102-09352011000100028

[25]. Crutzen, P.J., (1995). The role of methane in atmospheric chemistry and climate. In: von Engelhardt,W., Leonhard- Marek, S., Breves, G., Giesecke, D.E. (Eds.), Ruminant Physiology: Digestion, Metabolism, Growth and Reproduction. Proceedings of the 8th International Symposium on Ruminant Physiology, Stuttgart, Germany,pp. 291-315.

[26]. Demeyer, D. I. and Van Nevel, C. I. (1975). Methanogenesis, an integrated part of carbohydrate fermentation and its control. In digestion and metabolism in the ruminant (LW McDonald and A.C.I. Warner,eds) pp. 366-382. The University of New England Publishing Unit, Armidale, N.S.W., Australia.

[27]. Fievez, V. Babayemi, O.J , Demeyer. D. (2005). Estimation of direct and indirect gas production in syringes: a tool to estimate short chain fatty acid production requiring minimal laboratory facilities. Animal Feed Science. Technology.(123-124):197 -210

[28]. Flavia, G., Stephen, T.L., James, A.P., Eliane, S.M., Gustavo, L.C., Roberta, D. and Maria, C.S.F. (2016) The effect of ensiling and hay making on the concentrations of steroidal saponin in two Brachiaria grass species. Ciencia Rural. Vol. 45, no 5, Santa Maria. http://dx.doi.org/12.1590/01038478cr20141305

[29]. Getachew, G.H., P.S. Makkar and K. Becker, (1999). Stoichiometric relationship between short chain fatty acid and in vitro gas production in presence and absence of polyethylene glycol for tannin containing browses, EAAP Satellite Symposium, Gas production: fermentation kinetics for feed evaluation and to assess microbial activity, 18-19 August, Wageningen, The Netherlands.

[30]. Getachew, G., G.M. Grovetto, M. Fondivilla G., G.M. Grovetto, M. Fondivilla B. Krishnamoorthy, H. Singh,

[31]. Sphaghero P.H. Steingass, P.H. Robinson and M.M. Kailas,(2002). Laboratory Variation of 24h in vitro gas, production and estimated metabolizable energy values of ruminant feeds. Animal. Feed Science Technology. 102: 169-180.

[32]. Hasiah, A. H., Elsheikh, H.A., Abdullah, A.S.A.L.A.M, Khairi, H.M. and Rajion, M.A. (2000) Effect of phenobarbitone treatment against signal grass (Brachiaria decumbens) toxicity in sheep. The Veterinary Journal. Vol 160, Issue 3. Pg 267 - 272. https://doi.org/10.1053/tvj.2000.0498

[33]. Henderson. N. (1993). Silage additives. Animal Feed Science Technology.,45: 35-56

[34]. Humphreys, L. R., (1991). Tropical pasture utilisation. Cambridge University Press. Cambridge http://books.google.fr/books?hl=fr&lr=&id=hdKkU_4Y8QwC

[35]. Isah, O.A.,P.O. Fayemi, M.B. Gazaly, and R.Y. Aderinboye. (2012). "Nutritional Characteristics of Four Browse Plants Consumed by Free-Ranging Ruminants in Western Part of Nigeria". African Journal of Agricultural Research. 7(12):1944- 1949. http://www.academicjournals.org/AJA

[36]. Johnson, K.A., Johnson, D.E.,(1995). Methane Emissions from cattle. J. Anim. Sci. 73, 2483-2492.

[37]. Krishnamoorthy, U., Soller, H., Steingass, H.and Menke, K. H. (1995). Energy and protein evaluation of tropical feedstuffs for whole tract and ruminal digestion by chemical analysis and rumen inoculums studies in vitro. Anim. Feed Sci. Technol. 52: 177-188.

[38]. Kung, L. and. Shaver, R (2002). Interpretation and use of silage fermentation analyses reports. Dept. of animal and food science, University of Delaware Newark, DE 19717

[39]. Leng, R. A. (1993) Quantitative ruminant nutrition - a green science. Aust J. Agric. Sci. 44, 363-380.

[40]. Mahanna, W. C. (1993) Troubleshooting Silage Problems. 4-State Applied Nutrition Conference, June 29-30.

[41]. Man and Wilktosson H,(2001) Cassava tops ensiled with or without molasses as additives effect on quality feed intake and digestibility by heifers. Asian -Aust. J. Animal Science vol.14, No 5:624-630

[42]. Maijala, K. (1997), Genetic aspect of domestication, Common breeds and their origin In: piper, L and A Rvvinsky(eds).The genetic of sheep.CA

[43]. Mebrahtu O, Tenaye SB (1997). Analytical methods for Feeds Animal Excrements and Animal Tissues. International

[44]. Livestock Research Institute (ILRI) Nutrition Laboratory ILRI-Ethiopia, Addis Ababa, Ethiopia. Pp. 38 - 40

[45]. McDonald.P.,Henderson, A.R. and Heron, S.J.E.(1991).The Biochemistry of silage, 2nd ed. Chalcombe Publication, U.K. pp 9-19, 167-183

[46]. Mcdonald,P.R.A.,Edwards J.F.D., Greenhalgh and Morgan C.A (1995). Longman scientific and Technical, John Willey and Sons,Inc.New yolk.pp 28 -312

[47]. McDonald, P.; Edwards, R. A.; Greenhalgh, J. F. D., (2002). Animal Nutrition. 6th Edition. Longman, London and New York. 543 . http://books.google.fr/books?id=jxUXns9laAEC

[48]. Meissner, H.H., Viljoen, M.D and Van Nierkeki, W.A. (1991). Intake and digestibility by sheep of Anthephora, Panicum, Rhode and Smuts finger grass pastures: Proceeding of the IVth International Rangeland Congress, September1991. Montipellier, France, pp 648-649

[49]. Miles, J.W., Maass, B.L., do Valle, C.B., ( 1996) Brachiaria: Biology, Agronomy and Improvement; Eds.; CIAT: Cali, Colombia pp. 247-257

[50]. Menke, K.H., Raab, L., Salewski, A., Steingass, H., Fritz, D., Schneider, W. (1979). The estimation of the digestibility and metabolisable energy content of ruminant feedingstuffs from the gas production when they are incubated with rumen liquor. Journal Agricultural Science (Camb.) 93, 217-222.

[51]. Menke, K.H. and Steingass, H. (1988). Estimation of the energetic feed value from

obtained from chemical analysis and in vitro gas production using rumen fluid. Anim. Res. Dev., 28: 7-55.

[52]. Muck, R.E., (1996). Silage inoculation: In Inoculation of Silage and Its Effect on Silage quality, US, Dairy Forage Research Centre, International Conference With Dairy and Forage Industries, pp: 43-51.

[53]. Nasrullah, M Niimi, R Akashi and O Kawamura. (2003). Nuritive evalution of forage plants grown in South Sulawesi ,Indonesia. Asian-Aust. J. Anim. Sci. 16(5):693-701

[54]. Ndikumana, J.; de Leeuw, P.N.( 1996) Regional experience with Brachiaria: Sub-Saharan Africa. In Brachiaria: Biology, Agronomy and Improvement; Miles, J.W., Maass, B.L., do Valle, C.B., Eds.; CIAT: Cali, Colombia, 1996; pp. 247-257

[55]. NRC( 1985). National Research Council. Nutrition Requirements for Sheep Sixth Revised Edition. National Academy Press, Washington, DC.

[56]. NRC (2001): Nutrient Requirements of Dairy Cattle, 7th rev. ed. National Research Council, Washington, D.C., National Academy Press

[57]. Norton, B.W., (1994). The nutritive value of tree legumes. In: Forage tree legumes in Tropical Agriculture, Gutteridge, R.C., and Shelton, H.M. (Eds.) CAB International, UK, Pp. 177-191.

[58]. Oduguwa, B.O., A.O. Jolaosho and M.T. Ayankoso, (2007). Effect of ensiled on physical properties, chemical composition and mineral contents of guinea grass and cassava tops silage. Nigeria Journal of Animal Production. 34:100-106.

[59]. Opasina, B. A. (1996) Photosensitization jaundice syndrome in West African Dwarf sheep and goats grazed on Brachiaria decumbens. Tropical Grassland. 30: 155

[60]. Ortega-Gomez, R., Castillo-Gallegos, E., Jarillo-Rodriguez, J., Escobar-Hemandez, R., Ocana-Zavaleta, E. and Valles de la Mora, B. 2011. Nutritive quality of ten grasses during the rainy season in a hot humid climate and ultisol soil. Tropical and Subtropical Agro-Ecosystems. Vol. 13 no 3. Pp 481-491

[61]. Ørskov, E. R. and McDonald, I. (1979). The estimation of protein degradability in rumen from incubation measurements according to rate of passage. J. Agric.Sci. Camb., 92: 449-503.

[62]. Ranjhnan, S.K. (2001). Animal nutrition in the tropics (5th revised eds). Vikas Publishing House (PVT) Ltd. Pg. 89-96.

[63]. Rika, I.K. (1990). New forage species for coconut plantations in Bali. In Forages for Plantation Crops; ACIAR: Sanur Beach, Bali,.

[64]. Sallam, S.M.A., Bueno, I.C.S, Brigide, P., Godoy, P.B., Vitti, D.M. and Abdalla, A.L. (2009): Efficacy of eucalyptus oil on in vitro rumen fermentation and methane production. Options Mediterr., 85: 267-272.

[65]. SAS (2002). User's Guide. Statistical Analysis Institute Inc. Cary, NC.

[66]. Steingass H and K.H. Menke, (1986). Schatzung des energetischen Futterwertes aus der in vitro pansensaft bestimmten Gasbildung und der chemischen analysis. Tirerenahrung, 14:251.

[67]. Susan, G.L. (2015) Signal grass (Brachiaria decumbens) toxicity in grazing ruminants. Agriculture, 971- 990. Doi:10.3390/agriculture50404971.

[68]. Topps, J.H., (1992). Potential composition and use of legumes shrubs and trees as fodder for livestock in the tropics. J. Agri. Sci. Camb., 118: 1-8.

[69]. Van Soest, P.J., Robertson, J. B. and Lewis, B.A. (1991). Methods for dietry fiber, neutral detergent fiber and non-strach polysaccharides in relation to animal nutrition. Journal of Dairy Science. 74: 3583-3597.

[70]. Van Soest, P.J. 1994. Nutritional Ecology of Ruminants, 2nd edn. Cornell University Press, 476pp

[71]. Woolford, M. K (1990) .The detrimental effect of air on silage. Journal applied .Bacteriol. 68:101-106.

[72]. Wasinghe, D.D., Balasuriya, B.R.U., Horadagouda, N.U. 1987. A preliminary report on investigation into jaundice and photosensitization among goats and sheep. Sri Lanka Veterinary Journal, . 33:44-55.

[73]. Yusuf, K.O., Isah O.A., Arigbede, O.M., Oni, A. O and Onwuka , C.F.I (2013). Chemical composition, secondary metabolite, in vitro gas production characteristics and acceptability study of some forage for ruminant feeding in South -Westhern Nigeria. Nigeria Journal Animal. Production.40(1):179-190.

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