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Applying *In vitro* gas production technique to assess the nutritive value of *Gmelina arborea l*eaves as ruminant feed

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Abstract

In vitro gas fermentation method was used to evaluate the nutritive value of different forms of *Gmelina arborea* leaves. Two experiments were conducted. Experiment 1 involved the determination of chemical composition of green, yellow and brown leaves. In experiment 2 , the nutritive value of green, yellow and brown leaves of *Gmelina arborea* was assessed by in vitro gas production technique for total gas production over a period of 24 hr and to predict organic matter digestibility (OMD), metabolizable energy (ME) and short chain fatty acid (SCFA). Methane volume (CH_4) was measures after incubation at 24 hr. The in vitro gas production characteristics soluble degradable fraction (a), (insoluble degradable fraction (b), potential degradability (a+b) and rate of degradation (c) were also predicted.

Results revealed that the chemical composition of green, yellow and brown leaf varied significantly ($p<0.05$). Dry matter ranged from 80.15 to 91.24 % in green and brown leaf respectively. Same trend was observed for neutral detergent fibre, it ranged from 60.92 to 63.77%. The crude protein ranged from 24.84 to 26.44% in brown and green leaves respectively. The IVGP, ME, SCFA and methane production were not significant ($p>0.05$), except OMD. Same trend was observed for all the *in vitro* characteristics with the green leaf recording the highest value, while the lowest values were obtained in the brown leaf. They ranged between 3.75 and 5.25 ml/200mg DM; 3.27 and 3.49 MJ/Kg DM; 0.10 and 0.94 μmol; 1.5 and 3.0 ml/200mg DM in yellow and green leaf respectively. OMD ranged significantly from 41.57 to 45.05 % in yellow and green leaf respectively. The b, a+b and c also did not vary significantly.

It can be concluded that *Gmeilna arborea* leaf has potential in ruminant nutrition and any of the forms can serve as fodder in the tropics.

Key words: *Gmeilna arborea* leaves*, in vitro* gas production, nutritive value, ruminant feed

Introduction

The attainment of sustainable livestock production largely depends on the availability, quality and quantity of feed. Seasonal fluctuations and scarcity of forage in Nigeria is the major factor limiting the productivity of ruminants as animals rapidly loss weight gained during the lush season which may lead to death, thus resulting in a great economic loss to farmers

(Babayemi *et al*., 2003). Various efforts are being made by researchers in resolving these adverse effects. This has called for identifying feed resources that are non conventional and is under-utilized as fodder for ruminants. *Gmelina arborea* is a cheap non-conventional feed resource for ruminants in Nigeria (Amata, 2014). It is a fast growing deciduous Multi-Purpose plant of high nutritive value reaching up to 40 m tall and 140 cm in diameter and grows in climates with mean annual rainfall temperatures of 21-28^{0}C (2). The leaves are very high in protein and it a suitable source of energy (Amata and Lebari, 2011). The leaves are available all year round ensuring availability of feed to animals during the dry season (Amata, 2014). The *in vitro* gas production technique has over the tears proven to be the most reliable simple efficient way of evaluating fodder trees and shrubs for their potential in the animal industry (Theodorou *et al*., 1994).

The objective of this study is to evaluate the nutritive potential in three different forms of *Gmelina arborea* leaves as feed supplements for ruminants using *in vitro* gas production technique.

Materials and Method

Collection of samples

Ten matured *Gmelina arborea* trees were randomly selected and marked from the environment of University of Ibadan. Green and yellow leaves are plucked randomly from the selected *Gmelina arborea* trees, while the brown leaves were picked from the floor around the root of the plants. Reasonable numbers of each leaf type were collected and taken to the laboratory for analysis.

In vitro gas production

Rumen fluid was obtained from three West African Dwarf female goats through sunction tube before the morning feed. The animals were fed concentrate consisting of 40% corn bran, 35% wheat offal, 20% palm kernel cake, 4% oyster shell, 0.5% salt and 0.5% growers premix for three days prior to the collection of rumen liquor. Incubation was as reported (Menke and Steingass 1988) using 120 ml calibrated syringes in three batch incubation at 39 ^{0}C. 30 ml inoculums was introduced into 200 mg samples in the syringes containing cheese cloth strained rumen liquor and buffer ($NaHC0_3$ + Na_2HP0_4 + KCl + NaCl + $MgS0_{4.}7H_20$ + $CaCl_{2.}$ $2H_20$) (1:2, v/v) under continuous flushing with $C0_2$

The gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24, after 24h of incubation, 4 ml of NaOH (10 M) was introduced to estimate the amount of methane produced. The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample. The volume of gas produced at intervals was plotted against the incubation time, and from the graph, the gas production characteristics were estimated using the equation $Y= a+b(1-e^{-ct})$ described by Orskov and McDonald (1979) where:

Y= volume of gas produced at time ‘t’, a = intercept (gas produced from insoluble fraction), c = gas production rate constant for the insoluble fraction (b), t = incubation time, metabolizable energy (ME, MJ /Kg DM) and organic matter digestibility (OMD, %) were estimated as established (Menke and Steingass 1988) and short chain fatty acids (SCFA, *u*mol) was calculated as reported (Getachew *et al*, 1999)

- $ME = 2.20 + 0.136^{*}GV + 0.057^{*}CP + 0.0029^{*}CF$
- $OMD = 14.88 + 0.889GV + 0.45CP + 0.651XA$
- $SCFA = 0.0239^{*}GV – 0.0601$
- Where GV, CP, CF and XA are net gas productions (ml /200 mg DM), crude protein, crude fibre and ash of the incubated samples respectively.

Statistical analysis

Data obtained were analyzed and subjected to analysis of variance procedure (ANOVA) of SAS (2012). Significant treatment means were separated by Duncan's multiple range test of the same package.

Results and Discussion

Table 1 presents the *in vitro* gas parameters for the green, yellow and brown leaf of GA. Although gas production is a nutritionally wasteful product (Mauricco *et al*., 1999) but provides a useful basis form which Metabolizale Energy (ME), Organic Matter Digestibility (OMD) and SCFA may be predicted. The organic matter digestibility ranged significantly ($p<0.05$) from 41.47 to 45.05 % in brown and green leaf respectively The result of OMD in this present was generally low when compared to values reported elsewhere (Babayemi, 2007), but compared well with values (40.15%) reported for *Ficus polita* (Mako et al., 2012). The metabolizable energy (ME) was similar for all forms of GA leaf. This means that ruminants can obtain energy from any of the different form of GA leaf. The value range (3.27 to 3.49 MJ/Kg DM) in brown and green leaf respectively obtained for ME in the present study were lower than those obtained for some tropical browse plants which ranged from 8.31 to 11.88 MJ/Kg DM (Babayemi, 2007). Browse plants are generally high in DM and CP which are important factors for high degradability in the rumen by micro-organisms. A highly degradable feed stuff have been known to be enhanced in high ME (Babayemi *et al*., 2006). However, the ME values obtained here was in line with those obtained for some browse plants (4 – 6 MJ/kg DM) by Omoniyi *et al*., (2013). Similar trend was observed for SCFA, the values obtained for SCFA in this study compared well with the values reported for some dry season forages (Mako *et al*., 2012).

Table 1: *In vitro* gas production parameters of different forms of *Gmeilna arborea* leaves

	In vitro gas production parameters			
Leaves	ME	SCFA	OMD	TIVGP
Green	3.49	0.94	45.05^{a}	5.25^{a}
Yellow	3.28	0.13	42.18^{b}	4.33^{b}
Brown	3.27	0.10	41.57^{b}	3.75^{c}
SEM	0.11	0.04	0.53	0.17

The rate and extent of gas production can be considered a good indicator of the digestibility and fermentability of feeds and microbial protein synthesis (Elghandour et al. 2015a). Significant differences ($p<0.05$) were observed for all the parts from 3 to 24 hr incubation period. The net volume of gas produced increased progressively and significantly ($p<0.05$) with hour of incubation. Total gas produced ranged from 3.75 to 5.25 ml/ 200 mg DM in brown and green leaf respectively. Gas production is an indication of degradability of samples (Arifuddin *et al.*, 2017). The degradation observed in the samples is an indication that GA leaf can be used as feed supplement for ruminants

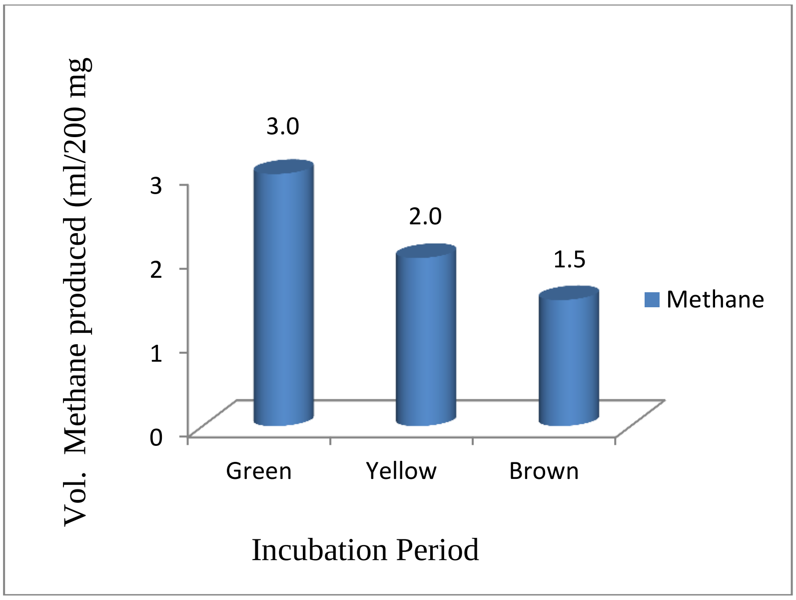

Fig 1: Methane production (ml/200 mg DM) of *Gmelina arborea* leaf

Presented in Fig 1 is the methane production from the different leaf form of GA. Significant variation was observed among the leaf forms. It ranged from 1.5 to 3ml/200 mg DM in brown and green leaf respectively. In most cases feedstuffs that show high capacity for gas production are also observed to be synonymous for high methane production, this could be attributed to the high methane production obtained for green leaf. Methane production indicates an energy loss to the ruminant and many tropical feedstuffs have been implicated to increase methanogenesis (Babayemi and Bamikole, 2006b) as an integrated part of carbohydrate metabolism (Demeyer and Van Nevel 1975).

Conclusions and Outlook

In vitro gas production is an indication of feedstuff degradability. Gas production parameters revealed that *Gmelina arborea* leaf has potential as feed supplement in the tropics. this research should proceed to feed *Gmelina arborea* leaf to different ruminant animals

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