DETERMINE *IN-VITRO* GAS (METHENE GAS) PRODUCTION ON SOME SELECTED PLANT SPECIES IN GUINEA SAVANNA, AGRO-ECOLOGICAL ZONE OF NORTH-CENTRAL NIGERIA

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Abstract
This study determines in-vitro gas production of 13 plant species potential of fodder crops used by livestock farmers in the guinea savanna, Agro-ecological zone of North-central Nigeria. Leaf samples from each of these fodder plants were harvested at the vegetative stage from mature plants around Jos, Lafia and Abuja vicinity: five multi-purpose trees; (leucaena leucocaphala, gmelina arborea, daniella olioverii, mangifera indica, acacia albida), four tropical browse crops; (arachis hypogea, manihot spp, vigna spp, zea mays), and four grasses;(digitaria exillis, sorghum bicolor, panicum maximum, and andropogon gayanus). The gas production profiles of the selected browse plant foliage were significant ($p<0.05$). The lowest volume (6.67ml/200mgDM) of gas produced was observed in Digitaria exillis and Andropogon gayanus at the 3-hour incubation periods while the highest volume (124.67ml/200mgDM) of gas produced during incubation were recorded in Arachis hypogea at the 48hr incubation time. Most gas were produced between 3 hours of incubation to 42 hours of incubation. It is therefore recommended that crop residues and multi-purpose trees foliage among the fodder crops should be used as feed supplements to feed ruminant in time of shortage of other feed resources like grasses because of its availability at this time.

Keywords: In-vitro gas, Plant species, Agro-Ecological Zone, North-Central, Nigeria

Background to the Study

Ruminant- animals have a four-compartment stomach. The rumen is the largest compartment, where millions of bacteria grow under anaerobic (low-oxygen) conditions. These bacteria are responsible for the digestion of fiber and are the reason why ruminants can consume a wide variety of by-product feedstuffs derived from the processing of plants for human food. Nigeria livestock industries utilize the majority of these highly fibrous by-products by including them in feeds (De-peter et al., 2003). Composition of feed given to animals has a very significant influence on animal performance such as milk production quality as well as growth performance (Meat production). The nutritive value, or energy content, of an animal feed is determined predominately by its digestibility, which affects intake, or how much the animal will eat. Digestibility and intake, in turn, determine the feed's productive performance, such as support to milk synthesis or muscle growth. However, studies with live animals (in-vivo) to determine the digestibility of feeds are time wasting, difficult, luxurious and require great numbers of fodder (Getachew et al., 2000). Such experiments are not suited for the rapid and routine feed evaluations undertaken by commercial laboratories that provide feed information to livestock producers and feed manufacturers. The digestibility of forages can also be projected by biological techniques known as in-vitro techniques, which are conducted outside of the animal system but simulate the digestion process. Generally, in-vitro techniques are those based on measuring either fermentation residues or products. The former measures the unfermented residue remaining after in-vitro incubation of a feed with rumen fluid. This approach involves collecting fluid by hand from the rumen of a ruminant that has been fitted with a rumen fistular. This method for forage evaluation was first reported in 1963, using ruminal fluid obtained from a goat with a rumen fistular (Getachew et al., 2000).

Browse plants, beside grasses, constitute one of the cheapest sources of feed for ruminants. The diversity and distribution of browse plants in Nigeria have received early attention in studies carried out for the north-east and north- west (Saleem et al., 1979), southwest (Carew et al., 1980) and southeast (Ibeawuchi et al., 2002) Nigeria. Available information on browse plants of north-central Nigeria is scanty (Mecha and Adegbola, 1985) and mostly unpublished. The result of an informal survey by Okoli et al., (2003) in this region contradicted the reports of Reynolds and Atta-Krah (1987) that respectively identified 35, 30 and 27 browse plants for the entire North-central region. Their report (Okoli et al., 2003) indicated that there were much more browse resources in the region than the few highlighted by the preliminary studies.

Through the help of animal keepers in a farmer-researcher combined survey, these investigators uncovered well over 160 browse plants found within the north-central ecological niche. Some of these plants however, were not common to all the sites understudied. Information on the distribution and diversity of browse plants in north-central states of Nigeria is also lacking (Alhamefule et al., 2006).

A detailed study of the browse plants found within North-central is essential to generate baseline data and to determine the potential browse resource within the major ecological frontiers of the states in the north-central states. The potential yield of browse would provide useful tool for the determination of stocking rate and indeed the carrying capacity of a range or land under grazing. Browse plants deliver vitamins and frequently mineral rudiments, which are mostly absent in savannah pasture. Their year-round evergreen presentation and nutritional abundance provides for year-round provision of fodder (Oji and Isilebo, 2000). It also enables standing feed reserve to be built so that herds can survive critical periods of shortfall, or even prolonged periods of drought, without remarkable losses (Odoh and Adamu-Noma, 2000). Deforestation, urbanization and bush burning are some of the major factors responsible for dwindling proceeds of browse feed resource for ruminant livestock. Conservatory methods however, would ensure that locally adapted and well-established species do not become extinct. North-central states are a major grazing route and access way from north to southern states, for the Hausa-Fulani herdsmen who crisscross the nation with their ruminants in search of fodder. It is also the grazing habitat for Faculty of Agriculture Nasarawa state university Keffi, University of Agriculture Makurdi and National Veterinary research institute Vom.

Materials and Methods

Location of Study

The study was carried out in Teaching, Research Farm and Laboratory of Department of Animal science, Faculty of Agriculture Nasarawa State University Keffi, Shabu-Lafia. Nasarawa state is situated at Guinea Savannah Region of North-Central Nigeria. It lies between latitudes 8° 35' and 9° 33'N of the equator and Longitude 8° 33' and 9° 31'E of the Greenwich meridian. The climate of Nasarawa State is largely controlled through two major air masses, the tropical maritime air mass and tropical continental air mass. The climate of the study area is categorized by tropical sub-humid climate with two distinct seasons; the wet season lasts from May to October. The vegetation of Nasarawa State fall within the Southern Guinea Savannah zone. However, clearance of vegetation for farming, fuel-wood extraction for domestic and cottage industrial use and saw milling has led to development of re-growth vegetation at various levels of development. Dense forests are few and far apart. Such forests are found in lowland areas, particularly where population pressure of both human and animals less on the land. Majority of the population in Nasarawa state are engaged in agricultural activities.

Because of the importance of farming, abundant food crops, agricultural raw materials are available in large quantities. Examples are groundnut, cassava and cereals (Nasarawa State Government, 2001).

Plate 1: Collection of Rumen Fluid from Teaching and Research Farm of Department of Animal Science, Nasarawa State University

Sample collection and preparation

Leaf samples from each of the following fodder plants were harvested from mature plants within North- Central states of the study area. The leaf samples from each of these fodder plants were harvested at the vegetative stage from mature plants around Plateau, Nasarawa State and Federal Capital Territory vicinity, which lies within the Guinea Savanna, Agro-ecological zone of North-Central Nigeria. The samples were weighed, air dried and further oven-dried at 60°C until crisp. The samples were then stored in airtight containers for two days. Thirteen (13) tropical fodder crops were investigated. They were categorized into three:

a. Four tropical crops (Vigna spp, Arachis hypogea, Manihot spp and Zea mays), in which the, haulms or leaves are usually fed to ruminants, collected as farm by-product, sundried, milled and stored at 30g for analysis.

b. Four tropical grasses which include Digitaria exillis was collected as farm by-product, Sorghum bicolor, Panicum maximum and Andropogon gayanus were collected at stage of maturity, sundried, milled and stored for analysis.

c. Five multi-purpose tree plants include Acacia albida, Gmelina arborea, Mangifera indica, Daniella olioverii and Leucaena leucocephala were collected before flowering for the season, sundried, milled and stored for analysis.

Determination of the in-vitro gas production

These were evaluated following the method of Menke and Steingass (1988). A delicate measure was used to quota out 200mg of the samples in three replicates and then put into 100ml advanced crystal syringes. The rumen fluid (inoculum) was collected inside a pre-warmed flask (390C) early in the morning (7.00am) from culled goat at the Teaching and Research Farm, Faculty of Agriculture Shabu-Lafia, Nasarawa state University. Four goats culled were tagged, well fed with wheat offal and salt lick with enough water for two (2) days and early in the morning of the third day around 7:30am the rumen fluid was collected. With the aid of stomach tube and suction pump as described by Wanapat and Khampa, (2007). The fluid was put in pre-warmed flask after removing the hot water to maintain the rumen temperature.

Table 1: In *vitro* gas production (ml/200mgDM) of selected browse plants foliage
Time (Hrs)

Sample	3	6	9	12	18	24	36	42	48
Multi-purpose Trees									
Acacia albida	11.33^{cd}	21.33^{de}	32.00^{bc}	44.67^{bc}	58.00^{bc}	66.00^{d}	75.33^{d}	78.00^{de}	78.67^{de}
Gmelina arborea	7.33^{e}	18.00^{efg}	26.00^{de}	37.33^{cd}	50.00^{cd}	56.00^{e}	66.67^{e}	70.67^{ef}	73.33^{ef}
Mangifera indica	7.33^{e}	13.33^{h}	20.00^{ef}	27.33^{fg}	35.33^{e}	42.00^{gh}	46.67^{hi}	48.67^{h}	48.67^{g}
Daniella olioverii	7.33^{e}	13.33^{h}	19.33^{f}	25.33^{g}	32.67^{e}	36.00^{h}	41.33^{i}	42.67^{h}	42.67^{g}
Leucaena leucocephala	10.00^{de}	23.33^{cd}	37.33^{b}	48.67^{b}	65.33^{b}	75.33^{c}	90.67^{c}	98.00^{c}	102.00^{c}
Grasses									
Digitaria exillis	6.67^{e}	14.00^{gh}	20.67^{def}	27.33^{fg}	36.67^{e}	44.67^{fg}	57.33^{fg}	62.67^{fg}	65.33^{f}
Sorghum bicolor	8.67^{de}	19.33^{def}	26.67^{cd}	36.00^{de}	47.33^{d}	51.33^{ef}	65.33^{ef}	69.33^{ef}	72.67^{ef}
Panicum maximum	7.33^{e}	16.67^{fgh}	24.67^{def}	32.67^{defg}	42.00^{de}	48.00^{fg}	60.00^{efg}	64.67^{fg}	68.00^{f}
Andropogon gayanus	6.67^{e}	14.00^{gh}	21.33^{def}	28.67^{efg}	37.33^{e}	42.00^{gh}	54.00^{gh}	59.33^{g}	66.67^{h}
Tropical Crop Residues									
Vigna spp (haulms)	18.67^{a}	36.67^{a}	50.67^{a}	62.67^{a}	78.67^{a}	88.67^{b}	102.67^{b}	108.67^{b}	111.33^{b}
Arachis hypogea (haulms)	13.33^{bc}	28.67^{b}	45.33^{a}	62.67^{a}	84.00^{a}	98.00^{a}	116.00^{a}	122.00^{a}	124.67^{a}
Manihot spp (leaves)	9.33d^{e}	19.33^{def}	26.67^{cd}	34.00^{def}	42.00^{de}	50.67^{ef}	61.33^{efg}	64.00^{fg}	67.33^{f}
Zea mays (leaves)	15.33^{b}	26.67^{bc}	35.33^{b}	44.00^{bc}	57.33^{bc}	64.67^{d}	77.33^{d}	81.33^{d}	84.67^{d}
SEM	0.63	1.13	1.61	2.05	2.68	3.01	3.45	3.65	3.70

$^{aa,\ b,c,d}$:Means in same column with different superscripts are significantly ($p<0.05$) different.
SEM = Standard Error of Mean
Tropical crop residues: Stovers, haulms and leaves are usually fed to ruminants

The sum of gas free when feedstuffs are incubated *in-vitro* has been stated to be closely linked to digestibility of fodder for ruminants (Mebrahtu and Tenaye, 1997). Thus, the gas volume can be considered a good image of substrate fermentation to VFAs and an appraisal of potential digestibility in the rumen. Therefore, the highest gas production at 45 hours observed for *Arachis hypogea* followed by *Vigna spp* submitted a higher nutrient digestibility of these crops' residues compared to other fodder crops investigated. This finding however, could be an image of a greater percentage of fermentable carbohydrate and Nitrogen obtainable for fermentation (Getachew *et al.,* 1999). In the meantime, the use of fodders is mainly reliant on microbial deterioration and the degree of deterioration, gas volume recommended *Arachia hypogea* influenced additional degradable and fermentable carbohydrates than others. The variation in cumulative gas production at 48 hours observed could be attributed to differences in their CP and fibre component. This is also reflected in the amount of substrate organic matter fermentation (OMD) and production of short Volatile Fatty Acids and ME of the leguminous crop residues. Significant increase in the volume of gas produced in almost all the fodder crops could be attributed to the high level of crude protein content. Gas production is certainly associated to microbial protein synthesis (Hillman et al., 1993) while Mauricco *et al.*, (1990) and Murrillo *et al.,* (2011) were of the opinion that gas production is a wasteful product but still it could be used to predict ME, OMD and SCFA of feedstuffs. The amount of gas produced is also affected by the nature of feed (Babayemi *et al.*, 2004). Generally, gas production is a task and reflect of potential degradable carbohydrate and the volume rest on the nature of the carbohydrate (Blummel and Becker, 1997). These differences among fodder crops in digestibility may be relatively ascribed to the variations in chemical configuration (mainly cell wall content and composition).

Conclusion

Based on the study, there is higher gas production observed for *Arachis hypogea* at the end of 48hr incubation periods which suggested a higher nutrient digestibility of these browse plant compared to others. The lowest gas produced was observed in *Digitaria exillis* and *Andropogon* volume *gayanus* at the 3 hours incubation periods.

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