Effect of nitrogen source and age at harvest on the *in vitro* digestibility of Oba Super II maize fodder

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Abstract
This experiment was carried out in the Pasture Section of the Directorate of University farms and the laboratory of Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria, to evaluate the effect of nitrogen source (Swine manure, N.P.K. 15:15:15 as well as the control) and age at harvest on the *in vitro* gas production and digestibility of Oba Super II maize fodder. The experiment was in a split plot design. The nitrogen source was applied at the rate of 120 kgN/ha two weeks after planting. Maize was harvested at 8, 10 and 12 weeks after planting, oven dried and milled. Samples were taken to laboratory for *in vitro* analysis. Data collected was subjected to analysis of variance (ANOVA) using General Linear Model (GLM). The result of this study showed that nitrogen source and age at harvest significantly influenced ($p<0.05$) the volume of gas produced throughout the period of incubation. Oba super II maize fertilized with swine manure harvested 12WAP had the highest dry matter digestibility value to be 84.80 %. It was concluded that Oba Super II maize fertilized with swine manure and harvested 12 weeks after planting had the highest gas volume and can be recommended as a potential source of nutrient for ruminant animals.

Introduction
Maize fodder is a major component of livestock feed in developed countries, and it is palatable to cattle especially dairy animals as it supplies them energy (Iken *et al*., 2001). The stalk, leaves, grain, and immature ears are cherished by different species of livestock (Dutt, 2005). High-yielding crops such as maize offer a possible means of increasing feed production and thereby animal production per hectare.

Production of quality forage maize can be achieved when the soil fertility is high but most tropical soils are low in fertility and this can be corrected by adding fertilizer to the soil. This fertilizer can be organic or inorganic. The organic manure improves soil fertility by influencing its physical, chemical, and biological properties. It improves water circulation and soil aeration, and increases the soil moisture holding capacity (Soltner, 1985). Inorganic fertilizers are used to supplement the natural soil nutrient supply in order to satisfy the demand of crops with a high yield potential and produce economically viable yields; compensate for the nutrients lost by the removal of plant products or by leaching or gaseous loss (IFIA, 2000).

Maturity is an important pre-harvest factor that affects nutrient content and digestibility of forages (Mussadiq *et al.*, 2012). However, the quality of fodder is very high at an early stage of growth but yield of DM per unit area is very low (Fariani *et al*., 1994). Therefore, in order to get more nutrients per unit area, the optimum time, keeping in view its nutritive value and DM yield of harvest must be considered. This study was carried out to evaluate the effect of nitrogen source and age at harvest on the *in vitro* digestibility of Oba Super II maize fodder.

Methods and Study Site
The field experiment was carried out at Pasture Section of the Directorate of University Farms (DUFARMS) which lies between Latitude 7°13′22″N and Longitude 3°25′43″E and the *in vitro* digestibility was carried out at the laboratory of Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria. After land preparation, representatives of soils were collected from plots at the depth of 0-15 cm using soil auger and was used to determine the pre-planting nutrient status of the soil. The study was a split plot design with three nitrogen sources (NPK, swine manure, as well as the control) and three harvest ages (8, 10 and 12 weeks after planting) as the main plot and the sub-plot, respectively. All nitrogen sources were applied at the rate of 120 kgN/ha. Oba super II maize fodder was planted at 50cm x 50cm. At the three harvest ages, samples were collected and dried to a constant weight for dry matter content determination. Oven dried samples were milled to pass through a 1mm sieve and stored for chemical analysis. The *in vitro* gas production was determined according to the modified procedure of Menke and Steingass (1988). Data

collected were subjected to analysis of variance (ANOVA) using General Linear Model. Level of significance will be taken at 5% probability level using SAS 1999 package.

Results

Table 1 shows the interaction effect of nitrogen source and age at harvest on the *in vitro* production of Oba Super II maize. Nitrogen source and age at harvest had a significant influence ($p<0.05$) on the volume of gas produced throughout the period of incubation. The unfertilized maize harvested 12 WAP significantly ($p<0.05$) produced the highest gas volume from the 6th hour of incubation. At the 24th hour of incubation the highest gas volume (14.00 ml/200mgDM) was obtained from both the unfertilized maize and maize fertilized with swine manure harvested at 12WAP. At 48th hour of incubation, the unfertilized maize harvested 10WAP had the lowest gas production which ranged from 9.00 ml/200mgDM to 13.00 ml/200mgDM and maize fertilized with swine manure had the highest which ranged from 14.00 to 20.00 ml/200mgDM. The result showed the interaction effect of nitrogen source and age at harvest on the dry matter digestibility and *in vitro* post incubation kinetics (b, c, lag) of Oba Super II maize fodder. Dry matter digestibility, values for b and lag were not significantly ($p>0.05$) affected by the interaction of the nitrogen sources and the age at harvest. Mean values for c significantly ranged from 0.01ml/200mgDM to 0.07ml/200mgDM.

Table 1: Effect of nitrogen source and age at harvest on the *in vitro* gas production, dry matter digestibility and post incubation kinetics of Oba Super II maize fodder.

Nitrogen source	Harvest age	6h Gas (ml/200mgDM)	24h Gas (ml/200mgDM)	48h Gas (ml/200mgDM)	DMD (%)	b (ml/200mgDM)	c (ml/hr)	lag (hr)
Swine manure	8	4.00^{ab}	11.00^{abc}	20.00^{a}	50.53	46.16	0.01^{c}	2.87
	10	4.00^{ab}	10.00^{abc}	17.00^{ab}	78.00	54.28	0.01^{c}	2.88
	12	4.00^{ab}	14.00^{a}	20.00^{a}	84.80	24.53	0.04^{bc}	1.10
NPK	8	3.00^{abc}	11.00^{abc}	19.00^{ab}	64.04	57.36	0.01^{c}	1.44
	10	4.00^{ab}	10.00^{abc}	19.00^{ab}	71.95	28.62	0.02^{bc}	3.13
	12	4.00^{ab}	13.00^{ab}	18.00^{ab}	66.00	14.43	0.10^{a}	1.09
Control	8	1.00^{c}	8.00^{bc}	16.00^{ab}	55.36	47.28	0.01^{c}	2.87
	10	2.00^{bc}	7.00^{c}	13.00^{b}	66.96	37.72	0.01^{c}	1.65
	12	5.00^{a}	14.00^{a}	18.00^{ab}	69.39	18.97	0.07^{ab}	1.38
SEM		0.27	0.54	0.56	2.82	3.97	0.07	0.24

$^{a, b, c, d}$: Means with different superscript in each column are significantly ($p<0.05$) different, SEM: Standard Error of Mean, b: insoluble fraction, c: constant gas production rate, lag: lag time, WAP: weeks after planting

Discussion [Conclusions/Implications]

The addition of swine manure raised the volume of gas produced when compared with the unfertilized maize in the present study. This is at variance with the report of Dele (2012) who observed a higher gas volume from the unfertilized grasses relative to the fertilized grasses. The reason for this observation might be because the manure raised the level of nutrient present in the maize plant as such there might have been a higher amount of carbohydrate reserve present in the maize plant available for microbial degradation. Coelho *et al*. (1998) reported that gas production is a result of substantial changes in carbohydrate fraction while Wolin (1960) reported that gas production from protein fermentation is relatively small compared to carbohydrate fermentation while contribution of fat to gas production is negligible. This might be the reason for the higher gas volume observed with the swine fertilized maize.

The age at harvest is an important factor affecting nutritive value of forages. However, plant harvested 12WAP produced the highest gas volume. Normally it is expected that with maturity of the plant, digestibility will reduce, reverse was however the case in the present study. The reason for this might be due to the presence of grain as the full stalk (fodder and grain) were fed to the rumen inoculum hence the higher gas produced might be due to the inclusion of larger quantity of maize cob. This is in conformity with the findings of Mussadiq *et al*. (2012) that maturity is an important pre-harvest factor that affects nutrient content and digestibility of forages. This is in line with report observed as maturity had positive effect on gas production in the plant. The fermentation of the insoluble fraction (b) which was measured by the volume of gas produced in time (t) was higher than the value of 3.20-3.70ml/200mgDM reported (Colkesen, 2005) for treating barley gain with formaldehyde. This might be as a result of the nitrogen sources and stage of harvest of the maize.

The value obtained for the constant gas production rate (c) of maize as affected by the nitrogen source and the age harvest was higher than values of 0.03-0.04mlhr^{-1} reported by Sodeinde *et al*. (2009). It showed that they are highly digestible, and this may be attributed to chemical constituent as influenced by the different nitrogen sources. The rate at which different chemical constituents are fermented reflects microbial growth and accessibility of the feed to microbial enzymes (Getachew *et al*., 2004). Similarly, Khazaal *et al*. (1996) suggested that the intake of a feed was mostly explained by the constant gas production rate (c) which affected the rate of passage of the feed through the rumen. Thus, the high value obtained for the (c) indicated a better nutrient degradation for rumen microorganism in animals.

The difference in lag time might be due to the difference in the rate of degradation. The *in vitro* dry matter digestibility of maize fertilized with swine manure was higher and it increased with increasing age at harvest. This is in contrast with reports of Zinash *et al*. (1995) who reported a depressed IVDMD of grass species harvested at relatively advanced ages.

Conclusion

From the result of this study, it can be concluded that Swine manure fertilized maize had the highest gas volume and dry matter digestibility. Oba super II maize fodder harvested 12 weeks after planting had higher gas volume compared to lower ages at harvest. Swine manure fertilized maize produced the highest dry matter digestibility and post incubation kinetics.

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