EFFECTS OF VARIETIES OF DRIED CASHEW PULP ON *IN VITRO* FERMENTATION PARAMETERS AND VOLUME OF GAS PRODUCED AT DIFFERENT INCUBATION TIME

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Abstract

This experiment was conducted to determine the effects of two varieties of dried cashew pulp on in vitro fermentation parameters and volume of in vitro gas produced at different incubation time. Pulps of yellow and red cashew varieties were obtained from Anyigba and its environs. Methane production was estimated. Rumen fluid was collected from goats before their morning feeding using suction tube. Incubation was done using 120ml calibrated transparent glass syringes fitted with silicon tube. Metabolizable energy (MJ/Kg) and organic matter digestibility were estimated and short chain fatty acids were calculated using 24 hours post incubation. In vitro gas production parameters measured were: first gas (a), potential gas production (b), potential degradable fractions (a+b), rate of gas production (c), organic matter digestibility (OMD), metabolisable energy (ME), short chain fatty acids (SCFAs), methane (CH_4) production and in vitro gas production at 24 hours (IVGP). Results showed that in vitro gas production for 3 and 6 hours incubation periods for red sun-dried cashew pulp meal were significantly higher ($P < 0.01$) than those for yellow sun-dried cashew pulp meal. The value of sun-dried red cashew pulp meal for first gas was significantly higher ($P < 0.01$) than yellow cashew pulp.

Metabolisable energy, OMD, potential gas production and methane production of the sun-dried yellow cashew pulp meal were significantly higher ($P<0.05/P< 0.01$). Overall result showed that the yellow cashew pulp meal was richer than the red variety.

Key words: *red cashew variety, yellow cashew variety, in vitro fermentation, gas, incubation time*

INTRODUCTION

The cashew pulp (a pseudo-fruit) is an accessory fruit which appears to be an oval or pear-shaped structure, a hypocarpium that develops from the pedicel and receptacle of the cashew flower. It ripens into a yellow or red structure about 5-11 cm long with sweet taste and smell (El-Nouby, 1991). The cashew apple can also be described as the edible portion which represents 90 % of the fruit (Denise *et al.,* 2002).

Cashew is an important industrial and export crop whose potential is yet to be fully exploited in Nigeria (Asiru *et al.,* 2005). Among thirteen (13) countries included in cashew production as noted by Krishnaswamy (2006) in the African zone, Nigeria ranks fourth after Tanzania, Cote d'Ivoire and Guinea Bissau, having a total area of 100,000 ha and an average annual production of 80,000MT, contributing almost 16 % of the total production of this particular zone. During the last three years, Nigeria has been one of the suppliers of raw cashew nuts exported to India. Nearly 18,000 to 23,000 MT of raw nuts per annum have been exported. The nut exported is negligible when compared with its total production (Krishnaswamy, 2006).

In Nigeria, cashew grows successfully in virtually all agro-ecological zones including the semi-arid areas but with high concentration in the middle belt areas in smallholder farms and plantations. Cashew production comes from over 20 States in Nigeria. These include: Anambra, Benue, Cross River, Edo, Enugu, Imo, Kebbi, Kogi, Kwara, Nassarawa, Ogun, Ondo, Osun, Oyo, Plateau and Sokoto among others (Ezeagu, 2002). The Cocoa Research Institute of Nigeria (CRIN), which has national mandate for cashew production estimates national production to be around 70,000MT annually. CRIN maintains a cashew observatory in Ochaja, Kogi State, (very close to Anyigba the

study area) where much cashew is harvested annually (Crusoe, 2006). According to personal interview with some staff of Cocoa Research Institute of Nigeria (who has cashew as one of their mandate crops), Kogi State is the highest cashew producing state in Nigeria.

Agriculture contributes significantly to emissions of greenhouse gases and other pollutants. It is also one of the sectors which any potential climate change will affect the most (UKDEFRA, 2013). Cashew pulp is considered as a waste in cashew nut processing industry. Although there is growing awareness surrounding the economic importance of cashew production in Asian and African countries, the present practice in most established large-scale plantations is to allow the apples to fall from the trees naturally before harvesting the nuts. This contributes a gross waste of this versatile cashew product (Shuklajasha *et al*., 2006). Muniz *et al*. (2006) also corroborated the manner in which cashew apple pulp has been underutilized, and therefore suggested the development of a new product to minimize the pulp waste by fermenting the juice, yielding an alcoholic beverage such as wine. The pulp of cashew apple is very juicy, but the skin is fragile. When these fruits are dried, they turn brown due to effect of heat on them and these can be incorporated in feed to be fed to animals such as cattle and goats.

This study was designed to explore the *in vitro* gas fermentation of both red and yellow varieties of sun-dried cashew pulp meal (CPM) with a view to recommending it as livestock feed ingredient since cashew pulp is considered a waste in the study area. In the study area cashew pulp is left to constitute environmental menace as the pulp is left to litter the surrounding.

MATERIALS AND METHODS

Preparation of Varieties of Cashew Pulp

The two (2) main varieties of cashew (*Anacardium occidentale*) pulp i.e. the red and yellow varieties were obtained from Anyigba and its environs. They were washed, sliced with the aid of knives and chopping boards into bits, air-dried and moved to a screen house where they were properly dried. The dried cashew pulp were packaged, weighed and sent to Nigerian Institute of Animal Science Centre of Excellence, Animal Science Department, University of Benin for *in vitro* analysis.

In vitro fermentation parameters measured

In vitro fermentation techniques were carried out in this experiment and the following parameters were measured:

(i). First gas (a) (ii). Potential gas production (b) (iii). Potential degradable fractions (a+b) (iv). Rate of gas production (c) (v). Organic matter digestibility (OMD) (vi). Metabolisable energy (ME) (vii). Short chain fatty acids (SCFAs) (viii). Methane (CH_4) production (ix). *In vitro* gas production.

In vitro Gas Fermentation Procedure

Rumen fluid was collected from goats before they were fed in the morning as described by Babayemi and Bamikole (2006) using suction tube. The collected rumen fluid was filtered into a pre-warmed thermo flask at a temperature of 39 ^{o}C using a cheese cloth.

The buffer solution used consist of (g/litre) 9.8 $NaHCO_3$ + 2.77 $NaPO_4$ + 0.5 KCl + 0.47 NaCl + 2.16 $MgSO_4.7H_2O$ + 0.16 $CaCl_2{\cdot}2H_2O$.

Incubation procedure was as reported by Menke and Steingass (1988) using 120ml calibrated transparent glass syringes fitted with silicon tube. Two hundred milligram (200 mg) of each sample (in triplicates) was loaded in the syringes. The rumen fluid and the buffer were mixed together in ratio of 1:4 (v/v). The 30 ml of the inoculum was drawn into 50 ml glass calibrated syringes; this was then dispensed into the calibrated transparent glass syringes containing the feed samples under continuous CO_2 flushing. Air bubbles were removed from the syringes by gently tapping them and pushing the

piston upwards to expel the air. The silicon tubes on the syringes were properly clipped to prevent escape of gas before placement in the incubator. The glass syringes were placed in the incubator at a temperature of 39°C for 24 hours. Gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24 hours. At post incubation period, 4 mL of NaOH (10M) was introduced to estimate methane production as reported by Fievez *et al.* (2005). ME (MJ/Kg) and OMD were estimated as established by Menke and Steingass (1988), and SCFAs were calculated as reported by Getachew *et al.* (1999) 24 hours post incubation. The formulae used for calculations were:

ME = 2.20 + 0.136Gv – 0.057 CP + 0.0029CF

OMD = 14.88 + 0.889Gv + 0.45CP + 0.0651 XA

SCFA = 0.0239Gv – 0.0601

Where: Gv = Net gas production (MlL / 200 mg DM)

CP = Crude protein, CF = Crude fibre, XA = Ash

Other parameters such as: a, b, a+b and c were derived by calculation, where

a = First gas, b = potential gas production, a + b = Potential degradable fractions.

c = Rate of gas production.

Experimental Design and Statistical Analysis

Completely randomized design was used. Data obtained were subjected to Analysis of Variance (ANOVA) and means that were significantly different were separated using Least Significant Difference (LSD), both contained in SPSS for Window, version 16.

RESULTS

In Vitro Gas Production of Sun-Dried Yellow and Red Cashew Pulp Meal for 24 Hours

The result on the *in vitro* gas production of both yellow and red sun-dried cashew pulp meal for 24 hours is presented in Table 1. *In vitro* gas production for incubation periods of 3 and 6 hours were highly significant ($P < 0.01$). Those for 9, 12, 15, 18 and 24 hours were not significant ($P > 0.05$). The *in vitro* gas production for 3 and 6 hours incubation periods for red sun-dried cashew pulp meal were significantly higher ($P < 0.01$) than that for yellow sun-dried cashew pulp meal.

Table 1. *In Vitro* Gas Production of Sun-dried Yellow and Red Cashew Pulp Meal for 24 Hours

Incubation period (Hours)	Cashew Varieties		SEM
	Yellow	Red	
3	5.00^{b}	10.50^{a}	1.31**
6	10.00^{b}	31.50^{a}	4.85**
9	31.50	34.50	0.87^{ns}
12	34.50	36.00	0.51^{ns}
15	37.50	36.00	0.51^{ns}
18	42.00	39.00	0.67^{ns}
21	42.00	39.00	0.67^{ns}
24	45.00	39.00	1.34^{ns}

a, b = Means with different superscripts on the same row are significantly different ($P < 0.01$)
SEM = Standard Error of Mean, ** = significant at ($P < 0.01$), ns = not significant

Effect of *In Vitro* Fermentation on IVGP, ME, OMD, SCFA and Methane of Sun-Dried Yellow and Red Cashew Pulp Meal

The result on IVGP, ME, OMD and SCFA of sun-dried yellow and red cashew pulp meal is presented in Table 2. Values for ME and OMD were highly significant ($P < 0.01$). Methane was significant ($P < 0.05$). Those for IVGP and SCFA were not significant ($P > 0.05$). Metabolisable energy, organic matter digestibility and methane production of the sun-dried yellow cashew pulp meal were significantly higher than those for sun-dried red cashew pulp meal.

Table 2. Effect of *In Vitro* Fermentation on IVGP, ME, OMD, SCFA and Methane of Sun- dried Yellow and Red Cashew Pulp Meal

In Vitro Parameters	Cashew Varieties		
	Yellow	**Red**	**SEM**
IVGP (ml/200 mg DM)	45.000	39.000	1.342^{ns}
ME (MJ/Kg DM)	7.511^{a}	6.525^{b}	0.226^{**}
OMD (%)	61.587^{a}	57.584^{b}	0.966^{**}
SCFA (µmol)	1.015	0.872	0.032^{ns}
Methane (mL/200 mg DM)	5.000^{a}	3.000^{b}	0.516^{*}

a, b = Means with different superscripts on the same row are significantly different
SEM = Standard Error of Mean, ** = significant at ($P < 0.01$), ns = not significant, * = significant at ($P < 0.05$)
IVGP - *In vitro* Gas Production (at 24hrs)
ME – Metabolisable Energy
OMD – Organic Matter Digestibility
SCFA – Short Chain Fatty Acids

In Vitro Gas Production Characteristics of Sun-Dried Yellow and Red Cashew Pulp Meal

In vitro gas production characteristics of both yellow and red sun-dried cashew pulp meal is presented in Table 3. Values for first gas and potential gas production were highly significant ($P < 0.01$) while those for potential degradable fraction and rate of gas production were not significant ($P > 0.05$). Values of sun-dried red cashew pulp meal for first gas was significantly higher ($P < 0.01$) than that of sun-dried yellow cashew pulp meal. Value of sun-dried yellow cashew pulp meal for potential gas production was significantly higher ($P< 0.01$) than that of sun-dried red cashew pulp meal.

Table 3. *In Vitro* Gas Production Characteristics of Sun-Dried Yellow and Red Cashew Pulp Meal

Fermentation Characteristics	Cashew Varieties		
	Yellow	Red	SEM
a	5.000[b]	10.500[a]	1.315[**]
b	40.000[a]	28.500[b]	2.613[**]
a+b	45.000	39.000	1.342[ns]
c	0.007	0.005	0.002[ns]

a, b = Means with different superscripts on the same row are significantly different ($P < 0.01$)
SEM = Standard Error of Mean, ** = significant at ($P < 0.01$), ns = not significant
a – First Gas Production (gas produced from the soluble fraction).
(a+b) – Potential Degradable Fraction (final gas produced)
b – Potential Gas Production (gas produced from the insoluble fraction)
c – Rate of Gas Production (gas production rate constant for the insoluble fraction (b))

DISCUSSION

In Vitro Gas Production of Sun-Dried Yellow and Red Cashew Pulp Meal for 24 Hours

The cashew varieties at 3 and 6 hours alone provided more soluble carbohydrates (which is the fermentable energy source within 24 hours) than those at 9, 12, 15, 18 and 24 hours, which were not significant ($P > 0.05$) (Oni *et al*., 2009). The result of this study shows that gas production increased with incubation time. This is as a result of the level of microbial activities in the rumen, the more degradable the plant materials are for the microbes, the higher the gas produced and once the plant materials become exhausted, there will be no more increase in gas production.

Methane gas is an important gas among gases produced by ruminants at fermentation, and has been reported by Babayemi and Bamikole (2006) to have a negative effect on the animal, on one hand when methane gas accumulate in the rumen, it results in bloat. On the other hand, it is an energy loss to the animals and when emitted it contributes to ozone layer destruction. Although gas production is nutritionally a wasteful effort, it provides a useful basis from which metabolizable energy (ME), organic matter digestibility (OMD) and short chain fatty acids (SCFA) may be predicted (Babayemi *et al*., 2009).

Effect of *In Vitro* Fermentation on IVGP, ME, OMD, SCFA and Methane of Sun-Dried Yellow and Red Cashew Pulp Meal

Metabolisable energy, organic matter digestibility and methane production of sun-dried yellow cashew pulp meal were higher than those for sun-dried red cashew pulp meal. The higher ME and OMD for the sun-dried yellow cashew pulp meal means that it is a better feedstuff in terms of metabolisable energy and organic matter digestibility, when compared to the red variety. In addition, the value of IVGP is an indicator of the digestibility of a feed sample (Falola and Babayemi, 2009), meaning the sun-dried yellow cashew pulp meal actually has higher digestibility.

The high methane gas production by the sun-dried yellow cashew pulp meal suggest that the use of the yellow variety could lead to more energy loss or wastage, when compared to the red variety, although 5.000mL/200 mg DM methane produced by the yellow variety is still not as high as that produced by some forages which can be as high as 15.000 – 20.000 mL/200 mg DM methane. The high SCFA value for the yellow variety (though not significant) means that it has more potential to produce energy. The values for ME and OMD in this study are within the range reported by Abegunde *et al*. (2009).

***In Vitro* Gas Production Characteristics of Sun-Dried Yellow and Red Cashew Pulp Meal.**

In vitro gas production characteristics of sun-dried yellow and red cashew pulp meals for first gas and potential gas production were highly significantly affected by variety while those for potential degradable fraction and rate of gas production were not significantly affected by variety. Also, values of sun-dried red cashew pulp meal for first gas was higher than that of sun-dried yellow cashew pulp meal, indicating that in the first gas produced, the sun-dried red cashew pulp meal had higher nutritive value (Sodeinde *et al*., 2008). Value of sun-dried yellow cashew pulp meal for potential gas production was also higher than that of sun-dried red cashew pulp meal. The rate of gas production value shows the rate at which feed or its chemical constituents are broken down in the rumen and it is as important as the extent of digestion (Arigbede *et al*., 2006). The rate of gas production value in this study indicates that the chemical constituents of the sun-dried yellow cashew pulp meal are better broken down in the rumen than the sun-dried red cashew pulp meal.

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