Mixture of Orange and Pineapple Pulps Meal as Alternative Energy Sources in the Diet of Ram Lambs

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Abstract

The study was conducted to assess the mixture of orange and pineapple pulps meal as alternative energy sources in the diet of ram lambs, using coefficient of preference, in vitro gas production characteristics and nutrient metabolism by ram lambs. Thirty growing West African dwarf (WAD) ram lambs with an average weight of 8.00+0.52kg and aged between 9 and 10 months old were randomly allotted to three treatment diets with ten animals per treatment in a completely randomized design. The compared treatment diets which were T_1, T_2 and T_3 *consisted of mixture of orange and pineapple pulps meal in a ratio of 30:40, 35:35 and 40:30 respectively. The obtained results showed that mean dry matter intake and coefficient of preference were best in* T_1. *Gas production from the insoluble fraction, potential gas production, gross energy intake, digestible energy (DE), metabolizable energy (ME), ME:DE ratio, nitrogen balance and nitrogen retention were also significantly (P<0.05) best for* T_1. *Compared to* T_2 *and* T3.*Gas production from soluble fraction, incubation time, total energy output were significantly (P<0.05) highest in* T_2, *while methane, metabolizable energy (MJ/Kg/DM), organic matter digestibility, faecal and urinary nitrogen output were significant (P<0.05) highest in* T_3. *No significant difference (P>0.05) was observed in gas production rate constant for the insoluble fraction (b), short chain fatty acids and nitrogen intake. It is concluded that mixture of orange and pineapple pulps meal in a ratio of 30:40 (*T_1*) has the potential as alternative energy source in the diet of ram lambs.*

Keywords: Orange with pineapple pulps, acceptability, in vitro gas production, nutrient metabolism, ram lambs

Introduction

One of the greatest challenges facing developing countries today is the inability to feed her ever increasing and teeming population with adequate animal protein. Though there are vast resources in livestock development in the nation of today, their resources cannot still withstand the challenges as a result of low level of animal production. Ruminant animals represent an important segment on livestock industry in the world. Their consumption increase with increasing in the need for more animal protein by human populace (Ngele et al., 2010). However, sheep constitute a very important part of small ruminants' sub-sector of the Nigerian agricultural economy. Thus, the potential of sheep production in alleviating the low animal protein intake by man in the developing nations such as Nigeria needs no emphasis (Aka et al., 2011). One of the major problems of development and expansion of sheep industry in Nigeria is the scarcity of forages and prohibitive cost of conventional feedstuffs. The inability of livestock farmers to feed adequately with high quality forages to their animals for all year round remain the most widespread technical constraint due to the seasonal fluctuation in nutritive value of natural pastures (Babayemi, 2007).

The high cost of conventional feeds due to stiff competition for their use by man and other livestock species have worsened the situation of inadequate nutrition in sheep production. To mitigate this problem of inadequate nutrition in small ruminants, the need to continuous searching for various alternative feeds that are less competitive for their use by man and other livestock could perhaps be one of the intervention areas needed to augment sheep production (Okoruwa et al., 2012a). The uses of unconventional feed resources that are cheap and locally available are gaining more recognition in the field of small ruminant animal nutrition. Orange and pineapple pulps are agro-industrial by-products that virtually constitute wastes in fruit processing industries. Potentially, orange and pineapple pulps are characterised by high energy but low in protein (Okoruwa and Adewumi, 2010; Fung et al., 2010). Limitations on the use of these pulps in the diet of ruminants involve low protein content, imbalance mineral content, bulkiness and toxic substances that require some form of processing before combining them with diets (Bampidis and Robinson, 2006). It has been reported by Pereira et al. (2008) that pressed citrus pulp can replace up to 75% corn silage in a fattening diet for lambs without any inverse effect on growth or carcass composition. Though dried orange or pineapple pulp has been successfully fed to sheep but there is still paucity of information regarding the combination of dried orange with pineapple pulps as alternative energy sources in sheep diet. Hence the objective of this study was to measure the free choice intake, in vitro gas production kinetics and nutrient metabolism in the diet of ram lambs in which combination of orange and pineapple pulps meal was used as alternative energy sources.

Materials and Methods

Site Location: The experiment was conducted at the Sheep and Goat Unit of the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria (Long. 6.09^0E and Lat. 6.42^0N). The area has an annual temperature that range between 26^0C and 34^0C with an average annual rainfall of 1556mm.

Preparation of Experimental Diets: Orange and pineapple pulps were collected fresh from their processing points located within Edo State. The entire pulps excluding the peels, after extraction of the juice were sun-dried consistently until some samples could be cracked manually before they were milled separately. The concentrate offered as supplement comprised the following; 80% brewery dried grain, 18% rice bran, 0.75% limestone, 0.5% dicalcium phosphate, 0.5% salt and 0,25% vitamin premix. The experimental diets prepared for the trial were basal and supplementary diets in a ratio of 70:30 respectively. Combination of dried crushed orange and pineapple pulps at different proportions were used as basal diets while the concentrate was used as the supplementary diet. The three compared experimental diets (T_1, T_2 and T_3) that were prepared were given to the animals at 5% (dry matter basis) of their body weight after free choice intake assessment. Diets T_1, T_2 and T_3 comprised combination of dried orange and pineapple pulps as basal diet in a ratio of 30:40, 35:35 and 40:30 respectively. Concentrate supplement of 30% was given to the animals in each of the treatment diets.

Experimental Animals, Feeding and Management: Thirty (30) healthy growing West African dwarf (WAD) ram lambs, purchased from weekly market at Ekpoma were used for this study. The ram lambs were between 9—10 months old with an average weight of 8.00 ± 0.52kg. The ram lambs were randomly allotted to the three (3) dietary treatment groups (T_1, T_2 and T_3) with replicates of ten (10) ram lambs per treatment group in a completely randomized design. On arrival, the ram lambs were immediately placed on prophylactic treatment through the administration of antibiotics (long acting). They were also treated against endoparasites and ectoparasites routinely together with prescribed vaccination. The ram lambs were allowed to acclimatize for the period of 21 days, during the adaptation they were fed only with the feedstuffs from where they were purchased. The trial lasted for 84 days excluding 14 days of preference study and 21 days of adjustment period. The experimental pens were cleaned and disinfected before animals were latter allotted to demarcate individual pens for the trial. Diets were offered once daily at about 8.00am in the morning to ram lambs. Water and mineral salt were provided for the ram lambs *ad libitum* throughout the feeding trial.

Preference Study: The thirty WAD ram lambs were used to evaluate the free choice intake of the three compared experimental diets. An open pen that had been designed to accommodate thirty to thirty five ram lambs was used. The floor of the open pen was covered with wood shavings to a depth of 5cm for the absorption of urine and faeces. In triplicates, 4kg each of the experimental diets were placed in strategic locations in feeder troughs measuring $2m \times 5m$. The ram lambs were allowed to feed from 8.00am to 4.00pm daily for 14 days. Consumption was measured by deducting leftovers from the amount of feed offered.

The diet preferred was assessed from the coefficient of preference (COP) value, calculated from the ratio between the intakes for the individual diet, divided by the average intake of the diets (Babayemi, 2007). Therefore, diet was inferred to be relatively acceptable provided the COP was greater than one unity.

In Vitro Gas Production Study: Rumen liquor used for the gas production study was obtained from the rumen of the ram lambs previously fed with the experimental diets after the preference study. About 200mg of dry milled samples of each of the three experimental diets (T_1, T_2 and T_3) were used as the standard substrates. Samples were replicated three times for each treatment and placed into 100ml graduated gas tight plastic syringes. Incubation was carried out at 39 ± 1^0C which lasted for 24 hours as reported by Menke and Steingass (1988). At post incubation period, 4ml of NaOH (10ml) was introduced to estimate methane production following the method described by Fievez et al. (2005). Data were obtained on volume of gas and methane produced,. Metabolizable energy (ME) and organic matter degradability (OMD) were estimated (Menke and Steingass, 1988). Short chain fatty acids (SCFA) were calculated as reported by Getachew et al. (2003). The equation $Y = a + b\left({}^{-}1 - e^{-ct}\right)$ was used to estimate gas production characteristics (Babayemi, 2007).

Where Y = Volume of gas produced at time t.

a = intercept (gas production from soluble fraction)
b = gas production from the insoluble fraction
c = gas production rate constant for the insoluble fraction (b)
t = incubation time.

$$a + b = \text{potential gas production}$$

$$ME = 2.2 + 0.136^{*}GV + 0.0057 * CP + 0.0002865 * EE^{2}$$

$$OMD = 14.88 + 0.889^{*}GV + 0.0448 * CP + 0.0651^{*}XA$$

$$SCFA = 0.0239^{*}GV - 0.0601$$

Where GV, CP, EE and XA were net gas production $(ml/200mg\ \text{DM})$, crude protein, ether extract and ash of the incubated samples respectively.

Nutrient Metabolism Trial: Eight (8) WAD ram lambs per treatment (totalling 24), were randomly selected from each treatment and housed in metabolic crates fitted with facilities for separate collection of urine and faeces. The quality of feed offered and leftover as well as faeces and urine were determined by weighing daily for seven (7) days after a 7-day adjustment period. Ten percent of faecal samples were stored in the desiccator after drying while urinary samples were stored in a refrigerator at 4^0C until required for nutrient determination in the laboratory. Heat combustion of feeds, faeces and urine were determined using an adiabatic bomb calorimeter. Digestible energy (DE) and metabolizable energy (ME) intake per animal were determined from the energy content of the feed intake and the amount of energy in faeces, urine and methane. The amount of energy loss through methane was set at 5% of the gross energy intake (CSIRO, 2001). Nitrogen balance by the ram lambs were calculated as the difference between nitrogen intake and nitrogen excreted from faeces and urine , while nitrogen retention percentage were computed from nitrogen balance expressed as a percentage of nitrogen intake.

Chemical and Statistical Analyses: Samples of orange pulps, pineapple pulps, concentrate supplement and faecal output were analysed for proximate composition using the procedure of AOAC (1990). Neutral detergent fibre and acid detergent fibre were determined as prescribed by Van Soest et al. (1991). Urine samples were also analysed for nitrogen content (AOAC, 1990). Data obtained from in vitro gas production kinetics, apparent nutrient digestibility, energy and nitrogen utilization parameters were subjected to analysis of variance (ANOVA) to determine the significance of treatment effects following the methods described by SAS (1999). Significant difference between means was separated by Duncan Multiple Range Test.

Results and Discussion

Chemical Composition and Gross Energy of Diets: The chemical composition and gross energy of the experimental diets are presented in Table 1. Dry matter (DM) values that ranged from 76.64% in OP to 86.24% in CS were quite high and showed tendency to be stored for considerable period of time without spoilage and microbial growth. Crude protein (CP) varied between 4.43% in PP and 16.92% in CS.

The values of crude protein for the PP (4.43%) and OP (5.99%) in the present study might not be adequate to meet the requirement for sheep hence, proper supplementation with concentrate was added to augment the supply of nutrients, encourage rumen degradation and enhance sheep performance as reported by Yousuf and Adeoye (2011). Ether extract (EE) had low contents in PP (1.26%) and OP (4.58%) compared with CS (7.01%). Crude fibre (CF) had similar contents in PP (17.29%) and CS (18.65%) with the exception of OP (11.41%) that was lower. The crude fibre value of OP obtained in this finding was lower than the value reported by FAO (2006). This marked difference between the values might have been as a result of genetic origin, soil fertility and time of harvest. Ash contents were considerably different, being highest in CS (5.86%) and lowest in OP (3.62%). This indicates that, the total mineral content present in CS was higher compared to OP and PP. This agrees with the report of Sparkes (2010) that citrus pulps have low mineral contents. Nitrogen free extract (NFE) values that range from 51.56% in CS to 74.40% in OP were considerable high in amount and indicate high carbohydrate content in the diets. Crude fibre fraction was highest in CS and lowest in OP as indicated by neutral detergent fibre (43.50 and 21.09%) and acid detergent fibre (26.58 and 17.06%) respectively. OP (18.13%) and PP (17.04%) had similar contents of gross energy (GE) compared with CS (14.03%).

Table 1: Chemical Composition (% DM basis) and Gross Energy (MJ/kg/DM) of Basal and Supplement Diets

Composition	**Diets**		
	OP	**PP**	**CS**
DM	76.64	82.08	86.24
CP	5.99	4.43	16.92
EE	4.58	1.26	7.01
CF	11.41	17.29	18.65
Ash	3.62	4.20	5.86
NFE	74.40	72.82	51.56
NDF	26.58	42.07	43.50
ADF	17.06	20.53	21.09
GE	18.13	17.04	22.03

OP = orange pulps, PP = pineapple pulps, CS = concentrate supplement

Table 2: Mean Dry-Matter Intake (MDI) (kgDM) and Coefficient of Preference (COP) by Ram Lambs fed Orange with Pineapple Pulps Meal Supplemented with Concentrate Diet.

Feedstuffs	Acceptability days									
	1		6		9		12		14	
	MDI	COP	MDI	COP	MDI	COP	MDI	COP	MDI	COP
OP+PP+CS (30:40:30)	2.40	1.51	2.90	1.87	3.50	2.45	3.80	3.09	3.60	2.67
OP+PP+CS (35:35:30)	1.20	1.02	2.50	1.49	2.60	1.87	2.90	2.05	3.10	2.21
OP+PP+CS (40:30:30)	0.50	0.43	0.70	0.71	0.90	1.01	1.00	1.19	1.20	1.42

OP=orange pulps, PP=pineapple pulps, CS=concentrate supplement.

Table 3: In Vitro Gas Production $(ml/200mgDM)$ Characteristics of the Mixture of Orange and Pineapple Pulps in Rumen Fluid of Ram Lambs Fed Experimental Diets (24 hours)

Parameters	Treatment			SEM±
	T_1	T_2	T_3	
$a(ml)$	2.00^{b}	3.68^{a}	2.00^{b}	0.02
$b(ml)$	47.00^{a}	41.32^{c}	44.00^{b}	0.92
$a+b(ml)$	49.00^{a}	45.00^{b}	46.00^{b}	0.96
$c(mlh^{-1})$	0.09	0.08	0.08	0.01
$t\,{}^{1}\!/_{2}(hr)$	15.00^{b}	17.00^{a}	13.56^{b}	0.68
$CH_4(ml)$	5.62^{b}	7.34^{a}	8.01^{a}	0.42
$ME(MJ/kg/DM)$	7.69^{b}	8.09^{b}	10.48^{a}	0.56
$OMD(\%)$	59.99^{b}	62.06^{b}	68.47^{a}	0.72
$SCFA(\mu M)$	1.14	1.06	1.02	0.04

CH_4 = methane, ME=metabolizabe energy, OMD=Organic matter digestibility, SCFA=Short chain fatty acids.

a, b, c Means on the same row with different superscript are significantly different ($P<0.05$). SEM=Standard error of mean.

Table 4: Nutrient Metabolism of Ram Lambs Fed Experimental Diets

Parameters	Treatment			SEM±
	T_1	T_2	T_3	
Energy metabolism $(KCal/g/day)$				
Gross energy intake	288.65^{a}	246.92^{b}	199.87^{c}	1.96
Faecal energy output	44.27^{b}	49.98^{a}	51.06^{a}	0.84
Digestible energy (DE) intake	84.66^{a}	79.76^{a}	74.45^{c}	1.03
Total energy output	60.70^{b}	70.33^{a}	70.06^{a}	0.98
Metabolizable energy (ME) intake	78.97^{a}	71.52^{b}	64.95^{c}	0.87
ME:DE ratio	0.93^{a}	0.90^{a}	0.86^{b}	0.02
Nitrogen metabolism (g/day)				
Nitrogen intake	18.00	18.03	18.97	0.24
Faecal nitrogen output	6.98^{b}	7.59^{b}	9.01^{a}	0.06
Urinary nitrogen output	1.91^{b}	2.44^{a}	2.69^{a}	0.08
Nitrogen balance	9.11^{a}	8.00^{b}	7.27^{b}	0.09
Nitrogen retention $(\%)$	51.01^{a}	44.37^{b}	38.32^{C}	0.74

a, b, c Means on the same row with different superscript are significantly different ($P<0.05$). SEM=Standard error of mean.

The chemical composition and gross energy values of OP and PP in this study were within the range reported by Rogerio et al. (2007); Fung et al. (2010); Okoruwa and Njidda (2012b).

Acceptability of different proportion of orange with pineapple pulps by ram lambs: Presented in Table 2, are the mean dry matter intake (MDI) and coefficient of preference (COP) by ram lambs placed on different proportion of orange and pineapple pulps. Several reports indicated that feed intake is an important factor in the utilization of feed by ruminant livestock and a critical determinant of nutrient intake and metabolism in small ruminants (Osasanya, 2010; Garba et al., 2010). In addition, Babayemi et al. (2009) reported that direct intake of feeds by animals through the use of cafeteria technique remains one of the authentic methods of assessing the nutritive value of ruminant feeds. Though this cafeteria method has been used to access the acceptability of forage by sheep and goats (Bamikole et al., 2004; Babayemi, 2007) but not in combination of orange and pineapple pulps by sheep.

In the present study, the free choice intake of combination of orange pulp (OP) with pineapple pulp (PP) and concentrate supplement (CS) in different proportion were generally accepted by ram lambs, despite the combination of $OP + PP + CS$ in a ratio of 40:30:30 was rejected in the first six days of offering the feedstuff to the animals. The acceptability of $OP + PP + CS$ in a ratio of 30:40:30 by ram lambs was observed to be increasing in trend with the continuous supply of the feedstuff. This could be attributed to the high sugar content of PP that increased the palatability of the feedstuff. This agrees with the findings of Babayemi et al. (2009); Garba et al. (2010) who reported that palatability and plant physical structure of feedstuffs are the most important factors that influence preference for feeds intake. Similar trend of increased in acceptability of ram lambs was observed in $OP + PP + CS$ in a ratio of 35:35:30. However, the observed poor receptivity of ram lambs to the feedstuffs in the first nine days could probably be due to the equal combination of $OP + PP$ in the feedstuffs that affected the chemical composition and fibre combination with increased in lectins nature of OP. This confirms the report of Oluremi et al. (2007) that high percentage of lectins in citrus pulps has inverse effect on intake of citrus by cow. The observed initial displeasure and less preference showed by ram lambs for $OP + PP + CS$ in a ratio of 40:30:30 at the onset before later accepted after six days, could be as a result of their sensation and palatability of the feedstuffs. This observation corroborates the earlier report (Babayemi et al., 2009) that animal's preference for feed swings in relation with instant over an elongated examination periods. This further suggests that much longer time is essential in carrying out preference study for ruminants, thereby paving ways for adjustment. However, the feedstuff in a ratio of 30:40:30 seemed to have been preferred by ram lambs, hence they showed more willingness to consume the feedstuff (MDI 3.60kgDM, COP 2.67) for the period of fourteen days of the acceptability study than the combination of the feedstuff in ratios of 35:35:30 (MDI 3.10kgDM, COP 2.21) and 40:30:30 (MDI 1.20kgDM, COP 1.42) respectively.

In Vitro Gas Production of the Mixture of Orange with Pineapple Pulps by ram lambs : Indicated in Table 3, is the in vitro gas production characteristics of different proportion of orange and pineapple pulps incubated in rumen fluid from dwarf ram lambs fed experimental diets for 24 hrs. Parameters assessed were all significantly (P<0.05) affected except rate constant of gas production (C) and short chain fatty acids (SCFA) that were not significantly (P>0.05) difference. The non-significant (P>0.05) difference observed in (C) and SCFA for samples incubated, suggests that mixture of orange and pineapple pulps can potentially produce gas and fatty acids at the same rate, every other factors being constant. Cerillo and Juarez (2004) reported that the intake of a feed is mostly explained by the rate of gas production which affects the rate of passage of the feed through the rumen. Gas production from soluble fraction (a) was significantly (P<0.05) higher in T_2 (3.68ml) compared to T_1 (2.00ml) and T_3 (2.00ml). The difference observed in (a) could probably explain the rate at which samples incubated were soluble in the rumen fluid. Earlier study by Babayemi et al. (2009) revealed that gas production is a function and a mirror of degradable carbohydrate and therefore, the amount depends on the nature of the carbohydrate. The higher significant (P<0.05) value recorded in potential gas production (a+b) in T_1 (49.00ml) might indicate a better nutrient availability for rumen microbes compared to T_2 (45.00ml) and T_3 (46.00ml).

Babayemi (2007) reported that potential gas production (a+b) is associated with the degradability factors in rumen which are different for all animals. Incubation time $\left(t\ {}^{1}\!/_{2}\right)$ was highest in T_2 (17.00hr) signify more time that was spent by rumen microbes to ferment the dietary treatment (T_2) compared to T_1 (15.00hr) and T_3 (13.56hr). The difference might be as a result of different fibre combination between orange and pineapple pulps in the diets. Methane production in the rumen has been reported by Babayemi and Bamikole (2006) as an energetically wasteful process, since the portion of the animal's feed which is converted to methane is eructated as gas. Methane production was significantly (P<0.05) lowest in T_1 (5.62ml) reflecting methanogenesis that was obviously suppressed and translated to a more efficient utilization of the diet. Methane production has also been recognized by most researchers (Babayemi and Bamikole, 2006; Akinfemi et al., 2009) to have a negative correlation with energy utilization in ruminants on one hand, when emitted it contributes to the destruction of zone layer on the other hand. Similarly, metabolizable energy (ME) and organic matter digestibility (OMD) values have the same pattern of variation as observed in methane production, suggesting the presence of non-methanogenic fibre degrading microbes in the dietary treatment (T_1). Babayemi (2007) reported that mutual relationship exists among total methane production, metabolizable energy and organic matter digestibility.

Nutrient Metabolism of Ram Lambs

Table 4, shows result for nutrient metabolism of ram lambs fed experimental diets. Parameter observed were all significantly (P<0.05) affected except nitrogen intake that was not significant (P>0.05). Gross energy (GE) intake was significantly (P<0.05) highest in T_1 (288.96KCal/g/day) followed by T_2 (246.92KCal/g/day) before T_3 (199.87KCal/g/day). The progressive decrease in GE intake across diets in response to increase in inclusion level of orange pulps (OP) could probably be explained by reduction in energy content of the feed and the increase in lectins nature of OP. The faecal energy output values for ram lambs were considerably greater in T_2 (49.98KCal/g/day) and T_3 (51.06KCal/g/day) than T_1 (44.27KCal/g/day). The imbalance levels of nutrient utilization caused by residual anti-nutritional factors of OP could account for difference observed. This is in line with the earlier report of Oluremi et al. (2007) that increase in level of lectins in citrus pulps have negative effect on nutrient intake and digestibility in ruminants. Digestible energy (DE) followed the same trend as observed in GE intake. The highest DE recorded in T_1 (84.66KCal/g/day) could be attributed to balance utilization of the nutrient and low faecal energy voided compared to T_2 (79.76KCal/g/day) and T_3 (74.45KCal/g/day). However, DE values obtained in this study was compared favourably with the mean value (93.22KCal/g/day) reported by Okoruwa et al. (2012a) for sheep but lower than average value of 134.06 KCal/g/day for cattle as reported by Calegare et al. (2007).

The estimated total energy output values ranged between 60.70KCal/g/day for T_1 and 70.33KCal/g/day for T_2. The significant (P<0.05) higher values of total energy output obtained in ram lambs on T_2 and T_3 might be as a result of higher energy loss through urine and methane. Babayemi and Bamikole (2006) reported that methane production in the rumen has a negative correlation with energy utilization in ruminants. Metabolizable energy (ME) values were 78.97, 71.52 and 64.95KCal/g/day for T_1 T_2 and T_3 respectively. The gradual decrease from T_1 to T_3 for ME as the level of orange pulps (OP) decreased with increase in the level of pineapple pulps (PP) inclusion in diets could further testify the higher energy content of PP and the degree of its utilization as noted by Okoruwa and Adewumi (2010). The ME:DE ratio values for ram lambs were significantly (P<0.05) higher in T_1 (0.93) and T_2 (0.90) compared with T_3 (0.86). Values obtained in T_1 and T_2 in this study were in agreement with the report of Amaefule et al. (2009) who reported that ME:DE ratio of complete feeds is relatively constant and equivalent to about 0.96.

Nitrogen intake values 18.00, 18.03 and 18.97g/day were recorded for T_1, T_2 and T_3 respectively. No significant (P>0.05) difference was observed between treatment effects. This might be a reflection of crude protein levels in the combination of OP and PP in the dietary treatments. This agrees with the report of Okoruwa and Adewumi (2010) who observed that nitrogen intake in sheep can be greatly affected by the nutrient combination in diets. Faecal and urinary nitrogen differed significantly (P<0.05) between treatment groups with values ranging from 6.98 to 9.01g/day and 1.91 to 2.69g/day for faecal and urinary nitrogen output respectively. The higher value for faecal nitrogen in T_3 could be traced to the amount of unfermented ingest in the gastrointestinal tract and reduction in digestibility effect by the level of OP in the diet intake. Similarly, higher urinary nitrogen output values were recorded in T_2 and T_3 compared with T_1. The difference could probably due to the concentration of ammonia content in the rumen, which was later converted to urea and excreted. This is in consonance with the findings of Ososanya (2010) who reported that nitrogen excreted in urine will depend on urea recycling and the efficiency of utilization of ammonia produced in the rumen by microbes for microbial protein synthesis.

Nitrogen balance and retention were significantly (P<0.05) highest in T_1 (9.11g/day and 51.01%) and lowest in T_3 (7.27g/day and 38.32%). Nitrogen balance and retention values decreased in trend with increased in level of OP inclusion in the diets, implies the poor degree of OP utilization in the dietary treatments. However, ram lambs on dietary treatment (T_1) promoted higher positive N balance, suggesting that PP was well utilized and efficiently used as fermentable nitrogen source for microbial growth in the rumen. Efficiency of nitrogen utilization expressed in terms of nitrogen retention was markedly affected in T_1 compared to T_2 and T_3. Earlier study by most workers (Olorunnisomo, 2010; Okoruwa and Njidda, 2012b) revealed that nitrogen retention is the proportion of nitrogen utilized by ruminants from the total nitrogen intake for body processes, hence the more the nitrogen consumed and digested the more the nitrogen retained and vice versa. Njidda and Ikhimioya (201), also noted that nitrogen retention is considered as a better criterion or/for measuring protein quality than digestibility. Nevertheless, nitrogen retention values obtained in this finding were comparable with the mean value (40.75%) reported by Olorunnisomo (2010) for growing ewe-lambs.

Conclusion

It has been concluded from the result of this study that, the combination of orange and pineapple pulps can enrich and enhance sheep production as well as solving the problem of sheep nutrition, particularly during the dry season. However, mean dry matter intake and coefficient of preference demonstrated that mixture of orange and pineapple pulps in a ratio of 30:40 was best accepted by ram lambs. Thus, it seems clear from the ratio (30:40) of combined orange and pineapple pulps that in vitro gas production characteristics was enhanced with suppressed methanogenesis. Nutrient metabolism of ram lambs were also improved with the same mixture of orange and pineapple pulps (30:40) without any inverse effect on their performance.

References

Aka, L.O., Ugochukwu, N.C., Ahmed, A. and Pilau, N.N. (2011). The effect of ruminal incubation of bioactive yeast (Saccharomyces carevisiae) on potential rumen degradability of Panicum maximum and Centrosema pubescens in west African dwarf sheep. Sokoto Journal of Veterinary Science. **9**(1):28–35.

Akinfemi, A., Adesanya, A.O. and Aya, V.E. (2009). Use of in vitro gas production technique to evaluate some Nigeria feedstuffs. American-Eurasian Journal of Scientific Research. **4**(4):240–245.

Amaefule, K.U., Onwudike, O.C., Ibe, S.N. and Abasiekong, S.F. (2009). Nutrient utilization and digestibility of growing pigs fed diets of different proportions of palm kernel meal and brewers dried grain. Pakistan Journal of Nutrition. **8**(4):361–367.

AOAC (1990). Official methods of analysis. (Association of Official Analytical Chemists) 14th edition, Washington DC. Pp. 141.

Babayemi, O.J. (2007). In vitro fermentation characteristics and acceptability by west African dwarf goats of some dry season forages. African Journal of Biotechnology. **6**(10):1260–1265.

Babayemi, O.J. and Bamikole, M.A. (2006). Effect of Tephrosia candida DC leaf and its mixtures with guinea grass on in vitro fermentation changes as feed for ruminants in Nigeria. Pakistan Journal of Nutrition. **5**(1):14–18.

Babayemi, O.J., Otukoya, F.K., Familade, F.O. and Daodu, M.O. (2009). Assessment of nutritive value of bovine liquor and urea treated corn-straw and corn-cobs as feed fro the West African dwarf sheep and goats. Nig. J. Anim. Prod. **36**(2):313–324.

Bamikole, M.A., Akinsoyinu, A.O., Ezenwa, I., Babayemi, O.J., Akinlade, J., Adewumi, M.K. (2004). Effect of six-weekly harvests on the yield, chemical composition and dry matter degradability of Panicum maximum and Stylosanthes hamata in Nigeria. Grass and Forage Science. 59:357–163.

Calegare, L.,Alencar, M.M., Packer, I.U. and Lanna, D.P.D. (2007). Energy requirements and cow/calf efficiency of Nell-ore, continental and British Bos Taurus x Nellore crosses. J. Anim. Sci. 85:2413–2422.

Cerillo, M.A. and Juarez, R.A.S. (2004). In vitro gas production parameters in cacti and tree species commonly consumed by grazing goats in a semi arid region of North Mexico,. Livestock Research for Rural Development. **16**(4):16021.

Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2001). Testing sheep for methane production. Science Image, CSIRO Division, GA 1334.

Fievez, V., Babayemi, O.J. and 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. Journal of Animal Feed Science. 86:168–175.

Food and Agriculture Organisation (FAO, 2006). Citrus statistics, fresh and processing citrus fruits. Annual statistics, commodities and trade division, FAO, Rome.

Fung, Y.T.E., Sparkes, A.J., Van Ekris, I., Chave, A.V., Bush, R.D. (2010). Effect of feeding fresh citrus pulp to merino wethers on wool growth and animal performance. Anim Prod. Sci. 50:52–58.

Garba, Y., Mohammed, A.S., Muhammed, I.R. and Nasiru, A. (2010). Intake and nutrient digestibility by yankasa rams fed graded levels. Guiera semegalensis as a complete diet. Proc. 35th Conf. Nig. Soc. Anim. Prod. Univ. of Ibadan, Nig. Pg. 514–517.

Getachew, G., Robinson, P.H., DePeters, E.J. and Taylor, S.J. (2003). Relationship between chemical composition, dry matter degradation and in vitro gas production of several ruminants feeds. Animal Feed Science and Technology. 3:57–71.

Menke, K.H. and Steingass, H. (1988). Estimation of the energetic feed value from chemical analysis and in vitro gas production using rumen fluid. Animal Research and Development. 28:47–55.

Ngele, M.B., Adegbola, T.A., Bogoro, S.E.F., Abubakar, M. and Kalla, D.J.U. (2010). Nutrient intake, digestibility and growth performance of Yankasa sheep feed urea treated or untreated straw with supplement. Nig. J. Anim. Prod. **37**(1):61–70.

Njidda, A.A. and Ikhimioya, I. (2010). Nutritional evaluation of some semi-arid browse forages leaves as feed for goats. European Journal of Applied Science. **2**(3):108–115.

Okoruwa, M.I. and A.A. Njidda (2012b). Rumen characteristics and nitrogen utilization of West African dwarf sheep as influenced by guinea grass and dried pineapple pulp. Pakistan Journal of Nutrition. **11**(6):580–583.

Okoruwa, M.I. and Adewumi, M.K. (2010). Effect of replacing Panicum maximum with dried pineapple pulp on nutrient digestibility and nitrogen balance of WAD sheep. Nig. J. Anim. Sci (formerly Tropical Journal of Animal Science). 12: 103–109.

Okoruwa, M.I., Igene, F.U. and Isika, M.A. (2012a). Replacement value of cassava peels with rice husk for guinea grass in the diet of West African dwarf (WAD) sheep. Journal of Agricultural Science. **4**(7):254–261.

Olorunnisomo, O.A. (2010). Utilization of raw, cooked or fermented cassava-urea meal in a total diet for growing ewe-lambs. Nig. J. Anim. Prod. **37**(2):237–246.

Oluremi, O.I.A., Ngi, J. and Adrew, I.A. (2007). Phytonutrients in citrus fruit peel meal and nutritional implication for livestock production. Livestock Res. Rural Dev. **20**(4):120–129.

Ososanya, T.O. (2010). Effect of varying levels of broiler litter on growth performance and nutrient digestibility of West African dwarf lambs. Nigerian J. Anim Sci. 12:123–128.

Ososanya, T.O. (2010). Effect of varying levels of broiler litter on growth performance and nutrient digestibility of West African dwarf lambs. Nigerian J. Anim. Sci. 12:123–128.

Pereira, M.S., Ribeiro, E.L. de. A., Mizubuti, Y.Y. Rocha, M.A. da., Kuraoka, J.T., Nakaghi, E.Y.O. (2008). Nutrient intake and performance of lambs in feedlot fed diets with different levels of pressed citrus pulp in substitution of corn silage Rev. Bras. Zootech. **37**(1):134–139.

Rogerio, M.C.P., Borges, I., Neiva, J.N.M., Pimental, J.C.M., Carvalho, F.C., Ponte, T.R., Gomes, T.O. and Santas, S.F. (2007). Nutritive value of pineapple by-product (Ananas comosus .L) in diets for sheep: Intake, apparent digestibility, energetic and nitrogenous balance. Arq. Bras. Med. Vet. Zootec. **59**(3):773–781.

SAS (1997). Statistical Analysis System. SAS user's guide. NY, CARY: SAS Institute.

Sparkes (2010). Effects of replacing lucern (Medicago sativa L) hay with fresh citrus pulp on ruminal fermentation and ewe performance. Asian-Aust J. Anim. Sci. **23**(2):197–204.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74:3583–3597.

Yousuf, M.B. and Adeloye, A.A. (2011). Performance response of goats fed shd leaves (Vitellaria paradoxa, Gmelina arborea and Daniella oliveri) based diets. Nig. J. Anim. Prod. **38**(1):99–105.