IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 5, Issue 3 (Sep. - Oct. 2013), PP 05-08
www.iosrjournals.org

In Vitro Gas Production Parameters and Characteristics of Four Types of Sweet Orange (C*itrus Sinensis*) Peels Meal

J. Oloche and J.A. Ayoade and *O.I.A. Oluremi

Department of Animal Production, University of Agriculture Makurdi
**Department of Animal Nutrition, University of Agriculture Makurdi*

Abstract: *Four types of sweet orange peel meals: Ibadan sweet peel meal (ISPM), Valencia peel meal (VPM), Washington peel meal (WPM) and composite sweet orange peel meal (CSOPM) were assessed using the in vitro gas technique. The proximate constituents were analysed, and also milled samples of the four types of sweet orange peel meals in triplicates were incubated using 200mg/30ml innoculum for 24hrs. At post incubation, total methane gas produced was measured using 4 ml of 10M NaOH. The metabolizable energy (ME), organic matter digestibility (OMD) and short chain fatty acid (SCFA) were estimated. Dry matter was highest in CSOPM (87.66%) and lowest in WPM (80.50%), while crude protein (CP) and nitrogen free extract (NFE) values were highest in WPM (9.95% and 69.28% respectively). In vitro gas production volume (IVGP), ME, OMD and SCFA were not significantly different (p>0.05) among the sample types. However, absolute values showed that WPM had highest values of IVGP (48.33ml/200mgDM), ME (9.36MJ/kgDM), OMD (66.71%) and SCFA (1.09mmol/200mgDM). The potential extent of gas production 'b' of WPM (75.82ml/200mgDM) was significantly higher (p<0.05) than the other peel meal types and VPM (36.86) was the lowest. The potentially degradable fraction 'a+b' for WPM (81.96ml/200mgDM) was significantly higher than all the other peel meal types, while VPM (44.72) was the least. The rate constant 'c' of VPM, WPM and CSOPM were similar (p>0.05) among the treatments.*

Key words: *Sweet orange peel meal types, chemical composition, in vitro fermentation*

I. Introduction

Increasing demand and consequently high cost of conventional animal feed ingredients in the tropics has created the need for sustainable alternatives, particularly natural feed resources indigenous to the region. In Nigeria, tremendous availability of crop residues and agro-industrial by-products has been highlighted (Egbunike and Ikpi, 1988) which can partially or completely substitute the scarce and expensive conventional feeds (Oluremi *et al*., 2007). This is because of the low cost of animal production, scarcity of cereal grains and oil seed cake and the very stiff competition existing between humans and the livestock industry for cereal grains which has greatly reduced the animal protein intake (Devendra, 1991). One such alternative feedstuff is sweet orange (*Citrus sinensis*) peel meal. Sweet oranges are the most cultivated citrus plants mainly for its fruits and juice which is used for preparation of squash flavouring (Yayock *et al*., 1988). About 140 countries produce citrus fruits and Nigeria's production is about 20%. Clusters of peels of the sweet orange are usually noticed on streets and along major roads in Nigeria (Oluremi *et al*., 2007). Rather than discard them, Ipinjolu (2000) suggested that, the orange peels could be sun-dried and milled in a milling machine to obtain the sweet orange peel meal (SOPM). Sweet orange peel meal has been observed to be a source of calorie and protein comparable with maize (Oluremi *et al*., 2006), and since citrus fruits have been reported to be available throughout the year (Oluremi *et al*., 2007) it could be harnessed for goat production. The *in vitro* method of evaluation is less expensive, less time consuming and allows incubation condition to be maintained more precisely. It also makes possible the screening of feed samples which are in small quantities possible (Njidda *et al*., 2010). Babayemi *et al*. (2004) reported that *in vitro* gas production is a quick and less expensive means of determining the nutritive value of feeds for ruminants. Although gas production is a nutritional wasteful product (Mauricco *et al*., 1990), it provides useful basis for which metabolisable energy (ME), organic matter digestibility (OMD) and short chain fatty acids (SCFA) may be predicted. The study was therefore designed to access the *in vitro* gas production parameters and *in vitro* gas production characteristics of four types of sweet orange peel meals.

II. Material and Methods

Collection of samples and preparation: Three varieties of sweet orange fruits (Ibadan sweet, Valencia and Washington) were purchased from a fruit market within Makurdi metropolis. These were peeled separately to obtain the sweet orange peels for the three types of sweet oranges. The fourth type (composite sweet orange peels) was obtained from orange fruit retailers who peel and retail the different varieties for direct consumption. The four types of sweet orange peels were sun-dried on concrete slab for 48hrs and when they became crispy, they were separately packed, crushed in a mortar and pestle and thereafter ground in a hammer mill to pass a

1mm sieve to obtain the four types of sweet orange peel meal (SOPM) for proximate analysis. The crude protein, crude fibre, ether extract and ash were determined according to AOAC (1995).

In vitro gas production**:** The *in vitro* gas production was determined according to the method of Menke and Steingass (1988). Rumen liquor was obtained from four West African dwarf bucks before their morning feeding. 200mg of each type of SOPM were placed in a 120ml calibrated plastic syringes in triplicates. To each of these was added 30ml inoculum containing cheese-cloth strained rumen liquor and buffer (1:4, v/v) under constant flushing with CO_2. Gas production was measured at 3, 5, 9, 12, 15, 18, 21 and 24 hours. At post incubation, methane production was measured as described by Babayemi *et al*. (2006). Metabolisable energy (ME) and organic matter digestibility (OMD) were estimated as described by Menke and Steingass (1988), while SCFA was estimated as given by Getachew *et al*. (1998). The *in vitro* gas production characteristics (a, b, a+b and c) were derived by calculation using the the formular $Y = a+b(1-e^{-ct})$, Where Y = Volume of gas produced at time t, a = Intercept (gas produced from the soluble fraction), b = gas produced from the insoluble but fermentable fraction, a + b = potential volume of gas produced, c = rate of gas production (constant), t = incubation time. Data collected were subjected to analysis of variance (ANOVA) using the Minitab (1991) software package in a completely randomized design. Means that were significant were separated using the Fisher's least square difference (LSD) as outlined by Akindele (1996).

III. Results and discussion

The chemical composition of the four types of sweet orange peel meal is presented in Table 1. Peel meal sample types had appreciable values of the different nutrients except ether extract. Dry matter (80.50-87.66%) and organic matter (74.20-82.86%) values were lowest in WPM and highest in CSOPM. The crude protein values of the peel meal samples ranged between 7.40-9.95%, and were comparable with 9.73% CP for maize as reported by Oyewole *et al*. (2013). Ether extract values which were between 1.63-3.35% were adequate because high fat in feeds reduces shelf life as a result of rancidity (Oluremi *et al*., 2006), also the capacity of rumen microbes to digest fat/lipids is normally low, so that if fat values in a diet increases above 100g/kg, the activities of the microbes will be reduced, fermentation of carbohydrates retards and feed intake falls. The effect of *in vitro* fermentation on IVGP, ME, OMD and SCFA for the four types of peels incubated for 24 hours is presented in Table 2. There was no significant difference ($p>0.05$) among the sample peel meal types, this implies that, none provided more fermentable carbohydrates than the other within the 24 hours of incubation. All the sample peel meal types had high energy potentials and digestibility. The IVGP parameters of the sample peel meal types in this study compared with 6.44-8.44MJ/kgDM, 57.35-63.16% and 0.59-0.95mmol/200mgDM for ME, OMD and SCFA respectively as reported by Abegunde *et al*. (2009) for six *Ficus species* and *Panicum maximum* in the dry season. The peel meal sample types seemed to be a viable and suitable feed ingredient for inclusion in ruminant diet. The *in vitro* gas production characteristics for the four types of sweet orange peel meal is presented in Table 3. Significant differences ($p<0.05$) were observed among the sample peel meal types. Ibadan sweet peel meal (9.72) was higher ($p<0.05$) than WPM (6.14), VPM (7.36) and CSOPM (4.55) in the soluble fraction 'a' while WPM had a significantly higher ($p<0.05$) value (81.96) for the potentially degradable fraction 'a+b' than VPM (44.22) and CSOPM (48.30). This may have been so because ISPM and WPM have thicker mesocarp than VPM and CSOPM. The potential extent of gas production 'b' of WPM (75.82) was significantly higher ($p<0.05$) among the sample peel meal types than the others, this indicates that WPM has a higher potential of producing more fermentable carbohydrates than the other sample peel meal types and it also means that WPM has higher digestibility. The fractional rate of gas production 'c' of all the sample peel meal types was high, observed values were 0.009, 0.05, 0.03 and 0.06 for ISPM, VPM, WPM and CSOPM respectively. This may have been influenced by the fermentable carbohydrate fraction that was readily available to the microbial population, as slow rate of gas production means that the feedstuff is less depreciated by rumen microbes (Akinfemi, 2011). Observed values were comparable with those of Arigbede *et al*. (2006) who reported 0.05-0.07ml/hr for guinea grass stem and leaf. The relatively high rate of fermentation in this study implies that the sweet orange peel meal types have highly digestible.

IV. Conclusion

Results from this study revealed that the types of sweet orange peel meal investigated showed high degradation and high nutritive potentials. This is an indication that any of the peel meal types could be considered as a potential feed ingredient source of energy in concentrate supplement mix for ruminants particularly during the dry season when feed resources are scarce.

Table 1: Chemical composition of the four types of sweet orange peel meal

	Sweet orange types			
Parameters (%)	ISPM	WPM	VPM	CSOPM
Dry matter	83.60	80.50	83.75	87.66
Organic matter	76.47	74.20	76.31	82.82
Crude protein	8.69	9.95	9.11	7.40
Crude fibre	14.72	12.79	15.01	13.23
Ether extract	2.16	1.63	2.02	3.36

Table 2*: In vitro* gas production parameters of samples of the four types of sweet orange peel meal at 24 hours post incubation

	In vitro gas production parameters			
Sweet orange peel meal types (mmol/200mgDM)	IVGP	ME	OMD	SCFA
Ibadan sweet	43.33	8.75	63.05	0.97
Valencia	46.00	8.94	64.99	1.02
Washington	48.33	9.36	66.71	1.09
CSOPM	44.67	8.92	63.04	1.04
SEM	4.30^{ns}	0.75^{ns}	3.88^{ns}	0.10^{ns}

^{ns} = not significant (p>0.05), IVGP = *in vitro* gas production, ME = metabolisable energy, OMD = organic matter digestibility, SCFA = short chain fatty acids, CSOPM = composite sweet orange peel meal, SEM = standard error of meal

Table 3: *In vitro* gas production characteristics of the four types of sweet orange peel meal a, b, c = means on the same row with different superscripts are significantly different (p<0.05). * = significant (p<0.05), ns = not significant (p>0.05), SEM = standard error of mean, CSOPM = composite sweet orange peel meal, a =

Fermentation characteristics	Varieties of sweet orange and composite				
	ISPM	VPM	WPM	CSOPM	SEM
a	9.72^{a}	7.36^{b}	6.14^{b}	4.55^{c}	0.58*
a+b	69.89^{a}	44.22^{b}	81.96^{a}	48.30^{b}	4.67*
b	58.17^{b}	36.86^{c}	75.82^{a}	$43.75^{b,c}$	4.41*
c	0.009^{b}	0.05^{a}	0.03^{a}	0.06^{a}	0.01*
lag time	4.65	4.42	4.49	4.57	4.65^{ns}

soluble fraction, a+b = potentially degradable fraction, b = potential gas production, c = rate of fermentation constant.

References

[1]. Abegunde, T.O., Babayemi, O.J and Akinsoyinu A.O. (2009). Chemical composition, *In vitro* digestibilityand gas production characteristics of six ficus species based diets with *panicum maximum* in the dry season. *Nig. J. Anim. Prod*. 2009. 36(1): 143 – 152.

[2]. Akindele, S. O. (1996). Basic Experimental Designs in Agricultural Research. Montem paperbacks, Akure, Nigeria. Pp. 25 - 34.

[3]. Akinfemi, A. (2011). Potential of fungal-degraded maize by-products as feed for West African Dwarf rams. A Ph.D Thesis submitted to the Department of Animal Science, Faculty of Agriculture and Forestry. University of Ibadan. Nigeria. Pp 53– 73.

[4]. AOAC (1995). Official method of Analysis (16th edition) Association of official AnalyticalChemists, Washington DC.

[5]. Arigbede, O.M., Anele, U.Y., Olanite, J.A., Adekule, I.O., Jolaoso, O.A and Onifade, O.S . (2006). Seasonal *in vitro* gas production parameters of three multipurpose tree species in Abeokuta, Nigeria. *Livest. Res. for Rural Develop*. 18(10). http:// www.cipav.org.co/lrrd 18/10/ariybed.htm

[6]. Babayemi, O. J., Demyer, D. and Fievez, V. (2004). Nutritive value and qualitative assessment of secondary compounds in seeds of eight tropical browse, shrubs and pulse legumes. *Courm. Appl. Biol. Sc. Ghent University*. 69 (1): 103 – 110.

[7]. Babayemi, O. J. and Bamikole, M. A. (2006). Nutritive value of *Tephosia candida* seed in West African Dwarf goats. *J. Cent. Eur. Agric*. 7:4, 731 – 738.

[8]. Devendra, C., (1991). Feed resources in goat husbandry and breeding in the tropics. Paper presented in an international seminar organized by German foundation forinternational Development (DSF) at Institute of Advanced studies. University of Malaysia. Kuala Lumpur, pp. 121-135.

[9]. Egbunike, G. N and Ikpi, A. E. (1988). Utilization of research results on forage and AgriculturalBy-products materials as animal feed resources in Africa. In: Azowela, B. H., Said, A. N., Wenen-Agenelia and Katogile, J. A. (Eds) Proc., OANESA/ARNAB workshop Malawi, December 5-9, pp 447-488.

[10]. Getachew, G., Blummel, M., Makkar, H. P and Becker, K. (1998). *In vitro* gas measuring techniques for assessment of nutritional quality of feeds. A review. *Anim. feed. Sci. Tech*. 72: 261 – 281.

[11]. Ipinjolu, J.K (2000). Performance of juvenile orange koi carp (*Cyprinucarpio leanneanus*) feddiets supplemented with sweet orange peel meal: Body composition, nutrition, Utilization and skin pigmentation. *Sokoto J.Vet.Sci.* 2000:228-229.

[12]. Mauricco, R.M., Mould, F.L., Dhanao, M.S., Owou, E., Channa, K.S and Theodorou, M.K (1990). A Semi-automated *in vitro* gas production technic for ruminant feedstuff evaluation. *Anim. Feed. Sci. Technol*. 79:321-330.

[13]. Menke, K. H and Steinguss, H. (1988). Estimation of the energetic feed value from chemical analysis and *in vitro* gas production using rumen fluid. *Anim. Res. Develop*. 28: 7 – 55.

[14]. Njidda, A.A., Ikhinioya, I and Mohammad, I.R. (2010). Feed potential of Ziziphus Mauritian as browse to goats in Sudano – sahelian region of Nigeria. Proc., 35th Conf. Nig. Soc. for Anim. Prod. Held on the 14th – 17th of March, 2010, Univ. of Ibadan, Ibadan, Nigeria. pp. 473 – 476.

[15]. MINITAB (1991). Statistical Software. V.10. 2 MINITAB Inc. P.A., USA.

[16]. Oluremi, O.I.A., Ojighen, V.O and Ejembi, E.H. (2006). The nutritive potential of sweet orange(*Citrus sinensis*) in Broiler production. *Int. Poult. Sci* 5(7):613-617.
[17]. Oluremi, O. I. A., Andrew, I. A and Ngi, J. (2007). Evaluation of the nutritive potential of thePeels of some citrus fruit varieties as feeding stuff for livestock production. *Park. J.Nutr*. 6(6): 653-656.
[18]. Oyewole, B. O., Oluremi, O.I.A., Aribido, S.O. and Ayoade, J.A. (2013). Comparative chemical compositionof fermented sweet orange (*Citrus sinensis*) fruit peel meal diets with maize and performance response of pullet chicks. *Nig. J. Anim. Prod.* In press.
[19]. Yayock, J. Y., Lombin and Owunobi, J. O (1988). Crop science and production in warm climates. Macmillan Int. Agri. Series. Macmillan publishers Ltd. London., pp 307.