ISSN: 2228-6322

International Journal of AgriScience

International Academic Journals

UNIVERSITY OF IBADAN LIBRARY

Intake, nutrient digestibility and rumen ecology of West African dwarf sheep fed palm kernel oil and wheat offal supplemented diets

Ososanya Tolulope O.*, Odubola Olajumoke T., Shuaib-Rahim A.
*Department of Animal Science, University of Ibadan, Nigeria *Author for correspondence (email: tososanya85@gmail.com)*

Received February 2013; accepted in revised form April 2013

ABSTRACT
Dried cassava peels (DCP), wheat offal (WO) and palm kernel oil (PKO) are readily available in the tropics during the dry season. Sixteen rams aged 15 months with weight range of 11.07 ± 0.8kg were randomly divided into four treatments with four replicates in a CRD. The treatments were: T1 – 100% DCP, T2 – 80% DCP + 20% WO, T3 – 77% DCP + 20% WO + 3% PKO and T4 – 97% DCP + 3% PKO. Parameters studied were feed intake, nutrient digestibility, total volatile fatty acids and microbial population. The dry matter intake values obtained were 869.98, 8415.89, 784.36 and 462.16g/dl for T1, T2, T3 and T4 respectively with significant differences (P < 0.05) between T1 – T3 against T4. Nutrient digestibility had significant differences (P < 0.05) amongst treatments for all parameters studied except in Neutral detergent fibre with no significance. The dry matter digestibility increased from 82.61% in T1 to 91.12% in T4, crude protein digestibility ranged from 82.89% to 89.98% for T1 and T2 respectively. There were no significant differences (P > 0.05) between T2 and T4, also between T3 and T4. Hemi cellulose appeared to be the most digestible nutrient studied. Rumen pH ranged from 6.00 to 6.70 for T2 and T4 respectively. The result was similar (P > 0.05) statistically across the treatments, except in T2. Ammonia nitrogen increased with supplementation of WO and PKO. However, supplementation of DCP with WO and PKO at 3% inclusion improved digestibility, but depressed feed intake in WAD sheep.

Keywords: Digestibility, Feed intake, Palm kernel oil, Performance, Sheep, Supplementation

INTRODUCTION
Feed cost is a major burden of livestock farms, thus, a major strategy to develop the livestock industry in developing countries could be to increase the use of locally available feed resources thereby reducing the cost of importation. Moreover, meeting the nutritional needs of ruminants throughout the year is a major challenge facing ruminant owners in the tropics due to seasonality of forages. Poor nutrient status and limited supply of forages notwithstanding, agro-industrial by-products (e.g. cassava peel, plantain peel, brewer's spent grain and corn cobs) constitute the largest feed resource for ruminants (Baah 1994). Amongst the agro-industrial by-products, cassava peel is the most abundant and has the greatest potential as a basal feedstuff for small ruminants. Cassava peel (CP), waste from cassava tuberous root processing, (Otukoya and Babayemi 2008) constitute 11% of the root and its production throughout the year ensures a consistent

UNIVERSITY OF IBADAN LIBRARY

supply for livestock feedingssss. However, to improve the nutrient composition of crude protein, supplementation with feed resources such as palm kernel oil and wheat offal would go a long way to improving feed intake, digestibility and feeding value.

Supplementation of good quality protein can improve roughage intake and digestibility by improving the rumen ecology. Hence, the purpose of this study was to determine the effect of wheat offal and palm kernel oil supplementation on feed intake, digestibility, microbial and fermentative characteristics.

MATERIAL AND METHODS

Experimental animals and management

Sixteen West African Dwarf (WAD) *sheep* aged between 12 – 18 months weighing between 15.56 – 16.58kg were purchased for the trial. The animals were treated with antibiotics (Oxytetracycline LA) at the rate of 1ml per 10kg live weight and Ivomectin at 1ml per 25kg live weight. Guinea grass and concentrate were fed to the animals during the adjustment period. Fresh and clean water was made available throughout the experiment. The animals were housed individually in pens with wood shavings on the floor to serve as beddings. During the digestibility trial, the animals were transferred to individual metabolic cages..

Experimental diets

Dried cassava peels (DCP), palm kernel oil (PKO) and wheat offal (WO) were used for the study. DCP was crushed in hammer mill to reduce the particle size for proper mixing and penetration of PKO in the mix. The ingredients were mixed together into four diets as shown in Table 1.

Chemical analysis

All diets and faeces were sampled and oven dried at 105^{0}C to obtain dry matter (DM), while crude protein (CP), fibre fractions [acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADF)] were analyzed as described by AOAC (1990).

Digestibility Study

Faeces and urine of all the animals was collected at the last seven days after seven days adjustment period in the metabolic cages. Feed intake, total faecal output, urine output and digestibility were measured and calculated. Aliquot samples of faeces and urine were analyzed.

Rumen fluid

Rumen fluid samples (80ml) were taken at 4 hour post-feeding on the last day of each period by using a stomach tube connected to a vacuum pump. Rumen fluid pH was determined by using portable pH meter and rumen fluid was fixed by adding 10% *sulphuric acid solution for analysis of* ammonia nitrogen concentration using the methods of Anderson and Ingram (1979) and VFA concentration as described by Gilchrist (1967). Microbial count was carried out using pour-plate technique.

Statistical analysis

Complete randomized design was used for the experiment. Data were analyzed using analysis of variance (SAS 1999). Significant means were separated using Duncan multiple range F - test of the same package.

RESULT AND DISCUSSION

The proximate composition of DCP and WO are presented in Table 2. The DM values for DCP and WO were 87.95% and 87.60% respectively. The value obtained in this study was similar to 90% reported by Amafuele et al. (2009). The CP values obtained were 3.80% and 16.20% for DCP and WO respectively. The CP recorded correlated with the values obtained by Devendra (1979), Khajaren et al. (1977) and Asaolu (1988). The NDF obtained for DCP (70%) was higher than that of WO (60%), while ADF and ADL values for WO (9.60% and 2.00% respectively) were higher than

UNIVERSITY OF IBADAN LIBRARY

that of DCP (5.60% and 1.90% respectively).

Table 1: Composition of experimental diets

Ingredients	T 1	T 2	T 3	T 4
DCP	100	80	77	97
WO	-	20	20	-
PKO	-	-	3	3
Total	100	100	100	100
Calculated Nutrients				
ME (Kcal/kg)	3200.00	2934.00	2984.00	3220.00
Crude protein (%)	2.50	5.40	5.63	2.80

T1 – 100%DCP; T2 – 80% DCP + 20% WO; T3 – 77% DCP + 20% WO + 3% PKO;
T4 – 97% DCP + 3% PKO

Table 2: Proximate composition of DCP and WO

Parameter	DCP	WO
DM	87.95	87.60
CP	3.80	16.20
EE	7.00	4.40
Ash	2.80	5.70
NFE	76.60	61.80
NDF	70.00	60.00
ADF	5.60	9.60
ADL	1.90	2.00

Dry matter digestibility increased with decreased DCP inclusion in the diets. This is shown in Table 3.

There were no significant (P < 0.05) difference between T1, T2 and T3, while T4 differed significantly (P < 0.05) from the others. The digestibility coefficient were comparable to 78 – 79% and 78 – 80% DM digestibility observed by Hadjipanayiotou (1990) respectively for sheep and goats fed hay supplemented with concentrate as well as those reported by Murphy et al. (1994) who fed concentrate at restricted intakes to lambs in complete diets.

Crude protein digestibility showed significant (P < 0.05) difference between T1 (82.89%) and T2 (89.98%) alone while others were similar (P > 0.05). The CP digestibility was highest at T2 (89.96%). This submission agrees with the speculation of Giri et al. (2000) that digestibility of nutrient varies with nutrient composition of feedstuffs. The NDF digestibility showed no significant (P > 0.05) difference between diets, but with T3 (89.46%) being the highest with WO and PKO supplementation. ADF digestibility showed significant (P < 0.05) difference between T1 and other treatments (12.08% versus 61.04%, 56.76% and 57.08% respectively). The values obtained in this study fell below the range (63.30% - 78.40%) recorded by Olorunisomo and Ososanya (2002) who fed maize offal and sorghum brewers grain as supplement to WAD sheep.

Dry matter intake (DMI) is an important factor in the utilization of feed by ruminants and is a critical determinant of energy intake and performance (Devendra 1997). The result obtained in this study showed that supplementation with PKO (at 3%) reduced voluntary feed intake. This observation

UNIVERSITY OF IBADAN LIBRARY

agrees with findings of Wanapat et al. (2005).

The intake was highest for T1 (869.98g/d). This finding is similar to the results of Vongsamphanh and Wanapat (2004) and Tran Quoc Viet and Dao Duckien (2005) who found that supplementation of cassava hay increased total rice straw DMI, growth rate and digestibility of cattle and buffaloes. The increase in DMI due to PKO in this study is in agreement with Mom Seng et al. (2001) and Nguyen et al. (2001, 2005).

Leng (1982) found that adding high levels of fat increased microbial activities. Normally, fat content of ruminant diets is low (< 50g/kg), and if it is increased above 100g/kg the activities of rumen microbes are reduced (McDonald et al. 2002). There were no significant (P > 0.05) difference in the faecal output for T1 (151.32g/dl), T2 (119.96g/d) and T3 (135.99g.d) respectively. Faecal output for T4 was significantly (P < 0.05) different from other treatments. There was significant (P < 0.05) difference across the treatments in nitrogen content. Urine nitrogen was lowest in T4 (44.05g/dl) where DCP 97% was supplemented with PKO 3%.

The fermentation characteristics of WAD sheep fed varying levels of DCP, WO and PKO are presented in Table 5. The rumen liquor pH was similar (P > 0.05) statistically across the treatments, except T2 (6.00) which were similar to the findings of Mom Seng et al. (2001), Nguyen et al. (2001) and Promkot and Wanaput (2003). However, except for T2, the values obtained in this study for pH are within the range (6.5 – 7.0) for maximum microbial growth (Hungate, 1966). There was significant (P < 0.05) difference in ammonia nitrogen across the treatments. The result was similar to the findings of Wanapat et al. (2005), who found that the ammonia nitrogen concentration in the rumen fluid was not significantly affected by increasing level of oil, but tended to increase when supplemented with a high level of urea. The most suitable rumen ammonia – nitrogen level for microbial activities were 5 – 20mg/100ml in ruminants fed low-quality roughages (Boniface et al. 1986). Wanapat and Pimpa (1999) found that optimum range for ammonia - nitrogen was 13.6 – 34.4mg/100ml for microbial protein synthesis and digestibility in buffaloes. Also, Preston and Leng (1987) reported an optimum level of ammonia - nitrogen in rumen fluid for microbial growth ranged from 5 – 25mg/dl. The findings from this study fell within the range of Preston and Leng (1987). Supplementation of WO and PKO significantly affected total volatile fatty acid (VFA) concentration, decreased with supplementation of PKO alone. This submission agrees with findings of Wanapat et al. (2005) that different supplementation levels of coconut oil significantly affected VFA proportions in the rumen.

Table 3: Nutrient digestibility (%) of WAD sheep fed varying levels of DCP, WO and PKO

Parameter	T1	T2	T3	T4	SEM
Dry matter (%)	82.61[b]	82.66[b]	85.87[b]	91.12[a]	0.22
Crude protein (%)	82.89[b]	89.98[a]	88.96[ab]	87.89[ab]	0.26
Ash (%)	24.89[b]	71.88[a]	74.58[a]	65.35[a]	0.81
Ether extract	74.35[b]	85.93[a]	79.45[ab]	85.09[a]	0.37
Crude fibre	61.00[b]	77.49[a]	79.56[a]	79.54[a]	0.42
NDF	81.87[a]	89.42[a]	89.46[a]	86.77[a]	1.19
ADF	12.08[b]	61.04[a]	56.76[a]	57.08[a]	0.75
ADL	10.68[b]	47.69[a]	47.66[a]	42.97[a]	1.11
Hemicellulose	88.57[b]	93.52[a]	93.60[a]	94.32[a]	0.16
Cellulose	8.39[b]	71.22[a]	59.92[a]	50.26[ab]	1.72

a, ab, b means in the same row with different superscripts are significantly different (P < 0.05).

UNIVERSITY OF IBADAN LIBRARY

Table 4: Dry matter intake, faecal and urinary output of WAD sheep fed varying levels of DCP, WO and PKO.

Parameter	T1	T2	T3	T4	SEM
DM	97.74^{a}	97.82^{a}	93.27^{b}	92.11^{a}	0.29
DMI (g/d)	869.98^{a}	845.89^{a}	784.36^{a}	462.16^{b}	5.98
Faecal output (g/d)	151.32^{a}	119.56^{a}	135.99^{a}	44.05^{b}	2.72
DM (Faecal) (%)	54.96	43.94	47.56	34.29	3.34
Urine (mls/day)	201.21	237.74	190.48	209.94	4.21
Urine Nitrogen (%)	0.0650	0.5350	0.5450	0.2195	0.05

a,b,c means in the same row with different superscript superscripts are significantly different ($P < 0.05$).

Table 5: Fermentative characteristics of WAD sheep fed varying levels of DCP, WO and PKO

Parameter	T1	T2	T3	T4	SEM
pH	6.50^{a}	6.00^{b}	6.50^{a}	6.70^{a}	0.04
Acetic acid (mg/dl)	6.06^{a}	5.40^{b}	4.56^{c}	3.12^{d}	0.02
Butyric acid (mg/dl)	6.16^{a}	5.49^{b}	4.63^{c}	3.17^{d}	0.01
Propanoic acid (mg/dl)	4.04^{a}	3.60^{b}	3.04^{c}	2.08^{d}	0.03
NH_3-N (mg/dl)	6.96^{c}	9.70^{b}	10.60^{a}	9.98^{b}	0.07

a,b,c,d means in the same row with different superscripts are significantly different ($P < 0.05$).

Table 6: Microbial population of WAD sheep fed varying levels of DCP, WO and PKO

Dilution Factor	T1	T2	T3	T4	SEM
10^{-2}	62.00^{a}	79.00^{c}	98.00^{b}	107.00^{a}	0.53
10^{-4}	27.00^{c}	32.00^{b}	34.00^{b}	62.00^{a}	0.53
10^{-6}	22.00^{a}	26.00^{a}	18.00^{c}	25.00^{a}	0.30

a,b,c,d means in the same row with different superscripts are significantly different ($P < 0.05$).

Microbial population of WAD sheep fed varying levels of DCP, WO and PKO are shown in Table 6. There were significant ($P < 0.05$) differences in the microbial population in the rumen fluid of the animals across the treatments. Supplementation with WO and PKO greatly led to an increase in microbial population, but the population reduced as the dilution rate increased. The population was highest with supplementation with PKO in the dilution factor 10^{-2} with the values 62.0cfu/ml; 79.0cfu/ml, 98.0cfu/ml and 107cfu/ml for T1, T2, T3 and T4 respectively.

CONCLUSION

Supplementation with wheat offal (WO) improved fermentative characteristics, digestibility and microbial population but did not affect rumen pH and VFA concentrations. However, supplementation with PKO alone recorded the highest microbial population but the DM intake was depressed. The use of WO as a protein source in diets for ruminants can be highly recommended as an appropriate feeding strategy to improve livestock production, especially in the dry season. However, inclusion of PKO at 3% improved digestibility, but depressed feed intake in WAD sheep.

REFERENCES

Association of Official Analytical Chemist (A.O.A.C.) (1990) Official methods of analysis. 15th Edition, Association of Official Analytical Chemists. Washington DC, USA

Anderson JM, Ingram JS (1979) Tropical soil biology and fertility. A handbook of methods. 2nd edition. Pp. 73 – 74

Amaefule KU, Abasiekong SF, Ibe SM, Onwudike OC (2009) Digestibility and nutrient utilization of some agro industrial by-products. J Anim Res *13*: 63 – 98.

Asaolu VO (1988) Utilization of cassava peels and *Gliricidia sepium* in the diet of the West African Dwarf

UNIVERSITY OF IBADAN LIBRARY

Sheep. Dissertation, Obafemi Awolowo University, Nigeria

Baah J (1994) Selection and evaluation of feedstuffs for urban and peri-urban small ruminant production systems in Ghana. A system approach. Dissertation. University of British Columbia, Vancouver, BC, Canada.

Boniface AN, Murray RM and Hogan JP (1986) Optimum level of ammonia in the rumen liquor of cattle fed tropical pasture hay. Proceedings of Australian Society of Animal Production. 16: 151 – 154.

Devendra C (1997) Cassava as a feed source for ruminants. Proceedings of Agricultural Conference on cassava as animal feed pp107 – 119.

Gilchrist SDW (1969) A practical course in Agricultural Chemistry. 1st edition, Pergamon Press, New York.

Giri SS, Shaon A and Pathak NN (2000) Feed intake, digestibility, plane of nutrition and live weight gain by crossbred growing bulls fed on grain less diet containing different nitrogen sources. Anim Feed Sci Technol 83: 195 – 203.

Hadjipanayiotu M (1990) Effect of grain processing on the performance of early weaned lambs and kids. Anim Prod 51: 565 – 572.

Hungate RE (1966) The rumen and its microbe. Academic Press, New York. Proceedings of Animal Feed Sci Technol 16: 151 – 154.

Khajaran S, Khajaren JM, Kitpanit N and Muller ZO (1979) Cassava in the nutrition of swine in proceedings of Cassava as animal feed pp 56 – 64.

Leng RA (1982) Modification of rumen fermentation. In: Hacker JB (eds) Nutritional limits to animal production from pastures. CAB, Royal, UK

McDonald P, Edwards RA, Greenhalgh JFD and Morgan CA (2002) Animal nutrition. Longman, Singapore

Mom Seng, Preston TR, Leng RA and Menlen U (2001) Effect of a single drench of cooking oil on the rumen ecosystem and performance of young local yellow cattle fed rice straw and cassava foliage. Tropical Animal Production 2: 209 – 300

Murphy TA, Loerch SC and Smith FE (1994) Effect of feeding high concentrate diets at restricted intakes on digestibility and nitrogen metabolism in growing lamb. J. Anim. Sci. 72: 1683 – 1590

Nguyen THN, Nguyen TN, Nguyen T, Preston TR and Leng RA (2005) Determination of the optimum level of a soybean oil drench with respect to the rumen ecosystem, feed intake and digestibility in cattle http://www.mekarn.org/proctu/rhan9.htm

Nguyen THN, Nguyen VH, Ngu NT, Von NT, Preston TR and Leng RA (2001) Practical application of defaunation of catle on farms in Vietnam. Response of young cattle fed rice straw and grass to a single drench of groundnut oil. Asian-Australian Journal of Animal Science 14(4): 485 – 490

Olorunnisomo OA, Ososanya TO (2002) Feed intake, digestibility and nitrogen balance of West African Dwarf goats fed maize offal and sorghum brewer's grain. Trop. Anim. Prod. Invest. 5: 211 – 218

Otukoya FK, Babayemi O (2008) Supplementation of Leucaena leucocephala hay as protein enrichment for cassava peels in West African Dwarf goats. J Food Agric Environ 6: 247 – 250

UNIVERSITY OF IBADAN LIBRARY

Preston TR, Leng RA (1987) Matching ruminant production system with available resources in the tropics and sub-tropics. Penambul books, Australia
Promkot C, Wanapat M (2003) Ruminal degradation and intestinal digestion of crude protein of tropical protein resources using nylon bag technique and three-step *in-vitro* procedure in dairy cattle. Livestock research for rural development http://www.irrd.org/irrd15/11/prom1511.htm
SAS (1999) User's Guide: Statistics version 6.06 SAS, Institute Inc Cary NC
Tran QV, Dao DK (2005) Effects of supplementation of cassava hay as a high protein feed source to the rice straw ration and Vong nem (*Erythrina senegalensis*), leaves as herbal medicine against helminthes, on growth rate and feed utilization efficiency of local beef cattle under household conditions. MEKARN-CTU. Making better use of local feed resources. http://www.mekarn.org/proctu/viet16.htm
Vongsamphanh P, Wanapat M (2004) Comparison of cassava hay yield and chemical composition of local and introduced varieties and effects of levels of cassava hay supplementation in native beef cattle fed on rice straw. Livestock research for rural development. http://www.lrrd.org/lrrd16/8/vong16055.htm
Wanapat M (1999) Feeding of ruminants in the tropics based on local feed resources.
Anim Feed Sci Technol 46: 67 – 70
Wanapat M, Petlum A, Chanthai S (2005) Effects of levels of urea and coconut oil on rumen ecology, milk yield and composition in lactating dairy cows fed on urea-treated rice straw. http://www.mekara.org/proctu/wana13.htm

UNIVERSITY OF IBADAN LIBRARY