

## THE UTILIZATION OF COMPLETE RATIONS BASED ON CROP RESIDUES BY THE BLACK HEAD SHEEP

E. M. Aregheore, R. Tembo

*University of Zambia, School of Agricultural Sciences, Department of Animal Science, Lusaka, Zambia*

Twelve growing lambs were allotted on the basis of weight to 3 treatment groups in a completely randomized design experiment to investigate the utilization of complete rations based on crop residues – groundnut shell (GNS), sunflower head (SFH) and citrus meal (CM). In the trial voluntary feed intake (DMI), live weight gain and apparent nutrient digestibility were measured. Physical treatment (grinding) of the residues before mixing with other ingredients in the rations influenced voluntary DMI. DMI was however, not significantly different ( $P > 0.05$ ) among lambs fed the three crop residue rations. Live weight gain values of 154, 181, and 202 g/head/day were obtained in lambs fed GNS, SFH and CM based rations. Lambs fed CM were better ( $P < 0.05$ ) in live weight gain than lambs fed GNS and SFH based rations. Except for the digestibility of ADF, ADL and cellulose which were low ( $P < 0.05$ ) in lambs fed GNS ration apparent nutrient digestibility were generally above average (above 60%). Results indicated that nutrient digestibility was better ( $P < 0.05$ ) in SFH and CM rations. Voluntary DMI, growth rate and apparent nutrient digestibility of lambs fed the rations indicated that crop residues are a good source of roughage for dry season feeding if properly handled and processed.

crop residues; dry matter intake; growth; lambs; Gwembe valley

### INTRODUCTION

In most African countries, there is shortage of feedstuffs. In the dry season of the year when there is a shortage of grasses, ruminants subsists mainly on fibrous agricultural wastes that are usually of poor nutritional quality. Crop residues are waste and they generally constitute environmental nuisance after harvest and processing. However, research findings over the years have shown that they could be a good source of roughage for ruminant livestock (Garrigus et al., 1960; Reddy, Reddy, 1981; Diarra, Bosma, 1988; Dixon, Egan, 1988) if properly handled and processed.

In most cropping areas of Zambia where ruminant livestock are kept by small holder farmers, crop residues are not processed before being fed to ruminants. They are fed either *in situ* where large herds are kept or in stalls where few animals are kept. In some areas these materials are either left to rot or burnt in the field of harvest. Loss of weight and even death in some cases have been observed in the dry season when animals are forced to graze on dead pasture residues which are generally very low in protein. The use of crop residues therefore promises a way out of this problem.

Annual and perennial crops generate large quantities of residues and their importance is immense, especially in the tropics where nutrition is seen as a major limiting factor in the improvement of ruminant production. Proximate chemical composition data of some locally available crop residues in Zambia show that they are characterized by protein content higher than what is obtained in some cereal grains, roots and tubers (Aregheore, 1993). Also their bulk and energy content make them valuable feedstuffs for ruminant livestock in the dry season or drought period.

Generally, most crop residues are low in protein, vitamins and minerals contents. Therefore to improve their feeding value involves the use of chemicals. Chemicals such as sodium hydroxide, biuret, ammonia bicarbonate and others are expensive and supply could be unreliable. Improvement of crop residues using chemicals may be too abstract for the small holder farmer to understand. Therefore, alternative and simple methods of improving crop residues to meet the nutritional requirements of ruminant livestock by small holder farmers need to be investigated. There are reports (Cappock et al., 1974; McCoy et al., 1966; Rakes, 1969; Jenny, O'Peil, 1979; Reddy, Reddy, 1988), that the processing of crop residues into complete rations helps to improve their nutritional quality. This paper therefore reports on the use of some processed crop residues (groundnut shell, sunflower heads and citrus meal) in complete rations for the Black Head sheep in the dry season in Zambia. The crop residues used are abundant in Zambian crop agriculture.

## MATERIAL AND METHODS

Groundnut shell (GNS), sunflower head (SFH) and citrus meal (CM) were gathered from different source in Lusaka. Citrus meal as used here referred to the peels, pulp and seeds after the extraction of juice. The residues were all sun dried to a constant weight; and then ground through a 6 mm sieve hammer mill (Turner and Metals, Lusaka). Other feed ingredients used were maize grain, maize bran, urea (46%N), mineral and vitamin supplement, and salt. The feedstuffs were compounded into three rations to represent each of

the residues (Tab. I). Crop residue in each of the ration was almost one and a half times the maize portion. Grinding of the residues helped in uniform mixing of the rations. The rations were formulated to be isonitrogenous.

Twelve growing black head sheep between 9–12 months with average live weight of  $16.6 \pm 0.09$  kg were randomly allotted on the basis of weight to the three crop residues based rations. Each ration had four lambs. The lambs were housed in individual pens. Floors of each pen were covered with wood shavings. Prior to the experiment, the pens were properly cleaned and disinfected with dettol (a disinfectant). Feed and water troughs were provided in each pen for individual feeding and watering. The rations and water were offered to the growing lambs *ad libitum*. Records of feed intake were taken every week. Body weight gain, feed intake and feed conversion efficiency were measured throughout the experimental period.

At the end of the feeding trial, three lambs from each ration were used for digestibility studies. Lambs were allowed a 7 day adjustment period before a 7 day collection period. Total faeces voided for each day were weighed and a 25% sample was removed for dry matter determination. Faeces were dried in a forced-draught oven at 70 °C for 24 h. The daily faeces for each lamb over the collection period were pooled together and milled with a Christy and Norris hammer mill (Process Engineers, Chemsford, England) to pass through

I. Percentage composition of rations (on an as fed basis)

Ingredients (%)	Rations		
	groundnut shell (GNS)	sunflower head (SFH)	citrus meal (CM)
Maize	36.1	36.1	36.1
Maize bran	15.5	15.5	15.5
Groundnut shell	45.0	–	–
Sunflower head	–	45.0	–
Citrus meal	–	–	45.0
Urea (46% N)	2.4	2.4	2.4
Mineral-vitamin supplement*	0.5	0.5	0.5
Salt	0.5	0.5	0.5
Total	100.00	100.00	100.00

\* Mineral-vitamin supplement provided the following: 5 000 000 IU vitamin A, 1 250 000 IU vitamin D<sub>3</sub>, 1 330 mg cobalt, 250 g calcium, 22 570 mg copper, 4 173 mg iron, 44 180 mg manganese, 38 220 mg zinc, and 113 400 mg magnesium

a 1.66 mm sieve and stored in air tight bottles until required for chemical analysis. The experimental rations were also processed for analysis.

The AOAC (1980) method was used for proximate chemical analysis of experimental rations (Tab. II) and faecal samples. Gross energy value of both rations and faecal samples was determined by a bomb calorimeter (Adiabatic bomb, Parr Instrument Co, Moline IL) using thermochemical benzoic acid as standard. Samples of rations and faeces were analyzed for NDF and ADF according to the procedures described by Goering and Van Soest (1970). Hemicellulose was calculated by difference between NDF and ADF while cellulose was calculated by difference between ADF and ADL. The determined values of nutrients in faeces and rations were used to calculate apparent nutrient digestibility. Voluntary DMI, liveweight gain, feed conversion efficiency and apparent nutrient digestibility were subjected to analysis of variance for completely randomized designs (Snedecor, Cochran, 1967) and where significant differences occurred, Bonferroni *t*-Statistics were utilized for comparison among treatment means (Gill, 1978).

## RESULTS

The summary of performance characteristics and apparent nutrient digestibility of growing lambs fed the complete rations based on crop residues are presented in Tab. III. Voluntary DMI values of 1.02, 1.04, and 1.04 kg/head/day were obtained for lambs fed rations based on GNS, SFH and CM, respec-

II. Proximate chemical composition of rations\*

Analysis of DM basis	Rations		
	groundnut shell	sunflower head	citrus meal
Crude protein	16.1	16.3	15.9
Ash	3.7	4.3	3.6
Ether extract	5.4	5.7	6.2
NDF	46.4	34.4	36.4
ADF	32.1	22.1	20.1
ADL	3.2	2.7	2.2
Hemicellulose	14.3	12.3	16.1
Cellulose	32.6	23.7	21.7
Gross energy ( MJ/kg)	16.9	16.9	17.00

\* Means of 3 determination, values expressed on a dry matter basis

tively. No significant differences ( $P > 0.05$ ) were observed in DMI among the lambs fed the three rations. Daily live weight gain values of 154, 181 and 202 g/head/day were obtained for GNS, SFH and CM rations, respectively. There were significant differences ( $P < 0.05$ ) in daily live weight gains of the lambs. Feed conversion efficiency (feed/gain) followed the pattern of daily live weight gains, and it was significantly different ( $P < 0.05$ ) among the lambs. Apparent nutrient digestibility was significantly higher ( $P < 0.05$ ) in the lambs fed SFH and CM rations than in GNS ration (Tab. III).

## DISCUSSION

The preparation of the rations discouraged selection of more palatable parts of plant such as usually observed when sheep are grazed. Feeding of the lambs in pens where they had free access to the rations may be another

III. Performance characteristics and apparent digestibility coefficients of growing black head sheep fed complete rations based on crop residues

Parameters	Rations		
	groundnut shell	sunflower head	citrus meal
Initial live weight (kg)	16.78 ± 0.08	16.53 ± 0.09	16.45 ± 0.12
Final weight (kg)	22.94 ± 0.88	23.77 ± 0.96	24.53 ± 1.08
Daily gain (g)	154 ± 0.03 <sup>c</sup>	181 ± 0.06 <sup>ab</sup>	202 ± 0.03 <sup>a</sup>
Average daily feed intake (kg)	1.02 ± 0.06	1.04 ± 0.04	1.04 ± 0.04
Feed conversion efficiency (feed/gain)	6.62 ± 2.0 <sup>b</sup>	5.75 ± 1.5 <sup>a</sup>	5.15 ± 1.3
Apparent nutrient digestibility (%) of: DM			
Dry matter	69.09 ± 0.89 <sup>b</sup>	80.64 ± 0.78 <sup>a</sup>	80.90 ± 0.69 <sup>a</sup>
Crude protein	64.08 ± 0.90	67.96 ± 1.6	65.84 ± 1.2
NDF	61.58 ± 0.42 <sup>b</sup>	82.33 ± 0.53 <sup>a</sup>	80.67 ± 0.48 <sup>a</sup>
ADF	51.42 ± 0.05 <sup>c</sup>	69.47 ± 0.32 <sup>a</sup>	66.29 ± 0.46 <sup>b</sup>
ADL	41.41 ± 0.18 <sup>c</sup>	62.54 ± 0.24 <sup>b</sup>	81.12 ± 0.58 <sup>a</sup>
Hemicellulose	63.03 ± 0.28 <sup>bc</sup>	73.06 ± 0.46 <sup>a</sup>	71.33 ± 0.12 <sup>ab</sup>
Cellulose	53.04 ± 0.34 <sup>c</sup>	71.84 ± 0.38 <sup>b</sup>	77.06 ± 0.22 <sup>a</sup>
Gross energy	69.83 ± 0.18 <sup>c</sup>	79.49 ± 0.23 <sup>ab</sup>	81.54 ± 0.18 <sup>a</sup>

NDF – neutral detergent fibre; ADF – acid detergent fibre; ADL – acid detergent fibre  
a, b, c – values on the same row with different superscripts are significantly different ( $P < 0.05$ )

reason for the insignificant difference among the lambs in voluntary DMI. The non-refusal of rations by all the lambs indicated that the complete ration system is a promising method of improving the utilization of crop residues in ruminant nutrition. Furthermore, the result on voluntary DMI seems to indicate that mixing of the processed crop residues which constituted 45% total ration (Reddy, 1988) with other locally available ingredients into complete rations, improved palatability, ensured the supply of nutrients and utilization for growth. Grinding has been reported to even the distribution of nutrients in crop residues (Dixon, Egan, 1988) and therefore better voluntary intake and live weight gain.

Live weight gains of the lambs showed that available nutrient in the rations were highly utilized for growth. Live weight gains obtained in lambs in this trial are higher than values obtained by Aregheore et al. (1990) for the same age group of lambs but of different breed (West African Dwarf sheep, Nigeria). The genotype of the lambs and possibly the quality of the rations offered may be implicated for the differences in live weight gains. The live weight gains obtained in this trial agreed with Reddy (1988) and Dixon, Egan (1988) who reported improved live weight gains in ruminants fed complete rations based on processed crop residues.

Nutrient digestibility in the three rations seems to suggest that the physical treatment (that is grinding) of the residues helped to improve their utilization. Preston, Leng (1987) and Dixon, Egan (1988) reported that physical treatment helps to improve apparent nutrient digestibility of complete rations based on crop residues. Also, the use of urea as nitrogen source may be implicated as a constituent that helped to improve apparent nutrient digestibility of the rations. Urea-N improves the quality of ration high in fibre for ruminant livestock. In this trial, a positive relationship was observed between average daily voluntary DMI and apparent nutrient digestibility of the rations offered.

In conclusion this trial has demonstrated that the complete ration system is a promising method of improving the utilization of crop residues in the dry season period. The system used for processing the crop residues ensured the supply of concentrate to roughage which improved DMI and subsequently improved live weight gain. Wastage was reduced thus promoting better consumption and non-refusal of unpalatable portions of the rations.

Finally, lambs performance and apparent nutrient digestibility were better in CM followed by SFH and the least GNS. The three residues proved to be valuable source of roughage for the fattening of lambs in the dry season period if properly harvested and processed.

## Acknowledgement

The authors are grateful for the financial grant from CIDA Small Ruminant and Stock Feed Research, Vote No. LL-13400, University of Zambia, Lusaka. They are also grateful to Sunquick Bottlers Company, Lusaka, for providing the citrus meal and finally to Mr. Y. Sikanyika for chemical analysis.

## References

- AREGHEORE, E. M.: Chemical composition of some Zambia crop residues for ruminant nutrition. *Zambia J. Agric. Sci.*, 3, 1993: 7-10.
- AREGHEORE, E. M. - JOB, T. A. - ALUYI, H. S. A.: The effect of fibre source on the potential intake, growth and nutrient digestibility coefficients of West African Dwarf (WAD) ram lambs fed predominantly cassava flour + urea diets. *World Rev. Anim. Prod.*, 26, 1990: 91-95.
- CAPPOCK, C. E. - NOLLER, C. H. - WOLFE, S. A.: Effect of forage concentrate ration in complete feeds fed *ad libitum* on energy intake in relation to requirements by dairy cows. *J. Dairy Sci.*, 57, 1974: 1371-1380.
- DIARRA, S. - BOSMA, R.: Crop residues utilization in the West African Savanna. In: DIXON, R. M. (ed.): *Ruminant Feeding System Utilizing Fibrous Agricultural Residues*. International Development Program of Australian University and Colleges Ltd, Canberra, 1987.
- DIXON, R. M. - EGAN, A. R.: Strategies for optimizing use of fibrous crop residues as animal feeds. In: DIXON, R. M. (ed.): *Ruminant Feeding System Utilizing Fibrous Agricultural Residues*. International Development Program of Australian University and Colleges Ltd, Canberra, 1988.
- GARRIGUS, R. R. - NEUMANN, A. L. - MITCHELL, G. E., Jr.: Digestibility of ground and flaked soyabean hulls by beef steers. *J. Anim. Sci.*, 19, 1960: 1261 (Abstr.).
- GILL, J. L.: *Design and Analysis of Experiments*. Vol. 1. Iowa State University Press. Ames, Iowa, 1978.
- GOERING, H. K. - VAN SOEST, P. J.: Forage fibre analysis (apparatus, procedures, and some applications). *Agric. Handbook 379 ARS USDA*. Washington DC, 1970.
- JENNY, B. F. - O'PELL, G. D.: Ration digestibility and mineral balances in steers fed a complete diet. *J. Anim. Sci.*, 48, 1979: 1525-1529.
- McCOY, G. C. - THURMAN, H. S. - OLSON, H. H.: A complete rations for lactating cows. *J. Dairy Sci.*, 49, 1966: 1058-1063.
- PRESTON, T. R. - LENG, R. A.: *Matching Livestock Production Systems to Available Resources*. Annidale, Australia, Penambul Press 1987.
- RAKES, A. H.: Complete rations for dairy cattle. *J. Dairy Sci.*, 52, 1969: 870-875.
- REDDY, M. R.: Complete rations based on fibrous agricultural residues for ruminants. In: DEVENDRA, C. (ed.): *Non-Conventional Feed Resources and Fibrous Agricultural Residues. Strategies for Expanded Utilization*. IDRC and Indian Council of Agric. Res., 1988.
- REDDY, M. R. - REDDY, D. N.: Complete rations for sheep. Utilizing crop-residues and agro-industrial by-products. *Indian J. Anim. Sci.*, 51, 1981: 455-458.
- SNEDECOR, G. M. - COCHRAN, G. W.: *Statistical Methods*. 6th ed. Iowa State University Press. Ames, 1967.

AREGHEORE, E. M. – TEMBO, R. (University of Zambia, School of Agricultural Sciences, Department of Animal Science, Lusaka, Zambia):

**Využití plnohodnotné krmné dávky založené na posklizňových zbytcích u černo-hlavých ovcí.**

Scientia Agric. Bohem., 28, 1997 (4): 293–300.

Ve výkrmovém pokusu s jehňaty jsme se zabývali využitím plnohodnotné krmné dávky založené na posklizňových zbytcích – slupkách podzemnice olejné (GNS), slunečnicových úborech (SFH) a citrusové moučce (CM). Dvanáct jehňat bylo podle hmotnosti náhodně rozděleno do čtyř pokusných skupin. V pokusu byly zjišťovány tyto ukazatele: volný příjem krmiva, přírůstek živé hmotnosti a bilanční stravitelnost živin. Fyzikální úprava (mletí) zbytků před smícháním s dalšími složkami v krmných dávkách ovlivnila volný příjem krmiva. Rozdíly v příjmu krmiva však nebyly významné ( $P > 0,05$ ) mezi skupinami krmenými různými druhy posklizňových zbytků. Hodnoty přírůstku živé hmotnosti byly u jehňat krmených krmnými dávkami s GNS, SFH a CM 154 g, 181 g a 202 g. Jehňata krmená CM měla vyšší přírůstek živé hmotnosti ( $P < 0,01$ ) než jehňata krmená dávkami založenými na GNS a SFH. S výjimkou stravitelnosti ADF, ADL a celulózy, která byla nízká ( $P < 0,05$ ) u jehňat krmených krmnou dávkou s GNS, byla bilanční stravitelnost živin obecně nadprůměrná (nad 60 %). U krmných dávek s SFH a CM byla zjištěna lepší bilanční stravitelnost ( $P < 0,05$ ). Výsledky příjmu krmiva, intenzity růstu a bilanční stravitelnosti živin zjištěné u sledovaných jehňat prokázaly, že posklizňové zbytky plodin jsou dobrým zdrojem objemných krmiv pro krmení v období sucha, pokud se s nimi správně manipuluje a pokud jsou správně zpracovány.

zbytky plodin; příjem sušiny; růst; jehňata; údolí Gwembe

---

*Contact Address:*

Eroarome M. Aregheore, Ph.D., College of Education, Department of Agricultural Sciences (Animal Production Unit), P.M.B. 1251 Warri, Delta State, Nigeria

---