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THE NUTRITIVE VALUE OF FOUR ARABLE FARM BY-PRODUCTS COMMONLY FED TO DAILY CATTLE BY SMALL SCALE FARMERS IN KENYA
III. NITROGEN AND MINERAL RETENTIONS BY WETHER SHEEP

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Nitrogen and mineral retentions were investigated when wether sheep were fed on green maize stalks, maize cobs, sugarcane stalks and sugarcane tops. All the arable by-products were low in nitrogen (N) except maize stalks, with an N content of 1.36 percent. Sheep fed on maize stalks (+ 3.4 g) and sugarcane tops (+ 1.4 g) were in positive nitrogen balance and those fed on sugarcane stalks (-3.6 g) and maize cobs (- 0.4 g) were in negative N-balance. It was established from the trial that supplementary protein could be beneficial when these by-products are fed to animals.

Mineral analyses showed that all the by-products were rich in calcium (Ca). Potassium (K) was also high in most of the by-products except in maize cobs (0.80%). Sodium (Na) and phosphorus (P) were particularly low in most cases studied. All wether sheep were in positive Ca and K balances. There was positive Na balance in those sheep fed on sugarcane tops while those which received maize stalks, maize cobs and sugarcane stalks were in negative Na balance. Negative P balance was obtained in all experimental by-products.

It was therefore recommended that liberal supplementation of minerals should be used when animals are fed these by-products. This practice is particularly important with those by-products where animals gave negative mineral retentions.

Key Words: ' By-products, N retention, mineral retention

In the preceeding paper in this series, Kevelenge et al (1982b) reported loss of liveweight or small gains when wether sheep were fed unsupplemented by-products. Most farmers in tropical countries feed farm by-products to their livestock without supplementary protein and minerals, and lack of these nutrients may be the cause to the resulting poor performance in terms of meat and milk production.

In recent years, it has been demonstrated that protein and/or non-protein nitrogen supplementation of arable by-products leads to improved utilization, nitrogen retention and performance of animals (Das Geupra et al 1949; Sherrot et al 1968; Butterworth 1962). Silvestre et al (1976) obtained significant linear responses in liveweight gains of animals when a 30 percent protein supplement was added to sugarcane diet. Milk yields in another trial by Perez and Garcia (1975) increased from 8.12 kg (control) to 9.14 kg per day in crossbred cows fed on ground sugarcane mixed with urea.

There is sufficient evidence to show that some of the possible causes of the observed low production in tropical animals are associated not only with limited intake of protein but also minerals. Metabolic Pro-

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file test (Thomas 1977) showed that cows in Government Institutions in Kenya were seriously affected not only by low intakes of protein but also by low intakes of minerals. There were very low calcium levels, low sodium levels and low Ca:high P, together with high potassium concentrations in in the blood. Imbalances in the minerals in the blood are a manifestation of metabolic diseases (milk fever and Mastitis). This situation is even worse, especially on small scale farms where supplementary minerals are rarely used.

As a result of these observations, it was, therefore, decided to carry out studies on nitrogen and mineral retention in wether sheep fed on arable by-products.

Materials and Methods

The experimental diets were green maize stalks, maize cobs, sugarcane stalks and sugarcane tops. The procedure adopted in the preparation of the experimental diets has been described (Kevelenge et al 1983a).

Twenty Romney Mash wethers were used in the trials. Two replicate trials were conducted in a completely randomized block design as described by Kevelenge et al (1983b). Each trial was run for a preliminary period of 10 days and collection period of 21 days. The sheep were provided with clean water ad libitum. Samples of feed offered to each sheep and feed left over were bulked daily for chemical composition analyses (Table 1).

Standard procedures of sampling and preservation of urine and faeces were adopted in these trials. The faeces excreted were collected in bags, weighed daily and a 10% sample was treated with 10 ml of 25% W/V sulphuric acid according to Ludri and Razdan (1980). The samples were bulked separately for each sheep in tightly closed plastic buckets and stored at -10°C.

The urine was collected in stoppered plastic bottles containing 50 ml of 50% W/V sulphuric acid (Oji and Mowat 1979). Each bottle was placed below the digestion crate and connected to the collection trough by a

Table 1:
Average nitrogen and mineral composition of four by-products[1]

Item		Experimental diets			
		Maize stalks	Maize cobs	Sugarcane stalks	Sugarcane tops
Nitrogen[2]	%	1.36	0.32	0.38	0.75
Ash	%	8.10	1.30	2.20	9.60
Ca	%	0.24	0.18	0.28	0.15
P	%	0.13	0.06	0.24	0.43
Na	%	0.05	0.37	0.03	0.05
K	%	2.65	0.80	2.81	2.31

[1] Means represent data from six replicate samples~~licate samples~~

[2] Dry matter basis

plastic delivery tube. The volume of urine excreted by each sheep was measured daily. A 10% sample of the urine was retained. The samples were bulked separately in tightly closed flasks and were stored at -10°C.

At the end of the collection period, the samples of faeces and urine for each sheep were separately thawed, composited and subsampled for nitrogen and mineral analyses.

Analytical procedures: Nitrogen determination was done by semi-micro Kjeldahl analysis according to Markham (1942). Samples for mineral determinations were dry-ashed in a muffle furnace at 450°C overnight, followed by extraction with nitric acid.

Sodium and potassium were determined by Flame photometry and phosphorus by absorption Spectrophotometry, according to AOAC (1975). Calcium was determined by EDTA tiration based on the method of Allen et al(1974).

Statistical analyses were done according to standard procedures (Snedecor and Cochran 1967; Steel and Torrie 1960).

Results

Nitrogen retention by Wether sheep: Nitrogen retention results are summarized in Table 2. Wether sheep fed on maize stalks and sugarcane tops consumed more ($P < 0.05$) nitrogen than those sheep which received maize cobs and sugarcane stalks. Similar trends were notable in the nitrogen absorbed daily by the sheep.

The sheep fed on maize stalks and sugarcane tops remained in positive nitrogen balance throughout the experimental period. Those animals fed on maize cobs and sugarcane stalks were in negative nitrogen balance.

The Wether sheep which were on maize stalks and sugarcane tops diets utilized 39.5 and 46.7% of absorbed nitrogen, respectively, daily equivalent to 21.3 g protein in maize stalks and 8.8 g in sugarcane tops. Sheep fed on sugarcane stalks and maize lost 22.5 and 2.5 g per day protein, respectively

Table 2:

Average daily nitrogen retention per sheep[1]

Item	Experimental Diets				SE
	Maize stalks	Maize cobs	Sugarcane stalks	Sugarcane tops	
Nitrogen intake g/day	13.7[a]	2.6[b]	1.2[c]	6.9[d]	± 0.83
Absorbed nitrogen, g/day (Apparent)	8.6[a]	0.5[b]	- 0.3[c]	3.0[d]	± 0.46
Urinary nitrogen, g/day	5.2[a]	0.9[bd]	3.3[c]	1.6[d]	± 0.30
Retained nitrogen, g/day	+ 3.4[a]	- 0.4[c]	- 3.6[a]	+ 1.4[b]	± 0.57

[1] Means represent data from 10 sheep

a,b,c Means in the same row with different superscripts were significantly different

Table 3:
Average daily mineral retention in sheep per by-product[1]

Treatments	Nutrients	Nutrient intake (gm)	Excretion: Faeces (gm)	Excretion: Urine (gm)	Excretion: Total Excretion (gm)	Balances	SE of treatment means
Maize stalks	Ca	1.83	0.37	0.02	0.39	+ 1.44	± 0.10
	P	0.87	2.32	0.06	2.38	− 1.51	± 0.25
	Na	0.38	0.38	0.17	0.55	− 0.17	± 0.04
	K	20.16	1.73	9.16	10.89	+ 9.27	± 1.24
Maize cobs	Ca	1.31	0.63	0.14	0.77	+ 0.54	± 0.22
	P	0.65	1.08	1.01	1.09	− 0.44	± 0.10
	Na	0.23	2.32	0.02	2.34	− 2.11	± 0.53
	K	6.79	3.10	3.60	6.70	+ 0.09	± 0.00
Sugarcane stalks	Ca	0.93	0.29	0.08	0.37	+ 0.56	± 0.10
	P	0.66	1.15	0.79	1.94	− 1.28	± 0.26
	Na	0.08	4.82	0.13	4.95	− 4.87	± 1.20
	K	9.68	1.12	2.79	3.91	+ 5.77	± 0.75
Sugarcane tops	Ca	1.29	0.48	0.03	0.51	+ 0.78	± 0.08
	P	3.90	4.07	0.03	4.10	− 0.20	± 0.14
	Na	0.43	0.24	0.03	0.27	+ 0.16	± 0.04
	K	21.40	3.50	9.42	12.92	+ 8.48	± 1.00

[1] Means represent data from 10 sheep

Mineral retention by Wether sheep: A summary of the mineral retention data is presented in Table 3. All experimental diets gave positive balance for calcium and potassium but negative phosphorus retention in the Wether sheep. There was negative sodium balance in those sheep fed on maize stalks, sugarcane stalks and maize cobs. Wethers fed on sugarcane tops, however, were in positive sodium balance.

Retention of calcium and potassium was greater ($P < 0.05$) in those sheep fed on maize stalks and sugarcane tops than in those which received maize cobs and sugarcane stalks. Those sheep whose diets were maize stalks and sugarcane stalks showed a higher ($P < 0.05$) negative phosphorus balance compared to those fed on maize cobs and sugarcane tops. Sodium retention by sheep gave high negative sodium balances in almost all the by-products.

Discussion

Results of this trial showed that sheep fed on maize stalks and sugarcane tops were in positive nitrogen balance largely due to a higher nitrogen ingestion than those which received maize cobs and sugarcane stalks. The negative nitrogen balance observed would probably explain the losses in liveweight by sheep fed on the maize cobs and sugarcane stalks diets (Kevelenge et al 1983b). There had been no attempt made to determine true nitrogen digestibility for all by-products. The apparent nitrogen values obtained in this trial, however gave a more realistic measure of the nutritive value of the by-products. Similarly, high protein contents (Kevelenge et al 1983b) contributed to high CP digestibility of the by-products. The observed nitrogen balance in this trial possibly could have been affected by the CP digestibility

There is much evidence available to support the need for protein supplement to arable by-products (Silvestre et al 1976; Perez and Garcia 1975; Elliott 1960; Preston 1975; Silvestre et al 1977; Ferreiro et al 1977). The low values of nitrogen retention observed in the sheep need to be increased, for efficient utilization of the by-products, especially maize cobs and sugarcane stalks. Utilization could be improved by supplementing the by-products with plant and animal protein or non-protein nitrogen, such as urea or biuret. Thus it is possible to conclude from these findings that supplementing arable by-products with protein could be beneficial.

Results on mineral retentions revealed that maize stalks and sugarcane stalks were richer than maize cobs and sugarcane tops in Calcium (Ca) Comparisons of tabulated Ca compositions of the by-products (Crampton and Harris 1969; Morrison 1961) were identical. This trial gave positive Ca balance for all arable by-products fed to the sheep. Calcium level therefore is unlikely to be limiting in livestock fed on maize stalks, maize cobs, sugarcane stalks and sugarcane tops.

Phosphorus composition of the by-products also agreed with the tabulated compositions by Morrison (1961) and Crampton and Harris (1969). A negative phosphorus balance was observed in all sheep in the experiment. Ranjan and Kariyar (1969) obtained positive phosphorus balance but negative calcium balance when calves were fed on maize stalks. The findings of this trial justify therefore that many factors may have contributed to

observed differences in the mineral retentions by sheep. Agronomic practices and environmental factors, play a major role towards the accumulation of any nutrient in crops (French 1957).

A negative phosphorus balance relative to a positive calcium balance in the sheep could upset the calcium/phosphorus ratio. It has been established that the optimum calcium/phosphorus ratio for farm animals other than poultry ranges from 1:1 to 2:1 (McDonald et al 1978). Abnormal ratio which probably would be the case observed in this trial could be as harmful as a deficiency of either element in the diet. The negative phosphorus balance confirmed the need for its addition to diets when arable by-products, particularly, maize stalks and sugarcane stalks are fed to livestock.

A high sodium content in sugarcane tops led to a positive sodium retention in sheep. Sheep fed on the other three by-products remained in negative sodium balance due to low sodium contents present in the by-products.

All Wether sheep fed on all by-products were in positive potassium balance. There was more postassium than sodium in all of these by-products. French (1957) associated low sodium contents with dry season when herbages were dry and mature. This suggested that those animals fed on these dry and mature by-products would not suffer as much from potassium deficiency as they would from sodium. It is also true that these varying available concentrations of sodium and potassium, may lead to interference with maintenance of the acid-base balance of the animals, as suggested by McDonald et al (1978). It would be advisable to supplement these minerals in diets, particularly sodium when animals are fed on these by-products.

These trials confirmed that arable by-products are a potential source of dry season feed in Kenya, but would require nitrogen and mineral supplementation to acheive a satisfactory level of production.

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