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Original Article

Nutritive evaluation of Sugarcane Tops and Meat parameters of Dairy Calves, Cross bred and Pure Local (Kenana Breed -Sudan)

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ABSTRACT

This study was carried to evaluate sugarcane tops (SCT) in terms of degradability and fermentation gas production and to evaluate local and crossbred calves fed (SCT) in terms of meat composition. Calves of various Friesian and Kenana blood levels 1/2, 5/8 and 3/4 Friesian and pure local Kenana breed fed (SCT) at levels of 20% ration (A) or 30% ration (B) added to conventional fattening ration. Each blood group was divided into equally two subgroups on average live body weight bases. In Sacco degradability, in vitro gas production for the two rations and meat analysis of calves were carried out. Concerning in vitro dry matter and crude protein degradability, ration (A) was significantly ($P<0.05$) degraded than ration (B) except in incubation period 3hr, 24hr and 48hr in which ration A was highly degraded. The effective degradability at three levels of rumen out flow rates (0.02, 0.05 and 0.08) were higher in ration A than ration B. Similarly the gas volumes produced at each incubation period were higher for ration (A) than for (B). Meat composition was studied in addition to water holding capacity and cooking loss. Differences due to rations were variable among the animal groups. However, moisture percent, water holding capacity and cooking loss were lower in animals consumed ration (B) than those consumed ration (A). Fat content was higher in ration (B) than in ration (A) for 1/2, 5/8 and 3/4 Friesian. Local calves that consumed ration (B) had lower moisture and fat content and higher percent of cooking loss compared to those consumed ration (A).

KEY WORDS: Suger Cane Tops, Crossbred, Insacco degradability, Meat parameters.

INDRODUCTION

Sudan is one of the main sugar growing countries in Africa possessing five factories that produce sugar from sugar cane and more than one are now proposed. In case of green harvest (SCT) will be available in abundance since one hectare of sugarcane yields 30 tons of tops. This abundant amount of (SCT) can be utilized as feed for livestock particularly ruminant Pate (1981) to minimize feed cost. Since cattle can be maintained entirely on (SCT) or with little supplement of protein either as concentrates mixture or leguminous feeds Preston and Leng (1976).

Any reduction in the cost of the ration or of individual ingredients could improve economic efficiency in livestock production. Also economic efficiency improvement may be through the proper utilization of any livestock resources for example dairy calves can be used for beef production.

The objective of this study is to evaluate (SCT) in terms of In Sacco degradability and *in vitro* gas production and to assess meat qualities of dairy calves fed (SCT).

MATERIALS AND METHODS

Experimental animals

Crossbred calves (Kenana x Friesian) were grouped according to the foreign blood percentage into three categories. 1/2, 5/8 and 3/4 and pure local (Kenana cattle). Table 1 shows the age of calves ranged from 10-18 months and the initial live body weights for the four categories. All of the experimental animals were treated against ecto and endo parasites, and branded at the hind quarter,

Rations

Two rations were formulated with the ingredient productions showed in Table 2. These two ration (A) and (B) had calculated CP 10 and 9.78% respectively, and calculated ME Mj/kg 11.02 and 10.9 respectively and had actual CP % 13.21 and 11.82 and actual ME Mj/kg 10.41 and 10.28 respectively.

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Thirty four calves were divided into four groups according to the foreign blood percentage 3/4 (Kenana x Friesian)10 calves, 5/8 , 1/2 and pure local 8 calves each, then each blood group was subdivided into two halves of similar body weight.

Half of each group had consumed ration (A) and the other half consumed ration (B). The experiment lasted for 56 days in addition to 7 days for adaptation; during the experimental period animals were weighted every two weeks. Animals had adequate amounts of feed with free access to water.

Table 1. The age of calves ranged from 10-18 months and the initial live body weights for the four categories.

Items		Ration A		Ration B	
		No.	Initial wt	No.	Initial wt
I	Pure local	4	77.5	4	77.5
II	1/2 friesian	4	96.2	4	95.0
III	5/8 friesian	4	125	4	129
IV	3/4 friesian	5	156	5	156

Table 2. The ingredient productions of two rations:

Ingredients	Ration A (%)	Ration B (%)
Sugarcane tops	30	30
Molasses	40	30
Wheat bran	26	26
Cottonseed cake	12	12
Salt	01	01
Urea	01	01

Degradability study

The degradability study of the experimental rations was carried out in two fistulated calves according to the polyester bag technique of Mehrez and Qrskov (1977), in Animal Production Research Center, Kuku. Calve were fed at maintenance level on a balanced roughage concentrate diet.

Nylon bags of 30 cm weighing 3-4 grams each were used. The bags were washed, oven dried at 60^{o}C overnight them individually weighed and their weights were recorded. 3g of oven dried tested sample was put in the bag, tied with a nylon ribbon and introduced into plastic tube of 8cm rumen. The bags (2 bag/calf/period) were incubated for different period of time 3, 6, 9, 12, 24, 36 and 48 hr for both experimental rations.

Bags were immediately remo9ved at the end of each period of time, thoroughly washed under tap water, oven dried, cooled in a desiccators and weighed. Dry residues in the bag were calculated. The percentage of dry matter loss was calculated as follows:

$$\frac{\text{Wt of incubated sample} - \text{wt. of residue after incubation}}{\text{Wt. of incubated sample}} \times 100$$

The dry matter disappearance at zero time (soluble fraction) was estimated as the washing loss of samples weighed into the nylon bag and rinsed through running tap water. Residual samples after incubation were mixed, pooled and made ready for analysis.

The degradation kinetics of the incubated experimental rations may be described by cure-linear regression of dry matter or crude protein loss from the bag with time Qrskov and McDonald (1979).

$$p = a + b\,(1 - \exp^{-ct}) \quad \ldots 1$$

Where:

p = Potential degradability

t = Incubation time

a = axis intercept at time zero represents soluble and complete degradable substrate that is rapidly washed out of the bag

b = The difference between the intercept (a) and the asymptote, represents the insoluble but potentially degradable substrate which is degraded by the microorganism according to first-order kinetics.

c = Rate constant of b function a, b and c are constant fitted by an interactive least squares procedure.

Equation (I) provide cure constant that can then be used in conjunction with predicated another rates for specified ration to estimate the effective degradability of the sample.

$$\text{Effective degradability} = a + \frac{bc}{c + k}$$

Where:

a, b & c= Constants as defined in equation I.

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k = Rumen small particle out flow rate

The graph was plotted by fitted values of dry matter or crude protein disappearance percentage against time of incubation in hours to form a curve Chen (1995). Means of dry matter D.M. and crude protein of variance according to general linear models procedures (SAS, 1990).

***In vitro* gas production:**

The *in vitro* gas production for the experimental rations was carried out according to Menke,et al (1979). The gas volume during the incubation was recorded at different periods of time 3, 6, 9, 12, 24, 36 and 48 hr, then a curve-linear regression of the gas volume with time was made according to Chen (1995) to be compared with that of dry matter and/or crude protein loss from the bag.

Samples

The experimental calves were slaughtered and the carcasses weighed, *Longissmus dorsi* (lumber part) samples were obtained from all the slaughtered experimental calves, the samples were deeply frozen for further chemical analysis.

Chemical analysis

Muscle samples were minced for chemical analysis. Protein, moisture, fat and ash were determined according to AOAC (1980). Protein fractionation was performed as described in Babiker and Lawrie (1983). Water-holding capacity determined by a compensating planometer according to (Grau and Hamm, 1953).

$$\text{Water holding capacity (WHC)} = \frac{\text{Loose water area} - \text{Meat film area}}{\text{Meat film area}}$$

Statistical analysis

The data were analyzed by student T-test (Snedecor and Cochran, 1980).

RESULTS

At each time interval, the proportion of DM disappearance were significantly ($P<0.01$) higher in ration A than in ration B Table 3.

Degradability constant a, b and c, potential degradation (a + b) and effective degradability (pe) at the three level of rumen out flow rate (K) 0.02, 0.05 and 0.08 are shown in Table 4. It can be seen that all values measured or fitted for ration (A) were higher than that of ration (B).

Table 3. Rumen degradation of dry matter of the experimental diets

Time	Ration (A)		Ration (B)	
	Measured	Fitted	Measure	Fitted
3	53.9[a]	52.0	44.7[a]	47.2
6	48.3[b]	54.6	46.2[a]	50.0
9	54.7[a]	57.2	53.9[a]	52.6
12	59.5[b]	59.6	58.5[a]	54.9
24	72.1[a]	67.9	61.7[a]	62.7
36	73.8[b]	74.4	68.0[a]	68.3
48	79.4[a]	79.7	72.5[a]	72.3

Values are mean of 4 observations (2 bag x 2 calves); Means in a row with different superscripts differ significantly ($P<0.01$)

Table 4. Rumen degradation constant (from fitted parameters)

Items	Ration (A)	Ration (B)
a	49.2	44.17
b	50.8	38.34
a + b	100	82.51
c	0.019	0.028
Pe at K= 0.02	74.0	66.4
Pe at K = 0.05	63.2	59.8
Pe at K 0.08	59.0	54.0
Residual s.d.	3.73	2.92

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The degradation curve for ration (A) is shown in Fig. 1 and that for ration (B) is shown in Fig. 2. The fitted degradation curve reached 100% at 17.4 and 28.8 h for ration (A) and (B) respectively. Generally ration (A) was found to be highly degraded than ration (B).

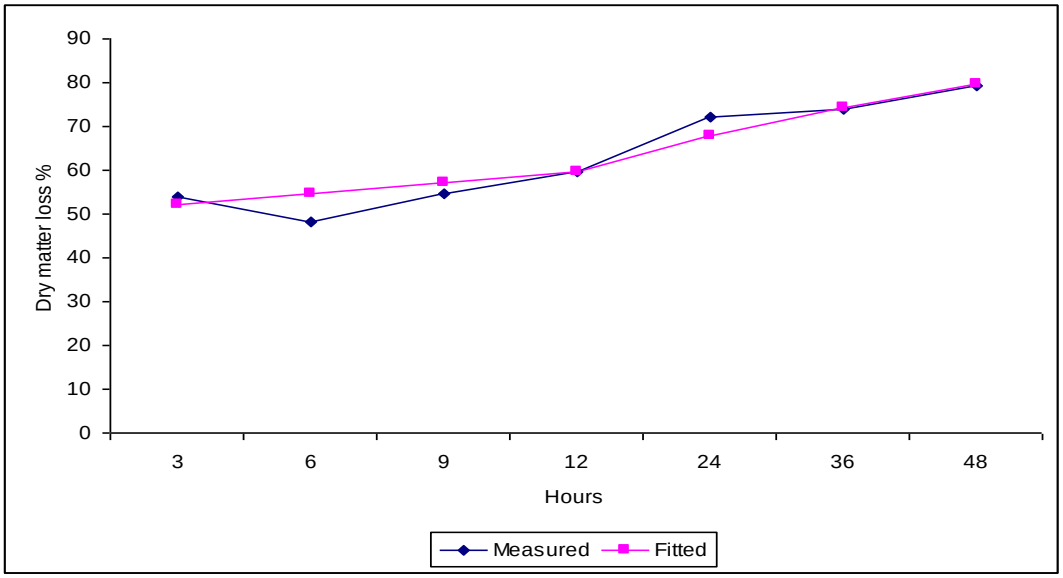

Fig.1: Dry matter degradation curve for ration A.

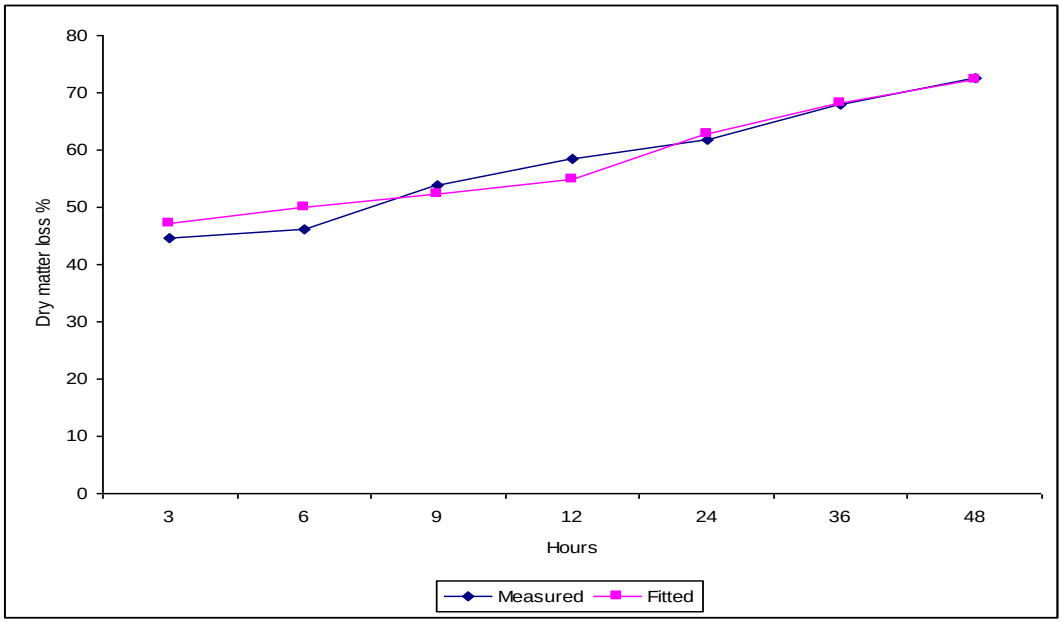

Fig. 2: Dry matter degradation curve for ration B

Concerning the crude protein (cp) degradation the mean proportion (measured and fitted of cp disappearing from the experimental rations at the different periods of incubation (h) in the rumen is shown in Table 5.

Table 5. Crude protein rumen degradation of the experimental rations

Time	C.P. loss % in DM basis			
	Ration (A)		Ration (B)	
	Measured	Fitted	Measure	Fitted
3	25.5[a]	23.7	20.9[a]	23.8
6	26.5[a]	26.8	27.6[a]	28.3
9	29.9[a]	29.7	32.6[a]	32.1
12	33.5[a]	32.6	35.9[a]	35.4
24	44.8[a]	74.4	68.0[a]	68.3
36	45.6[b]	51.7	43.9[a]	49.9
48	62.5[a]	59.1	55.5[a]	52.8

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Values are mean of 4 observations (2 bag x 2 calves). Means in a row with different superscripts differ significantly (P<0.01)

The constant a, b and c potential degradation (a + b) and effective degradability (pe) at the three levels of rumen out flow rate (K) are shown in Table 6.

Table 6. Rumen degradation constant (from fitted parameters)

Items	Ration (A)	Ration (B)
a	20.4	18.8
b	79.6	37.8
a + b	88.0	76.4
c	.014	.048
Pe at K= 0.02	53.0	45.5
Pe at K = 0.05	37.7	37.3
Pe at K 0.08	32.2	33.0
Residual s.d.	3.16	3.77

The same trend of DM degradation occurred in cp disappearing during the incubation and can be clearly noticed that ration (A) cp was highly degraded compared to ration (B) cp.

The cp degradation curve for ration (A) is shown in Fig. 3 and that of ration (B) is shown in Fig. 4, it can be observed that the highest measured degradation at 48 h was 62.5% for ration (A) and 55.5% for ration (B).

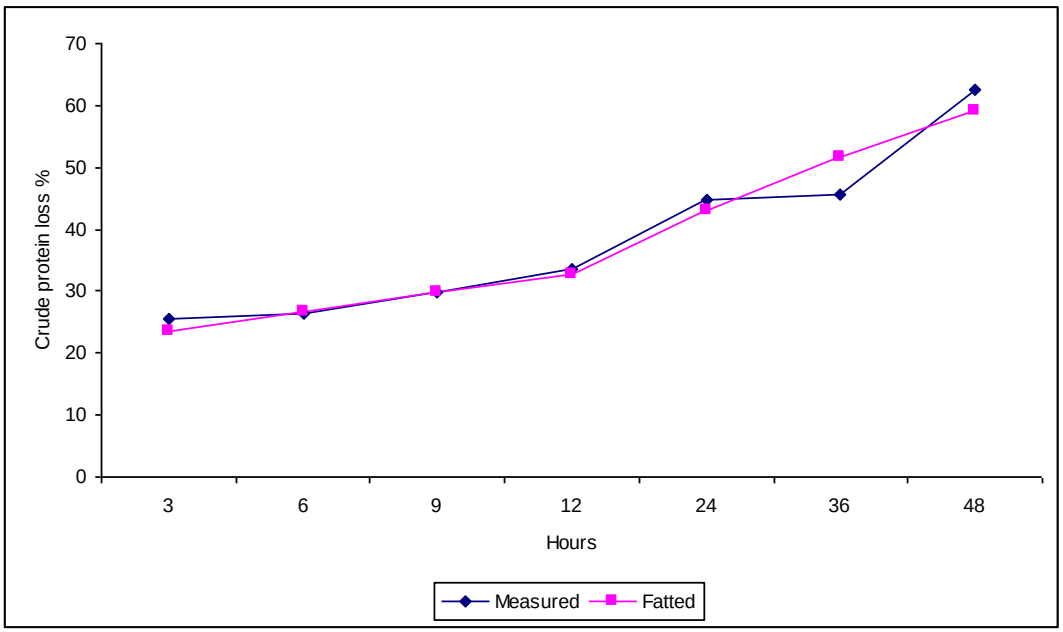

Fig. 3: Crude protein degradation curve for ration A

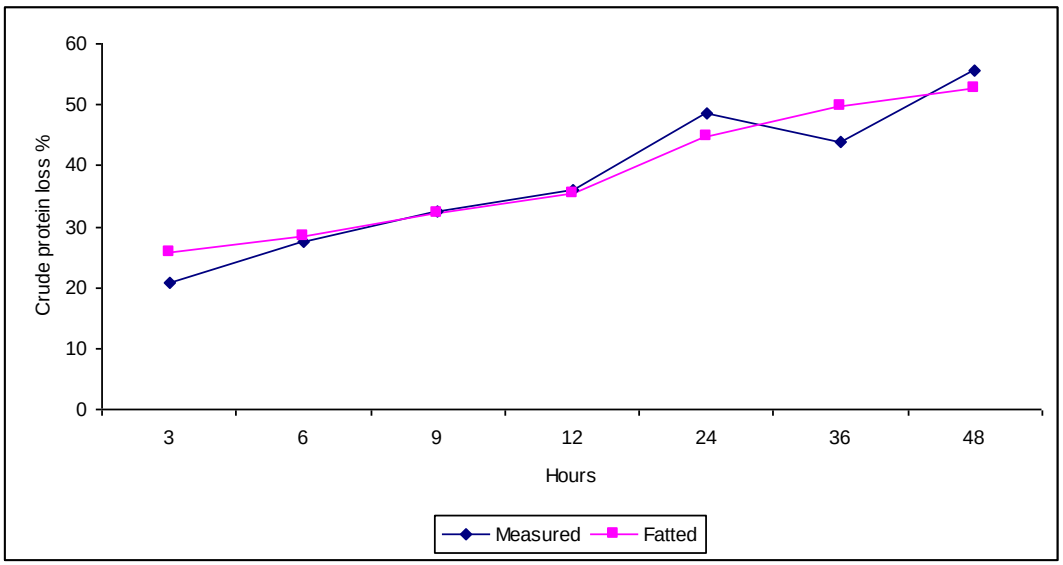

Fig. 4: Crude protein degradation curve for ration B

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Regarding rumen degradation constants at the same rate of degradation (c), the soluble fraction (a), the degradable protein (b), the potential degradability (a + b) and the effective degradability (pe) at the three level of rumen out flow rate (K) were higher for ration A than ration B for both DM and cp degradation.

Gas production experiment

The volumes of gas (ml) produced during incubation of the two experimental rations are shown in Table 7. Ration (A) produced large gas volumes during each period of incubation than ration (B). This indicates that ration (A) was highly fermented compared to ration (B). The fitted parameters, a, b and c gas production during incubation (a + b) and gas production rate constant are shown in Table 8. All these values were higher in ration (A) than ration (B). *In vitro* gas production curve for ration A is shown in Fig. 5 and of ration B is shown in Fig. 6.

Table 7. The value of gas (ml) produced during incubation of the two experimental rations.

Time in incubation (h)	Ration (A)	Ration (B)
0.00	0.00	0.00
3	2.83	1.83
6	8.33	3.66
9	13.2	6.83
12	16.7	9.16
24	26.7	16.3
36	29.0	20.0
46	38.5	28.0

Table 8. Fitted parameters of the gas production technique for the two experimental rations.

Items	Ration (A)	Ration (B)
a	2.80	1.80
b	38.5	28.0
c	0.05	0.50
Gas production during incubation a + b	41.3	29.8
Gas production rate constant (fraction/h)	0.05	0.05
Lag time (h)	0.00	0.00

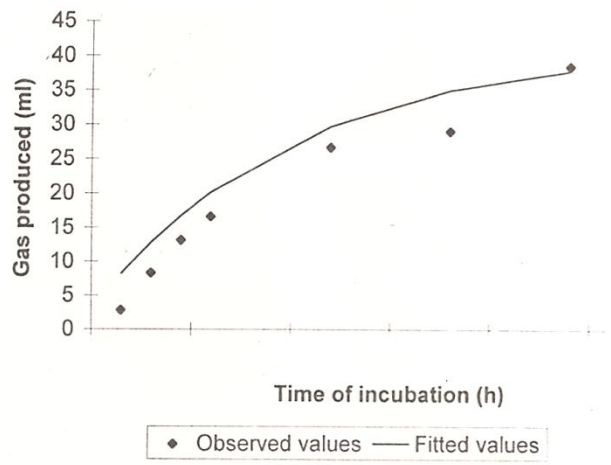

Fig. 5: *In vitro* gas production curve for ration A

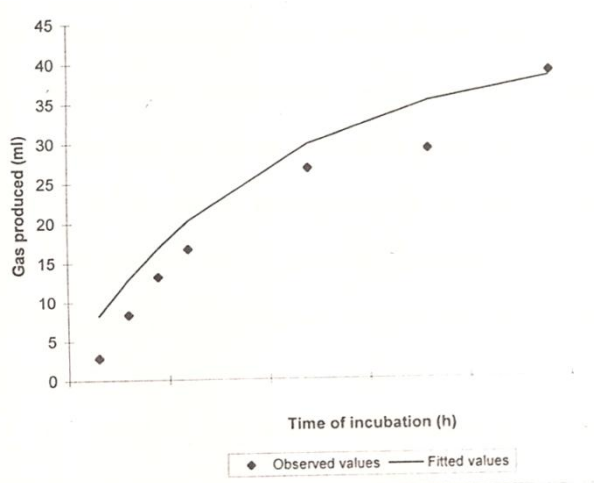

Fig. 6: *In vitro* gas production curve for ration B

Volumes of gas produced during incubation were found to be 41.3 and 29.8 ml for ration (A) and (B) respectively, this indicated that the *in vitro* gas production technique showed the same trend of DM and CP degradation for constant a, b and the volume of gas produced during incubation.

Chemical composition, water holding capacity and the percentage cooking loss for the local calves groups are shown in Table 9. The water holding capacity was significantly ($P<0.05$) superior in ration (B) than in ration (A) the moisture %, for the calves that consumed ration (B) was slightly lower than those which consumed ration (A) but the difference was not significant.

Chemical composition, water holding capacity and the percentage cook loss for the 1/2 Friesian calves groups are shown in Table 10. It can be observed that the moisture % and water holding capacity value for animals that consumed ration (B) were lower than those consumed ration (A), but the differences were not significant, and the cooking loss % was significantly ($P<0.05$) lower in ration (B) than ration (A).

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Chemical composition, water holding capacity and the cook loss % for the 62.5% Friesian calves groups are shown in Table 11, the moisture was significantly lower in ration (B) than ration (A) followed by lower water holding capacity value and lower cooking loss % in ration (B) than ration (A) but the differences were not significant.

Chemical composition, water holding capacity and the cook loss % for the 75% Friesian calves groups are shown in Table 12 the moisture %, water holding capacity value and cooking loss % were significantly (P<0.05) lower in animal group consumed ration (B) than those consumed ration (A).

Generally the moisture %, water holding capacity value and cooking loss % were lower in animals fed ration (B) than those of ration (A) and the fat content was higher in ration (B) than ration (A) for 50, 62.5 and 75% Friesian calves groups.

Local animal group that consumed ration (B) had low moisture % and fat content and high cooking loss %, compared to that which consumed ration (A).

Table 9. Chemical composition, water holding capacity and cooking loss % for the local calves groups.

Items	Ration (A)		Ration (B)		Level of significance.
	Mean	Std. dev.	Mean	Std. dev.	
Crude protein CP %	22.1	0.10	22.1	0.39	NS
Moisture %	73.1	0.41	72.9	0.55	NS
Ether extract EE %	2.45	0.16	2.23	0.21	NS
Ash %	1.21	0.01	1.19	0.18	NS
Non protein nitrogen NPN	0.44	0.01	0.46	0.01	**
Sarcoplasmic proteins	5.96	0.02	6.08	0.04	***
Myofibrillar protein	8.94	5.24	11.8	0.29	NS
Water holding capacity ratio	2.07	0.02	1.94	0.05	***
Cooking loss %	30.3	0.09	30.7	0.66	N.S

NS=not significant **= P<0.01 ***=P<0.001

Table 10. Chemical composition, water holding capacity and cooking loss % for 1/2 Friesian calves groups.

Items	Ration (A)		Ration (B)		Level of significance.
	Mean	Std. dev.	Mean	Std. dev.	
Crude protein CP %	23.8	0.62	21.3	0.39	***
Moisture %	74.1	0.33	73.5	0.39	*
Ether extract EE %	1.48	0.14	0.53	0.19	***
Ash %	1.02	0.01	1.19	0.03	***
Non protein nitrogen NPN	0.46	0.01	0.45	0.01	NS
Sarcoplasmic proteins	5.85	0.41	5.88	0.24	NS
Myofibrillar protein	12.1	0.10	11.9	0.18	NS
Water holding capacity ratio	1.99	0.19	1.91	0.19	NS
Cooking loss %	33.9	0.19	32.6	0.50	***

NS=not significant *= P<0.05 ***=P<0.001

Table 11. Chemical composition, water holding capacity and cooking loss % for 62.5% Friesian calves groups.

Items	Ration (A)		Ration (B)		Level of significance.
	Mean	Std. dev.	Mean	Std. dev.	
Crude protein CP %	23.3	1.41	22.9	0.72	NS
Moisture %	74.9	0.36	74.1	0.11	***
Ether extract EE %	1.60	0.13	1.93	0.32	NS
Ash %	1.02	0.04	1.02	0.01	NS
Non protein nitrogen NPN	0.45	0.01	0.43	0.01	*
Sarcoplasmic proteins	5.93	0.33	5.67	0.28	NS
Myofibrillar protein	12.3	0.08	12.1	0.38	NS
Water holding capacity ratio	2.06	0.11	1.97	0.05	NS
Cooking loss %	33.5	0.52	33.0	0.78	NS

NS=not significant *= P<0.05 ***=P<0.001

Table 12. Chemical composition, water holding capacity and cooking loss % for 75% Friesian calves groups.

Items	Ration (A)		Ration (B)		Level of significance.
	Mean	Std. dev.	Mean	Std. dev.	
Crude protein CP %	21.4	0.72	21.6	0.45	NS
Moisture %	75.9	0.70	73.3	0.65	***
Ether extract EE %	1.21	0.22	2.55	0.16	***
Ash %	1.00	0.02	1.21	0.01	***
Non protein nitrogen NPN	44.0	0.01	44.0	0.01	NS
Sarcoplasmic proteins	6.05	0.03	6.15	0.09	*

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Myofibrillar protein	12.1	0.02	1.65	0.04	***
Water holding capacity ratio	2.01	0.01	1.87	0.09	*
Cooking loss %	34.1	0.06	31.3	0.06	***

NS=not significant *= P<0.05 ***=P<0.001

DISCUSSION

Increases in (SCT) percentage in the diet clearly decreased*in sacco* dry matter and crude protein degradability. This reduction may be due to increase of fiber content which is slowly degraded. Dry matter disappearance for any of the exposure intervals were significantly higher for ration (A) least fiber than for ration (B) higher fiber, except for periods 3, 24 and 48 hr. This result agreed by Weakley et al. (1983) who suggest that differences among in situ measurements obtained over short 3hr or long 48hr periods of time were of little concern.

The volumes of gas (ml) produced during each period of incubation from ration (A) was larger than that from ration (B). This result agreed with *in vitro* dry matter disappearing from the bags at each incubation period. Similarly Blummel and Orskove (1993) found a good agreement between the volume of gas and in situ degradability, which indicated that the *in vitro* gas production reflected substrate fermentation accurately.

Respective water holding capacity, meat crude protein and fat content were 2.07, 22.12 and 2.45 for the local calves on ration A (20% SC) and 1.94, 22.15 and 2.227 for local calves on ration B that contained 30% SCT. This is in agreement with Ali (2000) who found 2.0, 1.3 and 2.1 water holding capacity, 22.6, 23.3 and 24.1 crude protein and 3.1, 2.1 and 2.5 fat content for three levels of supplement to Kenana bulls, while Eltahir (1994) found 1.68, 23.47 and 2.97 water holding capacity, crude protein and fat content for western Baggara cattle. Ash content values were 1.21 and 1.19 for the two rations (A 20% and B 30% SCT) respectively; which were low and moisture content were 73.13 and 72.95 for the two rations respectively which were high compared with the finding of Ali (2000), who found 2.1, 3.5 and 3.4 ash and 68.0, 66.5 and 65.8 and for crossbred calves 50%, 62.5% and 75% Friesian, the crude protein was 23.8,23.3 and 21.4 for calves on ration A (20% SCT) and 21.3, 22.9 and 21.6 for calves on ration B (30% SCT). These observations agreed with Kremler and Lutsevich (1991) who observed crude protein values of 22.41, 22.17 and 22.06 for black pied and zeba type and Holstein bulls respectively.

Moisture percentage in the meat of the crossbreed calves in this study ranged from 73.3 to 75.9 regardless of the rations. This agreed with Johnson et al. (1990), Touraille and Monin (1989) and Kremler and Lutsevich (1991).

Intramuscular fat content (E.E.) for crossbred calves (Tables 8,9 and 10) were slightly higher than that of Kremler and Lutsevich (1991) who reported slightly lower values 0.96, 1.16 and 1.14% and lower than that of Johnson et al. (1990) who reported relatively high fat content 4.2, 3.6 and 3.1%.

Intramuscular moisture was inversely related to intramuscular fat (Johnson et al., 1990), in meat from both local or crossbred calves

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