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Quality and sensory evaluation of meat from Nilotic male kids fed on two different diets

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Some quality and sensory traits of meat from Nilotic male kids subjected to feedlot trial and fed on sorghum- and molasses- based diets were evaluated in this study. Samples of *Semimembranosus* muscle were taken to determine the chemical composition of meat as well as water holding capacity (WHC) and cooking loss. Total moisture, crude protein (CP), ether extract (EE) and ash were also determined. Semi- expert panelists were requested to record their responses for tenderness, juiciness, flavor, color and over all acceptability of cooked samples. Analysis of covariance indicated that the chemical composition of meat from Nilotic kids was not affected by the type of diet where the moisture content were 76.62±0.53 and 76.37±0.60%; CP were 19.47±0.29 and 19.89±0.39%; fat were 0.97±0.49 and 0.97±0.86%; ash were 1.01±0.13 and 1.06±0.23% for the sorghum- and molasses-based fed groups, respectively. The differences were also not significant in the water holding capacity (1.62±0.56 and 1.62±0.55) and cooking loss (19.50±1.99 and 19.83±0.33) of meat muscles for the sorghum- and molasses-based fed male kids, respectively. Instrumental color (L*, a*, b*) indicated no difference in kids muscles from the two dietary groups. Chi square test revealed no significant differences between the two diet groups in tenderness, juiciness, flavor, color and over all acceptability of meat from Nilotic kids. It was concluded that meat from Nilotic male kids, compared with other goat meat, contained less fat which is a positive attribute in other respects and might be recommended as a valuable component of a low-fat diet.

Key words: Cooking loss, feedlot, molasses, sorghum, water holding capacity.

Goats are becoming important meat animals worldwide, yet their carcass composition and individual tissue distribution is not well studied unlike the other two well known meat animal species, such as beef cattle and sheep (Butterfield, 1988). There are virtually no religious or cultural taboos on the eating of goat meat, with the result that goats are readily available to societies in which eating beef, pork or other meat types is prohibited. Despite the individual preferences, it is widely recognized that goat meat is higher in quality than sheep or cattle meat because of its very low fat content. Nutritional characteristics of goat meat indicate that in the same cuts, goat meat has 50-65% less fat content than beef (with a similar proportion of protein), 42 to 59% less fat than lamb meat and approximatrly 25% less fat than veal (Addrizzo, 1994). Besides, the percentage of saturate fat in goat meat is 40% lower than poultry without skin; 85% lower than beef; 100% lower than pork and 90% lower than lamb (USDA, 1989).

The strategy for alleviating food shortage is aimed primary at reducing or eliminating man-animal competition for the already inadequate agricultural products, through the development of novel feed material unsuitable for human use and fed exclusively to livestock. In Sudan the conventional diet for feedlots consisted mainly of sorghum grains and cotton seed cake in the ratio of 1:1. Such ratio is relatively expensive and would place ruminant in direct competition for food with man and poultry. These facts necessitate the need to design strategies in animal nutrition to utilize alternative sources of nutrients and decrease cereals use. The industrial byproducts of crop residues supplemented with deficient nutrients such as energy and protein can provide alternative animal feed sources with reasonable cost. El Khidir & Ahmed (1989) reported that molasses, which represent

one of those abundant by-products, might be considered as a good source of energy for ruminant feeding and a complete substitute for sorghum. The objective of this study was to examine the effect of feeding sorghum- and molasses- based diets on some quality and sensory traits of meat from Nilotic male kids.

MATERIALS AND METHODS

A total of 13 Nilotic male kids were used in this study. The kids were born in Khartoum from a herd of Nilotic goats purchased from the Upper Nile State in 2006 and consigned to Khartoum. After sexual maturity the kids were kept for adaptation period of two weeks during which they were treated for internal and external parasite and then they were individually weighed and subjected to feedlot trial for nine weeks. The average age at the start of the experiment was 222.85 ± 16.45 days and average initial weight of the kids was 13.3 ± 1.9 kg. The kids were accommodated individually in separate pens and each pen was provided with feeding and watering troughs.

The kids were divided into two feeding groups: sorghum-based diet and molasses-based diet groups. There were 6 kids in the first group and 7 in the second. The sorghum-based feeding system was composed of two portions: concentrate and roughage portions. The concentrate portion contained crushed sorghum grains as the main source of energy, ground nut cake as the major source of protein and wheat bran to adapt the required energy and protein level. Sorghum straw was offered separately as a roughage portion. These two portions were given separately at a rate of 1:1 in one morning meal. The molasses-based feeding was a complete pelleted diet. It was composed of molasses and urea as the major sources of energy and protein sources, respectively, bagasses as the source of fiber and wheat bran to adjust the required levels of energy and protein. This diet was offered in one morning meal. The calculated metabolizable energy (ME) in the concentrate and roughage portions of the sorghum-based feeding system was 11.4 and 6.22 MJ/Kg DM, respectively. On the other hand the calculated ME in the molasses-based diet was 10.5 ME/Kg DM. The diets were offered for each kid daily at the rates that assure 10% weigh back. Fresh alfalfa (*Medicago sativa*) was given weekly as a source of carotene. Clean water and mineral licks were given *ad libidium*.

The thirteen kids were slaughtered at the end of the feedlot experiment. The kids were fasted for 12 hours with free access to water. They were weighed to obtain slaughter weight. The animals were bled by severing both the carotid arteries and jugular veins on both sides as well as trachea, using a sharp knife without stunning. After slaughter and complete bleeding, the head was removed at *allantoccipital* joints. All abdominal and thoracic organs were removed and weighed.

Six samples were selected from *Semimembranosus* muscle. Each sample was freed from external fat and connective tissues and subsampled for chemical analysis. Samples destined for quality attributes were allowed to oxygenate at 4^{o}C before color determination. Subsequently these samples were frozen and stored for cooking loss.

Samples weighing 0.5 g of minced *Semimembranosu*s muscle were placed on a humidified filter paper (Whatman No. 1) and pressed between two Plexglass plates for 3 minutes at 25 kg load. The meat film area was traced with a ballpen and then the filter paper was allowed to dry. The meat and moisture areas were measured with compensating plainmeter. The resulting area covered by meat was divided into the moisture area to give a ratio expressed as water holding capacity of the meat (WHC).

Color was determined on the *Semimembranosu*s muscles. Each sample was allowed to oxygenate for half an hour at 4^{o}C before color determination. Color was objectively measured using Hunter Lab tristismulus color meter D 25-2 that gave numerical values for lightness (L*), redness (a*) and yellowness (b*) (Simela, 2005). Subsequently these samples were frozen for cooking loss.

*Semimembranosu*s samples were thawed for 24 hours in a refrigerator (4^{o}C) and weighed. Samples were cooked in plastic bags in water bath at 80^{o}C for 90 minutes, and then they were cooled in running tap water for 20 minutes, dried from fluids and reweighed. Cooking loss was determined as loss in weight during cooking and expressed as percentage of pre-cooking weight (Babiker & lawrie, 1983).

The determination of total moisture, total crude protein (CP), ether extract (EE) and ash were performed according to the methods described by the Association of Official Analytical Chemists, (AOAC, 1990).

The sensory taste was conducted in the Meat Science Department, Faculty of

Animal Production, and University of Khartoum. Twelve semi- expert panelists were used to evaluate the treatments. The evaluation included color, flavor, juiciness, tenderness and over all aceptability. The frozen meat sample from each group was thawed for 24 hours in a refrigerator at 4°C. The samples were then cut into equal pieces and wrapped individually in aluminum foil and oven roasted at 125°C for 45 minutes (Griffin *et al.*, 1985). The cooked samples were then cut into pieces and saved warm. Twelve samples from the two groups of meat were evaluated at each session.

Analysis of covariance (ANCOVA) was conducted to examine the effect of diet group on meat chemical composition, color and quality attributes. The age of kids was taken as a covariate. Taste panel evaluations were analyzed for the significance of differences between the two diet groups using the chi square test. The data was analyzed using the statistical computer package for social science (SPSS) software.

RESULTS

As shown in Table 1, the type of diet had no effect (P >0.05) on the chemical composition of meat from Nilotic kids, where the moisture content were 76.62±0.53 and 76.37±0.60%; CP were 19.47±0.29 and 19.89±0.39%; fat were 0.97±0.49 and 0.97±0.86%; ash were 1.01±0.13 and 1.06±0.23% for the sorghum- and molasses-based groups, respectively.

Table: 1. Meat chemical composition (averages ± SD) of Nilotic male kids fed on sorghum- and molasses-based diets (% of fresh meat).

% composition	Type of diet		L.S
	Sorghum-based (N =3)	Molasses-based (N = 3)	
Moisture	76.62±0.53	76.37±60	NS
Protein	19.47±0.29	19.89±0.39	NS
Fat	0.79±0.49	0.79±0.86	NS
Ash	1.01±0.13	1.06±0.23	NS

L.S: level of significance.
NS: no significant difference between Values (mean ±SD) (P >0.05)
N = Number of samples

As shown in Table 2, the type of diet had no effect (P >0.05) in both attributes of the WHC (1.62 ± 0.56 and 1.62 ± 0.55) and in the cooking loss (19.50±1.99 and 19.83±0.33) for the sorghum- and molasses-based fed Nilotic male kids, respectively). Hunter lab parameters indicated that there was no significant differences in degree of Lightness (L*), redness (a*) and yellowness (b*) in kids muscles from the two feeding groups.

Table: 2. Meat quality attributes (averages ± SD) of Nilotic male kids fed on sorghum- and molasses-based diets.

	Type of diet		L. S.
	Sorghum-based (N = 3)	Molasses-based (N = 3)	
Water holding capacity	1.62±0.56	1.62±0.55	NS
Cooking loss (%)	19.50±1.99	19.83±0.33	NS
Color:			
L*	30.97±0.51	29.77±0	NS
a*	14.90±0.66	13.73±0.71	NS
b*	4.77±90	4.07±0.76	NS

L* Measure Lightness and varies from 100 for perfect white to zero for black
a* measure redness when +ve, grey when zero, green when -ve
b* measure yellowness when +ve, grey when zero, blue when -ve.
NS: no significant difference between Values (mean ± SD) (P ≥0.05)
N = number of samples

As shown in Table 3, the chi square test revealed no differences (P >0.05) between the diets in all meat sensory attribute. Thirty three Percent of the sample from the sorghum-based and 36% of the sample from the molasses-based fed kids were described by panelists as desirable color. Sample with extremely desirable and those with extremely undesirable colors were the least ascribed among the panelists.

In both type of diet the meat quality was described as very tender. About 30% of sample from sorghum-based and 27% of samples from molasses-based were ascribed as very tender. No panelist described the meat from Nilotic kids as very tough in this study. The most ascribed flavor in both diet groups was the moderately intense flavor with 30.56% and 27.78% in the sorghum- and molasses-based group, respectively. Twenty two percent of the samples were ascribed as moderately juicy and another 22% were ascribed as slightly juicy in both diet groups.

As shown in Table 4, the type of diet had no significant effect (P >0.05) on the overall acceptability of meat from Nilotic kids. Most of the panelists described the meat quality as acceptable (38.9% in the sorghum-based and 36.1% in the molasses-

Table: 3. Sensory evaluation (percentages±SD) of Meat from Nilotic male kids fed on Sorghum- or Molasses-based diet.

Type of diet	desirable				undesirable				Total
% Colour									
	Extremely	**Very**	**Moderate**	**Slightly**	**Extremely**	**Very**	**Moderate**	**Slightly**	
Sorghum	5.56(2)	19.44(7)	33.33(12)	19.44(7)	5.56(2)	5.56(2)	2.78(1)	8.33(3)	36
Molasses	2.78(1)	25.00(9)	36.11(13)	26.67(6)	2.78(1)	8.33(3)	5.56(2)	2.78(1)	36
Total	3	16	25	13	3	5	3	4	72
$X^2 = 2.57$, P = 0.92									
% Tenderness									
	Extremely tender	Very tender	Moderately tender	Slightly tender	Extremely tough	Very tough	Moderately tough	Slightly tough	Total
Sorghum	13.89(5)	30.56(11)	16.67(6)	19.44(7)	0	5.56(2)	11.11(4)	2.78(1)	36
Molasses	13.89(5)	27.78(10)	19.44(7)	16.67(6)	0	2.78(1)	8.33(3)	11.11(4)	36
Total	10	21	13	13	0	3	7	5	72
$X^2 = 2.47$, P = 0.87									
% Flavor									
	Extreme intense	Very intense	Moderately intense	Slightly intense	Extremely bland	Very bland	Moderately bland	Slightly bland	Total
Sorghum	5.56(2)	11.11(4)	30.56(11)	22.22(8)	2.78(1)	11.11(4)	13.89(5)	2.78(1)	36
Molasses	0.00(0)	25.00(9)	27.78(10)	22.22(8)	2.78(1)	2.56 (2)	11.11(4)	5.56(2)	36
Total	2	13	21	16	2	6	9	3	72
$X^2 = 5.08$, p = 0.65									
% Juiciness									
	Extremely juicy	Very juicy	Moderately juicy	Slightly juicy	Extremely dry	Very dry	Moderate dry	Slight dry	Total
Sorghum	5.56(2)	8.33(3)	22.22(8)	27.78(10)	8.33(3)	13.89(5)	8.33(3)	5.56(2)	36
Molasses	0.00(0)	5.56(2)	22.22(8)	16.67(6)	5.56(5)	11.11(4)	19.44(4)	19.44(7)	36
Total	2	5	16	16	8	9	7	9	72
$X^2 = 7.88$, p = 0.34									

Table: 4. Overall acceptability (percentage ±SD) of meat quality from Nilotic male kids fed on Sorghum- and Molasses-based diets.

	% Over all of acceptability					
Type of diet	Excellent	Very good	Good	Acceptable	Poor	Total
Sorghum-based	0.0(0)	16.67 (6)	25.00 (9)	38.89 (14)	19.44 (7)	36
Molasses-based	2.78 (1)	13.89 (5)	41.67 (15)	36.11 (13)	22,22 (2)	36
Total	1	11	24	27	9	72
X^2 =5.41, P = 0.25						

based groups). Only 19% and 22% of the samples were described as poor in the sorghum- and molasses-based diet, respectively.

DISCUSSION

The chemical composition of meat is influenced by different factors such as species, breed, age, sex, anatomical location of muscle and nutrition (Lawrie, 1998). The muscle consists of 75% water, 20% protein, 3.5% fat and 2% soluble non-protein substances (Tornberg, 2005). It has been stated that the protein content of goats was slightly higher than cattle beef or buffalo meat and considerably better than that of mutton (McDwell and Bove, 1977). However, the energy content of goat meat rank lower (2.3 Mcal/kg) because of the rather low fat content of their meat compared with 2.92 Mcal/kg for beef and 3.72 for mutton. Because of its very low fat content, it is widely recognized that goat meat is higher in quality than sheep or cattle meat. The fat in this study was 0.79 which was lower than those reported by Elkhidir, *et al.,* (1998) who stated a value of 2.8 in the desert goats. This result indicated that meat from Nilotic male kids has even lower fat content than other goat breed which is a positive attribute in other respects.

The WHC of meat products is a very important quality attribute which has an influence on product yield, which in turn has economic implications, but is also important in terms of eating quality. Cooking loss, which is one of the meat quality parameters, refers to the reduction in weight of meat during the cooking process. Both the WHC and cooking loss percentage in this study were inferior to those reported by Elkhidir *et al.,* (1998) who reported WHC of 2.14 and 2.84 and cooking loss percentage of 34.2 and 36.6 for goat and sheep, respectively. A larger ratio indicates an increase in the watery condition of the muscles or a decrease in water holding capacity (Babiker & Lawrie 1983). The value of WHC in the present study was 1.62 for both dietary groups. The effect of cooking on muscle is

method, time and temperature dependent. Cooking losses of meat are possibly exacerbated by its limited fat content (Lawire, 1998). It is partly because of these high losses that chevon has been perceived to be less juicy than lamb or mutton (Pike *et al.,* 1973).

Meat color is considered as an important parameter that attracts consumer to buy meat. The meat color is mainly affected by the level and state of myglobin. In this study, meat color values measured by Hunter Lab component were not affected by the type of diet in all parameters (Lightness L*, redness a* and yellowness b*). The values reported in this study were lower than those of Babiker & Bello (1986); Babiker *et al*.,1990 and Elkhidir, *et al.,* (1998) for meat of desert goats. The discrepancy might be due to the age and breed of the animals in the various studies.

The consumer seeks leanness above all other attributes of meat quality. Several studies have indicated that goat meat is inherently less tender than sheep. Schonfeldt (1989) found lamb and mutton to be tenderer with less fibrous tissue residue and a more intense aroma than Angora and Boer goat meat. Muscles of male Boer goat kids had higher collagen content with lower collagen solubility than male lambs of 4 sheep breeds (Heinze *et al.,* 1986). A remarkable finding in this study was that no panelist described the meat from Nilotic kids as tough. On the contrary, the majority found it very tender. The attributed toughness of goat has been ascribed to the marketing of mature animals, in which the collagen in the connective tissue has a decreased ability to gelatinize under the influence of heat and moisture..

CONCLUSIONS

Nilotic Goats kids have lower fat content than other goat breed and may be recommended as a valuable component of a low-fat diet.

Increased research is required in meat quality characteristics of the Nilotic goats to characterize these animals into distinct genetic groups/breeds/ strains and to determine their actual potentials.

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