Characteristics of beef from intensively fed western Baggara bulls and heifers: quality attributes and chemical composition

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Abstract

Fourteen samples of *L. dorsi* muscles were taken from western Baggara cattle, one sample from each of seven bulls and seven heifers randomly selected for slaughter at the end of an experimental feedlot feeding which lasted for 16 weeks at Kuku Research Station, Khartoum North, Sudan, to study sex effects on meat chemical composition and quality attributes. Moisture content of beef was higher in bulls meat than in heifers meat. Protein and ash content were significantly (P<0.001) higher in bulls meat, whereas fat content was significantly (P<0.001) higher in heifers meat than in bulls meat. Cooking loss of bulls meat was significantly (P<0.001) lower and water-holding capacity was also significantly (P<0.01) lower in the bulls meat than in heifers meat. Bull's meat colour had low lightness (L) and high redness (a) and yellowness (b), as determined by Hunter Lab. Tristimulus colorimeter, as compared with heifers meat. Sensory panelist scores were higher for colour darkness and flavour intensity and lower for tenderness, juiciness and overall acceptability of bulls meat as compared with heifers meat.

Keywords: Beef; Meat; Quality; Protein; Flavour.
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خصائص اللحم في عجول وعجلات أبقار البقارة السودانية المسمنة على نظام التغذية المركزة: خصائص الجودة والتركيب الكيميائي

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الخلاصة

استخدمت ٧ عينات من العضلة العينية الظهرية من ٧ عجول تم اختيارها عشوائياً للمقارنة مع ٧ عينات عشوائية أخري من ٧ عجلات ذبحت في نهاية تجربة استمرت لمدة ١٦ أسبوعا بمركز أبحاث الإنتاج الحيواني بحلة كوكو، شمال الخرطوم غذيت فيها الحيوانات على العلف الكامل بصورة حرة لدراسة أثر الجنس علي التركيب الكيميائي ومواصفات الجودة في اللحوم. أثبتت التجربة أن معدل الرطوبة في عضلات العجول كان أعلي مقارنة بعضلات العجلات ولكن الفرق غير معنوي كما وجد أن نسبة البروتين والرماد كانت أعلي معنوياً في عضلات العجول ولكن نسبة الدهون كانت أعلى معنوياً في عضلات العجلات بمقارنة بالعجول. لقد أثبتت التجربة أن محتوي البروتين الساركوبلازمي و المايوفابيرلي و النتروجين غير البروتيني اكبر معنوياً في عضلات العجول مقارنة بعضلات العجلات و ان نسبة فاقد الطبخ وقابلية حمل الماء أقل معنوياً في عضلات العجول مقارنة بالعجلات. كما أثبتت التجربة أن الدرجات التي أعطيت بالتقييم الحسي والمادي للون والنكهة كانت أعلى لعضلات العجول مقارنة بعضلات العجلات بينما أُعطيت عضلات العجلات درجات أعلى للطراوة و العصيرية و القبول العام من حيث التذوق ولكن دون فروقات معنوية.

Introduction

Sudan is the largest country in Africa and is of great potential in agriculture and livestock. The estimated cattle numbers were 39.5 million heads (1). They provide the main source of meat for local consumption and contribute considerably in the international trade of meat and livestock. These cattle were owned mainly by nomadic tribes of Baggara people and were subject to shortage of feed in the dry season each year and they take a considerable time to reach a marketable slaughter weight. It is known that continuous annual checks to carcass development lead to the production of poor quality meat.

In Sudan oilseed cakes, grains, molasses and bran are exported in large quantities and obviously at a later stage, Sudan will stop the export of live animals and raw animal feed ingredients and export beef instead. The demand for quality meat is growing due to increase in both the total human population and per capita consumption of meat due to the improvement in the living standard of many people worldwide.

Many researchers studied the effect of feeding source and level of production efficiency and meat quality of entire western Baggara bulls (2-5). The effects of sex with sheep and goat meat production were investigated in Sudan by El Moula (6), El Dow (7) and Masri (8). Meat production potential of heifers of western Baggara type is not well documented. This piece of work will compare beef quality in heifers and bulls of western Baggara cattle when fattened on similar complete diets.

Materials and methods

Fourteen samples of *L. dorsi* muscles were taken after 24 hrs postmortum chilling of carcasses at 4^{o}C, one sample from each of seven bulls and seven heifers slaughtered at the end of feedlot experiment of 112 days on a complete diet of 11.5 Mj ME/kg DM and 17.5% crude protein. Each sample was subsampled for chemical analysis and quality attributes determination.

Meat color was determined objectively by recording Hunter color components l (lightness), a (redness) and b (yellowness) using the Hunter lab. Triestimulus colorimeter Model D25M-2 after 24 hrs chilling at 4^{o}C. Other samples were stored at -10^{o}C awaiting evaluations.

Chemical analysis of total moisture, ash, total protein and total fat were taken according to AOAC methods (9). Samples for protein fractionation were trimmed of excessive subcutaneous fat and connective tissue before mincing. The fractionation procedure was performed as described by Babiker and Lawrie (10). For pH determination one gramme from each minced sample was homogenized in 20 ml distilled water for one minute then the pH was read on a laboratory pH (adjusted to buffer, pH 7.3) at room temperature.

Water holding capacity ratio and cooking loss % were determined as described by Babiker and Lawrie (10).

For sensory evaluation, *L. dorsi* muscle samples were thawed overnight at 4^{o}C and roasted in aluminum foil in electric oven at 175-180^{o}C for one hour according to Griffin *et al*. (11). Semi-trained panelists (n= 11) evaluated each sample using the appropriate scale for color (1= brown to 4 extremely dark brown), juiciness (1= dry to 4 very juicy), flavor intensity (1= bland to 4 extremely intense), tenderness (1= two-up to 4 tender) and overall acceptability (1= unacceptable to 4 acceptable) e. General linear model procedures of statistical analysis system SAS (12) were used for data analysis.

Results

Data for meat quality characteristics are shown in Table (1). bulls meat had significantly (P<0.001) lower water-holding capacity and cooking loss than heifers meat. Bulls meat had low lightness (L) and high redness (a) and yellowness (b) than that of heifers meat, though the differences were not significant.

Table 1: Meat quality attributes of western Baggara bulls and heifers.

Parameter		Means (± S.D.)		Level of Sign.
		Bulls	Heifers	
Water-holding capacity ratio[1]		2.96 (0.42)	2.36 (0.09)	**
Cooking loss (%)		33.21 (1.64)	37.74 (1.26)	***
pH value		5.16 (0.47)	5.02 (0.07)	**
Colour[2]	L (degree of lightness)	34.77 (1.48)	36.07 (0.90)	N.S.
	a (degree of redness)	20.89 (0.28)	20.57 (0.57)	N.S.
	b (degree of yellowness)	7.47 (0.22)	7.24 (0.45)	N.S.

N.S. =Non significant, S.D.=Standard deviation, *=P< 0.05, **=P< 0.01, ***=P< 0.001, 1=The greater the ratio the lower the water-holding capacity. 2.l: Measure lightness and varies from 100 for perfect zero for black, a: Measure redness when +ve (Grey when (zero), Greenness when (-ve)), b: Measure yellowness when +ve (Grey when (zero), Blueness when (-ve)).

Proximate chemical analysis of bulls and heifers meat is presented in Table (2). Moisture content of bulls meat was higher than that of heifers meat, though the difference was not significant. Protein and ash contents were significantly

(P<0.001) higher in bulls meat while fat content was significantly (P<0.01) higher in heifers meat than in bulls meat.

Sarcoplasmic proteins of muscle were significantly (P<0.001) greater in bulls muscle than in heifers muscle. Myofibrillar proteins and non protein nitrogen were significantly (P<0.01) greater in bulls muscle than in heifers muscle.

Subjective evaluation of meat quality is presented in Table (3). Sensory panelist scores indicated that bull meat had more darker brown colour and had more intense flavour as compared with heifers meat, though the differences were not significant between the two sexes. Heifers meat rated more tender, juicy and acceptable than bulls meat, yet the differences were not significant.

Table 2: Meat chemical composition of western Baggara bulls and heifers (as percentage of fresh muscle weight).

Item	Means (± S.D.)		Level of Sign.
	Bulls	Heifers	
Moisture	74.98 (0.4)	74.58 (0.27)	N.S.
Protein	20.92 (0.10)	19.97 (0.07)	***
Fat	2.80 (1.3)	3.96 (0.14)	***
Ash	1.19 (0.07)	0.99 (0.07)	***
Sarcoplasmic proteins	5.54 (0.14)	4.88 (0.19)	***
Myofibrillar proteins	13.66 (0.13)	13.34 (0.16)	**
Non-protein nitrogen	0.46 (0.09)	0.45 (0.07)	**

Table 3: Subjective evaluation of meat quality attributes in western Baggara bulls and heifers.

Parameter	Means (± S.D.)		Level of Sign.
	Bulls	Heifers	
Colour	2.83 (0.49)	2.66 (0.32)	N.S.
Flavour	2.61 (0.16)	2.41 (0.32)	N.S
Juiciness	2.23 (0.41)	2.41 (0.45)	N.S.
Tenderness	2.34 (0.37)	2.66 (0.25)	N.S
Acceptability	3.30 (0.22)	3.40 (0.32)	N.S

Discussion

Chemically bulls meat had higher moisture and significantly (P<0.001) higher protein and ash and had significantly (P<0.001) lower fat content as compared with heifers meat. This result supported the earlier findings by Fortin *et al*. (13) and Arthaud *et al*. (14).

Protein fractionation results were consistent with that of (6,8,15). Sacroplasmic protein and myofibrillar proteins were higher in bulls than in heifers meat and this could be attributed to the greater muscle content of bull carcasses. The bulls appear to be, though had similar starting feedlot weight as heifers, younger physiologically as their growth was in favour of protein deposition rather than fat deposition.

Bulls meat had significantly (P<0.001) lower water-holding capacity and cooking loss and significantly (P<0.01) higher PH value than that of heifer meat. These findings supported the earlier findings of (14). Heifers muscles had more fat deposition which improved water-holding capacity while more fat loss during cooking increased cooking loss.

The more bright color of heifers meat as compared with bulls meat could be due to the increased fat disposition content of heifers as fat increases brightness of meat color. Arthuad *et al.* (14) reported that the darker meat color of bulls meat is due to the increased myoglobin content as compared with heifers meat. Again the higher PH value of bulls meat could be implicated.

Sensory panelists scores were higher in bulls for flavour intensity and colour but they were lower for tenderness and juiciness as compared, respectively, with those of heifers meat. The tendency for lower tenderness scores in bulls meat was reported by (16,17) and could be attributed to the greater content of connective tissue in bulls meat than in heifers. The increased muscle fat content in heifers was reported to dilute the connective tissue content of the muscle and thus increasing its tenderness (18). The increased juiciness of heifers meat could be attributed to the increased fat content of heifers muscle as compared with that of bulls muscle. The increased flavour intensity of bulls meat in this experiment supported the earlier findings of (19) who reported that flavour intensity could be more affected by sex rather than fatness or age. The results obtained for acceptability in the present study was consistent with those of (20) who indicated that heifer meat was more acceptable as compared with that of bulls.

It may be concluded that with western Baggara bulls the meat tends to have more flavour intensity but darker red color, lesser acceptability and tenderness and juiciness as compared with that of heifers. Utilization of heifers of western Baggara type in feedlot operations could contribute positively to the production of high quality beef in the country.

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