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Meat Quality and Palatability from Western Sudan Baggara Heifers Finished on Different Dietary Energy Levels

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Abstract

Forty eight Baggara heifers were fed on three diets of similar crude protein and varying in dietary energy levels; diet (L) of low energy 9.5 MJ/Kg, (M) of medium energy 10.5 MJ/Kg and (H) of high energy 11.5 MJ/Kg. After a finishing period of 16 weeks, seven heifers from each group were slaughtered at Kuku Animal Production Research Station, Khartoum North, Sudan. Longissimus muscle samples were taken from each carcass to assess the effect of dietary energy level on meat quality, sensory evaluation and chemical composition. Meat chemical composition indicated that meat from heifers fed diet H had significantly ($p<0.01$) high ether extraction. Crude protein, and non–protein nitrogen were significantly ($p<0.01$) higher in meat from heifers fed diet L. Moisture, ash and myofibrillar protein, were higher in meat from heifers fed diet L. Tenderness, juiciness, and flavor intensity were not differed between the groups, but meat obtained from heifers fed diet H was significantly ($p<0.05$) more acceptable than that from the other two groups. Water holding capacity and pH were significantly ($p<0.01$) higher in meat from heifers fed diet L. Cooking loss was and improved by the energy level. Meat from heifers fed diet L had significantly ($p<0.01$) the lower degree of redness. While meat from heifers fed diet H had the least degree of yellowness. It could be concluded that finishing heifers on medium to high energy diets, will improve meat quality and acceptability.

Keywords

Baggara Heifers, Chemical Composition, Meat Quality

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1. Introduction

In the Sudan most of beef is produced from male cattle, while heifers and cows are kept only for breeding purposes. Culled heifers and cows are sold directly off the range in a very lean condition for slaughter (jazaria) mainly in countryside and villages. However, in some countries like USA most of beef produced for the fresh meat trade is from steers and heifers. Moreover, in Europe there is discrimination in price against well finished heifers and they argued that the grain of meat in heifers is finer and the quality is superior. Utilization of females for meat production will augment total beef production and relief the pressure on natural pasture in the tropics. Many researchers studied the effect of feeding source and level on production efficiency and meat quality of entire western Baggara bulls [1–4]. There is a lack of published

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information on the quality and palatability of meat that produced from Baggara heifers. So the objectives of this work are to study the effect of finishing on meat quality, palatability and chemical composition of Baggara heifers when placed in feedlots.

2. Materials and Methods

2.1. Sample Preparation

After a finishing for a constant time period (16) weeks on a complete diet of 17.5% crude protein and varying energy level of low (diet L), medium (diet M) and high (diet H). Seven heifers were slaughtered from each group, after the cold carcass was quartered muscle samples of 25 cm long were taken from the longissimusdorsi muscle of each of the slaughtered heifers. The samples were trimmed of the most visible external fat and connective tissues; and divided into two portions one is used for colour measurement, water holding capacity, protein fractionation and meat chemical composition. The remaining portion of the eye muscle was frozen for subsequent cooking loss determination and taste panel evaluation.

2.2. Colour Measurement

Apiece of the longissimusdorsi muscle was oxygenated for 2 hrs at 4 °C before colour determination. Hunter lab. Tristimulus Colorimeter model D25. M.2 was used to determine Hunter colour components L (lightness), a (redness) and b (yellowness).

2.3. Protein Fractionation

About 5 gm of the longissimusdorsi muscle was used for protein fractionation [5].

2.4. Meat Chemical Composition

Triplicate samples of about 5 gm each were analyzed for proximate determination of moisture, ash, protein and ether extract [6].

2.5 Meat Quality Attributes

2.5.1. Water Holding Capacity

About 5 gm from the minced longissimusdorsi muscle was placed on a KCl saturated filter paper (Whatman No. 1) and pressed between two plexiglass for 3 minutes at 25 Kg load. The meat film area and the diffused water boundaries were traced; and the filter paper was allowed to dry. The traced areas were measured using a planimeter. These two areas were used to calculate water holding capacity of the meat as follows.

$$\text{Water holding capacity} = \frac{\text{the diffused water area–meat film area}}{\text{Meat film area}} \quad (1)$$

2.5.2. Cooking Loss Determination

Samples from the frozen longissimusdorsi muscles were cut into about 2.5 cm steaks, thawed at 4 °C for 24 hrs, dried with towel and weighed. The steaks were then cooked in plastic bags in water path at 80 °C for 90 minutes and cooled in running tap water for 20 minutes. The bags were then opened to release the fluids and the steaks were again dried with towel and weighed. Cooking loss was determined as the loss of water during cooking and expressed as percentage of pre–cooking weight.

$$\text{Cooking loss} = \frac{\text{weight before cooking–weight after cooking}}{\text{weight before cooking}} \times 100 \quad (2)$$

2.5.3. Sensory Evaluation

The frozen samples from the longissimusdorsi muscles were cut into about 2.5 cm steaks, thawed at 4 °C for 24 hrs prior to roasting and serving. The steaks were roasted in aluminum foil in electric oven at 175–180 for one hour [7]. The roasted steaks were allowed to cool and served on preheated plates to seven taste panel members for the evaluation of colour, flavor, tenderness, juiciness and overall acceptability.

2.6. Data Analysis

The data were subjected to analysis of variance (ANOVA) for a complete randomized design [8]. LSD was used for means separation where significant differences were detected.

3. Results and Discussion

3.1. Meat Sensory Evaluation

The average scoring of panelist for meat of Baggara heifers fed different dietary energy levels are summarized in table 1. The data indicated that there were no significant differences among the treated samples in terms of tenderness, juiciness and flavor while, in term of overall acceptability it was significantly ($p<0.05$) superior in meat obtained from heifers raised on high dietary energy level than that obtained from heifers raised on low or medium dietary energy levels.

3.1.1. Tenderness

Panelist evaluations suggested that tenderness assessment of meat from heifers receiving low energy diet to be less tender. These results agreed with the findings stated that meat from animals receiving high energy diets were tenderer than that from animals receiving low energy diets [2, 4, 9].

3.1.2. Juiciness

Panelist evaluation indicated that meat from heifer receiving low energy diet was identified to be drier than with high and

medium energy levels. These findings agreed with the results that reported, meat from Baggara bulls receiving low energy level tended to be drier [2]. Similarly juiciness scores of strip loin steaks although not significantly affected by finishing regimen, it tended to improve with grain finished diets [10].

3.1.3. Flavour

Panelist evaluation indicated on significant differences between heifer groups fed different energy levels in flavour intensity although it was increased with the increasing of the dietary energy level. Generally, high-energy grain diets have a more acceptable or intense flavor than low-energy forage or grass diets [11, 12]. Additionally, flavor intensity and beef flavor scores were higher for steaks from grain-finished cattle compared to ryegrass-finished cattle [10]. In contrast beef odour and beef flavour intensities were negatively associated with the energy content of the diets [13].

3.1.4. Acceptability

Panelist scores indicated that the overall acceptability of meat was significantly ($p < 0.05$) affected by the energy level and meat from heifers receiving high and medium energy diets was more acceptable than that from heifers fed the low energy diet. Similarly Bowling et al. [14] found that forage finished beef was ($p < 0.05$) less desire than concentrated finished beef. Furthermore, Steaks from cattle finished on grain were rated more acceptable to consumers compared to steaks from cattle finished on ryegrass or ryegrass/grain, while ryegrass or ryegrass/grain steaks were not found differed when rated by consumers [10].

Table 1. Meat eating quality (sensory evaluations) of Baggara heifers fed different dietary energy levels.

Trait	Diets / energy level			S E	Level of significance
	Low	Medium	High		
Colour	2.69	2.97	2.85	0.65	N.S
Flavor	2.51	2.52	2.59	0.02	N.S
Tenderness	2.64	2.86	2.89	0.05	N.S
Juiciness	2.40	2.51	2.64	0.03	N.S
Acceptability	3.40^{b}	3.59^{b}	3.81^{a}	0.03	*

NS = Not significantly different
* = significantly different at 0.05

3.2. Meat Quality Attributes

Data related to the meat quality of Baggara heifers fed different energy levels are given in table 2. It was clear that the variations in dietary energy levels significantly affected water holding capacity, pH–value and the colour of the meat.

3.2.1. Water Holding Capacity

In viewing this findings meat from heifers fed the low energy diet had significant ($p < 0.05$) inferior water holding capacity than those fed either on high or medium energy levels. These results were in agreement with Uro et al. [15] who reported that water holding capacity was significantly ($p < 0.001$) superior in Baggara cattle meat with adlibitum concentrate than with 65% concentrate. Water holding capacity in beef cattle meat was increased slightly in low energy diets than with high energy diets but the difference was not significant [16]. This superiority of meat from heifers fed on high and medium energy levels in water holding capacity might be attributed to the higher fat deposition in the carcass [17].

3.2.2. Cooking Loss

Cooking loss was not significantly affected by the energy level, yet it was slightly greater in meat from heifers fed high and medium energy diets than with low energy diet. This finding was in agreement with the observation that no significant difference in cooking loss between grain finished and forage fed steers although grain finished steers muscle had high cooking loss [14]. Moreover, it was also similar to the findings of Li et al. [16] who reported that cooking loss although it was slightly increased with energy level but not significantly affected when beef cattle fed on different energy and protein levels. In contrast these results disagreed with Mohamed [2] who found that Baggara bulls fed low energy diet (8.5 MJ/Kg) had significantly ($p < 0.05$) higher cooking loss than those fed high and medium energy levels.

3.2.3. PH–Value

PH–value in this experiment was also significantly ($p<0.001$) higher in meat from heifers fed on low dietary energy level than that from the group fed high or medium dietary energy levels. Similarly, Li et al. [16] concluded that meat pH was significantly lower for cattle fed on high energy diet compared with low energy diet, which is might be due to there is an increasing effect of energy level with increased glycogen availability.

3.2.4. Meat Colour

Meat colour was significantly affected by the dietary energy level. The redness value was significantly ($p<0.001$) lower in the meat obtained from the group fed on low dietary energy level than that from the other two groups. In contrast it had the highest value of lightness compared to that from the other two groups but the different was not significant. The

yellowness value was significantly ($p<0.05$) higher in meat from the group fed on medium dietary energy level than those on high and low dietary energy levels.

The present findings indicated that meat from heifers group fed low energy diet had significantly ($p < 0.001$) lowest redness and highest lightness. This finding was comparable to that obtained with Baggara bulls and it is also on line with Kousgoard [18] who indicated that dietary energy and protein levels affect meat colour, and lean colour of ruminants kept on low plane of nutrition was significantly darker than that obtained from that kept on high plane of nutrition [2, 4]. The result also on line with the observation that lean colour was darker for forage–finished than concentrated–finished steers [19].

Table 2. Meat quality attributes of Baggara heifers fed different dietary energy levels.

Trait		Diets / energy level			S E	Level of significance
		Low	Medium	High		
Water holding capacity		2.62[a]	2.6[b]	2.40[b]	0.01	* *
Cooking loss		37.07	38.22	37.57	0.01	N.S
pH–value		5.10[a]	5.02[b]	5.03[b]	0.01	* *
Meat colour	L	36.21	36.20	36.07	0.14	N.S
	a	19.79[b]	21.01[a]	21.12[a]	0.13	* *
	b	7.71[b]	8.30[a]	7.24[b]	0.15	*

Degree of lightness (L), Degree of redness (a), Degree of yellowness (b)
NS = Not significantly different
* = significantly different at 0.05
** = significantly different at 0.01
Means with different superscripts within a row are different

3.3. Meat Chemical Composition

The proximate analysis of the longissimusdorsi muscle obtained from Baggara heifers raised on different dietary energy levels is presented in table 3. Ether extract, crude protein, sarcoplasmic proteins and non protein nitrogen were not significantly affected by the dietary energy levels, while moisture, ash and myofibrillar proteins were significantly affected by the dietary energy levels.

3.3.1. Moisture Content

Moisture content although it was higher for the group fed on low dietary energy level than those fed on medium and high dietary energy levels but the different was not significant. Moisture content was not significantly affected by the dietary energy level and it supported the general concept that moisture content was inversely related to fat content of the meat. This finding was in agreement with; Mohamed [2], Prior et al. [20], Gregory et al. [21] who reported that the decrease in moisture content of meat was induced by the significant increase in muscle fat content. Moreover, the higher percentage of total lipids in the muscle is usually related to lower moisture content in the muscle [22].

3.3.2. Ether Extract

Ether extract was significantly ($p<0.001$) higher for the group fed on high dietary energy level than those fed on medium and low dietary energy levels. From the data it was clear that ether extract was directly related to the dietary energy level. This finding agreed with Mohamed [2] who observed a significant ($p< 0.05$) differences in ether extract in meat from Baggara bulls fed different dietary energy levels. Additionally, French et al. [23] indicated that increasing energy intake was found to be significantly ($p<0.001$) increasing the carcass fat of steers.

3.3.3. Crude Protein

Crude protein was significantly ($p<0.001$) lower for the group fed on high dietary energy level than those fed on medium and low dietary energy levels. Crude protein in this work was significantly ($p <0.01$) increased with the decrease of energy level which was inversely related to the dietary energy level. This finding was in agreement with Ahmed [4] who reported that crude protein of meat obtained from Baggara bulls tended to increase with the decrease of energy level.

3.3.4. Ash Content

Ash content was higher for the group fed on low dietary energy level than those fed on medium and high dietary energy levels. The energy level did not significantly affect ash content in this work but the later tended to increase with the decrease of energy level. This finding was in agreement with Lawrie [24] who reported that ash percentage increased as energy diet decreased. The result of this study also supported by the findings of Mohamed [2] who found that meat from Baggara bulls kept on low energy diets contained significantly ($p < 0.05$) more ash percentage, and also Ahmed [4] found a slight increase in ash percentage in meat from Baggara bulls kept on low energy diet.

3.3.5. Sarcoplasmic Proteins

sarcoplasmic proteins percentage was significantly ($p<0.05$) lower for the group fed on low dietary energy level than those fed on high and medium dietary energy levels. This result supported by the finding of Ibrahim [9] who reported

that meat from desert goat kids fed high and medium energy diets contained significantly ($p < 0.05$) higher sarcoplasmic protein compared to that from kids receiving the low energy diet, by Mohamed [2] who reported that Baggara bulls kept on high and medium energy level produced meat with higher sarcoplasmic proteins compared to low energy diet and also Ahmed [4] found that sarcoplasmic proteins percentage was significantly higher in meat from Baggara bulls kept on high energy compared to that from bulls kept on low energy diet.

3.3.6. Myofibrillar Proteins

Myofibrillar proteins was higher for the group fed on low dietary energy level than those fed on medium and high dietary energy levels but the different was not significant. It is clear that it was inversely related to the dietary energy level.

3.3.7. Non-protein Nitrogen

non-protein nitrogen was significantly ($p<0.001$) higher for the group fed on low dietary energy level than those fed on medium and high dietary energy levels. It is clear that it was inversely related to the dietary energy level. From the data it was clear that ether extract was directly related to the dietary energy level, while crude protein, myofibrillar proteins and non protein nitrogen were inversely related to the dietary energy level.

Table 3. Meat chemical composition of Baggara heifers fed different dietary energy levels.

Trait	Diets / energy level			S E	Level of significance
	Low	Medium	High		
Moisture %	75.07	74.90	74.98	0.01	N.S
Ether extract%	2.46[b]	3.03[b]	3.21[a]	0.02	* *
Crude protein %	20.97[a]	20.47[b]	19.97[c]	0.03	* *
Ash %	1.05	0. 99	0.99	0.001	N.S
Sarcoplasmic proteins%	5.12[b]	5.72[a]	5.54[a]	0.01	*
Myofibrillar proteins %	13.35	13.24	13.34	0.008	N.S
Non protein nitrogen	0.46[a]	0.45[b]	0.45[b]	0.00	* *

NS = Not significantly different;
* = significantly different at 0.05
** = significantly different at 0.01
Means with different superscripts within a row are different

4. Conclusion

It could be concluded that high and medium energy diets resulted in an improved heifers meat tenderness and higher meat acceptability. Moreover, it enhanced meat colour and fat content of meat composition. Since Baggara cattle are beef breed; utilization of finished Baggara heifers could contribute to the production of high quality beef in the Sudan, with more investigations to evaluate Baggara their potential in meat production, carcass characteristics and composition and meat quality.

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