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ASSESSMENT OF SUDANESE CATTLE MEAT SLAUGHTERED IN EGYPT

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ABSTRACT

The current study was conducted to assess the quality of Sudanese cattle meat. Therefore, 500 imported Sudanese bulls slaughtered in Abu Simbel city abattoirs were selected and divided into 2 groups; Group (I) 250 Sudanese bulls aged 2-5.5 years were fed for a month before slaughter, and Group (II) 250 fattening Sudanese bulls aged 2 to 2.5 years were fattened for 6 months before slaughter. Longissimus dorsi muscle samples were subjected to sensory evaluation and chemical analysis (proximate analysis, cholesterol, hydroxyproline, and content of some essential elements content). Results cleared that Sudanese bulls of the second group (II) were significantly ($p < 0.05$) superior to bulls of the first group (I). Sudanese cattle meat types Baggara Nyalawi and Baggara Rizzaki were significantly ($p < 0.05$) superior to Baggara Messiri, Kenana and Butana breeds. In addition, the meat of younger age and higher-weight bulls was more tender than older age and lighter-weight ones in order. Sensory evaluation revealed that Sudanese cattle meat has good sensory characteristics including color, taste, odour and overall acceptability from consumers. Sudanese cattle meat is considered ideal for consumers, as it is a good source of animal protein and essential elements with low fat and cholesterol content. In conclusion, Sudanese cattle meat can play an important role in filling the red meat gap in Egypt. So it is recommended to expand the importing of Sudanese cattle, especially for fattening purpose during the upcoming years.

Keywords: Baggara Nyalawi, Baggara Rizzaki, Sudanese cattle, sensory evaluation, chemical analysis.

INTRODUCTION

Meat is the most valuable livestock product. Meat is composed of protein and amino acids, minerals, fats and fatty acids, vitamins and other bioactive components, and small quantities of carbohydrates **(FAO, 2019)**.

The global demand for meat is growing, but at different rates in different regions. Beef production, on the other hand, is scarcely growing. Production has risen in many countries in Africa, but significantly only in

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populous South Africa, Egypt, Nigeria, Morocco and Ethiopia (Alvarez-Kalverkamp *et al.,* 2014).

World meat production is projected to double by 2050, most of which is expected in developing countries. The growing meat market provides a significant opportunity for livestock farmers and meat processors in these countries (FAO, 2019).

The per capita share of red meats in Egypt in 2012 was about 12.7 kg/year, which is much lower than its counterpart worldwide in the same year, which was about 42.7 kg/year. Also, the food gap in red meats in Egypt in the same year was about 264,000 tons (Ismail and El-sogheir, 2015).

The average annual per capita consumption of red meat was about 13.4 kg during the period 2005-2020, with a minimum of about 9.03 kg in 2020 and a maximum of about 17.07 kg in 2007. The annual average of beef production in Egypt was about 347.5 thousand tons during the period 1990-2020. Time trend equations showed that beef amounts increased annually by about 7.45 thousand tons during the study period (Barakat *et al.,* 2023).

Egypt's live cattle imports in market forecasts year 2022 at 200,000 head, unchanged from post estimates in markets year 2021. Egypt's primary supplier of live cattle for immediate slaughter in recent years is Sudan. In 2018, Egypt and Sudan signed an agreement to import 800,000 head of Sudanese live cattle for immediate slaughter for three years (i.e., 2018-2020) (USDA FAS, 2021).

Aim of study: The present study was designed to assess the effect of breed, age and slaughter weight on sensory evaluation and chemical analysis of Sudanese cattle meat. In addition, meat cholesterol and essential elements were estimated.

MATERIALS AND METHODS

Study area: Abu Simble Veterinary Quarantines and abattoirs, Aswan, Egypt.

Animals: Group (I) 250 bulls were fed for a month from 1/12/2018 to 31/12/2018 before slaughter and subgrouped into 5 subgroups, each combining 50 bulls, according to bulls' age for (2-2.5 years, 2.5-3.5 years, 3.5-4.5 years, 4.5-5.5 years and >5.5 years), respectively. Each subgroup was also subdivided according to phenotypic characters into 5 divisions (10 bulls each) including (Baggara breed Nyalawi subtype, Baggara breed Rizzaki subtype, Baggara breed Messiri subtype, Kenana breed and Butana breed) each combined 10 bulls. Each division was subdivided into 5 subdivisions (2 bulls each) according to ration fed (ration a, ration b, ration c, ration d and ration e) each combined 2 bulls (Table and Figure 1).

Group (II) consisted of 250 fattening Sudanese bulls aged from 2 to 2.5 years and were fed for 6 months from 1/7/2018 to 31/12/2018 before slaughter. Bulls in the second group (II) were subgrouped into 5 subgroups, each combining 50 bulls, according to bulls' breed (Baggara breed Nyalawi subtype, Baggara breed Rizzaki subtype, Baggara breed Messiri subtype, Kenana breed and Butana breed). Each subgroup was subdivided into 5 divisions (10 bulls each) according to ration type including (ration a, ration b, ration c, ration d and ration e), (Table and Figure 1).

Sample collection: A meat sample from Longissimus dorsi muscle from each slaughtered bull weighing 500 g was collected in plastic bags and labeled then it was divided into 2 subsamples; a 400 g sample for sensory evaluation and a 100 g sample for chemical analysis.

Meat sample assessment:

1. **Sensory evaluation (Griffin *et al.,* 1985):** The sensory evaluation includes color, flavor, tenderness, juiciness, and

overall acceptability using a hedonic scale for each sample.

2. Chemical analysis
2.1. Proximate analysis (AOAC, 2000)
2.2. Determination of cholesterol

2.2.1. Lipid determination **(Bligh and Dyer, 1959).**

2.2.2. Preparation of lipid extract for cholesterol determination (Naeemi *et al.*, 1995).

2.2.3. Determination of cholesterol using Zak's method (Zlatkis *et al.,* 1954).

2.3. Meat tenderness

Measuring Hydroxyproline content chemically to determine connective tissue (collagen) content of meat by using (ISO-3496:1994(E) method.

2.4. Determination of the content of some essential elements content

Calcium, Phosphorus, Magnesium, Iron and Zinc content were determined according to **(AOAC, 2000)** using the dry ash acid extraction method described by **(James, 1995).**

3. Statistical analysis of quality assessment items using (SPSS, 2017) Version 25.

One sample t-test was applied to compare quality assessment items means for group I and group II.

One sample t-test was applied to compare quality assessment items means for different breed, age and slaughter weight subgroups with group I.

One sample t-test was applied to compare quality assessment items means for different breed and slaughter weight subgroups with group II.

NOTE:

Results in all tables: p value(<0.05=*), (<0.01=**) and(<0.0001=***).

RESULTS

Comparing sensory evaluations of the two groups, as illustrated in Table (2), revealed that Sudanese bulls of the second group (II) were significantly ($p < 0.05$) superior to bulls in the first group (I).

The effect of breed on both sensory evaluations and proximate analysis reflected mostly significant variation among both groups I and group II and breed subgroups ($p<0.05$) as shown in Tables (3,4,6 and 7).

The results in Table (5) revealed that Sudanese bull meat in the second group (II) was significantly higher in all proximate analysis items except moisture than the meat of group I ($p<0.05$).

Meat cholesterol concentration of group II was higher than group I (Table 8).

Effect of breed on meat cholesterol concentration reflected mostly significant variation among both group I and group II and breed subgroups ($p<0.05$), (Tables 9 and 10).

Table (11) declared that the bulls' meat of the second group (II) was more tender than that of the first group (I) meat ($p<0.05$).

As shown in Table (12), the effect of breed on meat tenderness reflected mostly significant variation among group I breed subgroups ($p<0.05$).

As illustrated in Table (13), the effect of breed on meat tenderness reflected mostly no significant variation among group II breed subgroups.

As shown in Table (14), the effect of age on meat tenderness reflected mostly significant variation among group I age subgroups ($p<0.05$) and negative linear correlation.

As declared in Table (15), the effect of slaughter weight on meat tenderness reflected mostly significant variation among group I slaughter weight subgroups (p<0.05) and negative linear correlation because of the positive correlation between age and slaughter weight of group I.

As illustrated in Table (16), the effect of slaughter weight on meat tenderness reflected significant variation among group II slaughter weight subgroups (p<0.05) and positive linear correlation.

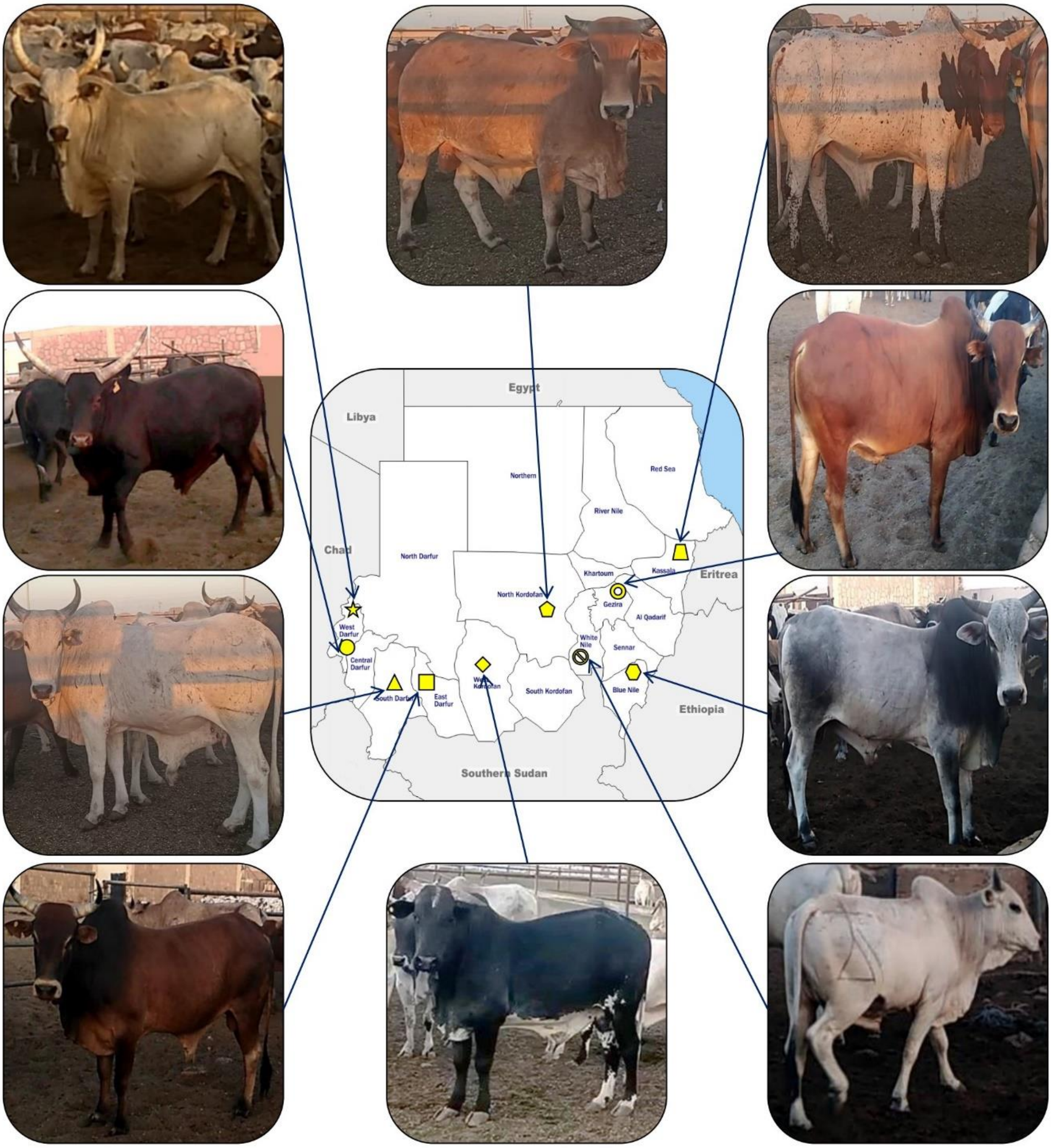
Comparing the content of some essential elements of the two groups clarified that group II was significantly lower in its content than group I (p>0.05), as illustrated in Table (17).

As shown in Table (18), the effect of breed on some essential elements reflected mostly no significant variation among group I breed subgroups.

As illustrated in Table (19), the effect of breed on some essential elements reflected significant variation among group II breed subgroups (p<0.05).

Table 1: Groups I and II subgroups, divisions, and subdivisions

		Group I					**Group II**						
		Breeds					Breeds						
Age	**Ration**	Baggara	Baggara	Baggara	Kenana	Butana	Butana	Kenana	Baggara	Baggara	Baggara	**Ration**	**Age**
		Nyalawi	Rizzaki	Messiri					Messiri	Rizzaki	Nyalawi		
		sub-type	sub-type	sub-type					sub-type	sub-type	sub-type		
2-2.5 years	**ration a**	2	2	2	2	2							
	ration b	2	2	2	2	2							
	ration c	2	2	2	2	2	10	10	10	10	10	**ration a**	
	ration d	2	2	2	2	2							
	ration e	2	2	2	2	2							
2.5-3.5 years	**ration a**	2	2	2	2	2							
	ration b	2	2	2	2	2							
	ration c	2	2	2	2	2	10	10	10	10	10	**ration b**	
	ration d	2	2	2	2	2							
	ration e	2	2	2	2	2							
3.5-4.5 years	**ration a**	2	2	2	2	2							
	ration b	2	2	2	2	2							
	ration c	2	2	2	2	2	10	10	10	10	10	**ration c**	**2-2.5 years**
	ration d	2	2	2	2	2							
	ration e	2	2	2	2	2							
4.5-5.5 years	**ration a**	2	2	2	2	2							
	ration b	2	2	2	2	2							
	ration c	2	2	2	2	2	10	10	10	10	10	**ration d**	
	ration d	2	2	2	2	2							
	ration e	2	2	2	2	2							
>5.5 years	**ration a**	2	2	2	2	2							
	ration b	2	2	2	2	2							
	ration c	2	2	2	2	2	10	10	10	10	10	**ration e**	
	ration d	2	2	2	2	2							
	ration e	2	2	2	2	2							



Fuja		Baggara Nyalawi sub-type		White Nile		Erashy	
White Fulani		Baggara Rizzaki sub-type		Kenana			
Red Fulani		Baggara Messiri sub-type		Butana			

Figure (1) Geographical distribution of the Sudanese cattle breeds in Sudan

Table 2: Sensory evaluations of meat of the two groups

Items		Colour	Tenderness	Flavour	Juiciness	Overall acceptability
Total	**Mean±SD**	3.31±0.09	3.2±0.11	3.24±0.1	3.4±0.25	3.29±0.13
Group I	**No.**	250	250	250	250	250
	DF	249	249	249	249	249
	Mean±SD	3.25±0.04	3.12±0.05	3.17±0.07	3.19±0.08	3.18±0.03
	SE	0	0	0	0	0
	p	***	***	***	***	***
Group II	**No.**	250	250	250	250	250
	DF	249	249	249	249	249
	Mean±SD	3.38±0.09	3.29±0.1	3.31±0.07	3.62±0.17	3.4±0.1
	SE	0.01	0.01	0	0.01	0.01
	p	***	***	***	***	***

Table 3: The effect of breed on sensory evaluation of bull meat in the first group (I)

Items			Colour	Tenderness	Flavour	Juiciness	Overall acceptability
Total	**No. 250**	**Mean±SD**	3.25±0.04	3.12±0.05	3.17±0.07	3.19±0.08	3.18±0.03
Baggara Nyalawi sub-type	**No. 50**	**Mean±SD**	3.27±0.03	3.13±0.04	3.23±0.05	3.21±0.08	3.21±0.03
		SE	0	0.01	0.01	0.01	0
		p	***	*	***	*	***
Baggara Rizzaki sub-type	**No. 50**	**Mean±SD**	3.26±0.03	3.13±0.05	3.2±0.05	3.2±0.08	3.2±0.03
		SE	0	0.01	0.01	0.01	0
		p	**	0.16	***	0.15	***
Baggara Messiri sub-type	**No. 50**	**Mean±SD**	3.19±0.04	3.08±0.05	3.17±0.05	3.13±0.07	3.14±0.03
		SE	0.01	0.01	0.01	0.01	0
		p	***	***	0.58	***	***
Kenana	**No. 50**	**Mean±SD**	3.26±0.03	3.12±0.05	3.13±0.05	3.2±0.07	3.18±0.03
		SE	0	0.01	0.01	0.01	0
		p	0.07	0.5	***	0.39	0.19
Butana	**No. 50**	**Mean±SD**	3.27±0.04	3.13±0.06	3.11±0.05	3.2±0.06	3.18±0.03
		SE	0.01	0.01	0.01	0.01	0
		p	**	0.28	***	0.12	0.26

Table 4: Breed effect on sensory evaluations of group II meat

Items			Colour	Tenderness	Flavour	Juiciness	Overall acceptability
Total	**No. 250**	**Mean±SD**	3.38±0.09	3.29±0.1	3.31±0.07	3.62±0.17	3.4±0.1
Baggara Nyalawi sub-type	**No. 50**	**Mean±SD**	3.42±0	3.35±0.02	3.43±0.05	3.73±0.04	3.48±0.02
		SE	0	0	0.01	0.01	0
		p	***	***	***	***	***
Baggara Rizzaki sub-type	**No. 50**	**Mean±SD**	3.38±0	3.29±0.02	3.3±0.07	3.63±0.03	3.4±0.02
		SE	0	0	0.01	0	0
		p	***	**	0.38	**	0.25
Baggara Messiri sub-type	**No. 50**	**Mean±SD**	3.32±0	3.22±0.01	3.29±0.07	3.51±0.02	3.34±0.02
		SE	0	0	0.01	0	0
		p	***	***	0.06	***	***
Kenana	**No. 50**	**Mean±SD**	3.37±0	3.28±0.02	3.26±0.07	3.61±0.04	3.38±0.03
		SE	0	0	0.01	0.01	0
		p	1	0.06	***	0.06	***
Butana	**No. 50**	**Mean±SD**	3.38±0	3.29±0.03	3.26±0.08	3.62±0.05	3.39±0.04
		SE	0	0	0.01	0.01	0.01
		p	1	0.69	***	0.69	0.08

Table 5: Proximate analysis of the meat of the two groups.

Components		Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Carbohydrate (%)	Energy (Kcal/100g)
Total	**Mean±SD**	20.96±1.3	2.46±0.35	1.05±0.04	75.06±1.51	0.47±0.14	107.83±7.82
Group I	**No.**	250	250	250	250	250	250
	DF	249	249	249	249	249	249
	Mean±SD	20.11±0.88	2.21±0.24	1.02±0.02	76.09±1.01	0.57±0.09	102.61±5.32
	SE	0.06	0.02	0	0.06	0.01	0.34
	t	-15.21	-16.1	-20.69	16.12	16.12	-15.51
	p	***	***	***	***	***	***
Group II	**No.**	250	250	250	250	250	250
	DF	249	249	249	249	249	249
	Mean±SD	21.8±1.07	2.7±0.27	1.08±0.03	74.03±1.21	0.38±0.11	113.05±6.28
	SE	0.07	0.02	0	0.08	0.01	0.4
	t	12.48	14.42	16.98	-13.48	-13.48	13.16
	p	***	***	***	***	***	***

Table 6: Breed effect on the proximate analysis of group I meat

Components			Protein (%)	Fat (%)	Ash (%)	moisture (%)	Carbohydrate (%)	Energy (Kcal/100g)
Total	**No. 250**	**Mean± SD**	20.11±0.88	2.21±0.24	1.02±0.02	76.09±1.01	0.57±0.09	102.61±5.32
Baggara Nyalawi sub-type	**No. 50**	**Mean± SD**	20.96±0.65	2.44±0.18	1±0.02	75.12±0.75	0.48±0.07	107.73±3.95
		SE	0.09	0.03	0	0.11	0.01	0.56
		p	***	***	***	***	***	***
Baggara Rizzaki sub-type	**No. 50**	**Mean± SD**	20.51±0.66	2.32±0.18	1.01±0.02	75.63±0.75	0.52±0.07	105.04±3.97
		SE	0.09	0.03	0	0.11	0.01	0.56
		p	***	***	***	***	***	***
Baggara Messiri sub-type	**No. 50**	**Mean± SD**	20.17±0.71	2.23±0.19	1.02±0.02	76.03±0.81	0.56±0.07	102.95±4.3
		SE	0.1	0.03	0	0.12	0.01	0.61
		p	0.58	0.58	0.58	0.58	0.58	0.58
Kenana	**No. 50**	**Mean± SD**	19.57±0.63	2.06±0.17	1.04±0.02	76.71±0.72	0.62±0.07	99.32±3.82
		SE	0.09	0.02	0	0.1	0.01	0.54
		p	***	***	***	***	***	***
Butana	**No. 50**	**Mean± SD**	19.35±0.62	2±0.17	1.04±0.02	76.96±0.71	0.64±0.06	98.02±3.76
		SE	0.09	0.02	0	0.1	0.01	0.53
		p	***	***	***	***	***	***

Table 7: Breed effect on proximate analysis of group II meat

Components			Protein (%)	Fat (%)	Ash (%)	moisture (%)	Carbohydrate (%)	Energy (Kcal/100g)
Total	**No. 250**	**Mean±SD**	21.8±1.07	2.7±0.27	1.08±0.03	74.03±1.21	0.38±0.11	113.05±6.28
Baggara Nyalawi sub-type	**No. 50**	**Mean±SD**	23.55±0.71	3.14±0.18	1.04±0.02	72.07±0.8	0.2±0.07	123.29±4.16
		SE	0.1	0.03	0	0.11	0.01	0.59
		p	***	***	***	***	***	***
Baggara Rizzaki sub-type	**No. 50**	**Mean±SD**	21.68±0.45	2.67±0.11	1.08±0.01	74.18±0.51	0.39±0.05	112.3±2.65
		SE	0.06	0.02	0	0.07	0.01	0.37
		p	*	*	*	*	*	*
Baggara Messiri sub-type	**No. 50**	**Mean±SD**	21.53±0.45	2.63±0.11	1.09±0.01	74.34±0.51	0.41±0.05	111.45±2.64
		SE	0.06	0.02	0	0.07	0.01	0.37
		p	***	***	***	***	***	***
Kenana	**No. 50**	**Mean±SD**	21.14±0.64	2.54±0.16	1.1±0.02	74.78±0.72	0.45±0.06	109.18±3.73
		SE	0.09	0.02	0	0.1	0.01	0.53
		p	***	***	***	***	***	***
Butana	**No. 50**	**Mean±SD**	21.12±0.62	2.53±0.16	1.1±0.02	74.8±0.7	0.45±0.06	109.05±3.64
		SE	0.09	0.02	0	0.1	0.01	0.51
		p	***	***	***	***	***	***

Table 8: Meat cholesterol concentration of the two groups

Item	Total	Group I						Group II					
	Mean±SD	No.	DF	Mean±SD	SE	t	p	No.	DF	Mean±SD	SE	t	p
Cholesterol (mg/100 g)	62.12±10.15	250	249	55.07±9.07	0.57	-12.29	***	250	249	69.17±4.92	0.31	22.67	***

Table 9: Breed effect on cholesterol concentration of group I meat

Item			Cholesterol (mg/100 g)
Total	No. 250	Mean±SD	55.07±9.07
Baggara Nyalawi sub-type	No. 50	Mean±SD	60.01±9.6
		SE	1.36
		p	***
Baggara Rizzaki sub-type	No. 50	Mean±SD	55.66±8.59
		SE	1.21
		p	0.63
Baggara Messiri sub-type	No. 50	Mean±SD	49.94±6.55
		SE	0.93
		p	***
Kenana	No. 50	Mean±SD	54.53±9.16
		SE	1.3
		p	0.68
Butana	No. 50	Mean±SD	55.21±8.54
		SE	1.21
		p	0.91

Table 10: Breed effect on cholesterol concentration of group II meat

Item			Cholesterol (mg/100 g)
Total	No. 250	Mean±SD	69.17±4.92
Baggara Nyalawi sub-type	No. 50	Mean±SD	72.22±5.16
		SE	0.73
		p	***
Baggara Rizzaki sub-type	No. 50	Mean±SD	69.52±4.6
		SE	0.65
		p	0.6
Baggara Messiri sub-type	No. 50	Mean±SD	66±3.21
		SE	0.45
		p	***
Kenana	No. 50	Mean±SD	68.86±4.94
		SE	0.7
		p	0.65
Butana	No. 50	Mean±SD	69.26±4.53
		SE	0.64
		p	0.89

Table 11: Meat tenderness of the two groups

Items	Total	Group I						Group II					
	Mean±SD	No.	DF	Mean±SD	SE	t	p	No.	DF	Mean±SD	SE	t	p
Connective tissue (%)	7.88±0.92	250	249	8.56±0.43	0.03	24.63	***	250	249	7.21±0.77	0.05	-13.71	***
Collagen (%)	1.65±0.16	250	249	1.72±0.12	0.01	9.85	***	250	249	1.57±0.16	0.01	-7.67	***
Hydroxyproline (%)	0.53±0.05	250	249	0.55±0.04	0	9.85	***	250	249	0.5±0.05	0	-7.67	***

Table 12: Breed effect on meat tenderness of group I

Item			Connective tissue (%)	Collagen (%)	Hydroxyproline (%)
Total	No. 250	Mean±SD	8.56±0.43	1.72±0.12	0.55±0.04
Baggara Nyalawi sub-type	No. 50	Mean±SD	8.44±0.35	1.77±0.1	0.57±0.03
		SE	0.05	0.01	0
		p	*	**	**
Baggara Rizzaki sub-type	No. 50	Mean±SD	8.48±0.38	1.74±0.1	0.56±0.03
		SE	0.05	0.01	0
		p	0.16	0.19	0.19
Baggara Messiri sub-type	No. 50	Mean±SD	8.86±0.41	1.79±0.11	0.57±0.04
		SE	0.06	0.02	0.01
		p	***	***	***
Kenana	No. 50	Mean±SD	8.52±0.43	1.67±0.11	0.53±0.04
		SE	0.06	0.02	0.01
		p	0.5	**	**
Butana	No. 50	Mean±SD	8.49±0.45	1.64±0.12	0.53±0.04
		SE	0.06	0.02	0.01
		p	0.28	***	***

Table 13: Breed effect on meat tenderness of group II

Item			Connective tissue (%)	Collagen (%)	Hydroxyproline (%)
Total	No. 250	Mean±SD	7.21±0.77	1.57±0.16	0.5±0.05
Baggara Nyalawi sub-type	No. 50	Mean±SD	6.73±0.81	1.59±0.19	0.51±0.06
		SE	0.11	0.03	0.01
		p	***	0.57	0.57
Baggara Rizzaki sub-type	No. 50	Mean±SD	7.16±0.72	1.55±0.15	0.5±0.05
		SE	0.1	0.02	0.01
		p	0.6	0.4	0.4
Baggara Messiri sub-type	No. 50	Mean±SD	7.71±0.51	1.66±0.11	0.53±0.03
		SE	0.07	0.01	0
		p	***	***	***
Kenana	No. 50	Mean±SD	7.26±0.78	1.53±0.15	0.49±0.05
		SE	0.11	0.02	0.01
		p	0.66	0.09	0.09
Butana	No. 50	Mean±SD	7.2±0.71	1.52±0.14	0.49±0.04
		SE	0.1	0.02	0.01
		p	0.89	*	*

Table 14: Age effect on meat tenderness of group I

Items			Connective tissue (%)	Collagen (%)	Hydroxyproline (%)
Total	**No. 250**	**Mean±SD**	8.56±0.43	1.72±0.12	0.55±0.04
2-2.5 years	**No. 50**	**Mean±SD**	7.99±0.2	1.55±0.07	0.5±0.02
		SE	0.03	0.01	0
		p	***	***	***
2.5-3.5 years	**No. 50**	**Mean±SD**	8.32±0.17	1.67±0.08	0.54±0.03
		SE	0.02	0.01	0
		p	***	***	***
3.5-4.5 years	**No. 50**	**Mean±SD**	8.56±0.16	1.74±0.06	0.56±0.02
		SE	0.02	0.01	0
		p	0.9	*	*
4.5-5.5 years	**No. 50**	**Mean±SD**	8.8±0.21	1.79±0.06	0.57±0.02
		SE	0.03	0.01	0
		p	***	***	***
>5.5 years	**No. 50**	**Mean±SD**	9.11±0.2	1.85±0.06	0.59±0.02
		SE	0.03	0.01	0
		p	***	***	***
	Regression equation		y =0.16717 x + 7.78704	y =0.04237 x + 1.52511	y =0.01232 x + 0.49535
	R^2		0.90604	0.80625	0.78026

Table 15: Slaughter weight effect on meat tenderness of group I

Items			Connective tissue (%)	Collagen (%)	Hydroxyproline (%)
Total	**No. 250**	**Mean±SD**	8.56±0.43	1.72±0.12	0.55±0.04
270-340 kg	**No. 50**	**Mean±SD**	8.22±0.31	1.61±0.1	0.51±0.03
		SE	0.04	0.01	0
		p	***	***	***
341-365 kg	**No. 50**	**Mean±SD**	8.31±0.38	1.66±0.11	0.53±0.03
		SE	0.05	0.02	0
		p	***	***	***
366-395 kg	**No. 50**	**Mean±SD**	8.57±0.43	1.73±0.11	0.55±0.03
		SE	0.06	0.01	0
		p	0.81	0.67	0.67
396-432 kg	**No. 50**	**Mean±SD**	8.82±0.34	1.78±0.08	0.57±0.03
		SE	0.05	0.01	0
		p	***	***	***
435-482 kg	**No. 50**	**Mean±SD**	8.87±0.22	1.83±0.04	0.59±0.01
		SE	0.03	0.01	0
		p	***	***	***
	Regression equation		y =0.00553 x + 6.43726	y =0.00173 x + 1.05994	y =0.00062 x + 0.31287
	R^2		0.93253	0.98701	0.9965

Table 16: Slaughter weight effect on meat tenderness of group II

Items			Connective tissue (%)	Collagen (%)	Hydroxyproline (%)
Total	**No. 250**	**Mean±SD**	7.21±0.77	1.57±0.16	0.5±0.05
365-402 kg	**No. 50**	**Mean±SD**	8.24±0.16	1.74±0.06	0.56±0.02
		SE	0.02	0.01	0
		p	***	***	***
403-436 kg	**No. 50**	**Mean±SD**	7.76±0.14	1.68±0.1	0.54±0.03
		SE	0.02	0.01	0
		p	***	***	***
440-465 kg	**No. 50**	**Mean±SD**	7.25±0.11	1.59±0.08	0.51±0.02
		SE	0.02	0.01	0
		p	*	0.16	0.16
465-507 kg	**No. 50**	**Mean±SD**	6.72±0.18	1.47±0.07	0.47±0.02
		SE	0.03	0.01	0
		p	***	***	***
509-566 kg	**No. 50**	**Mean±SD**	6.09±0.24	1.37±0.06	0.44±0.02
		SE	0.03	0.01	0
		p	***	***	***
	Regression equation		y =-0.01505 x + 14.0696	y =-0.00268 x + 2.79168	y =-0.00087 x + 0.90225
	R^2		0.99885	0.9929	0.99217

Table 17: Some essential elements of the two groups' meat

Elements		Ca (mg/100 g)	P (mg/100 g)	Mg (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)
Total	**Mean±SD**	4.96±0.38	193.43±13.18	24.55±3.77	2.22±0.28	5.43±0.56
Group I	**No.**	250	250	250	250	250
	DF	249	249	249	249	249
	Mean±SD	5.11±0.4	198.89±14.14	26.11±4.04	2.33±0.3	5.67±0.61
	SE	0.03	0.89	0.26	0.02	0.04
	t	6.12	6.12	6.12	6.12	6.12
	p	***	***	***	***	***
Group II	**No.**	250	250	250	250	250
	DF	249	249	249	249	249
	Mean±SD	4.8±0.27	187.96±9.39	22.99±2.68	2.1±0.2	5.2±0.4
	SE	0.02	0.59	0.17	0.01	0.03
	t	-9.2	-9.2	-9.2	-9.2	-9.2
	p	***	***	***	***	***

Table 18: Breed effect on some essential elements of group I meat

Items			Ca (mg/100 g)	P (mg/100 g)	Mg (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)
Total	**No. 250**	**Mean±SD**	5.11±0.4	198.89±14.14	26.11±4.04	2.33±0.3	5.67±0.61
Baggara Nyalawi sub-type	**No. 50**	**Mean±SD**	5.01±0.4	195.19±13.92	25.05±3.98	2.25±0.3	5.51±0.6
		SE	0.06	1.97	0.56	0.04	0.08
		p	0.07	0.07	0.07	0.07	0.07
Baggara Rizzaki sub-type	**No. 50**	**Mean±SD**	5.06±0.39	197.14±13.52	25.61±3.86	2.3±0.29	5.59±0.58
		SE	0.05	1.91	0.55	0.04	0.08
		p	0.36	0.36	0.36	0.36	0.36
Baggara Messiri sub-type	**No. 50**	**Mean±SD**	5.1±0.41	198.65±14.19	26.04±4.05	2.33±0.3	5.66±0.61
		SE	0.06	2.01	0.57	0.04	0.09
		p	0.9	0.9	0.9	0.9	0.9
Kenana	**No. 50**	**Mean±SD**	5.18±0.41	201.28±14.23	26.79±4.06	2.38±0.3	5.77±0.61
		SE	0.06	2.01	0.57	0.04	0.09
		p	0.24	0.24	0.24	0.24	0.24
Butana	**No. 50**	**Mean±SD**	5.21±0.4	202.22±14.17	27.06±4.05	2.4±0.3	5.81±0.61
		SE	0.06	2	0.57	0.04	0.09
		p	0.1	0.1	0.1	0.1	0.1

Table 19: Breed effect on some essential elements of group II meat

Items			Ca (mg/100 g)	P (mg/100 g)	Mg (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)
Total	**No. 250**	**Mean±SD**	4.8±0.27	187.96±9.39	22.99±2.68	2.1±0.2	5.2±0.4
Baggara Nyalawi sub-type	**No. 50**	**Mean±SD**	4.36±0.18	172.65±6.22	18.61±1.78	1.77±0.13	4.54±0.27
		SE	0.03	0.88	0.25	0.02	0.04
		p	***	***	***	***	***
Baggara Rizzaki sub-type	**No. 50**	**Mean±SD**	4.83±0.11	189.09±3.96	23.31±1.13	2.12±0.08	5.25±0.17
		SE	0.02	0.56	0.16	0.01	0.02
		p	*	*	*	*	*
Baggara Messiri sub-type	**No. 50**	**Mean±SD**	4.87±0.11	190.35±3.96	23.67±1.13	2.15±0.08	5.3±0.17
		SE	0.02	0.56	0.16	0.01	0.02
		p	*	*	*	*	*
Kenana	**No. 50**	**Mean±SD**	4.96±0.16	193.76±5.58	24.65±1.59	2.22±0.12	5.45±0.24
		SE	0.02	0.79	0.23	0.02	0.03
		p	***	***	***	***	***
Butana	**No. 50**	**Mean±SD**	4.97±0.16	193.95±5.45	24.7±1.56	2.23±0.12	5.45±0.23
		SE	0.02	0.77	0.22	0.02	0.03
		p	***	***	***	***	***

DISCUSSION

Results in Tables 2,3 and 4 cleared that bulls in the second group (II) were significantly ($p < 0.05$) superior to group I bulls. Sensory evaluation results run parallel to those obtained by Eltahir (1994) who found significant breed differences between Baggara and Friesian crossbred bulls. Friesian breed produced more red colored meat than the former. These differences were caused by maturity, as Friesian is known for late maturing. He also did not find breed differences in meat flavor and juiciness scores between the 2 breeds. While Gumaa (1996) reported no significant difference in flavor and meat juiciness between beef from Kenana and Baggara bulls. Mohammed (2004) mentioned that juiciness was significantly ($p<0.05$) higher for meat obtained from animals slaughtered at heavy weights than those slaughtered at lighter weights.

Meat proximate analysis of group II including protein, fat and ash percentages was higher than that of group I, while the moisture percentage for group I was higher than that of group II, (Table 5). Sudanese cattle meat type Baggara Nyalawi and Baggara Rizzaki were significantly ($p < 0.05$) superior to Baggara Messiri, Kenana and Butana breeds (Tables 6 and 7). Ahmed (2006) declared that that meat moisture content significantly ($p<0.05$) inversely related to slaughter weight. While protein and fat content ($p<0.05$) directly related to slaughter weight, while ash content significantly ($p<0.01$) decreased with increase of slaughter weight. Ibrahim, (2013) pointed out that proximate analysis of Baggara Cattle (Nyalawi and Messiri) meat revealed that there was no significant difference ($p>0.05$) in moisture content between the two subtypes, with higher content to the Nyalawi subtype. There was no significant difference in protein content. Messiri bulls were higher in muscle fat content significantly ($p<0.01$) than that of the Nyalawi subtype. Alamin *et al.* (2014) evaluated the composition of fresh beef meat chemically. They stated that moisture, protein, fat and ash content were 75.55, 21.07%, 2.74 and 0.47% respectively. Sayed *et al.* (2018) stated that proximate analysis revealed that the mean values of moisture, protein, fat, ash, carbohydrates and energy of young beef were 73.79 ± 0.47, 21.29 ± 0.35, 3.22 ± 0.26, 1.08 ± 0.04, 0.61 ± 0.09 and 116.61 ± 2.69, respectively. While for old beef, they were 76.11 ± 0.57, 19.57 ± 0.48, 2.54 ± 0.26, 1.32 ± 0.11, 0.46 ± 0.07 and 102.96 ± 3.33, respectively.

Sudanese cattle meat was found ideal for consumers, as it is a good source of animal protein and essential elements with low fat and cholesterol content. Meat cholesterol concentration for group II was higher than that of group I (Tables 8,9 and 10). Meat cholesterol concentrations run parallel to those obtained by many authors. Brugiapaglia *et al.* (2014) recorded significant differences in intramuscular fat content and fatty acids profile of Piemontese, Limousin and Friesian breeds, but did not record any significant differences in cholesterol content. Alamin *et al.* (2014) showed that the cholesterol concentration of Sudanese beef was (73.6 mg/100g). In another research, the cholesterol content of Sudanese beef was (74.5 mg/100gm) (Alamin 2019).

The obtained results emphasized that younger age bulls' meat was leaner than that of older ones. Also, fattened bulls' meat was found more tender than that of immediately slaughtered ones, and meat of higher weight bulls was more tender than that of lighter-weight ones (Tables 11, 12, 13, 14, 15 and 16). Dikeman *et al.* (1986) and Bosselmann *et al.* (1995) declared that collagen differences may have been involved in toughness differences between beef from bulls and steers. Brahman or Brahman-cross steers have less tender meat than British breeds. Smith (1990) did not recommend forage finishing of beef due to decreased flavor and tenderness in favor of grain finishing. Chambers and Bowers (1993) cited that tenderness of beef has been identified as a quality characteristic that is closely related to the overall acceptability of beef. Elhashmi (1998) and Mohammed (2004) found that shear force and connective tissue strength decreased with slaughter weight increase. Short *et al.* (1999) reported that tenderness improved with increased time on feed. Mohammed (2004) revealed that meat from lighter Baggara bulls was more tender ($P<0.01$) than meat from older bulls. Elmak (2008) revealed that meat from lighter animals was more tender ($P< 0.05$) than that of heavier animals.

Essential elements results (Tables 17, 18 and 19) run parallel to those obtained by many authors. Meat was recommended as a good source of iron and zinc by Bender (1992). USDA (2011) reported that beef provides human body by daily requirements in a 100 g portion as follows; around 37% of selenium, 26% of zinc and 20% of potassium. Humaeda (2018) showed that fresh beef chemical content of essential elements; Cr, Mn, Zn, Ni, Cu and Fe were 0.52, 0.08, 0.22, 0.34, 0.66 and 56.37, mg/kg respectively.

CONCLUSION AND RECOMMENDATIONS

In conclusion, Sudanese cattle meat has good sensory characteristics including color, taste, odour and overall acceptability by consumers. Sudanese cattle meat is considered ideal for consumers as it is a good source for animal protein and essential elements with low fat and cholesterol content. So, it is highly recommended to expand the importing of Sudanese cattle, especially for fattening purpose during the upcoming years to fill red meat gap in Egyp

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تقييم لحوم الأبقار السودانية المذبوحة في مصر

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صممت الدراسة الحالية من أجل تقييم جودة اللحوم البقرية السودانية ومن أجل تحقيق هذا الغرض فإنه قد تم اختيار ٥٠٠ عجل سوداني مستورد تم ذبحهم في مجازر مدينة أبو سمبل السياحية وتقسيمهم إلى مجموعتين. المجموعة الأولى تتكون من ٢٥٠ عجل سوداني تتراوح أعمارهم بين ٢ و ٥,٥ سنة تم تغذيتهم لمدة شهر قبل الذبح أما المجموعة الثانية فهي تضم ٢٥٠ عجل سوداني تتراوح أعمارهم بين ٢ و ٢,٥ سنة تم تسمينهم لمدة ٦ أشهر قبل الذبح. خضعت عينات عضلات الطولى الظهرية للتقييم الحسي والتحليل الكيميائي (التحليل التقريبي، محتوى الكوليسترول ، الهيدروكسي برولين وبعض العناصر الأساسية). من النتائج اتضح أن المجموعة الثانية تفوقت معنوياً ($p < 0.05$) على المجموعة الأولى. كما تفوقت سلالتي البقارة نيالاوي والبقارة رزيقي معنوياً ($p < 0.05$) على سلالات البقارة المسيري والكنانة والبطانة. وجد أن لحوم عجول المجموعة الثانية أكثر طراوة من لحوم عجول المجموعة الأولى ، كما وجد أن لحوم العجول الأصغر عمرا أكثر طراوة من نظيرتها الأكبر في العمر، وكانت لحوم العجول الأثقل وزنا أكثر طراوة من لحوم العجول الأخف في الوزن. أظهر التقييم الحسي أن لحوم الأبقار السودانية ذات صفات حسية جيدة بما في ذلك اللون والطعم والرائحة وقبول عام لدى المستهلكين. وقد تبين من الدراسة أن اللحوم البقرية السودانية تعتبر مثالية للمستهلكين لأنها مصدر جيد للبروتين الحيواني والعناصر الأساسية ومحتوى منخفض من الدهون والكوليسترول. يمكن أن نستخلص أن اللحوم البقرية السودانية يمكن أن تلعب دورا هاما في سد فجوة اللحوم الحمراء في مصر، لذا يوصى بالتوسع في استيراد العجول البقرية السودانية وخاصة بغرض التسمين خلال السنوات القادمة.