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Research Article

Phenotypic Characterization and Morphometrical Measurements of Sudanese Red Fulani Cattle (Kuri) in South Darfur, Sudan

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Abstract

The present research was conducted to study phenotypic description and body measurements of Sudanese Red Fulani cattle kept by Fulani people in South Darfur state, Sudan. This breed is called Fulani or Kuri. A total of 303 animals of the above-mentioned breed were examined. Data relating to phenotypic description were obtained from local livestock markets in the vicinity of Nyala town. Where Sudanese Fulani people herd their cattle during the rainy season in this state. Phenotypic characters that include (animal coat: hair, hump, profile descriptions, horn, ear and body colours) were assessed by designing a questionnaire and a distinguishing color chart. Results elucidated that the majority (97.3%) of coat pattern in examined herds was uniform (one color) with almost (100%) short and straight hair. The dominant color of head, ear, tail switch, hoof and muzzle for Sudanese Fulani red cattle was dark red (52.7%, 53.3%, 52% and 84%) respectively. Both dewlap and hump of the Sudanese Red Fulani bulls were of medium size (65.7%) and (65.7%) respectively. Whereas, the majority; were found to possess Cervico-thoracic humps (80.2%) and flat faces (88.1%). Both sexes of the studied breed were found to be Horned; (46.5%) with Lyre-shaped horns of upward orientation (81.2%) and wide spaces (95%). Live body weight of cows of 1 - 2 years of age within the studied breed was 210 kg, (244.3 kg) of average, the maximum live body weight of mature Sudanese Red Fulani cattle over 6 years old reaching up to 500 kg, with an average of (384.72 kg). The results of physical body measurements of Sudanese Red Fulani cattle bulls at different ages revealed that aged cattle had significantly ($p < .05$) higher mean values for all the body measurements investigated. It was found that Sudanese Fulani red are shorter than Senegalese and White Fulani. These findings suggest that phenotypic description could be considered in genetic improvement and breeding plans.

Keywords: *Physical; Description; Body Measurement; Sudanese Fulani; Cattle*

Introduction

Ruminants are found up over the world with exception of areas endemic with *Trypanosoma* that causes sleeping sickness. Cattle and their relatives (buffalos and bison) play an important role in the of rural households and is considered as a genetic reserve for genetic diversity [1,2]. Sudanese indigenous cattle descended from East African *Boss indicus* species that is referred to as Zebu type [3-5]. They are well adapted to tropical environments because of their high degree of tolerance or partial resistance to tick and many tick-borne dis-

eases and other diseases, survival on poor quality pastures as well as being considered as a reliable source of draught power [6,7]. These indigenous cattle are owned by nomadic and semi nomadic tribes [8]. The total population of cattle in the Sudan is estimated to be about 40 million cattle heads [9]. This type of cattle has many uses; domestic, social, political, and economic that impacts the social life of owners. One of these important indigenous beef cattle in South Darfur and Blue Nile, namely Fulani or (Kuri cattle)-local names, are owned by Fulbe or Fulani people" [9] who inhabit South Darfur and Blue Nile states during most of their migration route crossing the Sudan during the rainy season (June continued to September) passing South-Westward from West, Central Africa and Cameroon republics at the end of the dry season progressed [10]. According to our knowledge there are no reports or studies on phenotypic and genotypic characterization of these breed. The breed differs in appearance and formation from other indigenous cattle (Baggara breeds) in South Darfur. It is distinguished by possessing long horns and having tall features (Figure 1). The common features in most of Sudanese Red Fulani cattle differ from that of Senegalese and White Fulani [11]. Some authors reported that, their coat color is quite variable, usually with light grey spots, whereas the Senegalese and White Fulani are much larger than Red Kuri which coat is predominantly red or red with white spots [3,12]. Recently, selection and breeding of cattle herds have been directed to improve production potentials of indigenous animals [2]. This has led to an uncontrolled crossbreeding between indigenous breeds and high producing exotic ones. As a result, many indigenous breeds have been completely replaced and some have even disappeared [13]. Indigenous cattle breeds possess numerous unique features such as their being well adapted to the very harsh feeding and housing conditions, resistance to diseases, have a long production life and thus could be an initial material for developing new breeds [14,15]. Therefore, characterization of indigenous cattle breeds is the first step to a sustainable use of our animal genetic resources [16,17]. Phenotypic information will be the basis for the establishment of further characterization, conservation and selection strategies [18].

Figure 1: *Sudanese Red Fulani or (Kuri) cattle.*

Morphometric measurements have been traditionally used for characterization of indigenous cattle breeds by many researchers [19-21]. Morphometric measurements are conducted for characterizing animal breeds. Therefore, morphometric measurements of Sudanese Red Fulani cattle are important to establish a basis of identification of this breed as they play an important role in enters and inter

identification of various cattle breeds [18]. They are also used to assess several characteristics of animal [22]. Moreover, they are applied for monitoring growth rate, weight, carcass characteristics, performance characteristics, and to assess several economically important characteristics of animals [23,24]. In addition, they are used to describe the properties that changed with environmental effects and nutritional factors. However, the morphometric body measurements provide important data sources in terms of reflecting the breed standards [25,26]. Furthermore, they provide useful information on morphological structure, development ability of animals, Suitability of animals for selection and genetic improvement programs [25].

Objective of the Study

The objective of this present study was to provide information on phenotypic description and morphometric characteristic of Sudanese Red Fulani cattle in South Darfur State as part of a strategy for conservation of the breed.

Materials and Methods

Area of study

South Darfur state, western Sudan, lies within the savanna zone between latitude 9 - 30, 13˚N and longitude 15 - 27, 0 - 28˚E. The area of the state is about 127,300 square kilometers. Borders South Darfur state to the Southwest. Regarding climate of Southern Darfur, the average annual rainfall is 200 mm in the far north of the State, increasing towards the south, till reaching up to 1,000 mm in Alradoum and Jabal Marrah districs [27]. The State covers three different ecological zones; a semi-desert area in the north where the annual rainfall ranges between 250 to 400 mm, medium savanna with rain fall ranging between (400 - 600 mm) and in the south heavy savanna with annuaul rainfall ranging between 600 to 800 mm.

Data collection

Phenotypic data

Data on phenotypic description were collected through answering a designed questionnaire according to [28] with some modifications. Collected data covered some descriptions of animal phenotypic appearance including animal coat: hair, hump, profile descriptions, horn, ear and patterns of body colouration (Appendix 2).

Morphometric data

Data on morphological measurements of Red Fulani cattle were collected from the main local livestock market (it is the main livetock market where cattle are collected from different South Darfur State districts). Data were collected from both cows and bulls (n = 303). Sampled animals were divided into four age groups; Group A (1 - 2 years), Group B (3 - 4 years) Group C (4 - 5 years) and Group D (over 6 years).

Morphometric measurements include: body weight (BW), body length (BL), heart girth (HG), height at withers (HTW), hip height (HH) and rump width (RW) traits. Body weight and five morphological measures were taken on each animal. Body weight was measured in kilogram (kg) by using a mechanical scale (0 - 1000 kg), height at withers and hip height measurements were taken in centimeters (cm) by using a measuring stick. Body length, heart girth and rump width measured in centimeters (cm) using a tape ruler. Live animal measurements were taken according to methods descripted by [24,29] as follows as described in appendix 1.

Statistical analysis

The data collected were analyzed using SPSS software version 16.0. The analysis included descriptive statistics (frequencies, percentages, minimum, maximum). Regarding data on morphmoetric measurements, they were analyzed using analysis of variance (ANOVA).

Results and Discussion

Table 1 and 2 show detailed phenotypic descriptions and body coat color pattern for Sudanese red Fulani cattle. In this studied population, results revealed that the majority (97.3%) of coat patterns in the herds was uniform (one color) with almost (100%) short and straight hair. While, dark red color represnted (50%), moreso, other colors like red,white and black (36, 7.3 and 6.7%) were also respectively obtained. The dominant color of head, ear, tail swich, hoof and muzzle for the breed were dark red (52.7%, 53.3%, 52% and 84%) respectively. These descriptions coincided with those demonstrated [30] who comfirmed that the skin of Red Fulani cattle is a uniform (one color) red colour. Moreover, the dominant coat color pattern for Bororo (Wodaabé) cattle of Niger is red-pied (58.6%), while other colors: black (0.3%), white (0.3%), roan (1.4%) grey and dun-red (0.3%) fawn (2.5%) were reported [31]. The same authors had found that the most frequent coat color of MBororo zebu of BurkinoFaso was Black-pied (20.7%), then white (10.8%) and grey (9.4%), beside other color combinations such as, fawn (1%) and blond (0.3%). Where, the dominant (91.0%) coat color for zebu Bororo of Niger is red-pied. It is well known that the red Boraro or red Fulani is distinguished by its chestnut to deep mahogany coat color [30]. In contrary, coat of the Senegalese and White Fulani is predominantly white [32]. Also, these facts about the coat color of this breed agrees with [33,34] who claimed that Sudanese red Fulani is quite variable, usually with a spotted light grey.

Phenotypic descriptions		Frequency	%
Coat Patterns	Uniform (1 coluor)	293	96.7
Uniform (multicolored)	10	3.3	
Total	303	100%	
Hair	Short and straight	303	100
Dewlap	Medium	199	65.7
Large	104	34.3	
Total	303	100%	
Hump	Medium	183	60.4
Large	102	33.7	
Absent	12	4.0	
Small	6	2.0	
Total	303	100%	
Hump Orientation	Erect	191	63.0
Bent sideways	112	37.0	
Total	303	100%	
Hump location	Cervico-thoracic	243	80.2
Thoracic	60	19.8	
Total	303	100%	

Profile	Face	Flat	267	88.1
		Concave	36	11.9
	Total		303	100%
	Back	Hollow	186	61.4
		Straight	117	38.6
	Total		303	100%
	Rump	Flat	177	58.4
		Sloping	126	41.6
		Total	303	100%
Horn Present in all			303	100
Hon	Shape	Lyre-shaped	141	46.5
		Curved	120	39.6
		Spiral	36	11.9
		Straight	6	2.0
		Total	303	100%
	Orientatin	Upward	246	81.2
		Backward	27	9.9
		Forward	30	8.9
		Total	303	100%
Spacing		Wide	288	95.0
Narrow			15	5.0
Total			303	100%
Shape		Round-edged	270	89.1
Ears			33	10.9
Orientation			303	100%
Straight-edged			213	70.3
Total			90	29.7
Erect			303	100%
Lateral				
Total				
Udder Size		Medium	286	94.4
Small			17	5.6
Total			303	100%
Teats Medium			303	100

Table 1: *Phenotypic descriptions of Sudanese fulani cattle.*

Body Coat Colour Description	Colour	Frequency	%
Body predominant colour	Red dark (10)	150	50.0
	Red (9)	108	36.0
	White (2)	22	7.3
	Black (1)	20	6.7
	Total	300	100%
Body combination colour	White (2)	46	15.3
	Red dark (10)	15	5.0
	Red (9)	7	2.3
	Black (1)	3	1.0
	Total	71	23.7%
Head predominant colour	Red dark (10)	158	52.7
	Red (9)	106	35.3
	Black (1)	18	6.0
	White (2)	14	4.7
	Total	296	98.7%
Head combination colour	Black (1)	19	6.3
	Red dark (10)	17	5.7
	Red (9)	12	4.0
	White (2)	11	3.7
	Total	59	19.7%
Ear predominant colour	Red dark (10)	160	53.3
	Red (9)	106	35.3
	Black (1)	19	6.3
	White (2)	15	5.0
	Total	300	100%
Ear combination colour	Red (9)	26	8.7
	White (2)	15	5.0
	Black (1)	8	2.7
	Total	49	16.3%
Tail switch predominant colour	Read dark (10)	156	52.0
	Red (9)	104	34.7
	White (2)	21	7.0
	Black (1)	19	6.3
	Total	300	100%
Tail switch combination colour	White (2)	162	54.0
	Black (1)	25	8.3
	Total	187	62.3%
Hoof colour	Black (1)	252	84.0
	White (2)	18	6.0
	Red (9)	15	5.0
	Red dark (10)	12	4.0
	Total	297	99%
Muzzle colour	Red dark (13)	127	42.3
	Black (1)	48	16.0
	Red (9)	16	5.3
	Total	191	63.6%

Table 2: *Frequencies and percentages of different body colour found in Sudanese fulani cattle.*

**: Code from colour chart (See appendix 2).*

In addition, it was found that both dewlap and hump of Sudanese red Fulani bulls were medium size (65.7%) and (65.7%) respectively. The majority had cervico-thoracic hump (80.2%) and flat face (88.1%). Moreover, the horns were found in both male and female; (46.4%) with Lyre-shaped horns of upward orientation (81.2%) and wide space (95%). The results also, revealed that (89.2%) were round-edged ear shape and (70.3%) errect orientation. Whereas, the majority (94.4%) of the female had medium udder size and all of them (100%) possessed medium teat size. The present description of Sudanese Fulani is compeletely matching with those repoted [30] for M, boraro cattle; the dewlap hangs low and the horns are carried high, in a lyre shape, reaching between 0.8 and 1.2m in length. Moreover, a cervico-thoracic hump differentiates this breed from typical zebu of Western and Eastern Africa that possess thoracic or sometimes intermediate humps [10]. Similarly, [31] observed that (55.2%) of Zebo Bororo of Niger had poorly developed dewlap, (93.1%) lyre horn shape (89.7%) drop ear shape compared to (92.2%) other west African zebu. Table 3 demonstrates means and standard errors of body weight of Sudanese Fulani red cattle at different age stages. The results revealed that maximum live body weight of members of this breed at 1 - 2 years of age is 210 kg, avrage (244.3 kg), while the maximum live body weight of mature bulls over 6 years of age reached upto 500 kg, with an average of (384.72 kg). The present findings were in line with those demonstrated by [30]; who showed that adult MBororo cattle weight ranges from 400 to 500 kg for bulls and 350 to 450 kg for cows. This high within group variation is mainly attributed to seasonality and pasture quantity and quality.

Age group (year)	No.	Minimum	Maximum	Mean ± SE.
1 - 2 yrs	59	150	210	244.30^{a} ± 6.14
3 - 4 yrs	55	195	410	272.14^{b} ± 7.29
5 - 6 yrs	53	240	595	370.04^{c} ± 9.34
Over 6 yrs	58	300	500	384.72^{d} ± 9.33

Table 3: *Averge body weight of Sudanse fulani cattle at diffrernt ages*

Means in the same column with different superscripts are significantly different (p < .05).

	Age Groups															
	1-2 years				3-4 years				5-6 years				Over 7 years			
Traits	N	*Min*	*Max*	*Mean ± SE.*	N	*Min*	*Max*	*Mean ± SE.*	N	*Min*	*Max*	*Mean ± SE.*	N	*Min*	*x*	*Mean ± SE.*
BL	50	70	105	86.70^{d}±1.37	51	80	107	91.97^{c}±1.09	50	93	117	101.92^{b}±.86	50	93	116	103.28^{a}±.97
HG	50	110	159	144.35^{c}±1.77	51	130	178	154.43^{b}±1.37	50	141	201	170.88^{a}±1.71	50	141	195	170.67^{a}±1.92
HAW	50	112	137	125.12^{b}±0.93	51	117	138	125.49^{b}±0.86	50	125	182	136.00^{a}±1.27	50	121	183	136.95^{a}±1.81
DC	50	135	193	160.70^{d}±1.76	51	122	187	164.23^{c}±2.19	50	133	223	179.78^{b}±2.07	50	164	207	184.33^{a}±2.01
HH	50	115	152	131.25^{b}±1.16	51	122	145	131.74^{b}±0.89	50	125	265	142.42^{a}±2.64	50	129	160	142.51^{a}±1.24
RH	50	113	139	126.38^{b}±0.87	51	121	140	129.23^{b}±0.75	50	125	157	136.54^{a}±0.97	50	40	153	136.08^{a}±2.79
RW	50	28	46	37.48^{b}±0.65	51	25	46	37.94^{b}±0.809	50	33	64	45.32^{a}±0.77	50	35	83	45.31^{a}±1.362
STD	50	77	136	119.30^{d}±1.85	51	104	147	120.77^{c}±1.61	50	106	183	131.88^{b}±1.55	50	121	164	136.82^{a}±1.62
TL	50	78	122	104.82^{c}±1.24	51	88	136	106.69^{b}±1.43	50	98	137	117.48^{a}±1.30	50	92	137	117.79^{a}±1.62
HL	50	35	48	41.45^{c}±0.43	51	34	48	42.29^{b}±0.47	50	40	48	44.46^{a}±0.32	50	25	59	44.79^{a}±0.88
HW	50	18	26	21.33^{b}±0.24	51	18	26	21.57^{b}±0.28	50	17	48	22.86^{a}±0.59	50	18	28	22.41^{a}±0.29
HS	50	23	65	44.85^{d}±1.07	51	34	65	47.77^{c}±1.07	50	25	63	50.00^{b}±0.88	50	43	68	52.95^{a}±1.07
FL	50	19	26	22.72^{b}±0.26	51	19	26	22.94^{b}±0.24	50	20	57	24.82^{a}±0.69	50	20	31	24.10^{a}±0.36
EL	50	18	26	22.35^{b}±0.24	51	19	26	22.43^{b}±0.22	50	18	26	22.36^{b}±0.23	50	18	26	22.85^{a}±0.30
HLth	50	21	80	45.02^{c}±2.30	51	24	72	47.43^{b}±1.98	50	32	93	61.44^{a}±2.17	50	19	102	61.33^{a}±3.59
FLL	50	72	113	94.32^{c}±1.49	51	72	113	96.66^{b}±1.90	50	73	124	102.08^{a}±1.56	50	81	122	102.54^{a}±1.46
NL	50	31	52	38.55^{d}±0.75	51	30	48	40.17^{c}±0.77	50	33	59	41.58^{b}±0.78	50	33	106	44.10^{a}±1.89
RLL	50	77	126	106.30^{d}±1.64	51	84	121	108.17^{b}±1.87	50	84	143	113.14^{a}±1.61	50	86	137	113.85^{a}±1.54
CC	50	16	19	17.28^{c}±0.14	51	16	19	17.40^{c}±0.16	50	16	21	19.04^{a}±0.13	50	16	21	18.82^{b}±0.19

Table 4: *Morphometric measurements of Sudansese Fulain cattle (Bulls) at different ages.*

No.=Number of Observations= Standard Error; BL= Body Length; HG= Heart Girth; HW= Height at Withers; DC= Deep of Chest; HH= Hip Height; RW= Rump Width; RH= Rump Height; STD= Shoulder to Tail Drop; TL= Tail Length; HL= Head Length; HdW= Head Width; HS =Head; FL= Face Length; EL= Ear Length; HLth= Horn Length; FLL= Fore Leg Length; NL= Neck Length; RLL=Rear Leg Length; CC=Canon Circumference to Shoulder. Means in the same row with different superscripts are significantly different (p<.05).

Morphometric measurements of Sudansese Fulain cattle bulls at different ages is shown in table 4. The results elucidated that aged cattle had significantly ($p < .05$) higher mean values for all body measurements investigated. Averages BL (101.92 cm) and FL (24.82 cm) for mature (5 - 6 years) Sudanese red Fulani bulls in the present study were much lower than those obtained by [31] for Zebu Bororo (Wodaabé) cattle of Niger (138.1 cm and 53.6 cm) and Zebu Mbororo of Borkinafso (131.2 and 52.9 cm). Moreover, they were also, with lower BL (152.9 cm) and FL (47.19 cm) compared to White Fulani cattle according to [35]. These results confirm the findings professed by [10] who declared that the Senegalese and White Fulani are much larger than the Sudanese Fulani. However, HG (170.88 cm) and HW (136 cm) for Sudanese Red Fulani was found to be higher than those of Zebu Bororo (Wodaabé) and Zebu Mbororo; (160.3 and 128.4 cm) and (149.4 and 125.6 cm) respectively.

Conclusion

- The recent findings disclosed that body measurements of Sudanese red Fulani were lower than those of West African zebu cattle (Zebu Bororo (Wodaabé), Zebu Mbororo and White Fulani).
- The results proved distingquished differences in body components and phenotypic features between Sudanese red Fulani and West African zebu cattle breeds.
- Further deep researches are needed to verify the genetic variability and relationship between these African cattle breeds.

Appendix 1

- **Body length (BLT):** The distance on the dorsal midline from the top of the head to pin bones.
- **Heart girth (HG):** The narrowest circumference immediately posterior to the front legs.
- **Depth of Chest (DC)**: The distance between the top behind the scapular and the flow of the sternum (taken to be the depth of brisket) immediately behind forelegs.
- **Height at withers (HAW):** The vertical distance from the floor beneath the animal to the point of the withers will be measured with a measuring stick.
- **Hip height (HH):** Distance down to the hips from the distance down to the floor with a descending tape placed above the animal.
- **Rump width (RW)**: The distance between the most posterior points of pin bones.
- **Rump height (RH):** Measured from hips (*Tuber coxae)* to pins (*Tuber ischii).*
- **Face length (FL)**: Distance from between the dorsal surface of the forntal bone to the distal end of the nasal bone.
- **Head width (HW)**: Measured as the widest point of the head.
- **Head to shoulder (HS)**: The distance from the nose to point of shoulder.
- **Horn length (HLth):** The distance from the tip of the horn to the base of the horn.
- **Ear length (ELT):** The distance from the tip of the ear to the base of the ear.

- **Neck length (NK):** The distance from the dip in the vertebrate (takes practice to find the right dip) between the shoulder blades to just in front of poll.
- **Shoulder to tail drop (STD):** The distance from the point of the shoulder to the pin bones.
- **Tail length (TL):** The distance from the pin bones of the sacrum to the base of the tail switch.
- **Foreleg length (FL)**: The distance from the proximal extremity of the olecranon process to the ground.
- **Canon circumference (CC):** The narrowest circumference of the canon bone.

Appendix 2

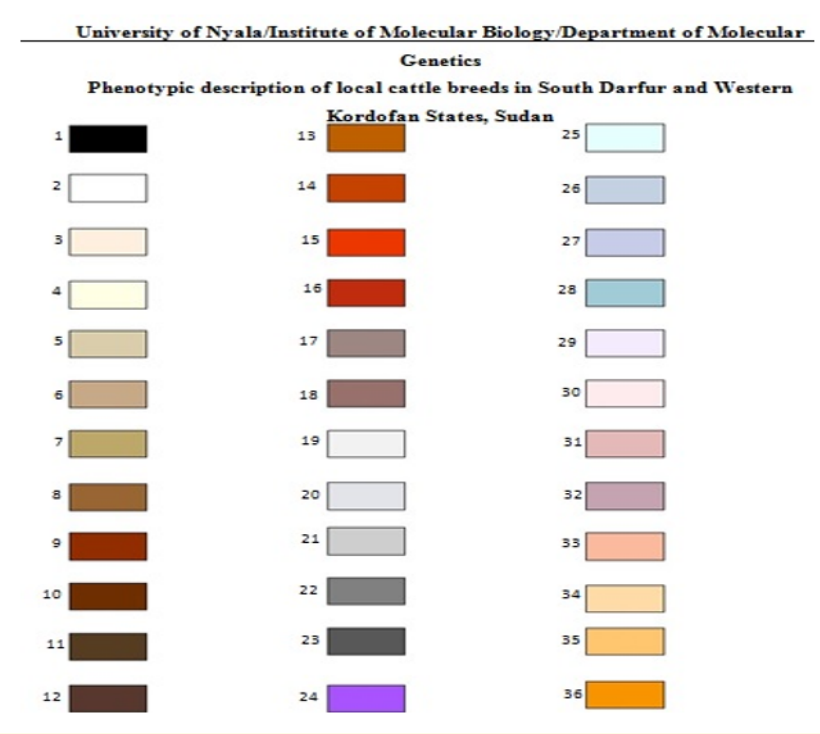

Plate 1: *Graded color chart to assess animal body color.*

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