

Research Article

Morphobiometric Characteristics of the Arab Zebu in Abeche, Chad

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Abstract

The objective of the study was to describe the phenotypic characteristics of Arab Zebu in Abeche city. A longitudinal survey was administered to 26 breeders to take body measurements, and identify the physical characteristics of 112 adult cattle (100 cows and 12 bulls, 4 years and over). The information sought was: the breeder's profile (name, sex, age, region, ethnicity, marital status, schooling and main activities), the animal descriptions (sex, coat, horns, profile of head, back, and rump, hump and dewlap size, scabbard size in males and the tail length) and some quantitative parameters (live weight, age, length, and width of head, and rump, length of horn, tail and trunk, height at withers, and thoracic circumference). After analysis of the data collected with the XLSTAT software (9.1.6), it appears that the breeders are mostly married men, of Arab ethnic group, uneducated, and practicing the white-coated breeding. Arab cattle are mostly white coated; straight in profile, straight back, flat rump, poorly developed hump and dewlap, long tail and small cupped horns. Males have an average weight of 403 kg and females, 297 kg. The height at the withers is on average 1.16m with 1.22m in males and 1.14m in females. Chest circumference, and live weight are strongly correlated. Studies in-depth on the phenotypic, and genetic characteristics of this breed will make a complete description of all the parameters and establish a suitable barymetry formula.

Keywords

Arab Zebu, Barymetry, Phenotype, Abeche, Chad

1. Introduction

A Sahelian country with an agro-pastoral vocation, Chad bases its economy largely on the development of livestock products. The livestock sector, which represents 53% of rural GDP and provides a livelihood for approximately 40% of the rural population [1], is home to a significant number of livestock. Chad's livestock population stands at 137,664,217 head of cattle, including 33,948,191 cattle [2]. Approximately 80%

of Chad's livestock is governed by highly diversified mobile pastoral systems that are largely dependent on renewable natural resources [1]. In rural areas, livestock farming is the main source of employment and the only source of income distribution for the most disadvantaged populations and the only way of exploiting semi-arid areas [3, 4]. Considering its significant contribution to the national economy and in im-

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proving the living conditions of populations, livestock farming, as an essential tool in the fight against poverty in Chad, constitutes a guarantee for food security [5]. Eastern Chad is one of the major livestock farming areas in the country. The cattle herd in this region is mainly transhumant but sedentary livestock farming exists, particularly on the outskirts of cities. Due to its small size, this livestock farming is very little studied and therefore little known [6]. The province of Ouaddaï has 2,119,020 heads of cattle [2]. The Arab Zebu is a Sahelian cattle par excellence that represents 80% of the Chadian cattle herd [5, 7]. It is a mixed breed, rustic and unimproved. High animal mortality due to epidemic diseases and the pasture losses accentuate transhumance to agricultural areas or the animal abroad sales. All these upheavals associated with the introduction of exotic breeds lead to erosion and loss of biodiversity [8]. Therefore, the phenotypic characteristics of cattle are essential to know to explore the possibilities of improving sustainable productivity and conserving cattle breeds. Knowledge of the physical and weight characteristics will make it possible to distinguish the Arab Zebu. This is what justifies this study. The objective of this study was to determine the morphobiometric and weight characteristics of the Arab Zebu in Abeche.

2. Materials and Methods

2.1. Study Area

The study took place in Abeche city, capital of Ouaddaï Province and capital of Ouara Department. Located in the East of Chad. It comprises seven (7) districts and stretches between 13°48'584"N latitude and 20°58'139"E longitude. The study area is influenced by an intertropical climate with a 9-month dry season and a 3-month rainy season. Average rainfall is approximately 300mm per year and the average annual temperature is approximately 28 °C, with variations in cold and hot periods.

2.2. Materials

The study was conducted through a survey form among 26 breeders and involved 112 adult Arab Zebras (100 females and 12 males). Various measurements were taken on the animals, as well as their weight, using a zoometric ribbon. An Android phone was also used to take images of animals for morphological description.

2.3. Data Collection

The study took place in Abeche city from June 4 to July 3, 2022. Survey forms were used to collect data on the breeders and their animals. The information sought included the breeder's profile (name, sex, age, religion, ethnic group, marital status, schooling, and main activities), animal descriptions (sex, coat color, horns, head profile, back profile,

and rump, size of the hump and dewlap, coat color and hooves, shape and ear orientations, the sheath size in males, and the tail length), and several quantitative parameters (live weight, age, length and width of the head and rump, the horn length, tail, and trunk, height at the withers, and thoracic circumference).

The goats (≥ 4 years of age) were measured and observed. The measurements took place in the morning, before feeding and watering the animals. The animals were restrained by the breeders or herdsman by grabbing the animals by their horns. Measurement data were collected using the traditional tape measure method on animals positioned in a standing position on horizontal surfaces.

The measurements taken were as follows:

Height at Withers (HW): vertical distance between the top of the withers and the ground;

Trunk Length (TL): length between the point of the shoulder and the point of the buttocks;

Thoracic circumference (ThC): chest circumference behind the withers, passing through the girth loop;

Rump Length (RL): distance between the points of the hips and the points of the buttocks;

Rump Width (RW): distance between the outer points of the hips;

Head Length (HL): distance between the top of the head and the tip of the muzzle;

Head Width (HWid): distance between the two eyes;

Horn length (HoL): distance from the root of the horn to its tip, following the outward curvature;

Tail Length (TaL): distance from the tail attachment to its tip.

The live weight of animals is determined by measuring the thoracic circumference, which allows the corresponding weight in kg on the zoometric ribbon: each chest circumference corresponds to a given live weight in kg.

The animal ages were determined reading the incisors (following the guidelines described above).

2.4. Data Analysis

XL-STAT software (9.1.6) was used for data analysis. Descriptive statistics were used to determine the dispersion parameters (mean, standard deviation, range, and frequency), and analysis of variance (ANOVA) was performed to compare means. The parameters measured were: trunk length, height at withers, thoracic circumference, rump length, rump width, head length, head width, horn length, and tail length. Means were compared using the Newman-Keuls test, and correlations between several numerical parameters were established using the Pearson two-tailed test at the 5% level.

2.5. Ethical Consideration

The study was conducted with consenting breeders following a research authorization delivered by the Higher

National Institute of Sciences and Techniques of Abeche. It was demonstrated that the animal handlings during this study was not likely to harm their physical integrity or the quality of their products (milk and meat).

3. Results

3.1. Breeder Profiles

The study showed that herders have an average age of 52 ± 2.57 years (32 to 92 years) and an average of 8 ± 1 children. The herder profile is presented in Table 1.

Table 1. Breeder Profiles.

Parameter	Variable	Effective (n)	(%)
Sex	Male	25	96.15
	Female	1	3.85
Ethnic Group	Arab	24	92.31

Parameter	Variable	Effective (n)	(%)
Schooling	Maba	2	7.69
	No	23	88.46
	Yes	3	11.54
Marital Status	Married	24	92.31
	Single	2	7.69
	Trade	12	46.15
Activities	Breeding	6	23.08
	Agriculture - Breeding	4	15.38
	Others	4	15.38

3.2. Description of Cattle Based on Qualitative Parameters

The general characteristics of the coat of the Arab Zebu cattle in the study area are presented in Table 2.

Table 2. General Characteristics of the Coat of the Arab Zebu cattle in Abeche, Chad.

Parameter	Coat	Effective (n)	(%)
Pattern	Simple	58	51.79
	Combined (variegated)	28	25.00
	Compound	26	23.21
	White	34	30.26
	Mottled	14	12.50
Color	Black Piebald	10	8.93
	Tinted	10	8.93
	Other	44	39.38

The most common coats are simple, followed by the combined (or piebald) coats, and the white color is the most common, followed by the speckled one.

This cattle breed has horned whose characteristics are presented in Table 3.

Table 3. Horn Characteristics of the Arab Zebu cattle of Abeche, Chad.

Variable	Horn	Effective (n)	%
Presence	Yes	111	99.11
	No	1	0.89
Orientation	Horizontal	105	94.59
	Drooping	6	5.41

Variable	Horn	Effective (n)	%
Color	Brown	58	52.25
	White	40	36.04
	Black	13	11.71
Shape	Cross-section	68	61.26
	Crescent-shaped	34	30.63
	Other	9	8.11

The majority of Arab cattle in the area have horizontal, brown, cupped horns, followed by white, crescent-shaped horns. The Arab Zebu can also be described by its different profiles (Table 4).

Table 4. Distribution of the Different Profiles of the Arab Zebu of Abeche, Chad.

Region	Profile	Effective (n)	(%)
Head	Straight	107	95.54
	Concave	1	0.89
	Convex	4	3.57
Back	Straight	110	98.21
	Hollow	2	1.79
Rump	Flat	74	66.07
	Pointed	38	33.93

The majority of animals of this breed have a straight head, a straight back, and a flat rump.

The characteristics of the Arab Zebu appendages were also variable (Table 5).

Table 5. Characteristics of the Appendages (Hump, Dewlap, and Tail) of the Abeche Arab Zebu in Chad.

Region	Hight	Effective (n)	%
Hump	Little developed	91	81.25
	Moderately developed	20	17.86
	Highly developed	1	0.89
Dewlap	Little developed	87	77.68
	Moderately developed	24	21.43
	Highly developed	1	0.89
Tail	Long	103	91.96
	Medium	9	8.04

Most animals have underdeveloped humps and dewlaps, with a long tail.

3.3. Zootechnical Parameters with Numerical Values

A summary of all measurements taken on the Arab Zebu in Abeche city is presented in Table 6.

Table 6. Quantitative parameters of the Arab Zebu in Abeche City, Chad.

Parameter	Minimum	Average $\pm$ SD	Maximum
Age (year)	4	6.91 $\pm$ 0.16	14
Weight (kg)	225	309.38 $\pm$ 5.08	473
WH (m)	1.06	1.16 $\pm$ 0.00	1.53
TL (m)	1.12	1.25 $\pm$ 0.00	1.32
ThC (m)	1.35	1.54 $\pm$ 0.01	1.76

Parameter	Minimum	Average $\pm$ SD	Maximum
RL (cm)	23	34.21 $\pm$ 0.30	42
RW (cm)	22	31.76 $\pm$ 0.28	39
HL (cm)	29	35.33 $\pm$ 0.29	42
HW (cm)	11	12.64 $\pm$ 0.11	16
HoL (cm)	11	25.47 $\pm$ 0.91	69
TaL (cm)	0.90	1.06 $\pm$ 0.00	1.19

3.4. Correlations Between Some Quantitative Parameters

Some correlations between different quantitative parameters varied according to sex. Comparing the mean values of certain parameters between the two sexes in Arab cattle in Abeche allowed us to obtain the following result (Table 7).

Table 7. Variation of Some Quantitative Parameters Between the Sexes of Arab Zebu in Abeche City, Chad.

Sex	Weight (kg)	TL (m)	WH (m)	ThC (m)	HoL (cm)	TaL (m)
Male	403.23 ^b	1.26 ^a	1.22 ^b	1.67 ^b	21.1 ^a	1.06 ^b
Female	297.06 ^a	1.25 ^a	1.14 ^a	1.52 ^a	26.0 ^a	1.09 ^a
Total	309.38 $\pm$ 5.08	1.25 $\pm$ 0.004	1.26 $\pm$ 0.003	1.54 $\pm$ 0.008	25.47 $\pm$ 0.91	1.06 $\pm$ 0.00

The highest mean values for live weight, withers height, and thoracic circumference were recorded in bulls, and the tail was longest in females ($p < 0.05$). Horn and trunk length did not vary significantly between sexes ($p < 0.05$).

The Figure 1 present the distribution graph of the correlation between certain parameters in Arab Zebu cattle in the study area.

Figure 1. Presents the Correlation Between Weight and Age.

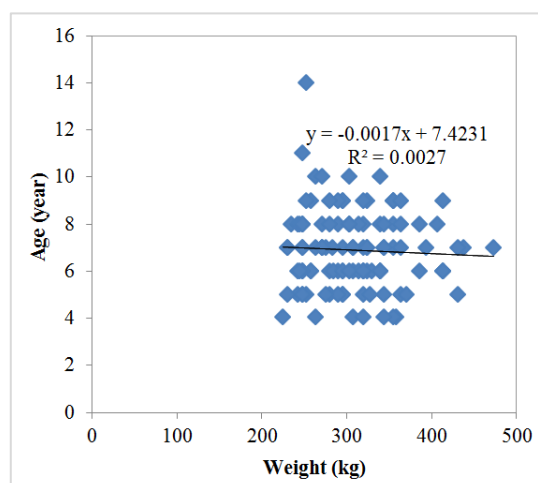


Figure 1. Correlation Between Weight and Age of Arab Zebu cattle in Abeche, Chad.

The correlation between weight and age is extremely low ($r = 0.05$).

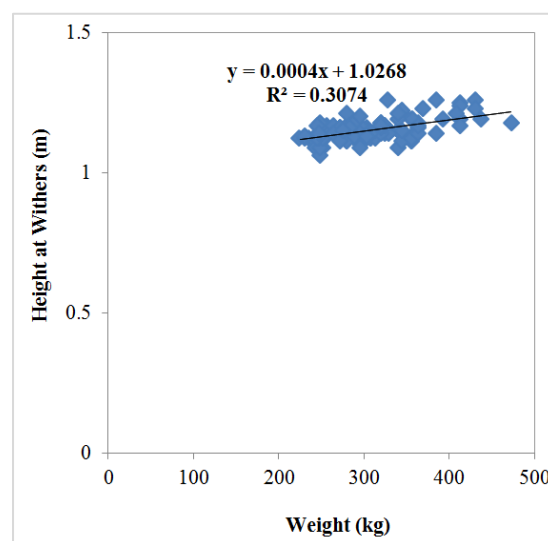


Figure 2. Correlation Between Weight and Withers Height.

The correlation between weight and withers height is shown in Figure 2.

There is a moderate correlation between weight and withers height ($r = 0.55$). The correlation between weight and chest circumference is presented by the following distribution (Figure 3).

Weight and chest circumference are highly correlated ($r = 0.97$).

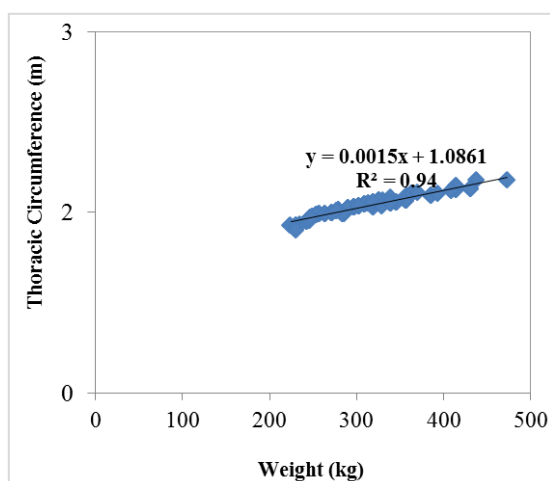


Figure 3. Correlation Between Weight and Chest Circumference.

4. Discussion

4.1. Breeder Profile

The results relating to the profile of Arab cattle herders in the study area show that cattle breeding is an activity practiced largely by men (96.43%) aged 32 to 92, the majority of whom are married (93.75%), uneducated (91.07%), and of Arab ethnicity (91.96%). The predominance of male herders is explained by the distribution of domestic tasks within households and by local cultures. The higher proportion of Arab breeders is due to the fact that individuals of this ethnic group are pastoralists. Most engage in trade associated with livestock breeding (40.17%), this to support family needs.

4.2. Description of Animals in Qualitative Parameters

The study of the qualitative parameters of the Arab Zebu in Abeche revealed that the majority of animals had plain coats (51.79%) and were white (30.26%). This result corroborates that of LRVZ [7], which indicates that in Eastern Chad, the preference is for white or predominantly white coats, and that this trend is observable in relation to breeders' practices. White coats dominate among the Mysserie Arabs of the East, while Kreda breeders in the Center-West have a preference for reddish brown coats, while among the Djelli breed of Niger, the dominant dirty white coat is dominant [9]. In contrast, the Ivory Coast zebus have very varied coats ranging from white to black to fawn [10]. Most Arab cows in the study area have horns (99.11%), horizontal (94.59%), brown (52.25%), and cupped (61.26%). This is consistent with the results obtained by LRVZ [7], which demonstrates that the Arab Zebu has two types of horn: cupped (54.8%) and crescent-shaped (15.7%), with a high rate of illegibility consisting of irregularly oriented horns. This is different from the lyre-shaped horn profile reported in the Djelli breed in Niger [9].

The Arab Zebu in Abeche have a straight head profile (95.54%), a straight back profile (98.21%), and a flat rump (66.07%). The hump (81.25%) and dewlap (77.68%) were mostly underdeveloped. The lesser development of the hump alludes to local cattle populations in Togo without humps [11].

The tail is long (91.96%). These results are similar to those obtained by Tacher and Landry [12] and that Arab Zebu cows have a moderately developed hump in males and a weak hump in females [13]. The same characteristics also show similarities to studies conducted by other researchers on local breed cows, respectively the Djelli breed in Niger and the N'Dama bull breed in Senegal [9, 14, 15].

4.3. Quantitative Zootechnical Parameters

The study of measurable variables in Arab Zebu cattle from the Abeche reported that males had an average weight of 403.23 kg versus 297.06 kg in females. These results are similar to those of previous studies on the same breed, with 350 to 400 kg for adult males, and 250 to 300 kg for females [7, 13]. The average weights obtained are higher than those reported for the same breed [16]. The same authors state that in the extensive system, the live weights of animals vary according to sex and season. This is similar to the results obtained for Massa cattle in the Mayo-Kebbi East province [17]. However, these results are higher than those obtained for Lagunaire and Muturu bulls in West Africa [18], and lower than those reported in Senegal for the Gobra zebu, in which the bull has a live weight of 577.5 ± 81.32 kg for 393.81 ± 51.69 kg in the cow [19].

The average trunk length of males was 1.26 m and that of females was 1.25 m. This difference is not significant, so we can say that the females' bodies are as long as those of the males. The height at the withers in males was on average 1.22 m and 1.14 m in females. This is close to 1.25 to 1.29 m in males and 1.18 to 1.26 m in females of the same breed [13]. These average values are higher than those reported in West African bulls [20-22] as well as in Malaysian cattle [23].

The thoracic circumference of males was on average greater than that of females. This justifies the fact that males have a higher live weight than females and confirms the pronounced sexual dimorphism reported by Queval *et al.* [13].

4.4. Correlations Between Some Zootechnical Parameters

The results of this study demonstrate that in Arab cattle in the study area, the correlation is significant between weight and withers height ($r = 0.55$) and very pronounced between weight and thoracic circumference ($r = 0.97$). The strong correlation between weight and thoracic circumference was demonstrated by Delage *et al.* [24], and Dodo *et al.* [25]. The better predictability of thoracic circumference for estimating live weight in African cattle has also been reported by several authors: in the Gobra Zebu in Senegal [26], the Azawak Zebu in Mali [27], the N'Dama taurine cattle in Congo Brazzaville

[11], and the Goudali Zebu in Cameroon [28].

5. Conclusions

This study was conducted to phenotypically characterize the Arab Zebu in Abeche and enabled the information collection from breeders and animal data. Cattle breeding in Abeche is a male activity practiced largely by individuals of Arab group ethnic, who associate this activity with trade. The white coat dominates in the Arab Zebu of the study area with a straight head profile, a straight back, a flat rump and a long tail. Males are larger and have the highest live weight. The measurement of the thoracic circumference taken with a metric tape can be used to determine live weight in this breed using the Crevat barymetric formula. In-depth studies on the zootechnical parameters and genetic characteristics of the Arab Zebu will allow its performance to be evaluated and improved and then a more precise description to be made. The scale installations for weighing will allow different methods of comparison to estimate live weight and to establish a more appropriate barymetric formula for the Arab Zebu in Chad.

Abbreviations

HW	Height at Withers
TL	Trunk Length
ThC	Thoracic circumference
RL	Rump Length
RW	Rump Width
HL	Head Length
HWid	Head Width
HoL	Horn length
TaL	Tail Length

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Author Contributions

Madjina Tellah: Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Validation Writing, and original draft.

Khadidja Hassaballah: Investigation, and review & editing.

Assadi Michel: review & editing and formatting references.

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



Madjina Tellah is an Associate Professor at Higher National Institute of Sciences and Techniques of Abeche, Chad, Animal Breeding Sciences and Techniques Department. He completed his PhD in Animal Genetics and Reproduction from Polytechnique University of Bobo-Dioulasso, Burkina Faso in 2016, and his Master of Engineering in Animal Production (Biotechnologies of Animal reproduction) from Higher National Institute of Sciences and Techniques of Abeche, Chad in 2008. Recognized for his numerous scientific publications in national and international reviews. In addition, he currently serves as a reviewer of some reviews and has been invited as a Speaker, Technical Committee Member, Session Chair, and Judge at international conferences.



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Research Field

Madjina Tellah: Animal Reproduction, Breeding System, Animal Genetics, Animal Demography, Animal Production, Socioeconomics of Animal Production.

Khadija Hassaballah: Animal Genetics, Breeding System, Animal Productions, Animal Reproduction, and Husbandry.

Assadi Michel: Animal Production, Animal Reproduction, Breeding System, Animal Genetics, and Husbandry.