Genetics and Biodiversity Journal

Journal homepage: https://journals.univ-tlemcen.dz/GABJ/index.php/GABJ/index

e-ISSN: 2588-185X p-ISSN: 2602-5582

Original Research Paper

OPEN ACCESS

Muturu Cattle Breed in Benin: Distribution, Phenotypic Diversity, Perception of Cattle Keepers and Implications for the Breed conservation

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Article history: *Received: 20 October.2021; Revised: 03December 2021; accepted: 01 January 2022*

Abstract

The present work involved updating information on the Muturu cattle breed in Benin, in order to design a sustainable breeding management scheme for its conservation. A total of 108 farmers were interviewed and 216 adult cattle physically looking like Muturu cattle as described previously were sampled in 6 departments of Southern Benin spread over 4 agro-ecological zones. Forty-one (41) qualitative traits were assessed and 10 to 11 morphometric measurements were carried out using the Animal Genetic Resources Characterisation, Inventory and Management Tool. The proportions and means obtained were analysed respectively by analysis of variance and two-tailed Z tests contained in the Agricola package of the R analysis software. The results showed that the lowest morphometric measurements were obtained from the animals of the department of Ouémé. These values were similar to those reported earlier in Muturu cattle. However, the highest values were obtained on animals from Mono and Couffo departments and were close to the values reported on taurine zebu cattle previously. Herd clustering results revealed the existence of subgroups in the populations of Muturu cattle of the Atlantic and Mono departments. Subject to confirmation by molecular testing, this study revealed that currently, Muturu cattle are found in the departments of Ouémé, Plateau and Atlantic in Benin where populations from Ouémé department are physically the closest to breed as described previously. The department of Zou has almost no Muturu cattle, and the departments of Couffo and Mono are dominated by Zebu x Muturu crossbreds. It is important therefore to design a conservation programme for the breed where it's still found, as its existence would probably be linked to the preferences of the cattle keepers and the local communities and to its capacity to overcome the challenges of these ecosystems.

Keywords: Endogenous breed, adaptive traits, biodiversity, community

Introduction

Africa has a great diversity of animal genetic resources including cattle with at least 22 different breeds (AU-IBAR, 2019). Like other African countries, Benin has different cattle breeds such as the Muturu cattle, which has a soci-economic and cultural value for certain local communities (Adoligbé et al., 2020a). The breed distribution extends along the African coastal zone including southern Benin,

Nigeria, Togo, Ghana, Liberia and part of Cameroon (Tijjani et al., 2019). Muturu cattle is trypanotolerant and well adapted to humid tropical environments and harsh breeding conditions. The average height at withers varies from 89 to 106 cm for the male and from 85-103 cm for the female while the weight of the adult male varies from 180 to 280 kg and the weight of adult female from 165 kg to 262 kg (Akoiret and Gbangboché, 2005; Ouédraogo et al., 2021). The milk production of the breed is too low however the meat quality and carcass yield are good and well appreciated by meat consumers (Salifou et al., 2013; Kassa et al., 2016).

In recent times, the Muturu cattle is threatened of extinction due to uncontrolled breeding with zebu but also the promotion of intensive agriculture in the Ouémé valley leading to a reduction in grazing land where the Muturu cattle is rifest (Adoligbé et al., 2020a). This calls for the genetic improvement and conservation of the breed in order to avoid a loss of their adaptive traits and biodiversity. According to FAO guidelines on phenotypic characterization of animal genetic resources, for a better management and sustainable use of animal genetic resources, it is essential to know the nature and distribution of the phenotypic and genetic characteristics that they possess (FAO, 2011). Unfortunately, in Africa and particularly in Benin, little effort has been made toward the characterization, inventory and monitory of local animal genetic resources. This research work is part of a regional initiative that aims to fill such gaps in the West African region. Specifically, we sought to find out:

- The current distribution of Muturu cattle in Benin;
- The phenotypic diversity of the different populations of Muturu cattle in Benin
- And the perception of cattle keepers in relation to the breed.

Materials and Methods

Study area

This study was conducted in 6 departments of southern Benin including Ouémé, Plateau, Zou, Mono, Couffo and Atlantic (Figure 1). These departments were chosen as study areas because it's believe that the Muturu Catlle expand all over southern Benin although the Ouémé region is known to be where there are rifest. The southern regions of Benin receive two seasons of rainfall from March to July and September to November with an average rain fall of around 1,200 mm. The dry seasons extend from August to September and from December to March (Haggett, 2002). The Ouémé, Atlantic and Mono departments are located in a coastal area that has interconnected lakes and lagoons and elongated coastlines with wide marshes. They are characterised by low-lying sandy coastal plains towards the Atlantic Ocean, marshes, lagoons and lakes (BMMSIBG, 2007). The highest elevation in the departments around the coastal plains is 20 m (66 ft) compared to the average 200 m (660 ft) above average mean sea level of the country. The Plateau, the Zou and the Kouffo departments are characterised by plateaus ranging from 20 to 200 m (66 to 656 ft) above the mid sea level. The plateaus are split by valleys running from north to south, created by the Zou River and Kauoffo River(Zou department), the Iguidi river (Plateau department) and the Sahoua River and Couffo River(Couffo department)respectively(McColl,2014).

Cattle keepers and Animal Sampling Procedure

The chain referral sampling method was used to reach out to the targeted cattle keepers as recommended by Bagheri and Saadati (2015). In order to ensure sample diversity, different sample seeds were chosen at each location.

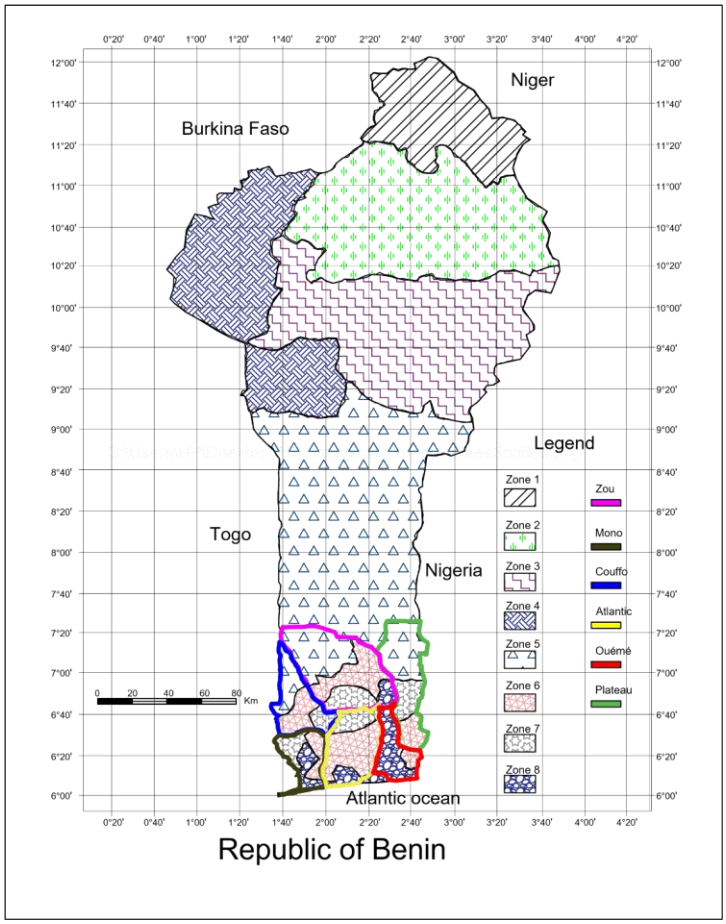


Figure 1. Study area.

Concerning the animals, only herds recognised to be physically a Muturu herds based on the traits described previously by Sedogbo (1993) were included in this study. The age of the animals was determined using the method of Torel et al. (2003). On the basis that cattle stop growing around five years old (cattle today, 2009), only animals age of 3 to 4 years were used for body measurement to minimize age effect on body traits.

Data Collection

The data collected included socio-economic and cultural data, herd size variation, cattle keeper's perception in relation to animal resistance, behaviour and production performances, cattle phenotypic traits and finally body measurement traits.

Data collections were done using the animal genetic resource characterization, inventory, and monitoring tool (AnGR-CIM Tool). The AnGR-CIM Tool is a comprehensive tool designed by the African Union Inter- African Bureau for Animal Resources using the Open Data Kit (ODK) software version 1.22.4 to collect data on animal genetic resources. (AAGRIS, 2019). The tool was installed on a tablet with the latest version of Android OS.

Prior to data collection, enumerators were trained for two days followed by a pre-testing to retain a reasonable number of respondents to be visited during the 60 days of survey. Therefore, an average of 15 respondents were selected per study area but this was increased to 30 in the departments of Atlantic and Ouémé due to their relatively higher number of Muturu cattle (Adoligbé et al., 2020a). In total, 108 interviews were carried out and data were collected from 216 animals (including 160 cows and 56 bulls).. Measurements were taken on 11 morphometric traits for females including body length(BL), wither height(WH), heart girth(HG), ear length(EL), horn length (HL), horn circumference (HC1), hock circumference (HC2), muzzle circumference (MC), teat length (TH), udder depth (UD) and udder length (UL) and on 10 morphometric traits for males including (BL, WH, HG, EL, HL, HC1, HC2, MC, testis length(TL) and testis circumference(TC) following AU-IBAR pictorial field guide for linear measurements of Animal Genetic resources (Fig 2)(AU-IBAR, 2015). To minimize experimental errors, all linear body measurements were taken early in the morning by the same operators on animals kept in the restrained standing position on four legs with their heads maintained in an upright position. The collected data are accessible on the website of the African Animal Genetics Resources Information System.(http://aagris.au-aris.org) (AAGRIS, 2019)

Figure 2. Body measurement traits

1-muzzle circumference, 2- horns length, 3- horn circumference, 4-body length, 5- height at the withers, 6-thoracic perimeter, 7-hock circumference, 8- ear length, (9-teat length, 10-udder depth, 11-udder length for Cow), (9- length of the testicles, 10-testicular circumference for Bull)

Statistical Analysis

The data collected were downloaded from the AnGR CIM Tool platform and analysed with the version 3.5.1 of the R software (Team, 2013). A descriptive analysis was performed and difference between variables was tested using either one-way analysis of variance(mean) or Bilateral Z test (frequencies) in Agricola Package in R software. For each relative frequency P, a margin of error (ME) was calculated using the formula: where p is the relative frequency and n the sample size (Lesaffre, 2009). Also, a Gower distance analysis was performed to cluster the mixed data using the 'gower_dist' function in the 'gower' package ver. 0.1.2 in R software (van der Loo, 2017). At this point, only the data that could best describe variation between cattle population were taking into account (phenotypic traits and body measurement traits). The number of cluster was defined base on silhouette analysis. A descriptive analysis was performed on the clusters based on selected variables, and differences between clusters were tested using Anova and Tukey HSD test.

Results and discussion

Socio-economic and cultural Factors

Socio-economic factors that may influence the Muturu cattle keeping included farmers' main activity, production objectives and socio-cultural believes associated to the breed. Figure 3 shows that except Mono (87%) and Zou (75%) departments, few farmers from the other departments consider livestock production as a major activity (33%). Inclusively in all departments, savings appeared to be the main purpose for keeping the Muturu cattle (99%). It's worth indicating that cultural and socio-economic status ranked second in this regard. In the department of Mono, some Muturu cattle keepers (20%) have recognised that religious believes are associated to the breed

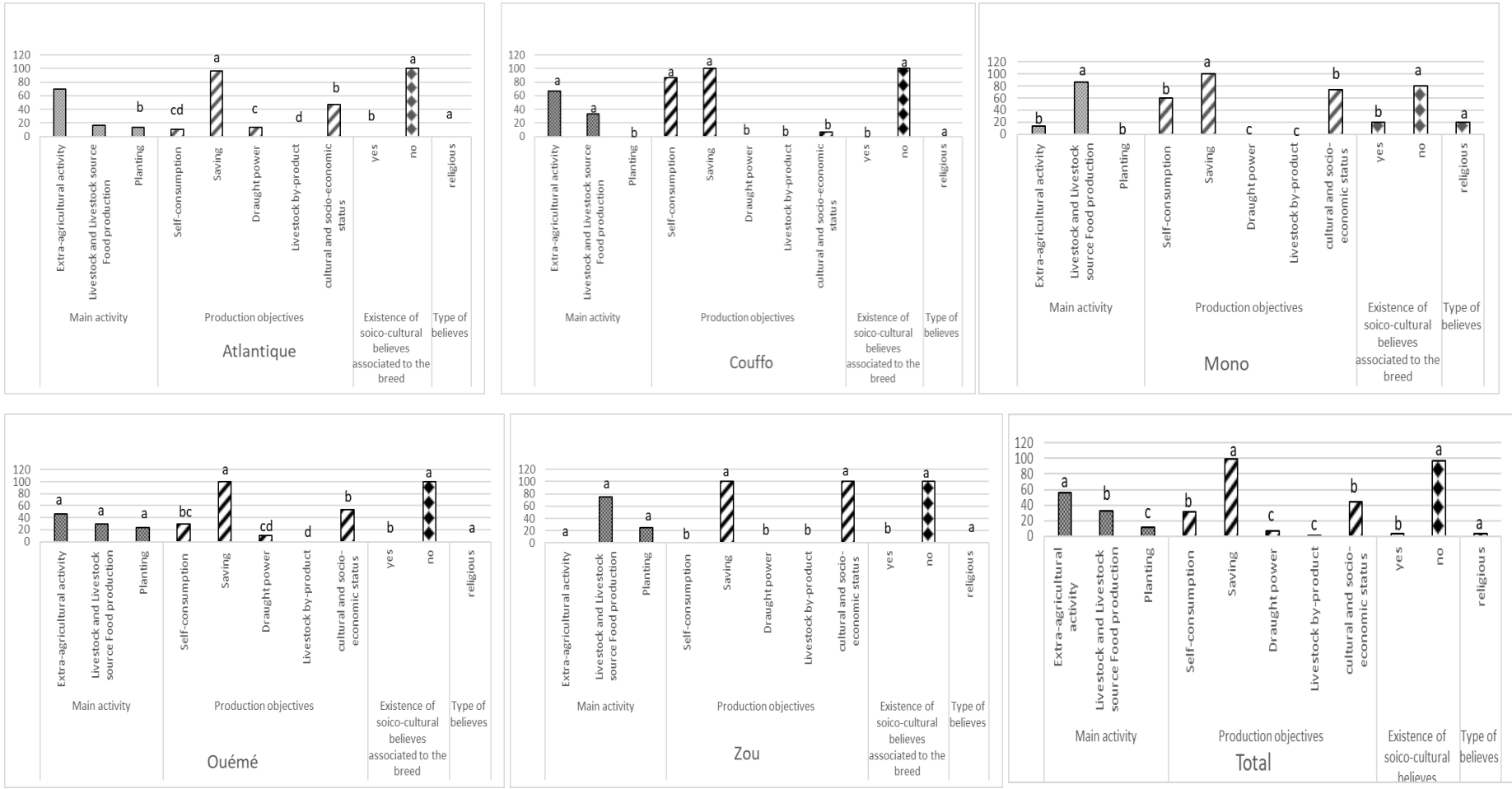


Figure 3. Main activity, production objectives and socio-cultural believes associated to the breed (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test

Herd size

In general, average herd size per department was about 19 animals. The highest average number was recorded in the department of Mono (49) and the lowest in the department of Ouémé (5) (Table 1). Animals were mainly owned by the household head who is in most case a male and animal fostering is particularly practice in the departments of Mono and Couffo(Table 2)

Table 1: Herd size

Variable	Atlantic		Couffo		Mono		Ouémé		Plateau		Zou		Total		Significance
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE	
Herd Size	18.93b	3.71	24.27b	6.21	48.73a	7.28	5.1b	0.59	7.71b	2.22	18.5b	4.57	18.5	22.44	***

M: mean; SE: Standard error; mean of the same line with different capital letter are significantly ($p \leq 0.001$) different acco rding to ANOVA test.

Table 2: Herd ownership

Variable	Atlantic		Couffo		Mono		Ouémé		Plateau		Zou		Total	
	M	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**
Animal own by Household head	12.93a	1.95	13.40a	5.86	35.33a	7.39	4.53a	0.61	7.71a	2.22	13.75a	4.67	14.61a	17.99
Animal own by spouse	3.93b	2.84	4.87b	4.2	1.47c	1.15	0.4b	0.24	0b	0	2.0b	2	2.11b	10.36
Animal own by children under 18 years	0b	0	0c	0	0.93c	0.93	0d	0	0b	0	0c	0	0.16b	1.35
Household animal reared elsewhere	0.07b	0.07	0c	0	0d	0	0d	0	0b	0	0c	0	0.01c	0.19
Animal in fostering in the household	2b	2.83	6b	0	11b	4.69	0.17c	0.12	0b	0	2.75b	2.75	3.65b	11.20

M: mean; SE: Standard error; mean of the same column with different capital letter are significantly ($p \leq 0.05$) different according to ANOVA test .

Cattle Keepers' Perception

Cattle keepers 'perception in relation to the animal resistance and behaviour

According to cattle keepers, Muturu cattle tolerate drought and heat (56%) and are docile (50%). However, their draught power is weak (50%) in general except for the respondents of Mono (53%). These animals are recognized to be resistant to disease (58%) and as proof they recover from pathologies they contract without any intervention (48%) and can resume their activity despite the presence of symptoms (68%). However, 85% of Plateau breeders believe that these cattle require care when they are sick (Figure 4).

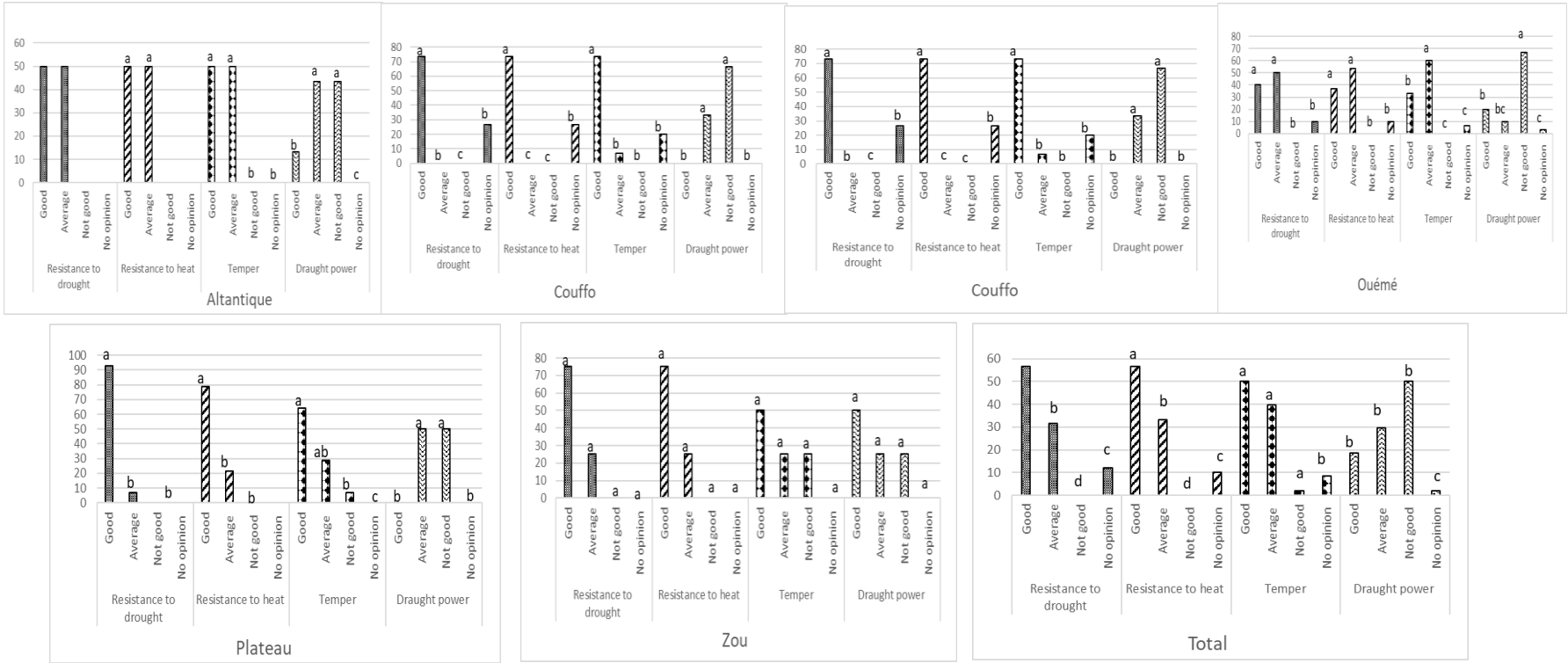


Figure 4. Cattle keepers 'perception in relation to the animal resistance and behaviour (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test.

Cattle keepers 'perception in relation to animal production performances

Figure 5 indicates that the milk production of the Muturu cows is low (82%). Meat production is quite good in general, except in the Mono department where 60% of the respondents have no opinion about it. Most respondents in Couffo (80%), Plateau (100%) and Zou (75%) claimed that the Muturu cattle grow slowly. However, 50% of the respondents in the Atlantic department consider the growth of the cattle to be good and 43% of the respondent of Ouémé department think it is average. The fertility of the Muturu cow is considered to be good in general (40%). However, the majority of respondent from Ouémé (40%) and Plateau (57%) though it's not while respondents from Mono (60%) had no opinion about.

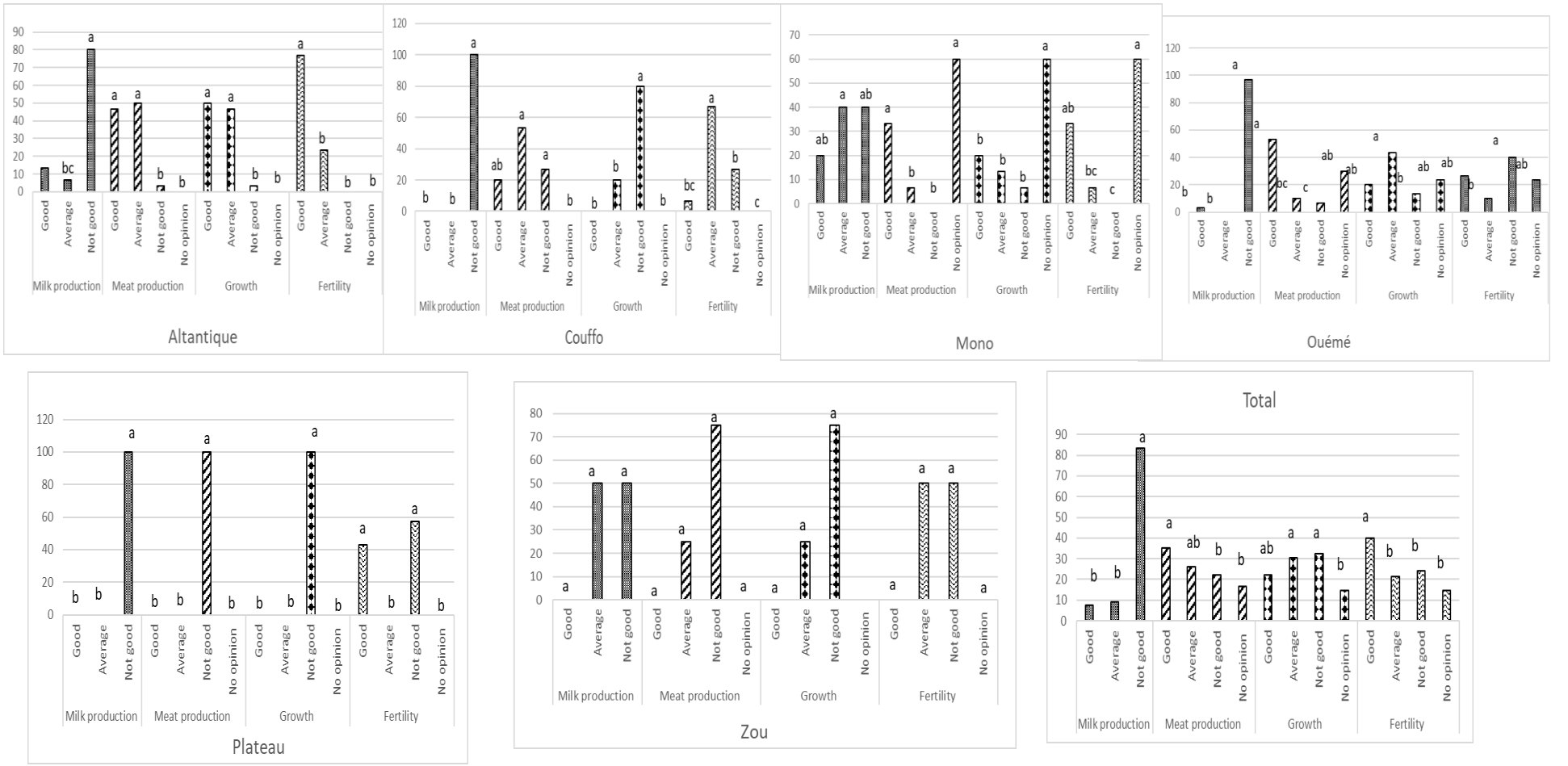


Figure 5. Cattle keepers 'perception in relation to animal production performances (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test.

Muturu Cattle Phenotypic Traits

Qualitative variables

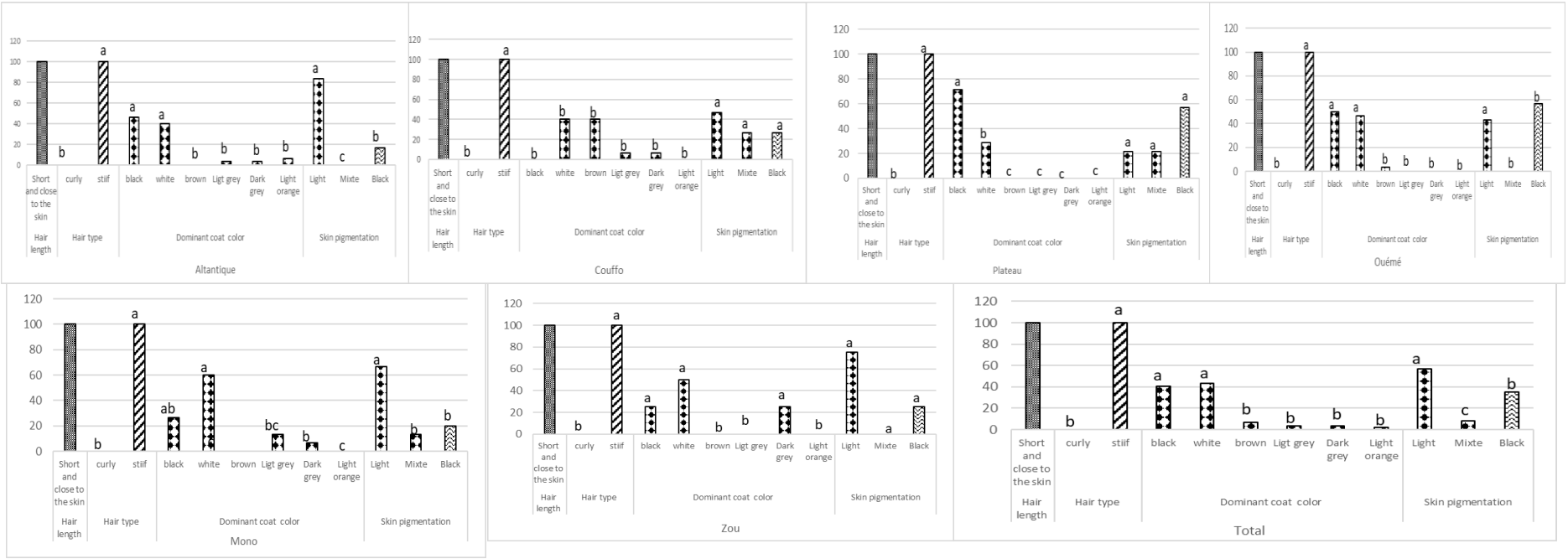
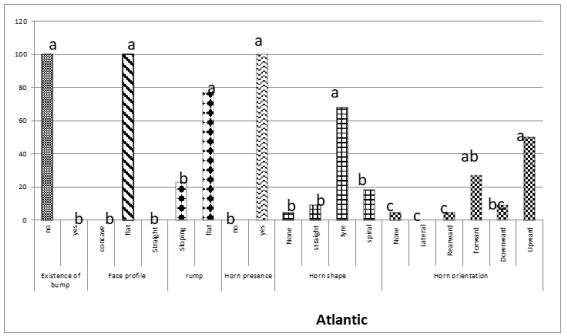


Figure 6. Cattle hair, coat and skin comparison (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test.

Figure 6 showed that the Muturu cattle have short hair close to the skin and stiff (100%) and most frequent dominant coat colors are black (41%) and white (44%). As regards to the skin pigmentation, black (35%) and light (56%) colors are the most frequent. The selected animals, regardless their sex, do not have a hump (Figure 7 and Figure 8). Majority of them has a flat face (82%), a flat rump (62% and 66 % respectively for bull and cow), upward lyre-shaped horns, and a medium size lateral ears with rounded edge. The tail is long (50%) and thick (55%) for most bulls but long (56%) with medium thickness (59%) for majority of cow. Within group comparison showed that almost all of the animals from the plateau department have a straight face profile (100% and 90% respectively for bull and cow); the majority of the animals from Mono department have forward spiral-shaped horns. The tail length is medium for the majority of animals from Atlantic, Couffo and Zou and most females from plateau and Zou department had thick tails (95% and 67% respectively)


Existence of bump
Face profile
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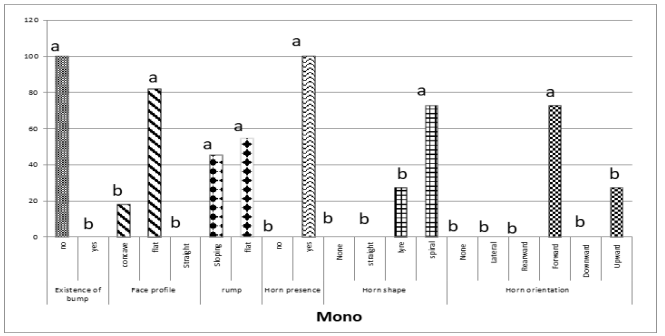
Horn shape
Horn orientation
Atlantic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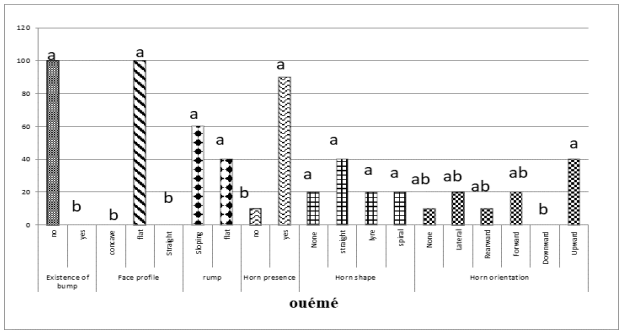
Horn orientation
Mono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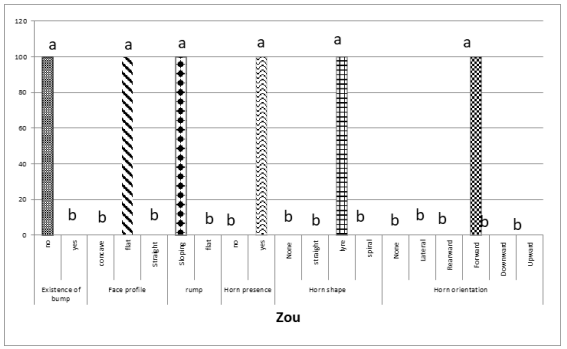
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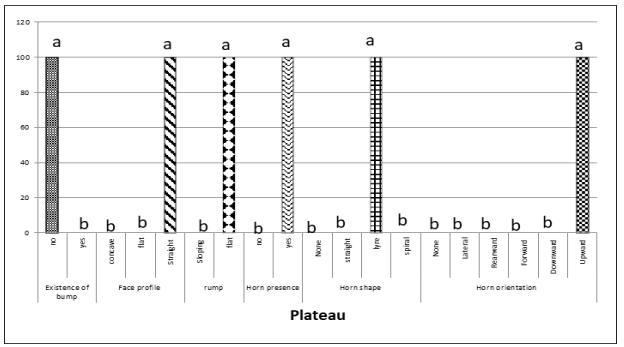
Zou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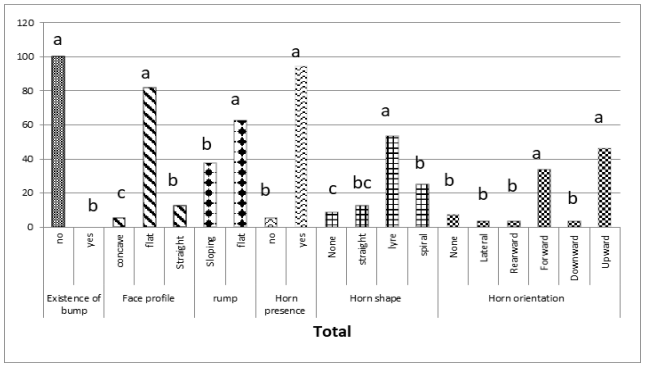
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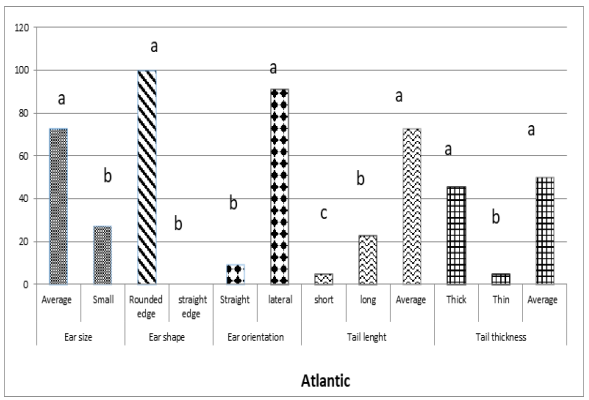
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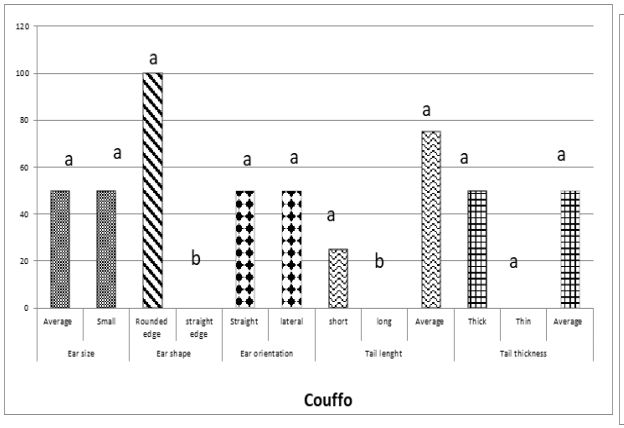
Tail thickness
Atlantic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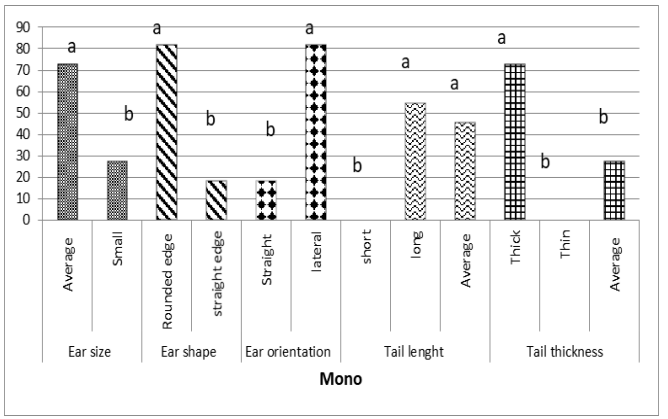
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Mono

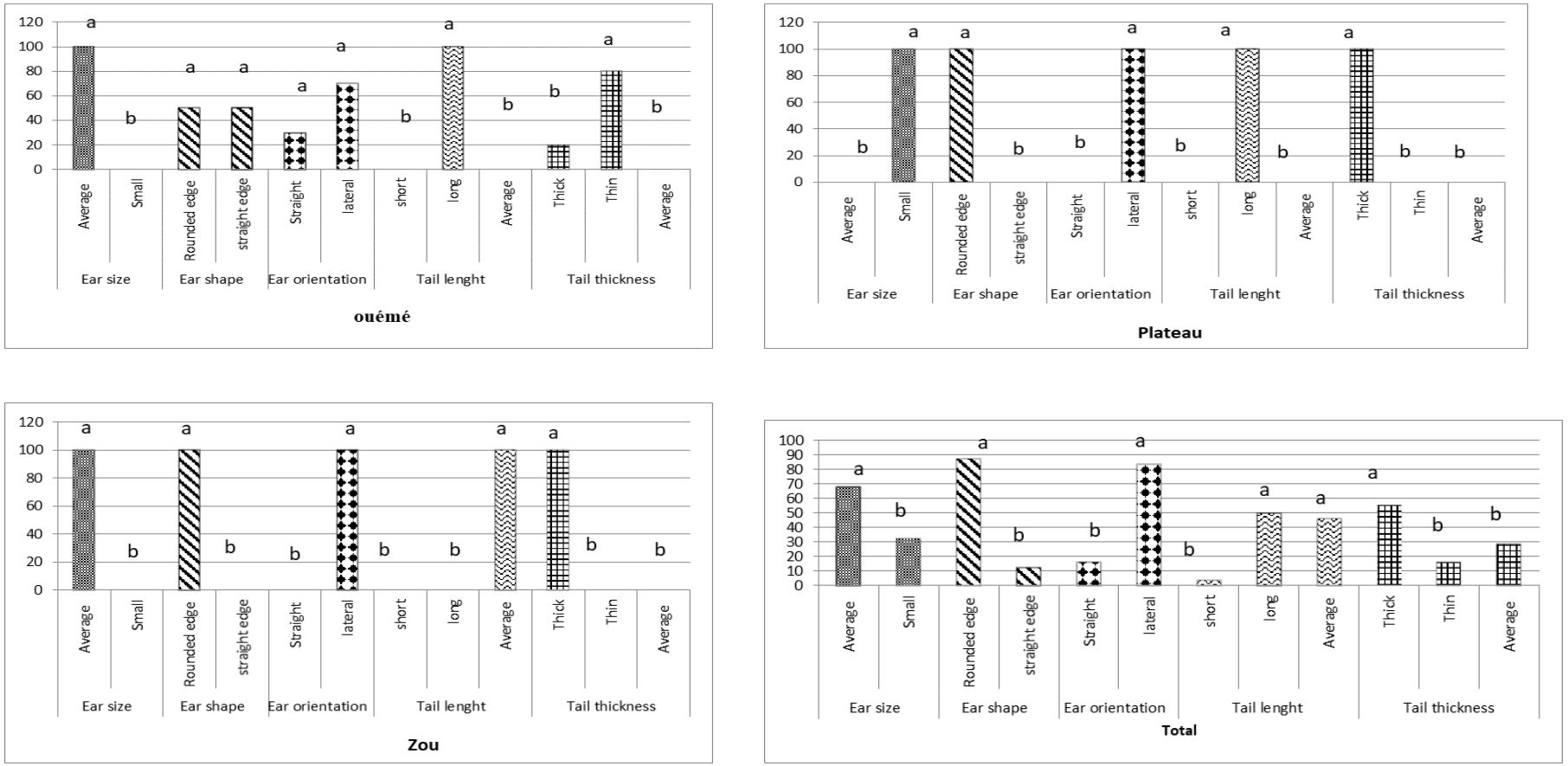
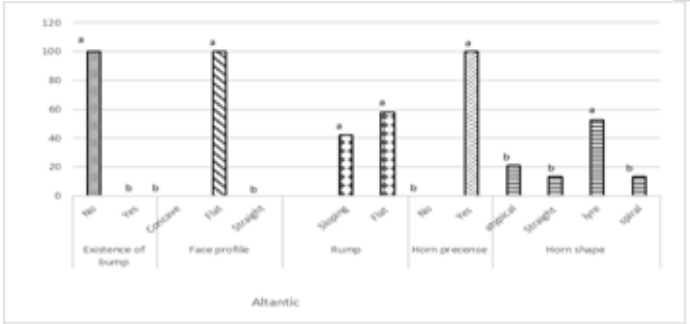


Figure 7. Bull 'Bump, Face profile, Rump, Horn, Ear and Tail (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test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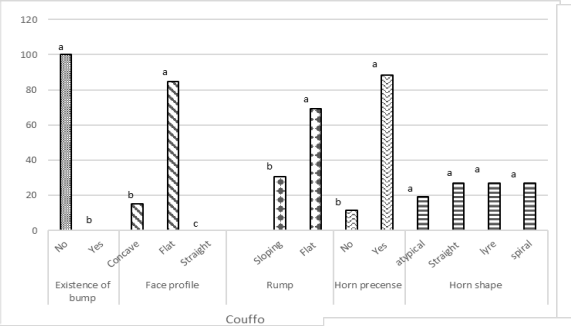
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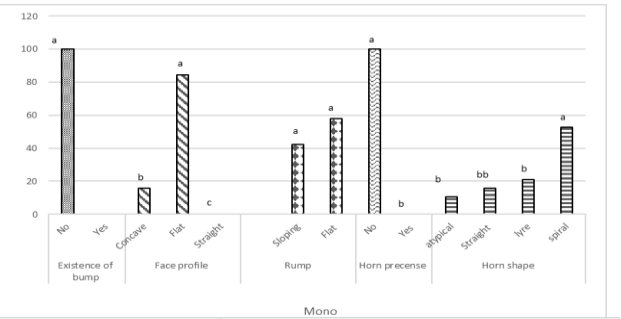
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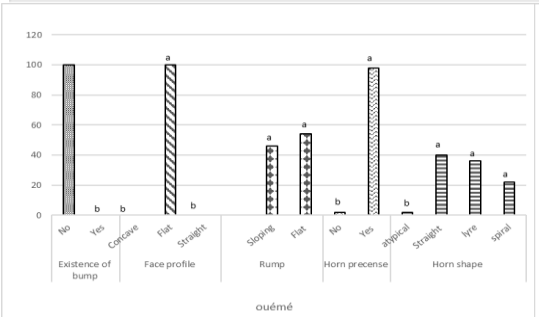
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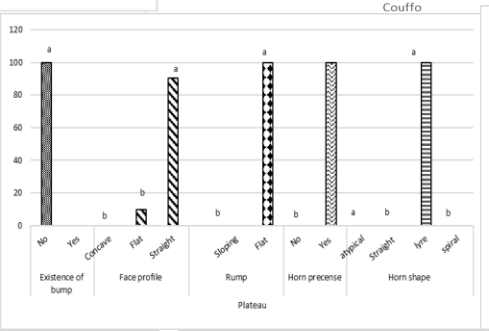
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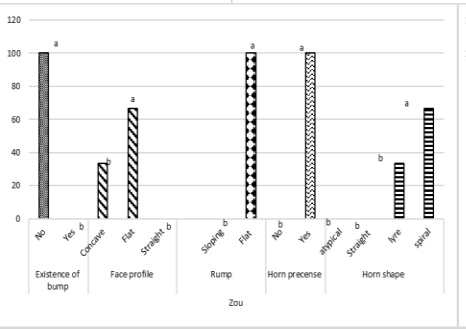
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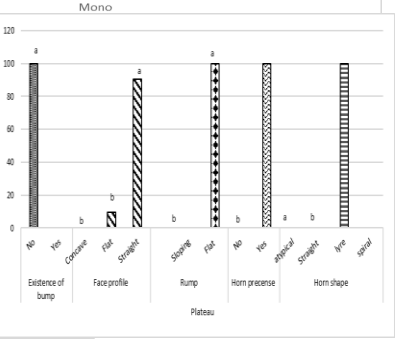
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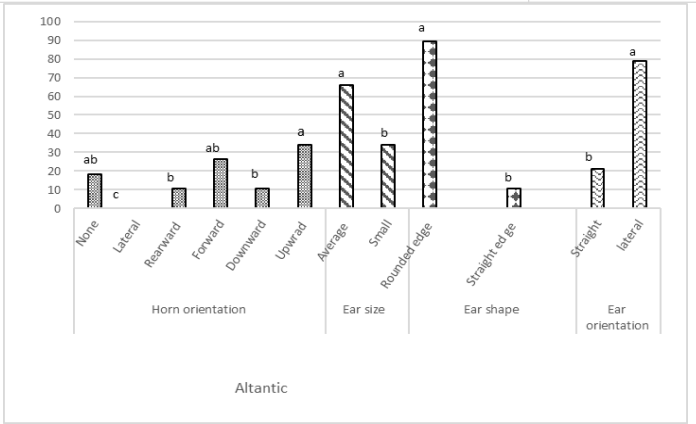
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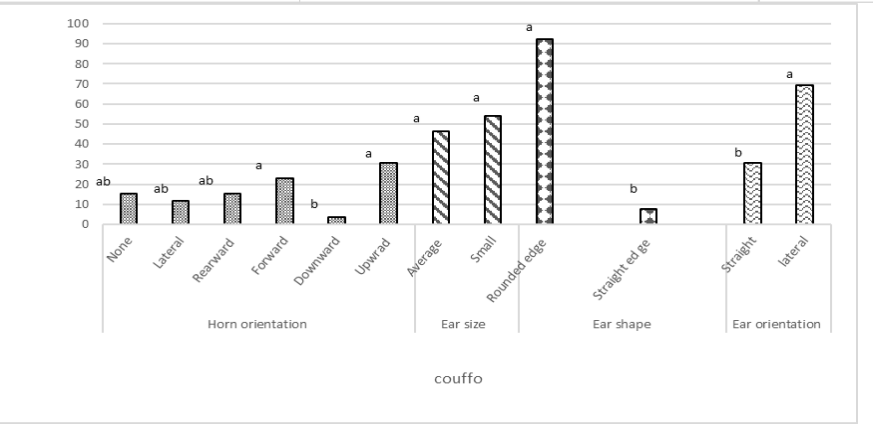
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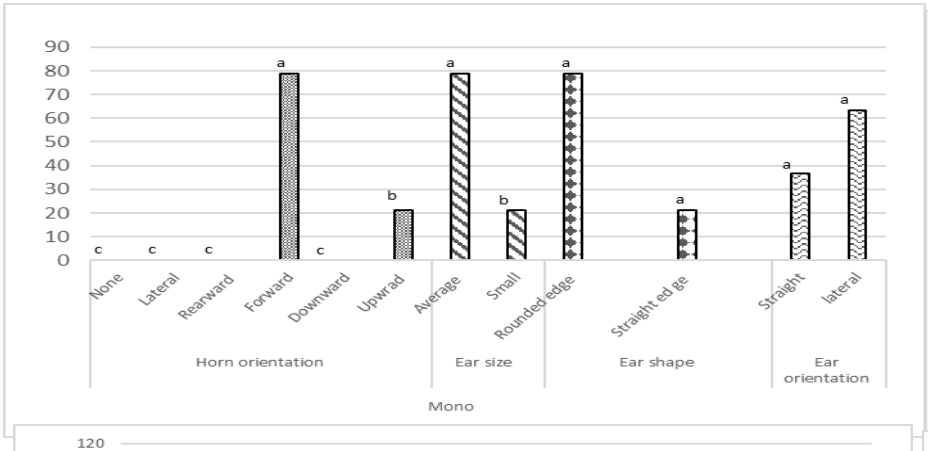
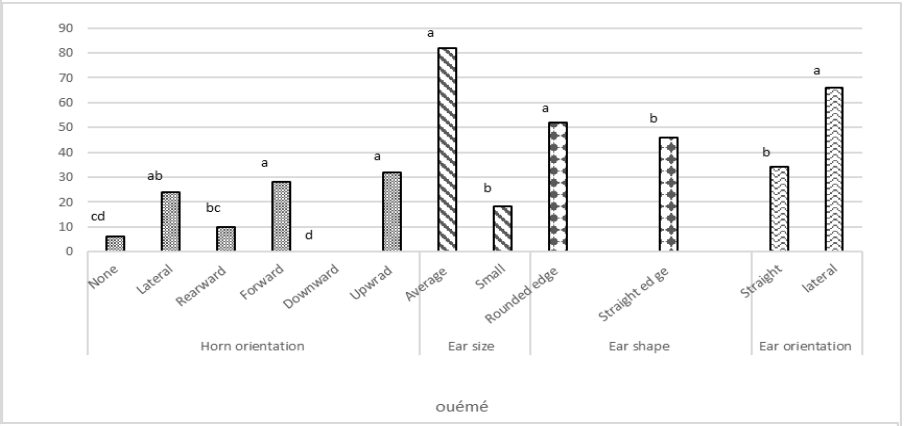
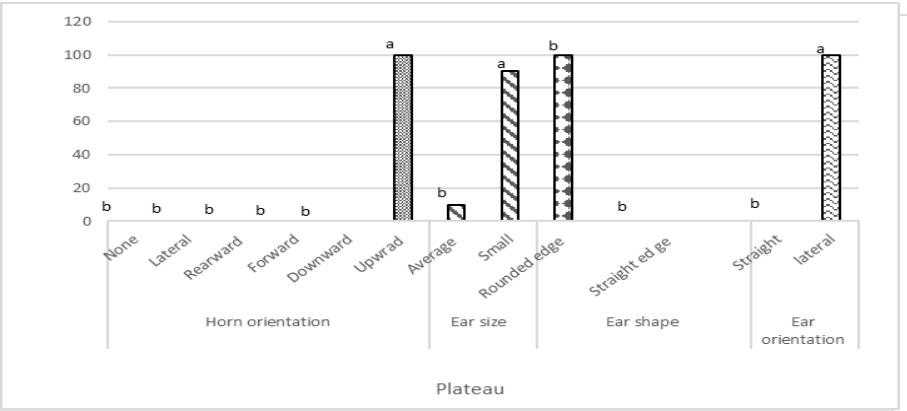


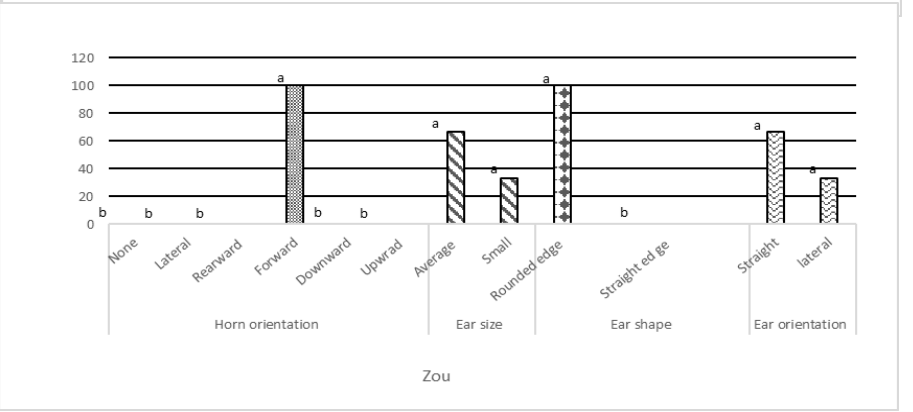
Mono



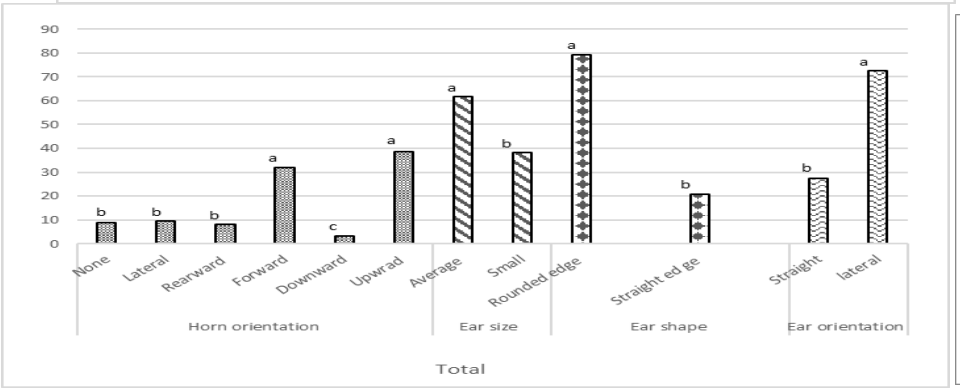
ouémé



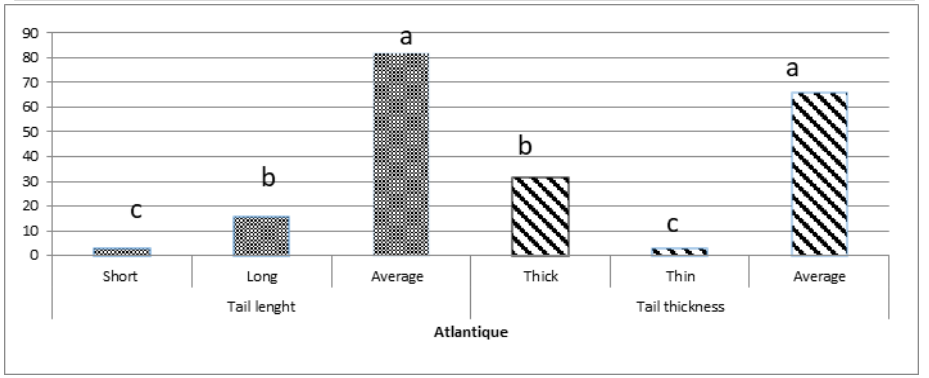
Plateau



Zou



Total



Atlantique

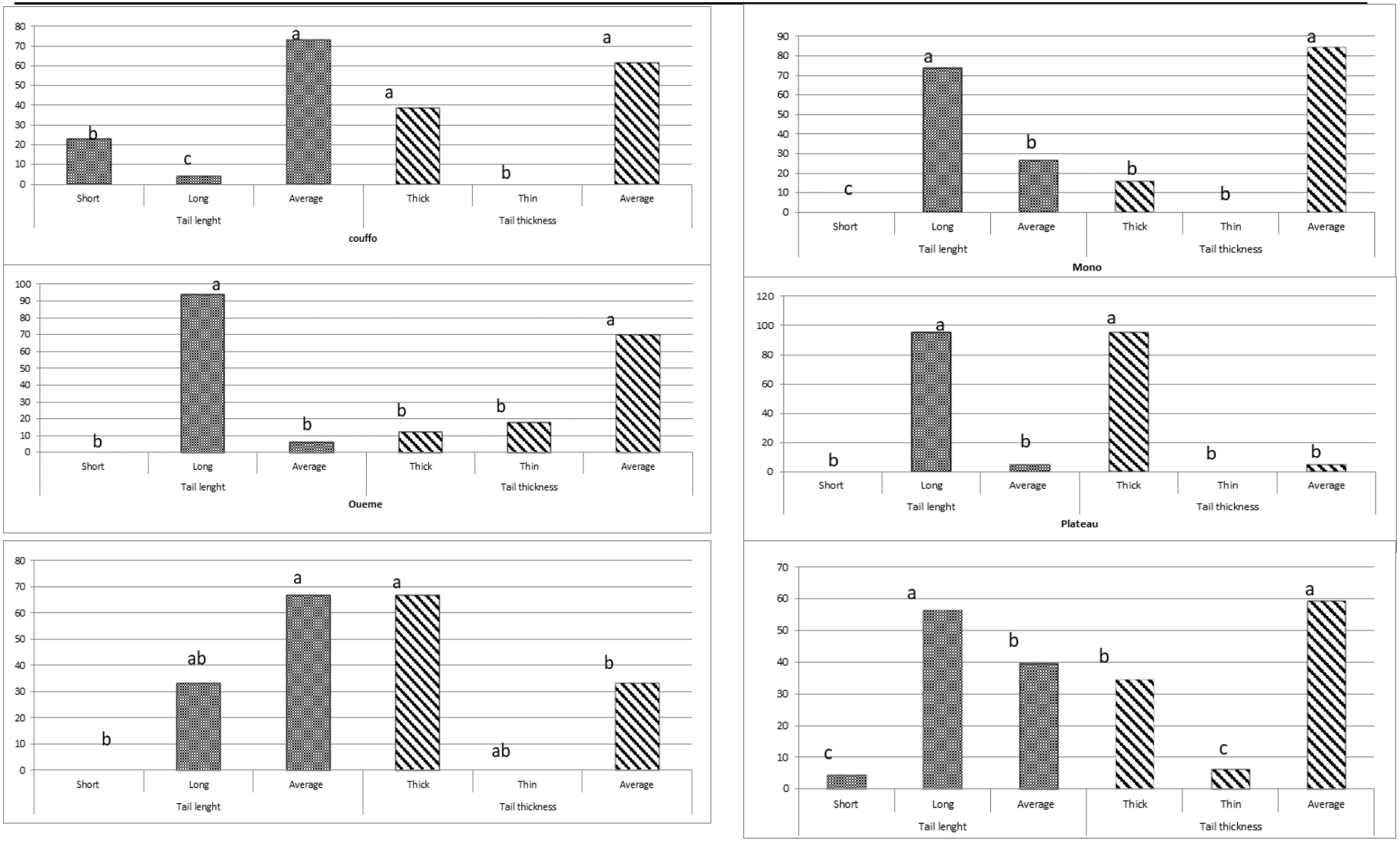


Figure 8. Cow 'Bump, Face profile, Rump, Horn, Ear and Tail (relative frequency). Rectangle followed by different superscripts show the existence of significant differences ($p \leq 0.05$) according to z-test.

Table 3: body measurement traits

	Variables	Atlantic		Couffo		Mono		Ouémé		Plateau		Zou		Total		
		M	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**M**	**SE**	**ANOVA**
Bull	Body length (cm)	136.24a	4.4.	147.47a	6.24	154a	3.04	152.14a	3.82	132.05a	7.31	156.75a	14.67	145.20	28.40	NS
	height at whiter (cm)	97.13a	1.28	109.12a	2.09	160.53a	52.59	81.21a	0.93	95.52a	3.47	95.00a	5.33	101.37	81.98	NS
	Chest circumference (cm)	134.26a	2.45	137.44a	3.1	140.74a	2.56	116.21b	1.21	127.19a	3.92	131.25a	6.76	128.79	16.17	***
	Ear length (cm)	15.59a	0.21	17.16a	0.79	16.15a	0.51	13.00b	0.37	16.57a	0.58	13.5b	0.96	15.16	3.03	***
	Horn length (cm)	12.95ab	1.33	16.88a	1.35	18.11a	1.45	8.39b	0.73	16.48a	3.02	15.75a	3.72	13.28	8.72	***
	Horn circumference	12.47ab	0.54	16.00a	1.08	13.68ab	0.64	10.09b	0.59	13.43ab	1.12	11.25b	1.93	12.52	4.63	***
	Muzzle circumference (cm)	31.58c	0.53	32.76bc	1.77	39.05a	0.78	34.77abc	0.53	35.24abc	1.22	37.25ab	0.75	34.32	5.46	***
	Hock circumference (cm)	26.97ab	0.64	22.92c	0.93	31.11a	0.64	25.83bc	0.78	27.76ab	0.65	28.25ab	1.03	26.60	4.88	***
	Testis Length(cm)	12.33a	0.95	15.33a	0.67	16.2a	1.33	13.9a	1.45	13.67a	0.8	13.2a	1.51	13.64	4.05	NS
	Testis Circumference (cm)	21.14a	1.54	21.00a	1	24.20a	1.09	20.70a	0.62	21.00a	0.89	20.36	0.12	21.7	5.22	NS
Cow	Body length (cm)	136.64a	5.55	129.50a	8.87	150.73a	9.11	128.70a	9.67	123.00a	5.34	139.50a	20.5	136.11	26.72	NS
	height at whither (cm)	94.81a	1.88	108.25a	2.02	106.73a	3.93	78.3b	2.39	95.43a	6.61	97a	8	95.32	14.07	***
	Chest circumference (cm)	122.73ab	3.22	132a	6.49	135.18a	4.08	107.8b	3.34	119.5ab	5.35	136.00a	13	123.31	16.25	***
	Ear length (cm)	15.9a	0.46	17.25a	0.85	16.82a	0.55	12.65b	0.57	16.83a	0.79	13b	1	15.666	2.45	***
	Horn length (cm)	9.07b	1.15	19.25a	4.77	15.73ab	1.1	7.25b	0.98	8.17b	1.79	16ab	11	11.07	6.51	***
	Horn circumference (cm)	14.00a	0.86	15.5a	2.59	15.27a	1.39	10.65a	1.29	14.00a	1.63	10.75a	3.75	13.76	4.34	NS

Muzzle circumference (cm)	30.59 b	0.6	37.25a	3.75	38.55a	1	33.65ab	1.27	32.83ab	1.25	37.75a	1.75	33.68	4.76	***
Hock circumference (cm)	27.64 b	0.65	21c	1.22	32.09a	0.95	26b	0.54	28.33b	1.09	28b	2	27.87	3.89	***
Teats length (cm)	2.27c	0.12	5.61b	0.42	9.47a	1.04	1.97c	0.12	2.7c	0.20	2.38c	0.37	3.68	3.17	***
Udder depth (cm)	37.57a	2.08	12.69c	1.42	13.47c	1.00	28.18b	2	9.43c	2.28	1.00d	1	22.87	15.65	***
Udder length (cm)	14.59	0.99	25	3.2	3.95	0.74	8.78	0.73	33.52	2.57	4.25	0.63	15.48	12.88	***

M : mean ; SE : Standard error ; mean of the same line with different letter are significantly($p \leq 0.05$) different according to ANOVA test.

Body Measurement Traits

Out of the 11 traits measured in cows, animals from Ouémé have the lowest values for 7 of them. These were height at withers (81.21cm), chest circumference (116.21cm), ear length (13 cm), horn length (8.39cm), horn circumference (10.09cm), hock circumference (25.83 cm) and teats length (1.97cm). The highest values in the majority of cases were held by animals from Mono department (height at withers(160.53cm), chest circumference (140.7cm), horn length (18.11cm), muzzle circumference (39.05cm), hock circumference (3.11)) and from Couffo department (ear length (17.16cm), horn circumference (16cm) and teats length (5.61cm)). Likewise, out of the 10 traits measured in bulls, animals from Ouémé had the lowest values for 5 of them. These were height at withers (78.3cm), chest circumference (107.8cm), ear length (12.65 cm), horn length (7.25cm) and horn circumference (10.65cm). The highest values were held by animals from Mono (body length (150.73cm), muzzle circumference (30.55cm), hock circumference (32.09cm) and testis length (16.2cm)) and from Couffo (withers height (108.25cm), ear length (17.25cm), horn length (19.25) and horn circumference (15.5cm)). In general, for the same traits, the values obtained in cows were lower than in bulls (Table 3).

Gower's distance analysis was applied to 24 variables (morphometric data and phenotypic data) to group the animals based on the dissimilarities and similarities of collected data. Thus, 7 distinct groups have been identified, on the basis of silhouette width, including two in the cattle population from Atlantic department and two in the cattle population from Mono department (Figure 9, Figure 10). The main traits that differentiate the groups are shown in table 4. Cattle population from Ouémé department had the lowest value for all morphometric traits except for body length while Mono cattle have highest value for all morphometric traits. The two groups from Mono cattle population are different due to the height at wither (significantly higher in group 6 compare to group 5) and the tail thickness (thin in group 5 et and average in group 6). In the same way, the two groups from Atlantic cattle population are different due to the chest circumference (significantly bigger in group 3 compare to group 2), horn length (significantly longer in group 3 compare to group 2) and tail length (long in group 2 and average in group 3)

Table 4: Descriptive analysis of different clusters

cluster	Origin of the majority of the animals	Body nght	Height at whiter	Chest circumference	Ear length	Horn lenght	Hock Circumference	Face profil	Tail thickness
1	Oueme(100%)	149.4a	80.87a	115.2a	12.96a	8.25a	25.83a	100%(flat)	76.92%(average)
2	Atlantic(68.65%)	134.2b	91.52b	**119.6a**	15.17b	**9.25a**	26.82b	100%(flat)	62.50%(average)
3	Atlantic(100%)	136.2b	97.13b	**134.3b**	15.59b	**12.95b**	26.97b	100%(flat)	57.89%(average)
4	Couffo(87.5%)	148.6a	107.4c	136.7b	16.70c	16.74c	23.59c	81,25%(flat)	62.50%(average)
5	Mono (87.5%)	149.3a	105.5c	**135.3b**	**16.34e**	15.76c	31.58d	87.5%(flat)	**87.50%(thin)**
6	Mono(100%)	154a	160.5d	**140.7b**	**16.15d**	18.11c	31.11d	87.5%(flat)	**75%(average)**
7	Plateau(93.33%)	130.7c	95.46b	124.9c	16.45e	13.66d	27.98e	3.33%(straight	100%(thin)

Mean of the same column with different letter are significantly different(P<0.001) according to Anova and Tukey HSD test

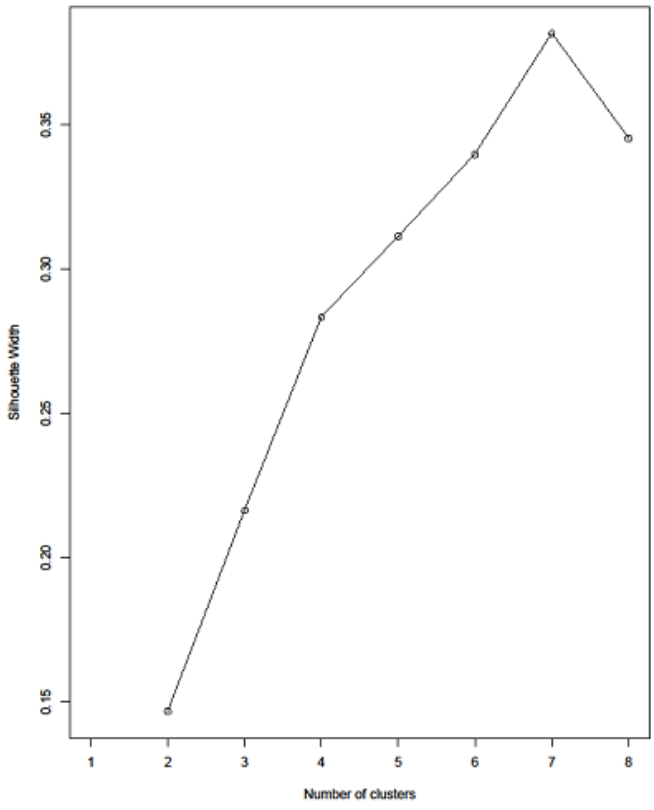


Figure 9. Number of clusters

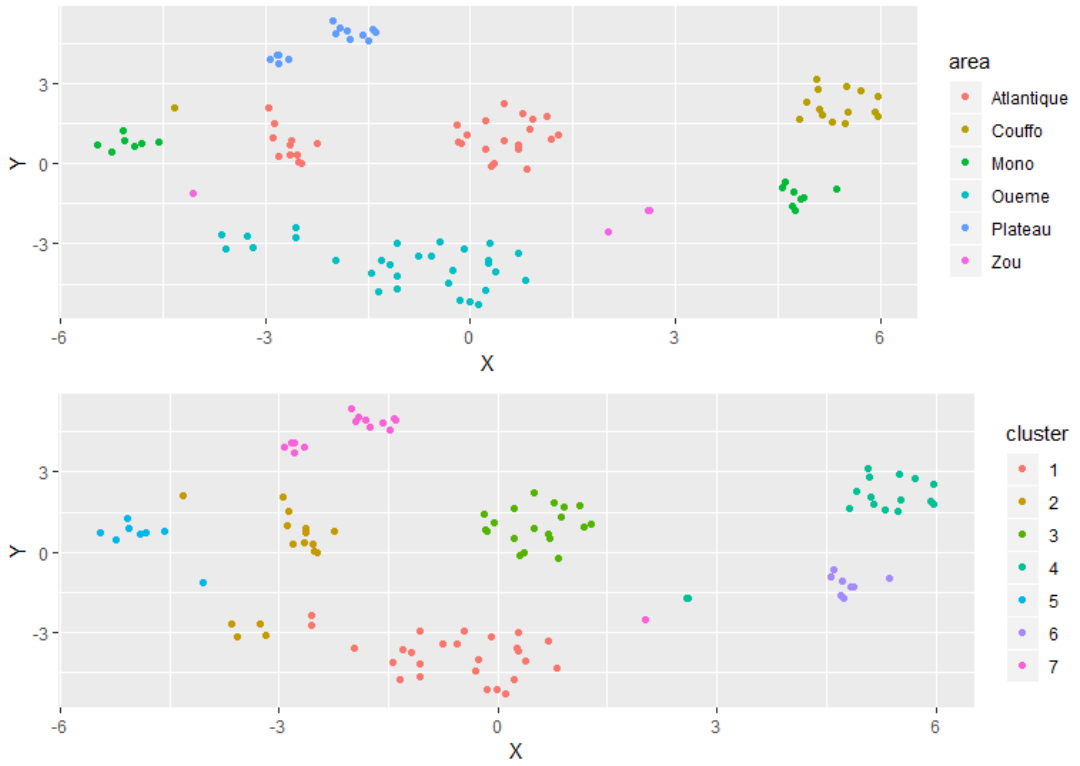


Figure 10. Herds distribution within clusters

Discussion

The impacts of climate change require more attention in terms of the management of indigenous animal genetic resources for sustainable food and agricultural production. The conservation and sustainable use of locally adapted indigenous breeds such as the Muturu cattle breed is one way to achieve this. According to the FAO, genetic characterization is one of the prerequisites for decision-making in the context of the sustainable management of genetic resources (FAO, 2011). Thus, the present study is an attempt to characterise the different populations of Muturu cattle breed in Benin, as well as the perception of cattle keepers towards the breed.

The predominance of male herders in this study is in agreement with the conclusions of other works in Benin and Africa (Soro et al., 2015; Whannou, 2016; Roessler, 2019). In fact, the division of roles and responsibilities in rural Beninese society implies that women are often responsible for the sale of the family business's products in the market, while men as the head of the family hold the property and exercise full control over production and the resulting profit (Adoligbé et al., 2020b). The presence of a few women among Muturu cattle keepers is certainly justified by the docility of this breed which makes its management relatively easier on the one hand, but also because some widowed women have inherited some herds from their deceased husbands.

In our study, the farmers most important income activity explained the variation of herd size between department with decreases observed with the department where most farmers have off-farm activities as most important income activity. This is probably because farmers are more keen to invest (labour and finance) to develop their most important income activity at the expense of others (Adoligbe et al., 2020a). Indeed, keeping the Muturu cattle is a means of diversifying sources of income and make saving that could be used for occasional needs (pay dowry, school fees, emergencies etc.) in southern Benin. In contrast, in the northern region of Benin and other Sahelian countries in Africa such as Mali, Niger and Burkina-Faso livestock herding remain the most important income generating activity, due to the existence a more suitable eco-climate (Diogo et al., 2021 ; Ouédraogo, 2021).

It is reported that cattle keepers' perception is generally influenced by many factors including, cattle keepers' preferences, breeding reasons, breeding objectives, socio-cultural considerations (Traoré, 2017). In our study, cattle keepers' perception regarding cattle production characteristics, resistance to drought and disease vary from one department to other although from a general point of view, the Muturu cattle are consider to be rustic, docile, with good meat quality but low milk production. This is consistent with the traits recognized for the Muturu cattle (Salifou, 2013; Gwaza and Momoh, 2016).

The comparative study of the morphometric data between study sites showed that the animals of the Mono department followed by those of Couffo had the highest values for most of the traits, particularly the body length, the height at whiter, the chest circumference and the horns length, compared to animals from other regions. Same results were obtained from the cluster s study. In addition, these values are higher than those recorded previously on the Muturu cattle in Benin and in other countries of West Africa but are close to those measured on zebu x taurin crossbreds products (Traoré, 2015; Traoré 2016; Daikwo, 2018; Ahozonlin, 2020). Animals from Ouémé had the lowest values for the traits measured, which were closed to the measurements made before on the Muturu cattle in Benin and in West-Africa (Sedogbo, 1993, Traoré, 2015, Traoré, 2016, Daikwo, 2018; Ahozonlin, 2019). The observed physical differences between and within groups could not be attributed to the breeding conditions (breeding system, feeding, watering, health monitoring) because they are similar on all the study sites (Adoligbe et al., 2020a, Diogo et al., 2021, Hounkeala, 2021). Moreover, the study sites have at least one agro-ecological zone in common: Mono (zone 7 and zone 8), Atlantic (zone 6, 7 and 8), Couffo (zone 5 and zone 6), Ouémé (zone 6 and zone 8) for instance, which makes unlikely the attribution of this physical difference to an adaptation to the living environment. Therefore, the most probable reason is cattle keepers practices particularly the uncontrolled crossbreeding between taurine and zebu that could lead to the production of hybrids physically resembling to taurines but having in their genetic heritage zebu genes. The relatively higher number of animal in fostering in the departments of Mono and Couffo as revealed by our survey supports this hypothesis. In fact, the cattle keepers in Mono and Couffo departments are generally Fulani tribes who contract with local people, usually farmers, to keep their cattle. In return they have the right to collect and use the milk from the animals. Given that taurine has lower milk production, they usually cross the animals with Zebu to get hybrids that produce more milk (Mwai, 2015).

Koudandé et al. (2009) after a genotypic characterization of Muturu cattle in the West African sub-region, concluded that the populations that have undergone the least introgression are found mainly in the eastern part of the plateau. Based on our phenotypic characterization the animals from the Ouémé valley are the closest to the Muturu cattle as described originally. For an objective comparison of the two results a molecular characterization as a follow up to the present study is required.

The negligible number of animal samples in the department of Zou showed that Muturu catlle are very rare in that department nowadays. This is because the department of Zou is a transhumance area which regularly receive zebu cattle coming from the north of the country (DE, 2017).

Conclusion

The present study revealed that the trypanotolerant Muturu cattle are nowadays found mainly in the departments of the Atlantic, Ouémé, and Plateau. The Zou department has almost no Muturu cattle and the departments of Couffo and Mono are dominated by Zebu x Muturu crossbreds. The morphological diversity recorded suggests the existence of genetic variation that can be utilized for the breed genetic improvement and conservation. In terms of conservation, we recommend:

- A molecular characterization of the various existing populations in order to better assess and explain their variability and their genetic structure.

- The revitalization of the Muturu breeders' association that have already been set up as a prelude to the conservation of the breed

- The establishment of a community-based breeding scheme, involving all stakeholders, for the conservation of the breed in the departments where they still exist (breeders, local populations, ATTDA, NGOs, DE, MAEP, etc.)

- A genetic improvement of the milk production of Muturu catlle breed in Benin

Acknowledgement

We extend our sincere appreciation to the staff of all departments Agriculture, Husbandry and Fisheries Directorate for their support and involvement in the data collection process. We are equally grateful for the smallholder cattle keepers who participated in this study

Funding Information

Funding from AU-IBAR under the genetics project is greatly appreciated

Author's Contributions

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Ethics

This research was conducted according to the national regulation of the Direction of Husbandry of Benin.

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