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Multivariate Characterisation of Oulmes-Zaer and Tidili Cattle Using the Morphological Traits

Research Article

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ABSTRACT

Fourteen different morphological traits in 169 and 131 cattle of Oulmes-Zaer and Tidili, respectively were recorded and analyzed using a multivariate approach. The characters measured included heart girth, wither height, rump height, rump length, rump width, chest depth, body length, neck length, cannon circumference, ear length, ear width, head length, horn length and tail length. Breed significantly influenced all the traits investigated. Correlation coefficients among the body measurements ranged from 0.12 to 0.85 in Oulmes-Zaer and from -0.14 to 0.81 in Tidili cattle. In the varimax rotated principal component factor analysis, three factors were extracted, which explained about 65.1% and 55.4% of the total variation in Oulmes-Zaer and Tidili cattle, respectively. The communality ranged from 0.28 (horn length) to 0.82 (heart girth) in Oulmes-Zaer cattle and from 0.25 (horn length) to 0.79 (rump height) in Tidili cattle. Stepwise discriminant analysis showed that 9 out of 14 body measurements were found to have a potential discriminatory power. The canonical discriminant analysis showed that the squared Mahalanobis distance between breed means was significant, indicating that significant differences exist between Oulmes-Zaer and Tidili breeds. The raw canonical coefficients for the first canonical variable provided the greatest difference between the breed means (1.498 *vs*. -1.933). The second canonical variable did not provide any difference between means. The discriminant analysis showed that 98.2% and 100% of Oulmes-Zaer and Tidili animals, respectively were correctly classified. It was concluded that clear morphological differences existed between Oulmes-Zaer and Tidili cattle indicating that there were two distinct populations.

KEY WORDS body measurements, cattle, discriminant analysis, factor analysis, Morocco.

INTRODUCTION

In Morocco, the cattle population is estimated to 2.8 million heads, where the local population, composed of Brune de l'Atlas, Oulmes-Zaer and Tidili breeds, represents about 46%. The local cattle are known for their disease resistance, adaptability to harsh environment and ability to survive and perform under scarce feed and fodder. They are source of livelihood to many people by providing milk and meat. Few studies focusing on the assessment of reproduction and production performance are available on this population (Boujenane, 2002). However, the information on its morphological traits is scarce. According to FAO (2011), studies using the phenotypic description and morphological traits are necessary to characterize, identify and differentiate populations. Moreover, morphological measurements are used to indicate the breed, origin and relationship or shape and size of individual. They have been traditionally used for characterisation of local breeds, which is the first approach to a sustainable use of the animal genetic resource. Thus, to distinguish between breeds, it is important to accurately analyse the morphological traits. However, biological relationship existing among the linear body variates may be different if these body measurements are treated as bivariates rather than multivariates (Yakubu *et al.* 2009).

Multifactorial analyses of morphological traits have been proved to be appropriate in assessing the variation within a population and can discriminate different population types when all measured morphological variables are considered simultaneously. The factor analysis can reduce the information contained in the original complex of variables by eliminating redundant information due to correlation among them (Cerqueira *et al.* 2011; Yakubu *et al.* 2011). Discriminant function analysis is a statistical technique that allows new individuals to be assigned to previously established or defined groups. The objective of this study was to provide the information about morphological structure of Oulmes-Zaer and Tidili local cattle reared in Morocco for the purposes of breed characterization and to distinguish between them using multivariate analyses.

MATERIALS AND METHODS

Description of breeds

The current study concerned two local cattle breeds; Oulmes-Zaer and Tidili. The Oulmes-Zaer is one of the principal native cattle breeds in Morocco. Its breeding area is located at piedmont of Middle Atlas mountain, at about 100 to 200 km south-east of Rabat, especially in Khemisset, Tiflet and Oulmès regions. The number of animals is about 80000 head. Coat colour of animals is uniformly red. Height at withers ranged from 120 to 135 cm. Adult weights were 300 kg for females and 450 kg for males. The Tidili breed is raised in the Ouarzazate region, south of Morocco. The number of animals is about 15000 head. This breed is phenotypically similar to the Brune de l'Atlas breed, with the exception of a voluminous udder. The most dominant coat colour is black with yellow to red on the back, but some animals are also either uniformly red or uniformly black. Height at withers ranged from 110 to 120 cm. Adult weights were 285 kg for females and 330 kg for males (Boujenane, 2002; Boujenane, 2010).

Data collection

A total of 300 adult animals (169 Oulmes-Zaer and 131 Tidili) were measured. Only adult cattle of two years old and above were considered in order to avoid age effect in the present study. Sampling was carried out randomly among cattle of 142 farms (32 and 110 farms for Oulmes-Zaer and Tidili, respectively) located in the breeding area of each breed and kept under extensive low input management conditions. These populations are mainly composed of small herds (not larger than 10 animals for Oulmes-Zaer and not larger than 5 animals for Tidili) of mainly cows and very few bulls.

The sample was constituted by 96.7% females and 3.33% males. The relatively high number of females in this sample could be attributed to the fact that they are normally retained in the breeding herd for reproduction, while the males are more frequently sold. Data on the age were also recorded. The age of animals was estimated by counting the number of permanent incisors present (2, 4, 6 or 8 permanent incisors). Adult ages associated with dentition status were as follows: two pairs, three pairs and four pairs of permanent incisors correspond to 2, 3, 4 and 5 years or more, respectively.

Variables studied

Variables studied are heart girth (HG, the circumference around the chest just behind the front legs and withers), wither height (WH, the distance from point of withers to the surface of a platform on which the animal stands), rump height (RH, the distance from rump to the surface of the platform on which the animal stands), rump length (RL, measured from hips to pins), rump width (RW, the distance between both of the hip bones, measured at trochanters), chest depth (CD, width immediately behind the shoulder blades), body length (BL, the distance from point of shoulder to pin bone), neck length (NL, measured from the base of the skull to the point of connection with the trunk), cannon circumference (CC, the smallest circumference of the cannon bone of foreleg), ear length (EL, the distance from the point of attachment of ear to the tip of the ear), ear width (EW, the circumference of ear at the mid-ear), head length (HEL, the distance from between the horn site to the lower lip), horn length (HOL, the distance from point of horn attachment to the tip of the horn) and tail length (TL, the distance from the tail droop to the tip of the tail excluding switch). All measurements were recorded using flexible tape (with records taken to the nearest cm), except for wither height, rump height, rump width and thorax depth that were taken by graduated measuring stick and calibrated wooden calliper. Animals were put on a flat floor and held by the respective owners. Measurements were taken from the left side of the animal by the same operator to avoid between-operator variations.

Statistical analyses

Statistical analyses were carried out using the SAS (2002). Data were first analyzed using MEAN and FREQ procedures to obtain descriptive statistics for morphological traits studied. PROC CORR was also used to compute the Pearson correlations among traits and Cronbach's alpha to measure the reliability of samples. To test the effects of breed, sex and age on variables studied, least-squares analysis of variance was applied using GLM procedure, fitting a model that included fixed effects of breed (Oulmes-Zaer and Tidili), sex (male and female) and age (2, 4, 6 and 8 permanent incisors). The effects of farm and locality were confounded with the breed, as breeds were reared in a single farm and locality, thus they were not included in the model. Interactions between effects were assumed negligible and were not tested. Least-squares mean comparison for breed, sex and age were performed using Tukey's test after examining the significance effect on variables observed. FACTOR procedure was used to perform the principal component factor analysis, which is a data reduction technique to combine measurements into uncorrelated factors. The scree test was used to determine the number of factors to be considered and it only retained those that had eigenvalues greater than 1. Moreover, to test the validity of the factor analysis of the data set, variables' communality was computed. Varimax rotation was used for rotation of principal factors through the transformation of the factors to approximate a simple structure. Stepwise discriminant analysis, using the 14 body measurements, was performed to identify morphological traits that best serve as racial marker between the breeds investigated. This traits' reduction was accomplished with STEPDISC procedure. The significance level used for adding or retaining a variable was 0.05. CANDISC procedure was used to perform canonical discriminant analysis to derive canonical functions, that is, linear combinations of body measurements that best separate the two breeds, and to compute the between-breed squared Mahalanobis distance matrix. DISCRIM procedure was used to perform discriminant analysis in order to determine percentage assignment of animals into their own breed. The percent of misclassification indicates the degree of mixture between the two breeds. Predictor variables introduced into the canonical discriminant and discriminant analyses were those body measurements retained following the stepwise discriminant analysis.

RESULTS AND DISCUSSION

Arithmetic and least-squares means

The arithmetic means and the least-squares means for body measurements of each breed are presented in Table 1. The body measurements observed in the present study suggested that Tidili are small size cattle compared to Oulmes-Zaer cattle, showing better skeletal and muscle development for the latter breed and indicating that they are better for meat production. The coefficients of variation for different measurements showed less variability in general indicating that cattle of each breed are almost similar in their body size. They ranged from 4.19% (WH) to 20.6% (HOL) for Oulmes-Zaer cattle and from 3.45% (WH) to 34.3% (HOL) for Tidili cattle, but all are lower than 10%, except for the tail length.

This homogeneity might be due to natural selection favouring particular shape and size that is well adapted to local environment. The analysis of variance obtained by GLM indicated that effects of breed were highly significant for all studied traits. Differences between breeds are in favour of Oulmes-Zaer cattle and equal to 13.5 cm, 8.6 cm, 10.4 cm, 3.3 cm, 4.7 cm, 6.1 cm, 12.1 cm, 7.9 cm, 2.9 cm, 2.0 cm, 2.2 cm, 3.3 cm, 9.7 cm and 7.7 cm for HG, WH, RH, RL, RW, CD, BL, NL, CC, EL, EW, HEL, HOL and TL, respectively. This situation is a good indication of substantial genetic difference between breeds. Relative to other factors studied, there was evidence of sexual dimorphism between males and females and evidence of age effects on most traits. Pearson's correlation coefficients among body measurements of Oulmes-Zaer and Tidili breeds are given in Table 2. Correlations among all traits of Oulmes-Zaer cattle were positive and among 91 correlations 87 were significant. Most correlations of Tidili breed were positive but some were negative and among 91 correlations 56 were significant. Moreover, most correlations between two same traits were higher in Oulmes-Zaer than in Tidili cattle. The highest correlations in Oulmes-Zaer cattle were recorded between HG and CD (0.85) and between WH and RH (0.85), while the lowest were observed between TL and CD (0.12) and between TL and NL (0.12). In Tidili cattle, WH showed the highest positive correlation with RH (0.81), while EL showed the lowest negative correlation with CD (-0.01). These correlations are in the range of those reported by Pundir *et al.* (2011), Slimene *et al.* (2012) and Tolenkhomba *et al.* (2012). The standardized Cronbach's alpha that measures how well a set of variables was taken is equal to 0.91 and 0.82 for Oulmes-Zaer and Tidili breeds, respectively, indicating that the internal consistency of the Oulmes-Zaer sample was better than that of Tidili sample, as higher values of alpha are more desirable. Moreover, since the standardized Cronbach's coefficients were greater than 0.70 for both breeds, this means that the internal consistency of the whole sample was satisfactory.

Multivariate analyses

Principal component factor analysis

The kaiser's measure of sampling adequacy (MSA) which gives an overall MSA computed across all variables, was equal to 0.90 and 0.80 for Oulmes-Zaer and Tidili cattle, respectively. Small values of MSA indicated that the correlations between any variable and the other variables are unique, that is not related to the remaining variables outside each simple correlation. Pundir *et al.* (2011) reported that variables with MSAs' below 0.50 should be dropped prior to factor analysis.

Table 1 Arithmetic means and least-squares means for body measurement traits (cm) of Oulmes-Zaer and Tidili cattle

Body measurement trait	Arithmetic means (CV)		Least-squares means±SE		Significance level
	Oulmes-Zaer	Tidili	Oulmes-Zaer	Tidili	
Heart girth	158.7 (5.38)	144.6 (4.13)	161.2±1.28	147.7±1.41	***
Wither height	115.0 (4.19)	106.2 (3.45)	116.8±0.76	108.2±0.84	***
Rump height	120.0 (4.20)	109.4 (3.68)	122.4±0.81	112.0±0.89	***
Rump length	45.9 (6.58)	42.3 (4.21)	46.9±0.43	43.6±0.47	***
Rump width	41.0 (6.54)	36.2 (6.74)	40.1±0.44	35.4±0.49	***
Chest depth	60.7 (5.01)	54.4 (5.04)	61.1±0.50	55.0±0.55	***
Body length	138.6 (6.02)	126.1 (5.77)	139.6±1.37	127.5±1.50	***
Neck length	62.2 (9.28)	54.0 (7.85)	62.3±0.90	54.4±0.99	***
Cannon circumference	17.4 (8.45)	14.3 (5.66)	18.6±0.20	15.7±0.21	***
Ear length	17.5 (9.66)	15.6 (9.04)	17.5±0.28	15.5±0.31	***
Ear width	14.0 (8.00)	11.7 (6.92)	14.0±0.18	11.8±0.19	***
Head length	43.5 (4.46)	40.1 (4.16)	43.4±0.32	40.1±0.35	***
Horn length	24.2 (20.6)	14.3 (34.3)	22.3±0.86	12.6±0.94	***
Tail length	76.0 (8.58)	68.0 (7.32)	77.0±1.05	69.3±1.16	***

CV: coefficient of variation (%).
SE: standard error.
*** (P<0.001).

Table 2 Pearson's correlation coefficients among body measurements of Oulmes-Zaer (above diagonal) and Tidili (below diagonal) cattle

Traits	HG	WH	RH	RL	RW	CD	BL	NL	CC	EL	EW	HEL	HOL	TL
HG	-	0.64	0.64	0.67	0.67	0.85	0.65	0.53	0.73	0.26	0.46	0.48	0.33	0.31
WH	0.40	-	0.85	0.61	0.57	0.71	0.52	0.33	0.61	0.31	0.41	0.38	0.28	0.36
RH	0.43	0.81	-	0.59	0.58	0.67	0.46	0.31	0.61	0.32	0.43	0.36	0.28	0.40
RL	0.60	0.53	0.43	-	0.62	0.67	0.57	0.36	0.66	0.21	0.33	0.41	0.24	0.30
RW	0.60	0.31	0.29	0.50	-	0.62	0.57	0.34	0.55	0.27	0.44	0.38	0.37	0.34
CD	0.52	0.35	0.28	0.41	0.43	-	0.65	0.51	0.65	0.30	0.44	0.47	0.34	0.29
BL	0.36	0.37	0.36	0.54	0.39	0.36	-	0.43	0.51	0.24	0.34	0.40	0.20	0.12
NL	0.18	-0.12	-0.14	0.15	0.21	0.17	0.22	-	0.42	0.26	0.27	0.30	0.10	0.12
CC	0.49	0.37	0.39	0.49	0.43	0.41	0.38	0.06	-	0.32	0.52	0.36	0.28	0.40
EL	0.14	0.16	0.15	0.22	-0.05	-0.01	0.22	0.06	0.14	-	0.57	0.22	0.19	0.28
EW	0.32	0.22	0.17	0.36	0.17	0.13	0.32	0.08	0.34	0.43	-	0.30	0.35	0.33
HEL	0.41	0.28	0.28	0.37	0.36	0.44	0.34	0.20	0.40	0.07	0.25	-	0.24	0.12
HOL	0.09	0.05	-0.04	0.13	0.21	0.13	0.05	0.14	0.09	0.08	0.17	0.15	-	0.20
TL	0.08	0.04	0.08	0.29	0.09	-0.03	0.28	0.02	0.22	0.16	0.21	0.15	0.14	-

HG: heart girth; WH: wither height; RH: rump height; RL: rump length; RW: rump width; CD: chest depth; BL: body length; NL: neck length; CC: cannon circumference; EL: ear length; EW: ear width; HEL: head length; HOL: horn length and TL: tail length.

This is not the case of the present study since all body measurements had MSAs' greater than 0.81 and 0.63 in Oulmes-Zaer and Tidili cattle, respectively. For each breed, three factors (1, 2 and 3) had eigenvalues greater than 1, indicating that these factors provided good summary of the data (MINEIGEN criterion). This was also confirmed by scree test. Therefore, only the first three factors were retained. For Oulmes-Zaer cattle, the factor 1 accounted for 48.7% of the total variance, while factors 1, 2 and 3 together accounted for 65.1% of the total variance. For Tidili cattle, factors 1, 2 and 3 accounted for 33.7%, 11.0% and 10.6%, respectively, totalizing 55.4% of the total variance. Subsequent factors contributed with less than 7% each in the two breeds. In comparison to three factors extracted with eigenvalues greater than 1 and accounted for 65.1% and 55.4% of the total variance in Oulmes-Zaer and Tidili cattle, respectively, Tolenkhomba *et al.* (2012) extracted seven factors which accounted for 64.31% of total variance in local cows of Manipur, Yakubu *et al.* (2009) extracted two factors which accounted for 85.37% of total variation in white Fulani cattle and Pundir *et al.* (2011) extracted three factors in Kankrej cows which accounted for 66.02 % of total variation.

The factor patterns which show the correlations between the factors and the body measurements, gave different weights and signs to the traits (Table 3). The first factor assigned positive coefficients to all body measurements of Oulmes-Zaer and Tidili breeds. The second factor gave negative weights to HG, RL, RW, CD, BL, NL and HEL of Oulmes-Zaer cattle and WH, RH, CD and CC of Tidili cattle and positive coefficients to all other traits. The third factor assigned negative coefficients to WH, RH, RL, RW, CC, HOL and TL of Oulmes-Zaer and HG, RW, CD, NL, HEL and HOL of Tidili cattle and positive weights to all other traits. The coefficients showed that the highest relative contributions to factors 1, 2 and 3 were HG, EL and EL, respectively for Oulmes-Zaer, and RL, NL and EL, respectively for Tidili cattle.

Table 3 Factor pattern and communality of the body measurements with factors 1, 2 and 3 in Oulmes-Zaer and Tidili cattle

Trait	Oulmes-Zaer				Tidili			
	Factor pattern			Communality	Factor pattern			Communality
	Fact 1	Fact 2	Fact 3		Fact 1	Fact 2	Fact 3	
Heart girth	0.88	-0.20	0.01	0.82	0.77	0.00	-0.21	0.64
Wither height	0.81	0.00	-0.26	0.73	0.67	-0.55	0.13	0.78
Rump height	0.80	0.06	-0.30	0.74	0.64	-0.60	0.15	0.79
Rump length	0.78	-0.21	-0.19	0.69	0.80	0.02	0.07	0.65
Rump width	0.78	-0.03	-0.12	0.62	0.67	0.10	-0.39	0.61
Chest depth	0.87	-0.19	0.01	0.80	0.63	-0.01	-0.44	0.59
Body length	0.72	-0.33	0.17	0.65	0.67	0.12	0.13	0.48
Neck length	0.55	-0.26	0.47	0.58	0.19	0.63	-0.31	0.52
Cannon circumference	0.81	0.03	-0.07	0.66	0.67	-0.01	0.00	0.49
Ear length	0.45	0.58	0.47	0.76	0.28	0.21	0.68	0.58
Ear width	0.62	0.52	0.29	0.74	0.49	0.29	0.50	0.57
Head length	0.56	-0.17	0.27	0.41	0.61	0.16	-0.20	0.43
Horn length	0.42	0.31	-0.04	0.28	0.21	0.46	-0.03	0.25
Tail length	0.45	0.51	-0.41	0.62	0.28	0.31	0.44	0.37
Eigenvalues	6.81	1.30	1.01	-	4.72	1.55	1.49	-
Percentage of total variance	48.7	9.26	7.20	-	33.7	11.0	10.6	-

After varimax rotation of the component matrix, three factors with ratio of variance of 65.1% and 55.4% were extracted for Oulmes-Zaer and Tidili cattle, respectively. Variables loading most heavily on factor 1 were BL, NL and HG, on factor 2 RH, WH and TL and on factor 3 EL, EW and HOL for Oulmes-Zaer. Variables HG, RW and CD were highly loaded on factor 1, variables EL, EW and HOL on factor 2, whereas variables RH, WH and NL were highly loaded on factor 3 for Tidili cattle. Likewise, variables' communality, which represents the proportion of variance of each of the 14 variables shared by all remaining body measurements, were medium to high. They varied from 0.28 to 0.82 and from 0.25 to 0.79 in Oulmes-Zaer and Tidili cattle, respectively (Table 3). Approximate range of communality was reported by Pundir *et al.* (2011) in Kankrej cows and Tolenkhomba *et al.* (2012) in local cows of Manipur. The communalities of the present study indicate that all the traits had high loadings on factor 1 which are good descriptors of general body size, while factors 2 and 3 seem to reflect the body shape and head size, respectively of both breeds.

In morphometric application of principal components, factor 1 was acceptable as a "size" vector and factor 2 as "shape" vector as reported in cattle (Carpenter *et al.* 1978; Hayashi *et al.* 1981; Yakubu *et al.* 2009). The lower communalities for some of the traits, like horn length in Oulmes-Zaer and tail length and horn length in Tidili, indicate that these traits were less effective to account for total variation of body conformation as compared to the other traits in local cattle of Morocco. Tolenkhomba *et al.* (2012) reported that ear length, tail length, arm length, elbow length and thigh length were less important traits as compared to the other traits in local cows of Manipur.

Stepwise discriminant analysis

Stepwise discriminant analysis was applied to gain information about traits particularly important in the separation of breeds. The analysis showed that 9 out of 14 body measurements were found to have a potential discriminatory power, thereby indicating that only a few measurements are needed to separate breeds. Their partial R^2 varied from 0.61 to 0.01. These traits were CC that was found to be the most discriminating character, followed by HOL, RH, EW, NL, RL, HEL, HG and CD in decreasing order of discriminating power. The traits retained were used to develop discrimination models in both the canonical discriminant and discriminant analyses. Yakubu *et al.* (2010) reported that the stepwise discriminant analysis showed that rump width, withers height and face length were the most discriminating variables between Bunaji and Sokoto Gudali cattle; their respective partial R^2 were 0.5824, 0.0948 and 0.0408.

Canonical discriminant analysis

Canonical discriminant analysis was used to obtain the function of all body measurements necessary for the separation of breeds. Thus, the squared Mahalanobis distance between breed means was 11.77 (P<0.001). The pairwise distance between Bunaji and Sokoto Gudali cattle was equal to 7.19 (Yakubu *et al.* 2010).

The resulting R^2 values ranged from 0.39 for neck length to 0.61 for cannon circumference, and each variable was significant (P<0.001). The squared canonical correlation between the canonical variable 1 and the breed was 0.74. The first canonical correlation, which is the greatest possible multiple correlation with the breeds, that can be achieved using a linear combination of the body measurements, was equal to 0.86.

The multivariate test for differences between the breeds (Wilks' Lambda, Pillai's Trace…) is also significant (P<0.001), indicating that significant differences exist between Oulmes-Zaer and Tidili breeds. These results corroborate with breed sub-structure using microsatellites found by Boujenane and Ouragh (2010) and may be a consequence of long term selective events with diverse preferences among breeders. The raw canonical coefficients (contribution or magnitude of the trait on the discriminant function) for the first canonical variable, Can1, showed that the breeds differ most widely on the linear combination of the variables. The first canonical variable, which is the linear combination of the nine traits: CAN1= 0.316CC + 0.074HOL + 0.080RH + 0.260EW + 0.048NL + 0.105HEL - 0.061HG + 0.064CD, provided the greatest difference between the breed means (1.498 *vs*. -1.933). The second canonical variable does not provide any difference between means. The Figure 1 shows that the first axis separates the two breeds. Clear morphological differences existed between Oulmes-Zaer and Tidili cattle because plots of breed membership using the canonical variables indicated that there were two distinct populations.

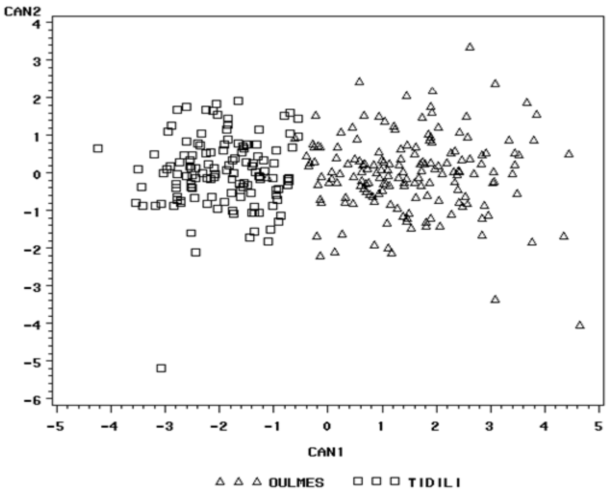

Figure 1 Canonical analysis for individual body measurements in Oulmes-Zaer and Tidili cattle

Discriminant analysis

The discriminant analysis was conducted to predict any of the traits measured that best distinguish the two breeds. Through the stepwise procedure, nine body measurements were significant in discriminating between the two breeds of cattle. The analysis showed that the number of animals correctly classified was 297 animals, leaving 0.89% rate of error. Relative to Oulmes-Zaer animals, 98.2% were correctly classified, but Tidili breed did better with 0% misclassified animals. Thus, confirming the non-mixture of the two breeds. In fact, their geographic locations are far from each other. The lowest misclassification error of Tidili breed may be the indication of more uniformity as the result of more homogeneity of this breed. The Tidili breed is small in body size; therefore most of them could not be wrongly categorized to Oulmes-Zaer, which is a larger breed. Yakubu *et al.* (2010) reported that 85.48% of Bunaji cattle and 96.55% of their Sokoto Gudali were correctly assigned into their source genetic group. The use of cross-validation option provided better assessment of classification accuracy. Thus, each data point was reclassified as if it was a new unknown observation; this provided a more conservative accuracy assessment. For these data, Oulmes-Zaer breed now showed error rate of 2.96%, while Tidili breed 3.05%. Overall, 3.01% of the animals were misclassified. Using the Crosslisterr option, these rates were found to correspond to 5 Oulmes-Zaer and 4 Tidili misclassified animals. The examination of these animals may be carried out to determine why they were not classified as expected.

CONCLUSION

The study showed that the Oulmes-Zaer cattle were larger than the Tidili cattle for all the fourteen body measurements investigated. The structure of the cattle was explained using three principal component factors. CC, HOL, RH, EW, NL, HEL, HG and CD traits were found as the most discriminating variables to separate the two cattle breeds. Most of the animals were correctly assigned into their breeds of origin. It was concluded that the characterisation of cattle in this study will be helpful to livestock farmers and researchers in preserving the genetic resources of the local Moroccan cattle breeds.

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REFERENCES

Boujenane I. (2002). Les Races Bovines au Maroc. Rabat, Morocco.

Boujenane I. and Ouragh L. (2010). Genetic analysis of native Moroccan cattle. *Livest. Res. Rural. Dev.* **22,** 154-151.

Carpenter Jr J.A., Fitzhugh H.A., Cartwright T.C., Thomas R.C. and Melton A.A. (1978). Principal components for cow size and shape. *J. Anim. Sci.* **46,** 370-375.

Cerqueira J.O.L., Feas X., Iglesias A., Pacheco L.F. and Araujo J.P.P. (2011). Morphological traits in portuguese bordaleira de entre douro e minho sheep: divergence of the breed. *Anim. Reprod. Sci.* **51,** 635-641.

FAO. (2009). Food and Agriculture Organization of the United Nations the State of Food Insecurity in the World. Draft guidelines on phenotypic characterization of animal genetic resources. Available at:

http://www.fao.org/docrep/meeting/022/am651e.pdf.
Hayashi Y., Nishida T., Mochizuki K. and Otsuka J. (1981). Measurements of the skull of native cattle and Banteng in Indonesia. *Japanize J. Vet. Res.* **43,** 901-907.
Pundir R.K., Singh P.K., Singh K.P. and Dangi P.S. (2011). Factor analysis of biometric traits of Kankrej cows to explain body conformation. *Asian-australas J. Anim. Sci.* **24(4),** 449-456.
SAS Institute. (2002). SAS/STAT, User's Guide. SAS Institute, Cary, NC, USA.
Slimene A., Damergi C., Chammakhi L., Najar T. and Ben Mrad M. (2012). The use of principal component analysis to characterize bulls aged between 14 and 26 months in Tunisia. *Res. Opin. Anim. Vet. Sci.* **2(3),** 207-211.
Tolenkhomba T.C., Konsam D.S., Singh N.S., Prava M., Singh Y.D., Ali M.A. and Motina E. (2012). Factor analysis of body measurements of local cows of Manipur, India. *Int. Multidisciplin. Res. J.* **2(2),** 77-82.
Yakubu A., Ogah D.M. and Idahor K.O. (2009). Principal component of the morphostructural indices of white Fulani cattle. *Trakia J. Sci.* **7(2),** 67-73.
Yakubu A., Idahor K.O., Haruna H.S., Wheto M. and Amusan S. (2010). Multivariate analysis of phenotypic differentiation in Bunaji and Sokoto Gudali cattle. *Acta. Agric. Slovenica.* **96(2),** 75-80.
Yakubu A., Salako A.E. and Imumorin I.G. (2011). Comparative multivariate analysis of biometric traits of west African Dwarf and red Sokoto goats. *Trop. Anim. Health Prod.* **43,** 561-566.