

Application of multifactorial discriminant analysis in the morphometric structural differentiation of West African Dwarf (WAD) and Yankasa Sheep in South West Nigeria

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Abstract

A total of 264 adult sheep comprising WAD and Yankasa rams and ewes traditionally managed in flocks within the south West Nigeria were investigated. Ten zoometrical variables were monitored in order to contrast their validity as racial markers and breed discriminants and identify metric characters which can be valuable for population classification within the species. Descriptive statistic showed that the Yankasa generally appear superior to the WAD in all variables measured except for shoulder width where WAD appeared superior giving the breed a blockier look than Yankasa which is relatively narrower. Neck circumference exhibited the highest variability in both sheep studied, c.v. being 18.34 and 20.12% respectively. These were followed by shoulder width in WAD and body length in Yankasa. The cephalic characters (head width and face length) exhibited the lowest variability in both breeds (c.v. being between 3.62 and 5.67%). High environmental sensitivity of neck circumference and shoulder width in WAD population explains the observed variability although measurement of neck circumference were affected by the neck ruff of the rams. The low variability exhibited by the cephalic characters in both breeds is a reflection of their relative insensitivity to environmental elements resulting from their close association with cranial bone growth. Stepwise discriminant analysis showed that tail length (the most discriminant variable between the breeds) was followed by shoulder width, the cephalic characters, body length and wither height in that order. Other variables did not qualify to enter the model. The small number of variables exhibiting high discriminant power (i.e. tail length, shoulder width, and head width) are explained by the genetic exchange that has existed between the breeds.

Keywords: Discriminant analysis, morphometry, structure, differentiation, sheep, breeds

Introduction

Genetic improvement of caprine races has formally been achieved through the crossing of exotic and local (indigenous) sheep to the disadvantage of the latter. This trend is currently being reversed with greater attention

focused on indigenous breeds (Maijala, 1993). These sheep have long been adapted to extreme harsh environmental conditions of nutrition, climatic and disease and might be more productive in their own environment than exotic breeds. They can also be valuable

experimental animals in fundamental research and a potential store of unique genes which may be useful to the industrialized nations such as developed countries especially when environmental concerns necessitate changes in production systems. There is therefore a need to study variations among their populations via breed characters so as to facilitate their efficient utilization.

The difference between WAD and Yankasa sheep has previously been studied by other workers based on few morphological characters (Adu and Ngere, 1979; Ngere *et al.*, 1984) but rarely have attempts been made to examine the characters as possible breed discriminants. This

Table 1 Descriptive statistics of the variables studied in each breed

Measurement	WAD (n = 226)		Yankasa (n = 58)		t-statistic
	Mean ± S. E	C. V.	Mean ± S. E.	C. V.	Significance
WH	61.74 ± 0.29	5.86	76.16 ± 0.97	6.38	***
RH	59.20 ± 0.30	6.46	72.57 ± 0.54	6.53	***
BL	62.56 ± 0.37	7.88	70.9 ± 0.74	8.42	***
TL	21.79 ± 0.30	5.29	35.20 ± 1.18	7.20	***
FaL	20.99 ± 0.12	5.16	23.77 ± 0.31	5.51	***
FL	38.92 ± 0.24	5.78	47.73 ± 0.44	6.18	***
SW	17.06 ± 0.16	16.20	15.08 ± 0.16	7.19	***
HW	14.15 ± 0.09	3.62	14.86 ± 0.16	5.67	***
HG	72.94 ± 0.51	6.67	86.33 ± 0.91	8.18	***
NC	28.75 ± 0.32	18.34	34.84 ± 0.89	20.12	*

S. E. = Standard error

C. V. (%) = Coefficient of variation

is the main thrust of this study. Given that the majority of genes influencing the configuration of an animal are of common action and not local, the formation of one part is found narrowly correlated with the formation of the other (Lener and Donald, 1996).

Morphometrical characters are easy to monitor and they facilitate the use of ethnological characterization and at the same time institute reliable racial discriminants (Herrera *et al.*, 1996). This informed our preference for metric traits to determine their value as racial makers. The discriminatory capacity of each measured variable is examined by the discriminant function. This function is generally useful for classification, diagnosis, study of relation between populations and as a multivariate

generalization of the t-test (Snedecor and Cochran, 1968).

Materials and methods

Two hundred and twenty six WAD and 58 Yankasa adults (>21 months of age) were sampled from traditionally managed flocks across the South West Nigeria. The relatively fewer Yankasa individuals encountered is a reflection of the relative abundance of the breed in the region. Ten metric traits were measured on each animal and using the primary identification marks already documented, each animal was assigned to a breed. Reference points for the linear measurements were observed according to the method of Searle *et al.* (1989) as shown in Figure 1. They comprise two height, two width, two circumference and four length measurements.

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Each animal was restrained with the help of at least two assistants who helped to hold the animals in an unforced position. Each dimension was measured at least three times and the mean was recorded in centimetres.

Statistical analyses

Common descriptive characteristics of each measured variable were computed for each breed. They include the mean (\bar{x}), standard error (s.e) and coefficient of variation (c.v.%) using the means procedure of the SAS statistics package (Statistical System Institute Inc, 1989).

The stepwise discriminant analysis was performed using STEPDISC programme of the SAS (1989) package which offers a stepwise discriminant analysis to 'either go ahead or turn back' taking into consideration the different discriminating powers of each variable.

A single multivariate t-test was also applied to test the null hypothesis of homogeneity of the two populations with regards to all the variables.

Results and discussion

Least square means, standard error and coefficient of variation estimates associated with each of the variables measured in the two breeds are presented in Table 1. The Yankasa sheep appeared consistently higher than WAD in all variables except the shoulder width (SW). This corresponds to the range of live weight reported in literature for adults of each breed in another study; 14.5-43.5kg for WAD and 30.5-57.4kg for Yankasa sheep. The WAD showed relatively higher variability than yankasa in five of the variables (RH, TL, FaL SW and HW) while Yankasa also exhibited higher variability than WAD sheep in the rest variables as judged by the coefficient of variation associated with each variable within breeds (Table 1). Neck circumference showed the highest variability in both WAD and Yankasa populations (c.v. being 18.34 and 20.12 respectively). This was

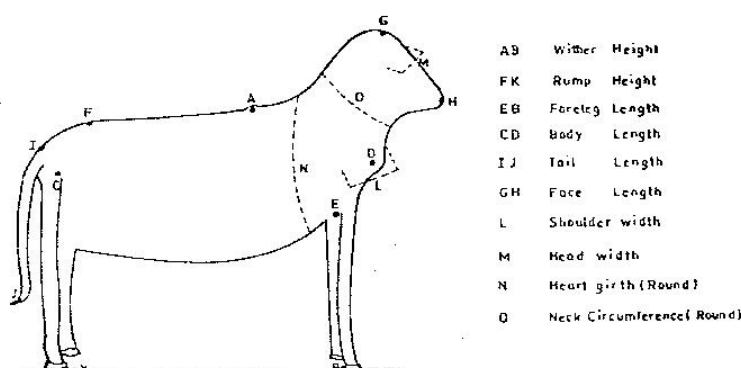


Figure 1 Anatomical points of reference for body measurements

These were measured as follows:

Wither height (WH): Distance between the most cranial palpable spinosus and the ground.

Rump height (RH): Distance from the highest point of the rump to the ground.

Body length (BL): Distance from the head of the humerii to the distal end of the pubic bone.

Tail length (TL): Measured from the base of the tail to the end of the Coccygeal vertebrae.

Face Length (FaL): Distance from between the horn site to the lower lip

Fore leg length (FL): Distance from the proximal extremity of the olecranon process to the mid lateral point of the coronet.

Shoulder Width (SW): Width at shoulders: the distance between the lateral taberosities of the humerii

Head width (HW): Measured as the distance between the outer end of both eyes.

Heart girth (HG): Measured as body circumference just behind the fore leg.

Neck circumference (NC): Taken as the distance round the mid neck region.

followed by shoulder width in WAD (16.20) and body length in Yankasa (8.42). The cephalic profile: face length (5.16) and head width (3.62) were least variable in both populations c.v. being 5.16 and 3.62 respectively in WAD and 5.67 and 5.51 respectively in Yankasa. The high variability observed in body length of the Yankasa in this study might have resulted from large difference between the ages of individuals within the age group utilized and not related to its environmental sensitivity. This is likely since Davis *et al.* (1937) and Searle *et al.* (1989) reported that body length in sheep is almost independent of the environment and therefore usually indicate inherent size.

Results of the stepwise discriminant analysis showing Wilk's Lambdal value and the probability statistics (used for weighing up the addition or deletion of variables from the analysis) associated with each variable are presented in Table 2. The results showed that tail length (the most discriminant variable) was followed by shoulder width, head width, face length, body length and wither height in that order. Tail length being the best is in agreement with some workers who have used the tail lengths of both breeds as a classifying element. The tail is longer in Yankasa reaching the hocks than in WAD where it is shorter. Shoulder width being the next is justified by the broader appearance of WAD sheep as compared with the narrow bodied Yankasa. This was reported also by Hall (1991) studying

the body dimensions of WAD and Fulani sheep of Nigeria. He found that the shoulder width of WAD was larger. As also observed in this study, the cephalic characters were confirmed as differentiating elements between the five Andalusian caprine breeds studied by Herrera *et al.* (1996). This was seen in the two large clusters shown in the dendrogram of differences presented. It is expected that the use of the cephalic profile and shoulder width as additional differentiating elements will reduce the assignment error levels usually associated with the placement of WAD and Yankasa individuals in a determined population. The discriminant variable obtained in this investigation may not be exhaustive as inclusion of other non-conventional valuables in the analysis might produce more discriminants. This will be a subject for another investigation.

Conclusions

No doubt, these two breeds belong to different populations as shown by the multivariate generalization of t-test. It will be of interest therefore to estimate the genetic (morphological) distance between them. Stepwise discriminant analysis is effective in identifying breed discriminants of WAD and Yankasa from morphometrical stand point. This could be used to enhance the screening and assignment of individuals animals to a breed for more effective breed evaluation. It will

Table 2 Summary of stepwise discriminant analysis of WAD and Yankasa sheep

Variables Entered	Prob. > F	Wilk's Lambdal	Prob.> F
Tail Length	0.0001	0.371	0.0001
Shoulder width	0.0001	0.329	0.0001
Head width	0.0001	0.275	0.0001
Face length	0.0002	0.254	0.0001
Body length	0.0189	0.248	0.0001
Wither height	0.0320	0.244	0.0001

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reduce the error made in population classification of individual animal. The racial discriminants furnished in this study could be useful in phylogenetic studies and measurement of genetic distance between the two populations. Tail length, shoulder width and cephalic profile must be given closer examination as classification criteria among the sheep studied and perhaps could be points of references for instituting reliable racial discriminants among other sheep populations.

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