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SHORT NOTE

VARIMAX ROTATED PRINCIPAL COMPONENT FACTOR ANALYSIS OF THE ZOOMETRICAL TRAITS OF UDA SHEEP

ANÁLISIS FACTORIAL DE COMPONENTES PRINCIPALES CON ROTACIÓN VARIMAX DE CARACTERÍSTICAS ZOOTÉCNICAS DE LA OVEJA UDA

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ADDITIONAL KEYWORDS

Morpphometry. Age. Correlation. Multivariate analysis.

PALABRAS CLAVE ADICIONALES

Morfometría. Edad. Correlación. Análisis multivariado.

SUMMARY

A study was conducted to determine the interdependence among the conformation traits of 359 Uda rams using principal component factor analysis. The body measurements were withers height, body length, heart girth, rump height, rump width, rump length, face length, foreleg length and shoulder width. Age group of animals was a significant (p<0.05) source of variation for the studied traits. The various constituent parts of the body developed at varying rates. From the factor analysis, with varimax rotation of the transformation matrix, two principal components were extracted, which accounted for 86.3% of the total variance. The first principal component alone explained 80.8% of the variation, and tended to describe general size, while the second principal component had its loadings for meat traits (rump width, shoulder width and rump length). The two extracted principal components could be considered in selection programmes to obtain animals with better conformation using fewer measurements.

RESUMEN

Se realizó un estudio para determinar la interdependencia entre los caracteres de conformación de 359 carneros Uda usando el analisis de componentes principales. Las medidas corporales fueron: alzada a la cruz, longitud corporal, perímetro torácico, alzada a la grupa, ancho y longitud de grupa, longitud de la cara, longitud de pata delantera y la anchura de la espalda. Los animales fueron agrupados por edades en: dientes de leche, 2 dientes, 4 dientes, 6 dientes, 8 dientes y dientes desgastados. El grupo de edad de los animales fue una fuente de variación significativa (p<0,05) de los caracteres estudiados. Las distintas partes componentes del cuerpo se desarrollaron a diferentes ritmos. Del analisis factorial a partir de la rotación varimax de la matriz de transformación, se extrajeron dos componentes principales que explicaron el 86,3 de la varianza total. El primer componente principal por si sólo explicó el 80,8% de la variación y tendió a describir el tamaño general, mientras que el segundo componente principal, responde por los caracteres relacionados con la carne (ancho de grupa y espalda y longitud de la grupa). Los dos componentes principales extraidos podrían ser considerados en los programas de selección, para obtener animales con mejor conformación usando pocas medidas.

INTRODUCTION

Body size and shape (conformation) are important traits in meat animals. Since the recording system in some developing countries is still in the initial stage, pedigree

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and progeny information is limited and has not yet formed the basis for estimating reliable genetic parameters. Therefore, phenotypic information becomes imperative to clarify the relationship among linear type traits (Ali *et al.*, 1995).

Analysis of variance and product moment correlations are widely used to characterize phenotypic and genetic relationships among traits in a breeding programme. However, principal component analysis is a valuable refinement for analyzing data on linear body measurements and performance test traits (Miserani *et al.*, 2002; Posta *et al.*, 2007). Principal components, according to Johnson and Wichern (1998), are linear combinations of the original variables and are estimated in such a way that the first principal component explains the largest percentage of the total phenotypic variance. This pave way for the explanation and identification of trait groups, which can allow a quantitative measure for animal conformation and enable genetic parameters for this trait (conformation) to be estimated; thereby permitting its inclusion in breeding programmes.

Uda sheep are the second largest breed of sheep in Nigeria. They constitute 10% of the total population of 22.1 million sheep in the country, and are reared primarily for meat production (RIM, 1992). However, multivariate techniques have not been exploited in the objective description of their body conformation. The present investigation therefore set out to document changes in the morphometric traits of Uda sheep across age groups. It equally explored the relationships among body dimensions using principal component analysis with a view to reducing the number of body measurements required for genetic and breeding purposes.

MATERIALS AND METHODS

359 extensively managed Uda rams were randomly selected at the Bodija sheep and goat market, Ibadan in South-Western Nigeria. Uda sheep of six age groups were measured. The grouping was done using the number of permanent incisors as follows: <15.5 (milk-tooth age), 15.5 - 22.3 (2-tooth age), 22.3 - 28.3 (4 - tooth age), 28.3 - 38.8 (6-tooth age), 38.8 - 48.8 (8-tooth age), and >48.8 months old (worn teeth age) respectively. Nine metric traits were measured on each animal following standard procedure and anatomical reference points described elsewhere (Yakubu, 2003). The body parts consisted of withers height (WH), body length (BL), heart girth (HG), rump height (RH), rump width (RW), rump length (RL), foreleg length (FL), face length (FAL) and shoulder width (SW).

Data collected were subjected to analysis of variance (ANOVA) using a general linear model. In the principal component factor analysis, Kaiser-Meyer- Olkin measures of sampling adequacy and Bartlett's Test of Sphericity (tests the null hypothesis that the original correlation matrix is an identity matrix) were computed to test the validity of the data set. Cumulative proportion of variance criterion was employed in determining the number of factors to extract. The varimax criterion of the orthogonal rotation method was employed for the rotation of the factor matrix. The overall reliability of the factor solution was tested using Chronbach's alpha (SPSS, 2001).

RESULTS

Average values for linear body measurements of Uda rams at different age groups are presented in **table I**. Age group significantly ($p<0.05$) influenced the body parameters.

In the factor analysis, the Kaiser-Meyer-Olkin measure of sampling adequacy (0.923) and Bartlett's test of sphericity (chi-square= 4729.699; $p<0.01$) indicated that true principal component factors existed in the data. The Chronbach's alpha (0.920) revealed the reliability of the factor solution.

Table I. *Average values (±SD) for body dimensions (cm) of Uda rams of different age groups.* (Valores medios (±DE) de las dimensiones (cm) corporales de carneros Uda de diferentes grupos de edad).

	Age group					
Traits	Milk-tooth age (n=20)	2-tooth age (n=50)	4-tooth age (n=122)	6-tooth age (n=100)	8-tooth age (n=36)	Worn teeth age (n=31)
Withers height	63.54±5.20[d]	77.88±3.96[c]	80.81±6.82[b]	82.42±3.20[ab]	83.97±3.47[a]	84.29±2.03[a]
Body length	57.69±4.02[d]	68.65±3.12[c]	74.38±4.73[b]	75.44±4.54[ab]	76.78±4.92[a]	76.88±3.57[a]
Heart girth	71.34±3.58[d]	81.94±4.36[c]	87.65±5.05[b]	91.98±3.96[a]	93.36±4.88[a]	93.82±3.57[a]
Rump height	62.66±5.57[d]	77.14±3.97[c]	80.75±3.88[b]	82.26±3.13[ab]	83.70±3.36[a]	83.96±2.55[a]
Rump width	12.65±1.10[d]	15.41±0.76[c]	16.44±1.04[b]	17.06±1.05[a]	17.15±1.08[a]	17.88±0.82[a]
Rump length	21.73±0.77[d]	23.67±0.89[c]	24.89±1.07[b]	26.01±1.10[a]	26.00±0.99[a]	26.44±0.86[a]
Face length	21.07±1.08[c]	24.85±1.46[b]	26.37±1.82[a]	26.82±1.59[a]	27.07±1.37[a]	27.19±1.87[a]
Foreleg length	40.93±2.98[c]	46.25±2.45[b]	50.41±2.78[a]	51.51±2.55[a]	51.77±3.10[a]	51.18±1.17[a]
Tail length	39.93±7.66[c]	47.49±4.86[b]	49.82±4.34[ab]	50.90±4.65[a]	50.21±4.11[a]	50.96±4.39[a]
Shoulder width	14.14±1.04[d]	17.23±1.13[c]	18.92±1.56[b]	19.81±1.53[a]	19.89±1.50[a]	20.07±1.23[a]

SD: Standard deviation.
Means in the same row bearing different superscripts differ significantly ($p<0.05$).

While the first two principal components explained approximately 86.3% of the total variance, the first principal component alone explained 80.8% **(table II)**. The second principal component contributed to 5.5% of the variability of the original nine traits. The first principal component (general size) represented a weighted average of the ten traits. The second principal component had its loading for meat traits [rump width, shoulder width and rump length]. The communalities, which represent the proportion of the variance in the original variables that is accounted for by the factor solution, ranged from 0.755-0.954.

DISCUSSION

Age is an important factor influencing the conformation traits of animals. Each measurement as observed in this study developed at a different rate at different age groups. Some body parameters were early maturing and stopped growing before others. This is consistent with the findings of earlier workers (Wiener *et al.*, 1992); which is an indication that the essential body evolution of mammalian animals occurred before the maturity stage and growth follows a general pattern till maturity stage.

The first two principal components of

Table II. *Eigenvalues and factor loading after varimax rotation and communality of each morphological trait of Uda rams.* (*Eigenvalues*, peso de cada factor después de la rotación varimax y comunalidad de cada carácter morfológico de carneros Uda).

Traits	PC1	PC2	Communality
Withers height	0.864	0.455	0.954
Body length	0.655	0.571	0.755
Heart girth	0.652	0.646	0.843
Rump height	0.878	0.422	0.950
Rump width	0.434	0.841	0.896
Rump length	0.431	0.788	0.806
Face length	0.718	0.509	0.775
Foreleg length	0.823	0.442	0.873
Shoulder width	0.458	0.839	0.913
Eigenvalue	7.271	0.494	-
% variance	80.783	5.489	-

the present study could be exploited in the evaluation and comparison of animals. Animals with large values for *general size* also gave larger values for the first principal component. This is similar to the findings of earlier workers in related species (Araujo *et al.*, 2006; Yakubu, 2009). Both principal components could play a role in the ranking of the animals, and thus provide an opportunity to select the animals based on a group of variables rather than on isolated traits. According to Pinto *et al.* (2006), the selection of animals for any principal component will not cause correlated response in terms of other principal components. As a result of this, a selection index could be obtained. When this is applied to the present result, the selection index would have only two weighted coefficients that would facilitate its estimation compared to the index with ten traits. Similarly, Gusmao Filho *et al.* (2009) extracted five principal components from eleven original traits and concluded that these could be of great importance in the determination of body attributes of sheep in both reproduction and meat production.

CONCLUSION

In conclusion, the principal component factor analysis technique explored the interdependence in the original nine body measurements of Uda rams. These generated two principal components which tended to describe general size and meat traits (indices of body shape). This can be exploited in ranking animals, thus aiding in the reduction of the number of traits required for selection in a breeding programme.

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