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Exploratory principal components analysis of growth traits in Red Sokoto goats

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Target/Primary Audience: Animal Breeders, Geneticists and Goat farmers

Abstract

Growth traits of Red Sokoto goats were evaluated using 387records generated from goats raised under semi-intensive system of management at National Animal Production Research Institute (NAPRI), Shika, Zaria, Nigeria. Sex, type of birth, birth weight (BWT), weaning weight (WWT),12-month weight (WT12), adjusted weaning weight, season of birth and weaning were subjected to multivariate factor analysis with varimax rotation using IBM® SPSS® Version 21. Season of birth and weaning were classed into Season 1 (January-June) and season 2 (July-December). The factor scores and growth traits were subjected to stepwise regression procedure of SAS. The variables WWT, CWT, WT12 and sex combined to form the first principal component (PC1). Birth weight and season of birth formed the second component (PC2). Weaning season was the only outstanding variable in the third component. Predicted BWT of kids is expected to increase with increasing PC1 and PC2, but decrease with increasing PC3. Similar prediction pattern is obtained for CWT. However, predicted WT12 is expected to increase with increasing PC1, PC2 and PC3. Variability of growth traits of Red Sokoto goats at birth and thereafter up to 12 month of age are closely linked with season at which goats were given birth and weaned, respectively. The similarity of intercepts of regression equations and those of average values for growth traits in this study indicated the possibility of improvement of goat stocks through the principal components. Goat farmers and breeders are advised to increase efforts in improving the environmental conditions of their stocks because birth season is highly correlated with PC2 (birth characteristics). Also, weaning season (PC3) should be controlled to favour improved weaning weight of Red Sokoto goats.

Keywords: Exploratory PCA, Red Sokoto goats, growth traits, prediction equations

Description of Problem

Growth traits of livestock species are affected by many factors such as type of management, season of birth and the physiological state of the growing animals (1,2); sex and parity (3,4,5,6)

and breeding season (6,7) were some of the factors that had been studied. Interrelatedness among these factors had mostly been investigated as univariate and bivariate rather than multivariate. Okpeku*et al*. (8) stated that the biological relationships among such factors can be more accurately evaluated through appropriate multivariate techniques such as factor analysis. This technique is capable of defining the underlying structure among variables through exploratory and confirmatory means (9).

However, it is of note that most work that employed factor analysis and principal component scores in livestock researches focused more on prediction of body weight from morphological traits (8,10,11). Obtaining uncorrelated new-latent independent variables from genetic composition, nutrition, management type, climatic dispositions, sex, parity and type of birth of goats is uncommon. This study was therefore aimed at exploring variables from goat production traits to generate new-latent variables for predicting growth traits.

Materials and Methods

Growth traits of Red Sokoto goats were evaluated using 387records generated from goats raised under semi- intensive systemof management at the Goat Project Unit of Small Ruminant Research Programme of National Animal Production Research Institute (NAPRI), Shika, Zaria, Nigeria. Sex, type of birth, birthweight (BWT), weaning weight (WWT),12-month weight (WT12), adjusted weaning weight, season of birth and weaning were subjected to multivariate factor analysis with varimax rotation using IBM® SPSS® Version 21 (12). Season of birth and weaning were classified into Season 1 (January-June) and season 2 (July-December). The factor score variables and growth traits were subjected to stepwise regression procedure of SAS (13).

Results and Discussion

Table 1 shows the descriptive statistics of growth traits of Red Sokoto goats. The average birth weight (BWT) was 1.60±0.02 kg. The kids were weaned with an average weaning weight (WWT) of 6.95±0.04 kg which was adjusted (CWT) to 12 weeks average weight of 6.21±0.04 kg. The average weight of Red Sokoto goats at 12 months of age (WT12) was 11.96±0.07 kg. The yearling weight obtained in this study was lower than 13.0 kg reported by (14). The slightly lower value for yearling weight for Red Sokoto goats in this study could be a better evaluation of the weight of the goat studied because of the larger sample size as compared to smaller goats sampled by(14).Table 2 shows the frequencies of sex, type of birth, season of birth and weaning of Red Sokoto goats. More male kids (50.4%) were given birth to in the population than the females (49.6%). The male to female sex ratio at birth (secondary sex ratio) was reported to be 50.8±4.0 in West African Dwarf goat (15). The same authors also stated that apart from breed; parity and season of birth significantly influenced sex ratio of kids. Akpa*et al*. (16) had reported that more male was given birth to during the early wet season while late wet season recorded more female births

Table 1: Descriptive statistics of growth traits of Red Sokoto goats

	Mean	SE	Minimum	Maximum	SD
BWT (kg)	1.60	0.02	1.0	2.5	0.36
WWT (kg)	6.95	0.04	4.0	11.0	0.86
CWT (kg)	6.21	0.04	3.8	9.8	0.88
WT12 (kg)	11.96	0.07	4.0	14.5	1.33

BWT = birth weight; WWT = weaning weight; CWT = adjusted weaning weight; WT12 = weight of kids at 12 months of age

Table 2: Frequencies of sex, type of birth, season of birth and weaning of Red Sokoto goats

Variable	Frequency	Percentage
Kid sex		
Male	195	50.4
Female	192	49.6
Type of birth		
Single	131	33.9
Twins	230	59.4
Triplet	24	6.2
Quadruplet	2	0.5
Season of birth		
January-June	160	41.3
July-December	227	58.7
Season of weaning		
January-June	197	50.9
July-December	190	49.1

Table 3: Correlation coefficients among growth traits, sex, type of birth, season of birth and weaning of Red Sokoto goats

	BWT	WWT	CWT	WT12	SEX	TOB	BSEAS
WWT	0.257**						
CWT	0.207**	0.776**					
WT12	0.256**	0.533**	0.472**				
SEX	-0.078	-0.300**	-0.264**	0.281**			
TOB	-0.155**	-0.356**	-0.268**	-0.304**	-0.052		
BSEAS	0.246**	0.076	0.003	0.087	0.014	-0.120*	
WNSEAS	-0.021	0.020	0.010	0.108*	0.080	0.101*	0.09

BWT = birth weight; WWT = weaning weight; CWT = adjusted weaning weight; WT12 = weight of kids at 12 months of age; TOB = type of birth; BSEAS = season of birth of kids; WNSEAS = season of weaning of kids ; *P<0.05; **P<0.01

for Nigerian goats (West African Dwarf and Red Sokoto goats). Male kids (128) outnumbered female kids (112) in traditionally managed Red Sokoto goats (17). The same trend of observation was recorded by (18) for Blended goats at Malya, Tanzania where there were 1877 male births as against 1814 female births.

About 60% of the kids in this current study were born as twins.Amoah*et al*. (19) also reported that most goats are very prolific, with twin birth being the most frequent litter size. Most of the kids (60%) were born between July-December (late wet and early dry season). Nearly equal proportion of kids were weaned during Janury-June and July-December periods (50.9% and 49.1%, respectively). Result of Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.688) showed the suitability of the data for factor analysis. Also, result from Bartlett's test of Sphericity with Chi-square = 697.893 and 28 degree of freedom confirmed the feasibility of factor analysis application on the data. Pearson correlations among factor score variables; FS1, FS2 and FS3 were zero (r = 0.000) as statistically expected.

Correlation coefficients among growth traits, sex, type of birth, season of birth and weaning of Red Sokoto goats were shown in Table 3. Birth weight of kids were moderately correlated with weaning weight (0.257; P<0.01), weight at 12 months of age (0.56; P<0.01) and season of birth (0.246; P<0.01). However, negative and low relationships were recorded between birth weight and type of birth (-0.155; P<0.01), sex of kids (-0.078; P>0.05), season of weaning of kids (-0.021; P>0.05). Birth type had been reported to significantly affect birth weight of goats because individual birth weight of kids is negatively correlated with litter size (20). Single born kids were significantly heavier than Twins or Triplets. Similarly, the twins were significantly heavier than triplets. These observations were confirmed by many authors(4,21,22,23,24).

Weaning weight was highly and positively correlated with adjusted weaning weight (P<0.776; P<0.01) and weight at 12 months (0.533; P<0.01). Sex of kids had negative relationship with BWT (-0.078; P>0.05), WWT (-0.300; P<0.01) and CWT (-0.264; P<0.01). Sex was however moderately and positively correlated with weight of kids at 12 months of age. Iyiola-Tunji (6) had earlier reported malekids to have heavier weight than females from birth to12monthsof age. Similar negative relationships were recorded between type of birth and all the growth traits in this study. Season of birth and weaning were lowly and positively correlated (P>0.05) with most of the growth traits.

Table 4 shows the rotated component loadings and communalities for growth traits, sex, season of birth and weaning for Red Sokoto goats. The variables WWT, CWT, WT12 and sex were the variables that best describe the first principal component (PC1). Birth weight and season of birth were much more correlated with the second component (PC2). Weaning season and type of birth were the outstanding variable that is highly correlated with the

Table 4: Rotated component loadings and communality for growth traits, sex, season of birth and weaning for Red Sokoto goats

Variable	PC1	PC2	PC3	Communality
BWT	0.225	**0.618**	-0.058	0.436
WWT	**0.858**	0.211	-0.104	0.791
CWT	**0.840**	0.106	-0.093	0.725
WT12	**0.723**	0.256	0.072	0.594
SEX	**-0.583**	0.299	-0.056	0.432
TOB	-0.276	-0.495	0.492	0.563
BSEAS	-0.087	**0.752**	0.187	0.609
WNSEAS	0.074	0.144	**0.889**	0.816
Eigenvalue	2.443	1.424	1.099	4.966
%Variance	30.543	17.798	13.732	62.073

BWT = birth weight; WWT = weaning weight; CWT = adjusted weaning weight; WT12 = weight of kids at 12 months of age; TOB = type of birth; BSEAS = season of birth of kids; WNSEAS = season of weaning of kids

Table 5: Prediction equations for growth traits from principal components for Red Sokoto goats

Growth trait	Prediction equation	R^2
BWT	1.596 + 0.223PC2	0.382^{**}
WWT		0.791^{**}
CWT	6.210 + 0.742PC1 + 0.094PC2 – 0.024PC3	0.725^{**}
WT12	11.956 + 0.962PC1 + 0.341PC2 + 0.095PC3	0.594^{**}

BWT = birth weight; WWT = weaning weight; CWT = adjusted weaning weight; WT12 = weight of kids at 12 months of age; R^2 = Coefficient of determination; **P<0.01

third component. The first component can be named growth characteristics; the second component is related to birth characteristics while the third most important component is season of weaning of kids. Improvement of environmental conditions such as provision of adequate nutrition for dams before parturition during dry season and climate control through provision of warm beddings during cold weathers can affect birth and weaning weight of Red Sokoto goats positively.

Table 5 showed the prediction equations for growth traits from principal components for Red Sokoto goats. BWT is expected to increase with increasing PC2. Predicted WWT of kids is expected to increase with increasing PC1 and PC2, but decrease with increasing PC3. Similar prediction pattern is obtainable for CWT. However, predicted WT12 is expected to increase with increasing PC1, PC2 and PC3. The communalities for the traits (WWT, CWT and WT12) were the same with the R^2 for the traits. Also, the intercepts for each of the traits (Table 5) is the same values with the average of the corresponding traits (Table 1). Eyduran*et al.* (11) had confirmed that use of factor and principal component scores in multiple regression analysis might offer a good opportunity without multicollinearity problem for predicting body weight of indigenous goat.

Conclusion and Application

1. Variability in growth traits of Red Sokoto goats at birth and thereafter up to 12 month of age are closely linked with season at which goats were given birth and weaned, respectively.
2. The similarity of intercepts of regression equations and those of average values for growth traits in this study indicated the possibility of improvement of goat stocks through the principal components.
3. Goat farmers and breeders are advised to increase efforts in improving the environmental conditions of their stocks because birth season is highly correlated with PC2 (birth characteristics).
4. Also, weaning season (PC3) should be controlled to favour improved weaning weight of Red Sokoto goats.

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