Egyptian Journal of Sheep & Goat Sciences, Vol. 14, No. 1, P: 83 -92, April 2019

Principal components analysis of body measurements of Sohagi sheep in Upper Egypt

Reda Elsaid[1] and A. Elnahas[2],

[1]Department of Sustainable Development, Environmental Studies and Research Institute (ESRI), University of Sadat City, Menofyia, Egypt, P. Code 32897

[2]Animal Production Department, Faculty of Agriculture, Sohag University, Egypt

Corresponding author: reda.elsaid@esri.usc.edu.eg; redaelsaid@gmail.com

SUMMARY

The current study was conducted to evaluate 383 Sohagi sheep in Sohag governorate, Egypt using a multivariate approach. Data were divided into two age groups of 294 young animals less than 10 months old (147 for each sex) and 89 adults animals from 10 months old and above (9 males and 80 females). Body weight (BW) and four body measurements (heart girth (HG), height at withers (HW), height at rump (HR) and body length (BL)) were measured through the period 2017 and 2018. In young and adult sheep, two factors (principal components) were extracted and accounted for 89.2% and 57.8% of the total variance, respectively. The first factor explained 46.4% and 30.6% of the total variance and the higher positive loading was observed for HW, RH and BL in young sheep whereas the higher positive loading was for HW and RH in adult sheep. The second factor accounted for 42.8% and 27.2% of the total variance and the higher positive loading was obtained for BW and HG in young sheep while was influenced by BW, HG and BL in adult sheep. The use of principal components was more proper than the use of original associated traits to explain body measurements in this study. Thus, extracted factors could be useful in breeding programs with enough decrease in the number of measurements traits to be registered to interpret the body conformation. Also, these principal components could be used as factor scores to predict body weight of Sohagi sheep.

Keywords: Sohagi sheep, body measurements, principal components analysis, stepwise regression.

INTRODUCTION

Sohagi sheep represents one of the breeds in Upper Egypt and is considered an important source of wool and meat in Sohag governorate. Researchers in Egypt gave little importance to this breed compared with other sheep breeds and no breeding program has been applied to Sohagi sheep. **Elnahas et al., 2017** stated that measurements traits have an important effect on sheep performance. Many researchers have been used animal body measurements to evaluate the growth of skeletal parts and in describing changes in the shape of the animal as age increase (**Ngere et al., 1984; Yakubu, 2013).** In some developing countries, the recording system is still in the initial stage and information of progeny and pedigree have not yet represented the basis to estimate credible genetic parameters, information of phenotypic measurements becomes inevitable to illustrate the relationship between linear type traits (**Yakubu et al., 2011).** In a breeding program, correlations and analysis of variance are extensively used to describe genetic and phenotypic associations between traits. Knowledge of variation of measurements traits in local genetic resources is important, as these measurements were found to be very helpful in comparing body size, including animal shape **(Latshaw and Bishop, 2001).** This comparison could be used as a basis for improvement programs and selection **(Egena et al., 2014)**. Principal components analysis (PCA) is a method of interdependence whose main objective is to determine the underlying structure between traits in the analysis. In general, factor analysis offers the tools needed to analyze the structure of associations between a large number of traits by reducing related traits to lower number of uncorrelated variables, known as principal components (**Yunusa et al., 2013**). The number of principal components generated is equal to the number of traits in the analysis; the first few factors explained the highest percentage of total variation in the original traits **(Egena et al., 2014**). Principal component analysis has been used as a tool for assessing body shapes that permit to understand the complicated growth process that occurs between animal body dimensions throughout growth phase (**Salako, 2006; Yunusa et al., 2013**). **Pinto et al. (2006)** stated that because the associations between the principal components are zero, the selection of animals for any principal component produces independent response of other components. The findings of the PCA help the breeders in selection of multiple traits (**Silva et al., 2015; Yunusa et al., 2013).** Increased body weight in sheep production is one of the basic aims of improvement programs which need sufficient knowledge of the associated traits that can be taken into account when applying the selection **(Mavule et al., 2018).** In the study of **Okpeku et al. (2011),** they used the extracted principals components for prediction body weight of goats in southern Nigeria and reported that the resulting factor score coefficients could be used for prediction body weight more precisely than the original correlated traits. **Sankhyan et al. (2018)** stated that the use of principal component factors analysis showed an accurate evaluation of body weight than the estimation of unstable regression because, it was able to break multicollinearity, a problem related with the use of correlated original body measurements. There is a lack of information on the body measurements of Sohagi sheep using a multivariate approach and so far no breeding program has been applied in this breed. Therefore, the aim of this study was to estimate the relationship between different morphological traits in young and adult Sohagi sheep as well as prediction the body weight from morphological traits using factor scores derived from principal components analysis rather than associated original morphological traits.

MATERIAL AND METHODS

The current study was conducted at the experimental farm, Faculty of Agriculture, Sohag University. The body measurements of 383 Sohagi sheep were used. Based on significant effect of age in the analysis of variance, data were divided into two age groups of 294 young animals less than 10 months old (147 for each males and females) and 89 adults animals from 10 months old and above (9 males and 80 females). Body weight (BW) and four body measurements (heart girth (HG), height at withers (HW), height at rump (HR) and body length (BL)) were measured through the period between 2017 and 2018. Flock has been raised under lambing system of three crops every two years. The seasons of mating system were in January, May and September, where ewes were divided into groups, each of which 30 ewes joined the ram for 45 days. The flock fed on concentrates such as soybeans and corn, as well as the green fodder (Trifolium Alexandrium) in the winter**.**

Statistical analysis

Correction for fixed effects

The GLM procedure of SAS (2003) was used to study the effect of age, sex and their interaction on the studied traits according to the following model:

$$Y_{ijk}=\mu+S_i+A_j+(S*A)_{ij}+e_{ijk}$$

Where, Y_{ijk} is the observation of the response variable (BW, HG, HW, HR or BL) of k^{th} animal of i^{th} sex and j^{th} age of animal; μ is the overall mean; S_i is the fixed effect of sex; A_j is the fixed effect of age of animal (1 = young, less than 10 months of age and 2 = adult, equal or above 10 months of age), $(S*A)_{ij}$ is the interaction between sex and age and e_{ijk} is the residual assuming to be NID $(0,\sigma^2 e)$.

Factor Analysis

Factor analysis was performed using the extraction method of principal component analysis (PCA) using SAS (2003). Varimax rotation has been applied to enhance the possibility of interpretation of the principal components. The criterion of Kaiser Rule **(Manly, 1994)** was done to determine the number of extracted factors and only retained the factors that had eigen values greater than 1. A Kaiser-Meyer-Olkin (KMO) Test is a measure of the appropriateness of data for factor analysis. The test measures the sampling adequacy for each variable in the model and for the full model. The KMO statistics vary between 0 and 1. The value close to 0 indicates that there are large partial correlations compared to the total of correlations. A value close to 1 indicates that the sampling is appropriate. It was possible to accept a measure of sampling adequacy greater than 0.5 (Kaiser, 1974). The procedure of stepwise multiple regressions were applied to predict body weight from original body measurements (model 1) and from principal components scores (model 2) using the following models:

$BW = a + \sum b_i x_i$ i= 1, 2,…k   (model 1)

The second model for the same response variable was:

$BW = a + \sum b_i PC_i$ i= 1, 2,…k (model 2)

Where BW is the body weight, a is the intercept, b_i is the i^{th} partial regression coefficient of the i^{th} linear body measurement, x_i or the i^{th} principal component (PC_i).

RESULTS AND DISCUSSION

Correction for fixed effects

The analysis of variance of fixed effects affecting the studied traits is presented in Table 1. Results indicated that the sex found to be significant (P<0.05) only for BW and RH. The effect of age was significant (P<0.01) for all studied traits. The interaction between sex and age was significant for BW, HW and RH. Means,

Table 1. Analysis of variance for the studied traits of Sohagi sheep.

Sources of variation	df	Mean square				
		BW	HG	HW	RH	BL
Sex	1	265.70*	125.40	119.03	250.21*	48.03
Age	1	40386.55**	48869.31**	17134.98**	20694.36**	16349.45**
Sex*Age	1	420.57**	380.92	219.14*	395.08**	214.44
Residual	379	60.29	138.30	53.35	57.63	68.21

BW, body weight; HG, heart girth; HW, height at whither; RH, rump height and BL, body length.
*, ** significant at P<0.05 and P<0.01, respectively.

standard error and coefficients of variation are presented in Table 2. In young sheep, the results showed that no differences between females and males (P>0.05) in all morphological measurements. In adult sheep, the significant (P<0.05) differences between sexes were observed in BW, HW and RH. These results are in agreement with Mavule et al. (2013) who reported that the differences in body measurements between males and females in adult sheep may be due to the differences in hormonal secretions and their activities in both sexes. Also, from findings of Table 2, the differences observed in the body measurements in both age groups are not surprising assuming that as the animal grows with age, the animal parts are expected to increase differentially (**Salhab et al., 2001; Yakubu, 2013).** This indicates that the evolution of the animal's body occurred before maturity and animal growth follows a general pattern until maturity **(Wiener et al., 1992; Yakubu et al., 2011)**. The present results of BW, HG, HW and BL in young sheep were close to those results reported from the study of **Sankhyan et al. (2018)** for young Rampu-Bushair sheep. Whereas in adult sheep, the results of BW, HG, HW and RH for males and females were higher than those reported by **Mavule et al. (2013)** for Zulu sheep except BL, the values were similar**.** Different estimates may be due to breed differences, condition of management and feeding **(Elnahas et al., 2017)**. According to the coefficient of variation (CV), BW showed the maximum variation either in young sheep or the adult sheep. Also, the CV values in young sheep were higher than those obtained in adult sheep for all body measurements. Coefficient of variation for measurements traits in young sheep (16.17% to 69.16%) and in adult sheep (4.97% to 24.29%) had the same trend of those values recorded by **Mavule et al. (2013)** for Zulu adult sheep breed (8% to 31.18%) and

Table 2. Least square means and their standard errors (SE) and the coefficient of variation (CV) for all body measurements in young and adult Sohagi sheep.

Trait	Young sheep (n=294)				Adult sheep (n=89)			
	Male (n=147)		Female (n=147)		Male (n=9)		Female (n=80)	
	Mean±SE	CV%	Mean±SE	CV%	Mean±SE	CV%	Mean±SE	CV%
BW	10.59^{c}±0.64	69.16	11.37^{c}±0.64	64.21	51.61^{a}±2.59	24.29	44.79^{b}±0.87	19.4
HG	48.33^{b}±0.97	24.83	49.87^{b}±0.97	26.19	92.89^{a}±3.92	6.73	87.2^{a}±1.32	10.13
HW	47.01^{c}±0.60	16.17	47.74^{c}±0.60	17.45	74.00^{a}2.44	6.76	69.24^{b}±0.82	6.18
RH	49.79^{c}±0.63	16.41	50.54^{c}±0.63	17.10	80.11^{a}±2.53	5.05	73.50^{b}±0.85	4.97
BL	39.94^{b}±0.68	21.98	41.37^{b}±0.68	22.32	66.33^{a}±2.75	11.73	62.34^{a}±0.92	7.35

Row means not followed by the same letter differ significantly (P<0.05). BW, body weight; HG, heart girth; HW, height at whither; RH, rump height and BL, body length.

Sankhyan et al. (2018) for Rumpur-Bushair sheep (14.29% to 40.87% for young sheep and 6.76% to 14.80% for adult sheep). The results of BW indicated that their coefficient of variation were the highest which could be important for selection and improvement. The higher variability in some traits is a reflection of absence of selection or the parts of body are most affected by the environment **(Mavule et al., 2013; Salako, 2006)**.

Correlation Coefficients

Pearson's correlation coefficients between body measurements for young sheep and for adult Sohagi sheep are shown in Table 3. All correlation coefficients between body measurements were positive and significant (P<0.01). These results are consistent with **Guedes et al., 2017, Kunene et al., 2009 and Sankhyan et al., 2018).** In young sheep, the coefficients of correlation ranged from 0.76 to 0.98 and the highest correlation coefficient was obtained between height at withers and rump height while the lowest correlation coefficient was observed between heart girth and body length. The same trend was recorded in adult sheep but with lower correlation coefficients (0.34 to 0.83). The higher correlation coefficients between all body measurements in young sheep than those of adult sheep are a reflection of the changing growth prevailing at this stage of life **(Salako, 2006; Yakubu, 2013**). In young sheep, BW was more closely related to other body measurements. Adult sheep also showed similar trend for BW but the coefficients of correlation were lower. Also, heart girth showed highest correlation coefficient with body weight in the two age groups, illustrating why some researchers have supported the use of heart girth as a sole predictor of body weight **(Mavule et al., 2013; Yakubu and Ayoade, 2009).**

Factor Analysis

The KMO for young and adult Sohagi sheep (0.86 and 0.66) were consistent with those reported by Sankhyan et al. (2018) for young and adult Rumpur-Bushair sheep (0.86 and 0.69) and lower than those obtained by Mavule et al. (2013) for young and adult Zulu sheep (0.94 and 0.79). These values indicated that the sample size was appropriate for principal component factor analysis (Kaiser, 1974). Table 4 summarizes the estimates of factor loading extracted after varimax rotation, eigen values, communalities of body measurements and variation explained by each factor.

Table 3. Correlation coefficients between body measurements in young sheep (upper triangle) and adult sheep (lower triangle).

Trait	BW	HG	HW	RH	BL
Body weight, BW		0.94	0.91	0.92	0.79
Heart girth, HG	0.55		0.91	0.92	0.76
Height at withers, HW	0.49	0.33		0.98	0.81
Rump height, RH	0.44	0.48	0.83		0.82
Body length, BL	0.48	0.34	0.43	0.37	

All the correlations were significant (p<0.01).

The importance of principal component analysis was clear in reducing a large number of traits into a few numbers of traits which is known as the principal components giving a better explanatory of size and shape (Morrison, 1970). Two principal components (PC1 and PC2) were specified with eigen values of 2.32 (PC1) and 2.14 (PC2) in young sheep while in adult sheep, those values were 1.53 (PC1) and 1.36 (PC2). In young sheep, the two principal components (factors) were accounted for 89.2% of the total variation in the data. The first principal component explained 46.4% of the total variance and the higher positive loading was observed for height at withers, rump height and body length. The second principal component explained 42.8% of the total variance and the higher positive loading was obtained for body weight and heart girth. In adult sheep, the two principal components were accounted for 57.8% of the total variation in the data. The first principal component explained 30.6% of the total variance and had higher positive loading for height at withers and rump height. The second principal component accounted for 27.2% of the total variance and was influenced by body weight, heart girth and body length. These results are in agreement with the percentage reported by **Yakubu (2013)** of 89.27% in young Yankasa sheep. While in adult sheep, the percentage is close to that obtained by **Sankhyan et al. (2018)** of 61.5% in adult Rumpur-Bushair sheep and lower than those obtained by **Yakubu (2013)** of 75.2% for adult Yankasa sheep.

Table 4: Eigen values, share of total variance, factor loading after varimax rotation and communality of body weight and body measurements in young and adult Sohagi sheep.

Trait	Young sheep			Adult sheep		
	PC1	PC2	Communality	PC1	PC2	Communality
Body weight, BW	0.59	0.76	0.92	0.28	0.69	0.56
Heart girth, HG	0.58	0.76	0.92	0.23	0.63	0.45
Height at withers, HW	0.79	0.59	0.97	0.82	0.32	0.78
Rump height, RH	0.78	0.61	0.98	0.81	0.36	0.78
Body length, BL	0.63	0.53	0.68	0.26	0.50	0.32
Eigen-value	2.32	2.14		1.53	1.36	
% of Total variance	46.4	42.8		30.6	27.2	

PC1, first principal component and PC2, second principal component.

In particular, the total variation relies on the number and type of traits included in the analysis and how they were associated (**Silva et al., 2015).** The measurements of HW, RH and BL in young sheep and HW and RH in adult sheep related with the first principal component are good descriptors of body size while the measurements of BW and HG in young sheep and BW, HG and BL in adult sheep related with the second principal component are good descriptors of body shape. These results are in agreement with the findings of **Salako** (**2006)** in immature Uda sheep of Nigeria who reported that the first principal component, which explained the highest proportion of the total variation, had high loading for traits associated with body size, while the second principal component related to the traits that describe the shape of the body. According to **Salako (2006); Yakubu (2013)**, collecting of morphological measurements into principal components may be linked to the different correlations of each measurement with skeletal growth, impact of environment or the maturity interval. Also, they stated that the traits that are highly correlated with each component may be under the same gene (pleiotropism). The two principal components obtained from the present study may be important to evaluate the Sohagi sheep for selection programs and therefore selecting the animals based on a group of traits instead of separate traits. **Pinto et al. (2006)** stated that because the associations between the principal components are zero, the selection of animals for any principal component produces independent response of other components.

In the present study, the estimates of communality for a given variable showed the proportion of variation in that variable explained by the two principal components (factors) and these estimates indicate that the factor model explained most of the variation of these variables **(Sankhyan et al., 2018)**. It ranged from 0.68 (BL) to 0.98 (RH) in young sheep while in adult sheep, those estimates were ranged from 0.32 (BL) to 0.78 (HW and RH). The large estimates of communality that recorded in this study gave further credibility to the principal component analysis appropriateness. These results are in agreement with **Egena et al. (2014).** The lower estimates of communality for BL and HG in adult sheep suggest that they may not explain the total variance in the body measurements of Sohagi sheep.

Prediction of body weight of Sohagi sheep from linear body measurements and principal components scores are presented in Table 5. The results of stepwise regression analysis exposed that heart girth alone explained 88% and 31% of the variation in body weight in young and adult sheep, respectively. Inclusion of rump height into the model improved the proportion of explained variance to 89% and 41%, respectively. The accuracy of the model was further increased to 90% and 0.46 when inclusion body length to the model. In the case of young sheep, heart girth importance in estimating the weight described in the current study could be due to reality that muscle, along with bone structure assign to its formation. These findings are in agreement with **Mavule et al. (2013).** Also, many studies showed that the heart girth can be used as a single predictor of body weight as a result of the high regression coefficient obtained (**Kumar et al., 2017; Kunene et al., 2009; Mavule et al., 2013**). In adult sheep, the proportion of explained variance improved to 47% when inclusion height at withers to the model. The use of PC2 as a single predictor accounted for 86% and 83% of the variation in body weight in young and adult sheep, respectively. While the two principal components together explained 95% and 84% of the total variance in body weight in young and adult sheep, respectively. The present study proved that using principal components scores was more proper than using the original associated traits in prediction of body weight. The same results were reported by **Altarriba et al. (2009); Keskin et al. (2007); Sankhyan et al. (2018).** The use of principal components scores has shown a better and more accurate evaluation of body weight than the estimation of unstable regression because it was able to break multicollinearity, a problem arises with the use of original correlated body measurements (**Sankhyan et al., 2018, Malau-Aduli et al., 2004 and Yakubu and Ayoade, 2009)**.

Table 5. Stepwise regression of body weight (kg) on original body measurements and their principal components scores in young and adult Sohagi sheep.

Estimator	Model	R^2	SE
Young sheep			
Original biometric traits as estimators			
1 HG	-15.80 + 0.55 HG	0.88	2.58
2 HG and RH	-21.97 + 0.35 HG + 0.31 RH	0.89	2.37
3 HG, RH and BL	-21.67 + 0.35 HG + 0.23 RH + 0.09BL	0.9	1.53
Principal component as estimators			
1 PC2	10.98 + 0.65 PC2	0.86	2.78
2 PC2 and PC1	10.98 + 0.65PC2+0.38 PC1	0.95	1.64
Adult sheep			
Original biometric traits as estimators			
1. HG	-6.04 + 0.59 HG	0.31	7.79
2. HG and RH	-44.75 + 0.46 HG + 0.71 HW	0.41	7.2
3. HG, RH and BL	-56.40 + 0.40 HG + 0.55 HW + 0.45 BL	0.46	6.94
4. HG, HW, RH and BL	-48.53 + 0.45 HG + 0.87 HW – 0.46 RH + 0.45 BL	0.47	6.9
Principal component as estimators			
1 PC2	45.50+1.26 PC2	0.83	3.8
2 PC2 and PC1	45.50+1.26 PC2 + 0.13 PC1	0.84	3.79

BW, body weight; HG, heart girth; HW, height at whither; RH, rump height and BL, body length. PC1, first principal component and PC2, second principal component.

CONCLUSION

The technique of principal component factor analysis examined the interdependence in the original five body measurements by analyzing them simultaneously instead of each separately. In young and adult sheep, two principal components which explained 89.2% and 57.8% of the total variation were extracted. The present study revealed that principal components could be used effectively to select animals in breeding programs based on a group of traits instead of separate traits. Also, the use of principal components scores was more proper than using the original associated traits to predict body weight of Sohagi sheep where problem of multicollinearity were eliminated which could result in unstable regression coefficients and thus the wrong conclusion.

ACKNOWLEDGEMENT

The authors thank Dr. Manal Elsayed, Professor of Animal Breeding at the Faculty of Agriculture, Ain Shams University, for providing valuable advice in statistical analysis.

REFERENCES

Altarriba, J., L.Varona, C. Moreno, G. Yague and F. Pastor, 2009. Effect of growth selection on morphology in Pirenaica cattle. Anim. Res. 55, 55-63, https://doi.org/10.1051/animres:2005042 .

Egena, S.S.A., A.T. Ijaiya, D.M. Ogah, V.E. Aya, 2014. Principal component analysis of body measurements in a population of indigenous Nigerian chickens raised under extensive management system. Slovak J. Anim. Sci. 47, 77-82.

Elnahas, A., A.M. Manal Elsayed and M. Elshennawy, 2017. Prediction of live body weight from body measurements using stepwise regression analysis in Sohagi sheep. J. Anim. Poult. Prod., Mansoura Univ. 8, 415 – 418.

Guedes, D.G.P., N. Maria Ribeiro and F.F.R. de Carvalho, 2017 Multivariate techniques in the analysis of carcass traits of Morada Nova breed sheep. Cienc. Rural, Santa Mari, 48, 1-7, http://dx.doi.org/10.1590/0103-8478cr20170746.

Kaiser, H.F., 1974. An index of factor simplicity. Psychometrika, 39, 31-36, https://doi.org/10.1007/BF02291575.

Keskin, S., I. Dasiran and A. Kor, 2007. Factor analysis scores in a multiple linear regression model for prediction of carcass weight in Akkeci kids. J. Appl. Anim. Res. 31, 210–214, https://doi.org/10.1080/09712119.2007.9706664.

Kumar, S., S.P. Dahiya, Z.S. Malik and C.S. Patil, 2017. Prediction of body weight from linear body measurements in sheep. Indian J. Anim. Res. 52, 1263-1266, https://doi.org/10.18805/ijar.B-3360.

Kunene, N.W., C.C. Bezuidenhout and N. Sahlaii, 2009. Determination of prediction equations for estimating body weight of Zulu (Nguni) sheep. Small Rumin. Res. 84, 1–3, https://doi.org/10.1016/j.smallrumres.2009.05.003.

Latshaw, J.D. and B.L. Bishop, 2001. Estimating body weight and body composition of chickens by using non-invasive measurements. Poult. Sci. 80, 868-873, https://doi.org/10.1093/ps/80.7.868.

Malau-Aduli, A.E.O., M.A. Aziz, T. Kojina, T. Niibayashi, K. Oshima and M. Komatsu, 2004. Fixing collinearity instability using principal component and ridge regression analyses in the relationship between body measurements and body weight in Japanese Black cattle. J. Anim. Vet. Adv. Vol. 3, 856-863, http://medwelljournals.com/abstract/?doi=javaa.2004.856.863.

Manly B.J., 1994. Multivariate Statistical Methods: A Primer. Chapman and Hall, New York. Biom. J. 30, 874-875, https://doi.org/10.1002/bimj.4710300742.

Mavule, B.S., V. Muchenje, C.C. Bezuidenhout and N.W. Kunene, 2013. Morphological structure of Zulu sheep based on principal component analysis of body measurements. Small Rumin. Res. 111, 23-30, https://doi.org/10.1016/j.smallrumres.2012.09.008.

Morrison, D.F., 1970. Multivariate Statistical Methods. McGraw-Hill Book Company, New York. Biom. J. 12, 68-69, https://doi.org/10.1002/bimj.19700120121.

Ngere, L.O., I.F. Adu and I.O. Okubanjo, 1984. The indigenous goats of Nigeria. Anim. Genet. Resour. 3, 1-9, https://doi.org/10.1017/S1014233900000109.

Okpeku, M., A. Yakubu, S.O. Peters, M.O. Ozoje, C.O.N. Ikeobi, O.A. Adebambo and I.G. Imumorin, 2011. Application of multivariate principal component analysis to morphological characterization of indigenous goats in Southern Nigeria. Acta agriculturae, Slovenica, 98, 101-109, https://doi.org/10.2478/v10014-011-0026-4.

Pinto, L.F.B., I.U. Packer, C.M.R. De Melo, M.C. Ledur and L.L. Coutinho, 2006. Principal components analysis applied to performance and carcass traits in the chicken. Anim. Res. 55, 419-425, https://doi.org/10.1051/animres:2006022.

Salako, A.E., 2006. Principal components factor analysis of the morphostructure of immature Uda sheep. Int. J. Morphol. 24, 571-774, https://doi.org/10.4067/S0717-95022006000500009.

Salhab, S.A., M. Zarkawi, M.F. Wardeh, M.R. AL-Masri and R. Kassem, 2001. Development of testicular dimensions and size, and their relationship together, body weight and parental size in growing Awassi ram lambs. Small Rumin. Res. 40, 187-191, https://doi.org/10.1016/S0921-4488(00)00224-8.

Sankhyan, V., Y.P. Thakur, Sanjeet Katoch, P.K. Dogra and Rakesh Thakur, 2018. Morphological structuring using principal component analysis of Rampur-Bushair sheep under transhumance production in western Himalayan region, India. Indian J. Anim. Res. 52, 917-922, https://doi.org/10.18805/ijar.B-3296.

SAS, 2003. Statistical Analysis System, User's Guide, Statistics, SAS Institute, Carry, North Carolina.

Silva, M.S., Luciana Shiotsuki, R.N.B. Lobo and O. Faco, 2015.Principal component analysis for evaluating a ranking method used in the performance testing in sheep of Morada Nova breed. Semina: CiênciasAgrárias, Londrina. 36, 3909-3922, https://doi.org/10.5433/1679-0359.2015v36n6p3909.

Wiener, G., G.J. Lee and J.A. Woolliams, 1992. Effects of rapid inbreeding and of crossing inbred lines on the growth of linear body dimensions of sheep. Anim. Sci. 55, 101-114, https://doi.org/10.1017/S0003356100037326.

Yakubu, A. and J. Ayoade, 2009. Application of principal component factor analysis in quantifying size and morphological indices of domestic rabbits. Int. J. Morphol. 27, 1013–1017, https://doi.org/10.4067/S0717-95022009000400009.

Yakubu, A., 2013. Principal component analysis of the conformation traits of yankasa sheep. Biotechnol. Anim. Husb. 29, 65-74, https://doi.org/10.2298/BAH1301065Y.

Yakubu, A., A.E. Salako and A.R. Abdullah, 2011.Varimax rotated principal component analysis of the zoometrical traits of Uda sheep. Arch.Zootec. 60, 813-816, http://dx.doi.org/10.4321/S0004-05922011000300069.

Yunusa, A.J., A.E. Salako and O.A. Oladejo, 2013. Morphometric characterization of Nigerian indigenous sheep using multifactorial discriminant analysis.Int. J. Biodivers. Conserv. 5, 661-665, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.876.2246.

الملخص العربى

تحليل المكونات الأساسية لقياسات جسم الأغنام السوهاجى فى صعيد مصر

رضا السعيد[1] ، أحمد النحاس[2]

1 -قسم التنمية المتواصلة، معهد الدراسات والبحوث البيئية، جامعة مدينة السادات، المنوفية، مصر
2 -قسم الإنتاج الحيوانى، كلية الزراعة، جامعة سوهاج

أجريت الدراسة الحالية لتقييم عدد 383 حيوان من الأغنام السوهاجى في محافظة سوهاج فى مصر باستخدام طريقة متعددة المتغيرات. تم تقسيم البيانات إلى مجموعتين عمريتين (294 من الحيوانات الصغيرة التي يقل عمرها عن 10 أشهر (147 لكل جنس) و 89 من الحيوانات البالغة من عمر 10 أشهر وما فوق (9 ذكور و80 أنثى)). تم قياس وزن الجسم الحى وأربعة قياسات للجسم هى محيط الصدر، إرتفاع الكاهل، إرتفاع الكفل وطول الجسم وذلك خلال الفترة بين عامى 2017 و 2018. تم استخراج عدد اثنين من العوامل (المكونات الأساسية) فى كل من الأغنام الصغيرة والبالغة يمثلان نحو 89.2 ٪ و57.8 ٪ من إجمالي التباين ، على التوالي. يفسر العامل الأول 46.4٪ و 30.6٪ من التباين الكلي وكان التحميل الإيجابي الأعلى لإرتفاع الكاهل، وارتفاع الكفل وطول الجسم في الأغنام الصغيرة في حين كان التحميل الإيجابي الأعلى لارتفاع الكاهل وارتفاع الكفل في الأغنام البالغة. واستأثر العامل الثاني بنسبة 42.8٪ و 27.2٪ من التباين الكلي فى كل من الأغنام الصغيرة والبالغة على التوالى وتم الحصول على التحميل الإيجابي الأعلى لوزن الجسم ومحيط الصدر في الأغنام الصغيرة في حين تأثر وزن الجسم ومحيط الصدر وطول الجسم في الأغنام البالغة. أظهرت نتائج هذه الدراسة أن استخدام المكونات الأساسية أكثر ملاءمة من استخدام الصفات الأصلية المرتبطة لشرح مقاييس الجسم. وبالتالي يمكن أن تكون العوامل المستخرجة مفيدة في برامج التربية مع انخفاض كافٍ في عدد القياسات التي يتم تسجيلها لتفسير تكوين الجسم. أيضا يمكن استخدام درجات هذه العوامل للتنبؤ بوزن الجسم للأغنام السوهاجى.