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Short Communication

MULTIVARIATE ANALYSIS OF BIOMETERIC TRAITS IN CHOLISTANI CATTLE

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ABSTRACT

Data on 18 biometric traits of lactating Cholistani cows (N=325; age, 4-6 years) were recorded and analyzed through principal component analysis . These animals were maintained at Livestock Experimental Station Jugaitpeer Distric Bahawalpur, Punjab, Pakistan. The average values of these traits indicated that Cholistani cows are of medium type. Factor analysis with promax rotation revealed that head width (HW), face length (FL), eye to eye space (EE) and neck length (NL) were 83.618 % of the total variation. Head width (HW) explained 56.817% variation in the general body conformation. It showed significant positive high loading of body length (BL) and heart girth (HG). The results suggested that PCA may be used with minimum number of biometric traits of body conformation.

Key words: Cholistani cattle, Principal component analysis, Traits, Body length, Breeding program.

INTRODUCTION

Cholistani cows are one of the familiar cattle breeds and probably among all cattle breeds of this country has the largest body size. The homeland of this breed is Cholistan area of Punjab, Pakistan and is a source of income by providing milk and draft power to many people. This breed has dairy potential and better ability to thrive on water, feed scarcity than many other breeds (Khan *et al.*, 2008). The animals of this breed can produce ~2200 kg milk per lactation. Presently, the standards for the selection of best animals are based upon cow size i.e. body measurements. Body dimensions of breed, relationship or size and shape give a hint of body conformation of an individual. However, when the recorded traits are correlated, the PCA can explain relationships between biometric traits in a better way. While characterizing the individuals, it provides information about the relative importance of each variable. Therefore, this study was conducted to represent better body conformation along with relationship and to develop latent factors with the help of body measurements of Cholistani cattle.

MATERIALS AND METHODS

Data collection: Collection of data on various body measurement was recorded of 325 lactating Cholistani cows. The animals were kept at government livestock experimental station in Jugaitpeer, Distt Bahawalpur, and Punjab, Pakistan. The measurements were taken according to FAO (2011) standards for phenotypic characterization.

Measuring traits: Eighteen (18) biometric traits i.e., Head width (HW), Face length(FL), Eye to eye space (EE), Neck length (NL), Neck circumference (NC), Heart girth (HG), Switch length (SL), Foreleg length (FLL), Withers height (WH), Canon circumference (CC), Rump length (RL), Rump width (RW), Rump height (RH),Hindleg length (HLL), Tail length (TL), Switch width (SW), Pes length (PL) and Body length (BL) were measured (cm) on each animal.

Height measurements (cm) were taken by a graduated measuring stick. Flexible tape was used for circumference measurement and width was measured using calibrated wooden caliper. Measurements were taken by the same person to avoid any variation in recording. All the measurements taken were in centimeters (cm).

Principal component analyses (PCA): The goal of PCA is to explain the maximum portion of the variance with the least number of compound variables. Promax rotation was used for rotation of principal factors by transforming the factors to assess a simple structure. The factors which were having eigen value more than one were retained as followed by Kaiser Rule criterion (Johnson and Wichern, 1992). The data were analyzed by using SPSS (2001) statistical package.

Rotation of factors: For the estimation of approximate simple structure, principal factors rotation was done through the transformation. The following model was used:

$$Y_{ij} = \sum_{K=1}^{q} a_{ik} c_{kj} + e_{ij}$$

Y_{ij} depicts i^{th} value on jth observation (j = 1, 2, …., 18), where q depicts common factor. Furthermore, a_{ik} represents i^{th} value for k^{th} factor loadings. Moreover, j^{th} and e_{ij} observation and measure for the of the i^{th} observation on the j^{th} unique has regression coefficient regression c_{kj} correspondingly

RESULTS

Means of morphometric traits: The descriptive statistics of body measurements including HW, FL, EE, (NL, NC, HG, SL, FLL, WH, CC, RL, RW, RH, HLL, TL, SW, PL and BL are given in table -1.

Table 1 Descriptive statistics of body measurements

Sr. No.	Trait	Mean ± SD (cm)
1	Head width (HW)	13.50 ± 0.87
2	Face length (FL)	37.56 ± 2.87
3	Eye to eye space (EE)	16.10 ± 1.44
4	Neck Length (NL)	33.10 ± 2.72
5	Neck circumference (NC)	55.60 ± 5.53
6	Heart girth (HG)	119.80 ± 11.90
7	Switch length (SL)	79.20 ± 7.25
8	Foreleg length (FLL)	74.160 ± 4.31
9	Wither height (WH)	109.04 ± 10.47
10	Canon circumference(CC)	10.90 ± 1.30
11	Rump length (RL)	28.64 ± 3.20
12	Rump width (RW)	25.28 ± 3.75
13	Rump height (RH)	110.80 ± 8.70
14	Hind leg length (HLL)	78.24 ± 4.74
15	Tail length (TL)	63.44 ± 8.61
16	Shoulder width (SW)	5.76 ± 1.96
17	Pes length (PL)	35.08 ± 2.75
18	Body length (BL)	85.16 ± 8.24

Phenotypic correlations: The correlation coefficients between biometric traits are given in table-2. The correlation coefficient ranged from -0.620 (SW and SL) to 0.942 (BL and WL). It was found that 92 corelations were positive and 39 negative. BL had higher correlations with HG (0.914), Pes length (0.060) had the least phenotypic correlation. The correlation between NL and NC was 0.481. The SW had negative correlations with SL (-0.620), RH (-0.553) and TL (-0.466). High predictability among different traits was observed significantly (P<0.05/0.01) correlated.

Multifactor Analysis: Anti-image correlations computed showed that partial correlations were low indicating true factors existence in the data.The measure of sampling adequacy which was 0.692 supported by Kaiser-Meyer-Olkin (KMO).The assessment of sampling adequacy as pointed out by KMO exposed the proportion of the variance in various biometric traits. When the correlations were verified with Bartlett's test of Sphericity for the biometric traits, the results were significant (P<0.01, Chi-square value 182.865) which was supportive for the rationality of the factor analysis of the data as indicated in Table- 4. The Eigen values and the difference described by each factor are shown in table -3. From total measurements, the first factor (Head width) accounted for 56.817% of the variation. A significant positive high loading of HW, BL and HG was observed. This factor might be helpful in clarifying the cow body. The second factor (Face length) accounted for 14.314 % of total variability. The third factor (Eye to eye space) accounted for 6.339 % of entire variant, contained high loading for hind leg length and neck length.

Factor analysis: Anti-image correlations showed that partial correlations were low and true factors existed in the data. This was supported by KMO measure of sampling adequacy which was 0.609. The estimated factors loading extracted by factor analysis are also presented in table -3. It was found that 4 factors extracted i.e. Head width (HW), Face length (FL), Eye to eye space (EE), Neck length (NL) with Eigen values were found greater than 1 and accounted for 83.618 % of total alteration. In a similar study, Yakubu et al. (2009) dig out 2 factors in the animals having age between 2.5 - 3.6 years, reported 86.47% of the total variability by studying 14 morpho-structural traits of White Fulani cattle. In the current study, out of total measurements, the first factor (Head width) accounted for 56.817% of the variation. It had significant positive effect of high loading on body length, height at wither, paunch girth, heart girth, and ear length. The face length accounted for 14.314 % of total variability. It had comparatively greater loading for horn characteristics. The eye to eye space accounted for 10.49% of total variation, contained high loading for neck length and hind leg length. The neck length accounted for 9.07% of total variation with high loading of fore leg length and tail length. The neck circumference consisted 8.24% and of total variation containing high loading for switch length. The communality ranged from 0.597 (body length) to 0.857 (heart girth) and unique factors ranged from 0.403 to 0.143 as shown in table -2. In the current study, 83.618% variance was observed among first 4 measures. The coefficients of PCA regarding the 4 extracted factors had shown different weightage to the variables (Table - 3). The head width represented the general shape and size of the animal. The face length showed higher importance for horn characteristics.

Table 2. Correlation Matrix of all morphometric traits.

Variable	HW	FL	EE	NL	NC	HG	SL	FLL	WH	CC	RL	RW	RH	HLL	TL	SW	PL	BL
HW	1	0.104	0.499	-0.122	0.236	0.058	-0.022	0.212	-0.052	0.457	-0.100	-0.159	-0.058	0.099	0.115	0.313	-0.086	0.035
FL		1	0.130	0.548	0.839	0.801	0.670	0.800	0.746	0.030	0.771	0.826	0.076	0.604	0.594	-0.322	0.105	0.758
EE			1	-0.002	0.100	0.020	-0.018	0.307	-0.080	0.650	-0.016	-0.043	-0.035	-0.009	-0.110	0.390	0.019	-0.085
NL				1	0.481	0.473	0.350	0.496	0.398	-0.162	0.520	0.441	0.408	0.321	0.217	-0.207	0.055	0.360
NC					1	0.936	0.789	0.784	0.866	0.105	0.738	0.787	0.833	0.754	0.789	-0.399	-0.037	0.871
HG						1	0.766	0.797	0.861	0.058	-0.730	0.809	0.819	0.766	0.741	-0.405	0.081	0.914
SL							1	0.617	0.928	-0.139	0.890	0.808	0.934	0.788	0.861	-0.620	0.056	0.892
FLL								1	0.689	0.241	0.706	0.714	0.675	0.538	0.592	-0.143	0.143	0.786
WH									1	-0.039	0.878	0.881	0.946	0.827	0.866	-0.528	-0.035	0.942
CC										1	-0.111	0.033	-0.130	-0.015	-0.095	0.428	0.014	-0.060
RL											1	-0.883	0.835	0.640	0.664	-0.565	-0.086	0.835
RW												1	0.823	0.616	0.706	-0.497	-0.043	0.836
RH													1	0.870	0.861	-0.533	0.179	0.906
HLL														1	0.707	-0.436	0.228	0.733
TL															1	-0.466	0.100	0.849
SW																1	-0.058	-0.045
PL																	1	0.060
BL																		1

Head width (HW), Face length(FL), Eye to eye space (EE), Neck length (NL), Neck circumference (NC), Heart girth (HG), Switch length (SL), Foreleg length (FLL), Withers height (WH), Canon circumference (CC), Rump length (RL), Rump width (RW), Rump height (RH),Hindleg length (HLL), Tail length (TL), Switch width (SW), Pes length (PL) and Body length (BL)

Table 3. Eigen values and variation of all 18 Biometric traits (%).

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
Eigen value	10.227	2.577	1.141	1.107	0.701	0.566	0.445	0.389	0.271	0.218	0.163	0.092	0.038	0.024	0.022	0.011	0.006	0.003
Variability	56.817	14.314	6.339	6.148	3.892	3.144	2.469	2.159	1.507	1.209	0.908	0.512	0.212	0.135	0.121	0.062	0.031	0.019
Cumulative	56.817	71.131	77.470	83.618	87.510	90.655	93.124	95.283	96.790	97.999	98.907	99.419	99.631	99.766	99.888	99.950	99.981	100.00

F1=Head width (HW), F2=Face length(FL), F3=Eye to eye space (EE), F4=Neck length (NL), F5=Neck circumference (NC), F6= Heart girth (HG), F7=Switch length (SL),F8= Foreleg length (FLL), F9=Withers height (WH), F10= Canon circumference (CC), F11=Rump length (RL), F12=Rump width (RW), F13=Rump height (RH), F14=Hindleg length (HLL), F15=Tail length (TL), F16=Switch width (SW), F17=Pes length (PL) and F18=Body length (BL)

Table 4. Bertlett's test of Sphericity

Chi-square (observed value)	291.627
Chi-square (critical value)	182.865
DF	153
P value	<0.0001
Alpha	0.05

Test interpretation

H_0: There is no correlation significantly different from 0 between variables

H_a: At least one of the correlation between the variables is significantly different from 0

As the computed p value is lower than significance level alpha=0.05, one should reject the null hypothesis H_0 and accept alternate one H_a. The risk to reject null hypothesis while it is true is lower than 0.01%

DISCUSSION

The results recommended that PCA could be used in breeding programs with a severe decline in the number of biometric traits to clarify the body conformation.

Biometric Traits: The result of biometric traits as indicated in table-1 were in line with the reports of Khuram, (2013) for the approximations of wither height, body length, and heart girth in Dhanni cattle. The coefficient of variation fluctuated from 4.38 (height at withers) to 19.22 (heart girth) for different biometric traits. It was observed that height at wither and heart girth had more fluctuation, which might be due to the reason that the traits selected, responded more to the environment than others. The neck length with neck circumference (NC) had more deviation. Sadek et al. (2006) reported approximate range of communality i.e. 0.42 to 0.87. Yakubu et al. (2009) observed higher estimates of communality ranging from 0.79 to 0.93.

Phenotypic Correlations: The morphometric characteristics as observed in this study revealed that Cholistani cows have medium body size than Dhanni cows with pendulous ears, long tail similar to that of Sahiwal cows of Pakistan.

Multivariate Analysis: The measure of sampling adequacy, Kaiser-Meyer-Olkin (KMO) was 0.521. Yakubu et al. (2009) and Khuram,(2013) reported that it was 0.9 and 0.63 in Dhanni cattle and White Fulani, respectively. The estimates of sampling acceptability Kaiser-Meyer-Olkin showed the proposition of different biometric traits. Lower estimates of Bartlett's test of Sphericity were observed as compared to the Yakubu *et al.* (2009). Yakubu *et al.* (2009) and Khuram, (2013) dig out two factors in the biometric traits, which accounts for 85.37% of total variation and 71 % of the total fluctuation by observing the different biometric traits of White Fulani and Dhanni cattle. Salako (2006) in Uda sheep found two factors from 10 biometric traits, to the tune of 75% as far as total variation is concerned. Khuram (2013) reported two different variance 51 and 43 % of observed traits in Dhanni cattle. Head width accounted for 51.62 %. This factor seemed to be explaining the general animal size. Yakubu *et al.* (2009) observed in White Fulani cattle that the head width clarified 78.99 and 67.05% of total difference among traits. Similar to the current study, Pundir *et al.* (2007 b;c), Karacaören and Kadarmideen (2008) Yakubu *et al.* (2009) and Khuram (2013) reported that the first factor explained maximum variance. Yakubu *et al.* (2009) and Khuram (2013) reported that the face length described 6.38% of the full variance, whereas Salako (2006) reported that the face length clarified 11.03 % of the total variance in Uda sheep. The Third factor of the present study i.e. eye to eye space may define the back view of the animal. Pundir and Singh (2008) reported that there would be at least three variables per factor. The community ranged from 0.54 (face length) to 0.42 (shoulder length) and unique factor ranged from 0.344 to 0.234 for 18 different biometric traits. Yakubu *et al.* (2009) observed higher estimates of communality ranging from 0.87 to 0.67. Whereas, Sadek et al. (2006) reported as 0.42 to 0.87. While Yakubu et al.,(2009) estimated communality range from 0.79 to 0.93. Whereas, the common variance was observed as 66.02% of the total variance. The lower communalities for neck length and neck circumference were less effective to consider for total variance as compared to the other traits of this breed. Pundir et al. (2011) reported that the head width was 38.89% of the total variation. The communalities estimates indicated that neck length and neck circumference did not contribute effectively.It is suggested that PCA may be helpful to explain the body confirmation.

REFERENCES

FAO, (2011). Draft guidelines on phenotypic characterization of animal genetic resources. Commission on Genetic Resources for Food and Agriculture. 13th Regular Session. 18 - 22 July, Rome.

Johnson R.A. and D.W. Wichern, (1992. Applied multivariate statistical analysis (Vol. 4). Englewood Cliffs, NJ: Prentice hall.

Karacaören, B. and H. N. Kadarmideen, (2008). Principal component and clustering analysis of functional traits in Swiss dairy cattle. Turk J. Vet. Anim. Sci. 32: 163-171.

Khan M. S., Z. Rehman, M. A. Khan and S. Ahmad (2008). Genetic resources and diversity in Pakistani cattle. Pakistan Vet. J. 28(2): 95-102.

Khurram, S. (2013). Factor analysis of biometric traits of Dhanni cattle. MPhil thesis Deptt. of Livestock Prod., Univ. of Vet. & Anim. Sci., Lahore.

Pundir R.K. and P.K. Singh (2008). Status, characteristics and performance of red Kandhari cattle breed in its native tract. Indian J. Anim. Sci. 78(1): 56-61.

Pundir, R.K., P.K. Singh, B. Prakash and S.P.S. Ahlawat, (2007c). Characterization and evaluation of Kenkatha breed in its native tract. Indian J. Anim. Sci. 77(2): 177-180.

Pundir R.K., P.K. Singh, S.N. Uppadhaya and S.P.S. Ahlawat (2007b). Status, characteristics and performance of Red Sindhi cattle. Indian J. Anim. Sci. 77(8): 755-758.

Sadek, M.H., A.Z. Al-Aboud and A.A. Ashmawy (2006). Factor analysis of body measurements in Arabian horses. J. Anim. Breed. Genet. 123: 369-377.

Salako A.E (2006). Application of Morphological indices in the assessment of type and function in sheep. Int. J. Morphol. 24(1): 13-18.

Yakubu A., D. M. Ogah, and K.O. Idahor (2009). Principal component of the morphostructural indices of White Fulani cattle. Trakia J. Sci. 7(2): 67-73.