Indian Journal of Animal Sciences **83** (3): 281–284, March 2013/Article

Principal component analysis of body measurements of bulls of local cattle of Manipur, India

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Received: 27 August 2011; Accepted: 6 July 2012

ABSTRACT

Biometric traits (height at withers, body length, heart girth, paunch girth, ear length, tail length, switch length, neck girth, neck length, head length, distance of horn at base, circumference of horn at base, length of horn, hind leg length and fore leg length) in 107 bulls of Manipuri local cattle were recorded from Imphal valley of Manipur, India and analyzed by principal component analysis to explain body conformation. The average of these traits indicated that this local cow is a smaller type of cattle breed. Factor analysis with promax rotation revealed 6 factors which explained about 69.77% of the total variation. Factor 1 described the general body conformation and explained 21.93% of total variation. It was represented by significant positive high loading of height at wither, body length, heart girth, paunch girth and ear length. The communality ranged from 0.493 (elbow length) to 0.782 (neck girth) and unique factors ranged from 0.507 to 0.218 for all these 18 different biometric traits. The result suggested that principal component analysis (PCA) could be used in breeding programs with a drastic reduction in the number of biometric traits to be recorded to explain body conformation.

Key words: Body measurements, Local cattle, Manipur, Principal component analysis

Body dimensions are used to indicate breed, origin and relationship or shape and size of an individual as they give an idea of body conformation. However, principal component analysis (PCA) is a refinement and can explain relationships between biometric traits in a better way when the recorded traits are correlated. It provides information about the relative importance of each variable in characterizing the individuals. This analysis transforms an original group of variables into another group, principal components, which are linear combination of original variables. A small number of these new variables are usually sufficient to describe the individual without losing to much information. The indigenous cattle of Manipur are still considered as non-descript cattle in the country. Therefore, the present study was undertaken to study the different body measurements, relationships among different body measurements and to develop unobservable factors (latent) to define which of these measures best represent body conformation in bulls of local cattle of Manipur. Thus, the study will help in stabilizing these cattle as a breed and to indulge in the conservation strategies.

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MATERIALS AND METHODS

Source of data: Data, consisting of 15 different body measurements on 107 local bulls (Fig.1) of Manipur (4 years of age and above), were collected during 2010 from 20 villages of their native tract i.e. Imphal valley of Manipur, India. All measurements were recorded twice by the same recorder to minimize the error and to avoid between-recorder effects. The circumference measurements were taken by a measuring tape while the other measures were taken by a mapping stick. The recorded body measurements were height at withers (HW), body length (BL: distance from the point of shoulder to the pin bone), heart girth (HG), paunch girth (PG), ear length (EL), tail length without switch (TL), switch length (SL), neck girth (NG: at the mid-point of the neck), neck length (NL), head length (HL: length from the poll up to the tip of the nostril, excluding the muzzle), distance of horn at base (DH), circumference of horn at base (CH), horn length (HnL), hind leg length (HLL: length between the pastern joint up to the stifle joint) and fore leg length (HLL: length between the pastern joint up to the point of elbow).

Statistical analysis: Data collected were analysed using

Fig.1. A bull of local cattle of Manipur

fixed effect model, by considering the village effect as fixed so as to adjust the data for significant effect of village if any for further analysis.

Principal component analyses: The objective of principal component analysis is to account for the maximum portion of the variance present in the original set of variables with a minimum number of composite variables. Promax rotation was used for rotation of principal factors through the transformation of the factors to approximate a simple structure. The Kaiser rule criterion (Johnson and Wichern 1982) was used to determine the number of factors i.e. retaining only the factors that have eigen value greater than one. Kaiser's measure of sampling adequacy (MSA) was used to determine whether the common factor model was appropriate. All the analysis was carried out using the SPSS (2001) statistical package for social science.

RESULTS AND DISCUSSION

Means of morphometric traits: There was no significant effect of village on all the traits studied in the bulls of local cattle of Manipur. The height at withers (HW), body length (BL), heart girth (HG), paunch girth (PG), ear length (EL),tail length (TL), switch length (SL), neck girth (NG), neck length (NL), head length (HL), distance of horn at base (DH), circumference of horn at base (CH), horn length (HnL), hind leg length (HLL) and fore leg length (HLL) were 112.55±0.78, 120.36±0.84, 142.94±1.16, 147.00±1.18, 18.96±0.20, 70.06±0.70, 27.45±0.36, 74.74±0.38, 31.73±0.21, 41.86±0.24, 13.94±0.17, 14.00±0.22, 16.65±0.50, 69.25±0.46 and 63.74±0.31, cm respectively. The average height at withers, body length and chest girth of adult males of local cattle of Manipur were comparable to that in adult males of Bachaur cattle (Singh *et al.* 2010). They reported the respective average of these body measurements as 118.39±0.51, 117.40±0.40 and 148.58±0.71 cm. Gaur *et al*. (2004) recorded almost similar heart girth (140.6±0.50 cm), but shorter body length (102.5±0.5 cm) in adult males of Ponwar cattle. However, Phanchung and Roden (1996) reported much lower average body length (108±2.04 cm) but higher wither height (138±2.6 cm) and heart girth (170±4.8 cm) in 22 Siri bulls. Singh *et al*. (2002) also reported higher height at wither (134.36=2.03 cm) in male Deoni cattle.

Phanchung and Roden (1996) observed similar ear length (19±0.6 cm) in Siri bulls, but much longer tail length including switch (109±4.7 cm), neck girth (82±2.5 cm), neck length (48±0.8 cm), head length (52±1.5 cm) and horn length (33±1.6 cm) as compared to the present estimates. Singh *et al*. (2002) also reported higher mean head length as 54.87±7.10 cm in adult male Deoni cattle.

The coefficient of variation for different biometric traits ranged from 4.90 (fore leg length) to 30.19 (horn length). All body measurements showed less variability, indicating that the local cows of Imphal valley are almost similar in their body size. It might be due to natural selection favouring a particular shape and size from generation to generation for better adaptability.

Factor analysis: Anti-image correlations computed showed that partial correlations were low, indicating that true factors existed in the data. This was supported by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy which was 0.609. Pundir *et al.* (2011) reported higher estimates of sampling adequacy as 0.891 in Kankrej cows. The estimate of sampling adequacy Kaiser-Meyer-Olkin (KMO) revealed the proportion of the variance in different biometric traits caused by the underlying factors. The overall significance of the correlations tested with Bertlett's test of Sphericity for the biometric traits (chi-square was 372.99, P<0.01) was significant and provided enough support for the validity of the factor analysis of data. Higher estimate of Bertlett's test of Sphericity (5,182.01) as compared to the present study were observed by Pundir *et al.* (2011).

The estimated factors loading extracted by factor analysis, eigen values (Fig.2) and variation explained by each factor are presented in Table 1. There were 6 factors extracted with eigen values greater than 1 and accounted for 69.77% of total variance. Yakubu *et al.* (2009) extracted 2 factors in the age group of 2.5 to 3.6 years explained 86.47% of the total

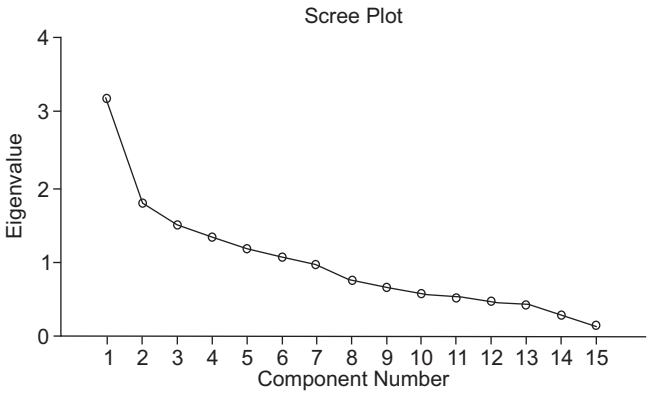

Fig. 2. Scree plot showing component number with eigen values.

Table 1. Total variance explained by different factors in bulls of local cattle of Manipur

Component	Initial Eigen values			Extraction sums of squared loadings			Rotation sums of squared loadings
	Total	% of variance	Cumulative%	Total	% of variance	Cumulative%	Total
1	3.290	21.931	21.931	3.290	21.931	21.931	2.824
2	1.854	12.361	34.293	1.854	12.361	34.293	1.782
3	1.574	10.491	44.784	1.574	10.491	44.784	1.976
4	1.360	9.069	53.853	1.360	9.069	53.853	1.566
5	1.236	8.239	62.092	1.236	8.239	62.092	1.534
6	1.151	7.675	69.767	1.151	7.675	69.767	1.303
7	0.862	5.748	75.515				
8	0.763	5.090	80.604				
9	0.687	4.580	85.185				
10	0.608	4.052	89.237				
11	0.455	3.036	92.272				
12	0.369	2.459	94.732				
13	0.355	2.367	97.099				
14	0.288	1.922	99.021				
15	0.147	0.979	100.000				

variation by studying the 14 morpho-structural traits of White Fulani cattle. In the present study, the first factor accounted for 21.93% of the variation out of the total of 15 original measurements. It was represented by significant positive high loading of height at wither, body length, heart girth, paunch girth and ear length. This factor seemed to be explaining the body of the cow, i.e. general size of the cow. Pundir *et al*. (2011) reported in Kankrej cows that the first factor explained 38.89% of total variation. The second factor accounted for 12.36% of total variability. It had comparatively higher loading for horn characteristics. The third factor accounted for 10.49% of total variation, contained high loading for neck length and hind leg length. The fourth factor accounted for 9.07% of total variation with high loading of fore leg length and tail length. The fifth factor accounted for 8.24% and of total variation containing high loading for switch length and 6 factors, 7.67% with no particular variable having high loading.

The communality ranged from 0.597 (body length) to 0.857 (hind girth) and unique factors ranged from 0.403 to 0.143 for all these 15 different biometric traits (Table 2). Aproximate range of communality i.e. 0.42 to 0.87 was reported by Sadek *et al*. (2006) in Arabian mares. Higher

Table 2. Communalities of different morphometric traits in bulls of local cattle of Manipur

Traits	Communalities	Unique factor
Height at wither	0.757	0.243
Body length	0.597	0.403
Heart girth	0.857	0.143
Paunch girth	0.813	0.187
Ear length	0.757	0.243
Tail length	0.614	0.386
Switch length	0.666	0.334
Neck girth	0.648	0.352
Neck length	0.696	0.304
Head length	0.647	0.353
Horn distance at base	0.736	0.264
Horn circumference at base	0.651	0.349
Horn length	0.653	0.347
Hind leg length	0.683	0.317
Fore leg length	0.688	0.312

Table 3. Component matrix of different factors for biometric traits in bulls of local cattle of Manipur

Traits	Component					
	1	2	3	4	5	6
Height at wither	0.736	–0.065	–0.285	0.218	0.253	–0.134
Body length	0.716	0.125	–0.225	–0.080	0.111	–0.008
Heart girth	0.780	0.004	–0.025	–0.219	0.175	0.411
Paunch girth	0.843	–0.041	0.037	–0.082	–0.090	0.289
Ear length	0.667	–0.040	–0.156	0.307	–0.026	–0.438
Tail length	0.057	0.306	0.411	0.533	0.235	–0.096
Switch length	0.045	–0.199	0.325	0.333	0.540	0.342
Neck girth	0.283	0.336	0.044	–0.186	–0.595	0.254
Neck length	0.008	0.319	0.529	–0.397	0.211	–0.335
Horn length	0.353	–0.051	0.368	–0.431	0.124	–0.428
Distance between horns at base	–0.050	0.773	–0.281	0.033	0.229	–0.048
Circumference of horn at base	–0.291	0.576	0.068	–0.084	0.248	0.402
Horn length	0.043	0.698	–0.318	0.137	–0.101	–0.185
Fore leg length	0.120	0.059	0.348	0.598	–0.438	0.009
Hind leg length	0.396	0.247	0.646	–0.015	–0.209	0.063

estimates of communality (ranged from 0.79 to 0.93) were observed by Yakubu *et al*. (2009). In the present study, common variance explains approximately 69.77% of the total variance present among all 15 measures.

The inter-factor correlations between different factors ranged from –0.07 to 0.17. The first factor showed positive correlation with all other factors except the sixth factor. The second factor was negative with third factor.

The coefficients of the principal analysis of the 6 extracted factors showed different weights to the variables (Table 3). This first factor represents the general shape and size of the cow. The second factor showed higher weight for horn characteristics. The third factor assigned negative weights to wither height, body length, hearth girth, ear length, distance between the horn and horn length and positive sign to all other measurements.

The 6 extracted factors determine the source of shared variability to explain body conformation in local bulls of Manipur. The first factor contributes effectively to explain general body conformation in local bulls of Manipur. The results suggested that principal component analysis (PCA) could be used in breeding programs with a drastic reduction in the number of biometric traits to be recorded to explain the body conformation.

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