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Principal component analysis of growth traits in Aseel native chicken

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ABSTRACT

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Aseel is a well-recognised native chicken breed, known for its endurance, fighting skills, majestic gait and higher tolerance for heat and stress conditions etc., and is being used for development of superior crosses for backyard poultry farming. This study investigated relationship between earlier body weights with the subsequent weights until the market age, i.e., 20-week. Records of chick weight (n=620) and weights at bi-weekly intervals (n=1070) were analysed for Principal Component Analysis (PCA) using IBM-SPSS *version* 26. All the coefficients were significant ($p \leq 0.01$) and positive, indicating that trait has good predictability, which could be useful in chalking out of selection and improvement programs. Low to moderate correlations were estimated between juvenile body weights with weight at marketable age (0.10-0.55) while the correlations were higher (0.63 - 0.95) thereafter. Kaiser-Meyer-Olkin measure of sample adequacy and Bartlett's test of sphericity and communality at different ages were also calculated, which revealed adequacy of samples for PCA. The selected two components collectively explain the 79.46% of total variability present in the dataset. The first component explained 66.51% variability while the second component accounts for 12.94% variability. It was concluded that PCA is an excellent tool for reducing the recording of number of traits or dimension of the original data. Further, the extracted principal components were useful in prediction of body weight at market age in Aseel native chicken.

Keywords: Aseel Chicken, Bartlett's Test, Body weight, Kaiser-Meyer-Olkin Test, PCA

INTRODUCTION

The Indian poultry industry has witnessed enormous expansion and has made significant contributions in the national economy. The growing need for poultry products has radically altered poultry production from a simple household/ backyard activity into a full-scale industry. Technological advancements have transformed the structure of India's poultry industry (Pandey *et al.,* 2022). India stands seventh in the world in terms of poultry population (851.81 million tons) (BAHS, 2019), third in egg production (138.38 billion eggs/year), and with 4.89MT/year meat production stands fifth (Singh, 2023). The total eggs produced in India from chickens are nearly 95% and the remaining 5% eggs are from other poultry species, suggesting the dominance of chickens in the poultry industry. The contribution from organized and unorganized (backyard) sectors in the Indian poultry market is 70% and 30%, respectively. Backyard poultry farming is widely practiced in impoverished population and areas with poor resources for income generation and employment to women and unemployed youth, provides nutritional security and bridges the demand-supply gap for eggs and poultry meat (Kumar and Pandey, 2021). Improving the productivity of backyard and free-range agricultural systems requires selective breeding to improve native germplasm. Indigenous chicken breeds are widely recognized for their high adaptability to extreme and harsh environmental conditions, higher resistance/ tolerance to diseases as compared to other breeds (Singh *et al.*, 2009). These native breeds demonstrate higher thermo-tolerance as well (Nayak *et al.*, 2021). Aseel breed is appreciated for its toughness, aggressiveness, stunning gait, and fighting ability (Kumar, 2022). Owing to the higher immunocompetence, Aseel birds can better tolerate the infections like Newcastle disease virus (NDV), as compared to other native breeds of chickens (Girija *et al.*, 2023). Data collected for any genetic improvement program of poultry are either highly correlated or sometime redundant too. Simultaneous analysis of data of correlated traits does not improve accuracy but requires increased recording and analytical work, thus necessitating extensive computational work and decreasing the dimension. PCA is a multivariate method used to reveal structural relationships across different traits and reduces data dimensions through the elimination of redundant information. It linearly transforms the data on highly correlated variables into a new set of uncorrelated variables known as 'Principal components'

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(Pundir *et al.*, 2011). As a result, general applications of this multivariate technique include data reduction and interpretation (Johnson and Wichern, 2007). Further, phenotypic characterization of chickens using different morphometric traits can also be done employing PCA (Saikhom *et al.*, 2017, 2018; Dalal *et al.*, 2020; Kumar *et al.*, 2022), and determination of phenotypic relationships between body conformation and weights (Pinto *et al.*, 2006; Yakubu *et al.*, 2009; Udeh and Ogbu, 2011; Egena *et al.*, 2014; Amao, 2018). It has also been applied with more or less same objectives in other poultry species such as duck (Ogah *et al.*, 2009; Maharani *et al.*, 2019) and turkey (Ogah *et al.*, 2011; Dalton *et al.*, 2017). According to Brody (1964), growth is an irreversible/permanent and correlated increase in body mass during a specific time period. Owing to this correlated nature of growth traits, the current study aims to identify various uncorrelated growth traits, using the PCA approach and to reduce their number so as to explain commercial/ market body weight in Aseel native chicken, with computational ease.

MATERIALS AND METHODS

Experimental birds

Aseel Peela native chicken, undergoing fourth generation of selective breeding for higher body weight at ICAR-Central Avian Research Institute, Izatnagar, being maintained and managed at Desi Fowl Experimental Unit under standard conditions of feeding, housing, vaccinations etc. were used in this study.

Traits Recorded

Data on 11 growth traits i.e., chick weight (CW) and biweekly body weights from 2 to 20 weeks of age (the market age), i.e. BW2, BW4, BW6, BW8, BW10, BW12, BW14, BW16, BW18 and BW20, were individually recorded using electronic weighing balance. Data on chick weight (n=620) and weights from second week of age to 20-weeks of age at biweekly intervals on 1070 progenies from 30 sires and 139 dams, hatched in three hatches, were recorded and analysed.

Statistical analyses

Data were analysed using the Statistical Package for Social Sciences (SPSS, 2007) for PCA. First, the descriptive statistics was used, followed by the Bartlett (1950) test to determine whether the given dataset with 11 traits could be factored as recommended. The Kaiser-Meyer-Olkin (KMO) test (1960) of sampling adequacy was performed to determine the data set's validity at 1% level of significance. Varimax rotation was used through component transformation to approximate a simple structure for rotation of principal components to maximize sum of variances of squared loadings, which are percent of variance in variable explained by that particular principal component (PC). For each variable, sum of all square loadings across all PCs is one.

RESULTS AND DISCUSSION

The descriptive statistics including number of observations, means, standard deviation and coefficient of variation etc. of the traits are presented in Table 1.

Table 1: Descriptive Statistics of the recorded traits in Aseel native chicken

Traits	No. of Observations	Mean (g)	Standard Deviation	Coefficient of Variation (%)
CW	620	28.05	2.42	8.61
BW2	1070	64.92	15.36	23.65
BW4	1070	133.36	36.48	27.35
BW6	1070	225.83	51.81	23.00
BW8	1070	337.46	71.08	21.06
BW10	1070	496.57	95.73	19.27
BW12	1070	664.68	126.84	19.08
BW14	1070	849.21	151.21	17.80
BW16	1070	1048.85	182.20	17.37
BW18	1070	1194.35	215.93	18.07
BW20	1070	1323.96	248.20	18.74

The phenotypic correlation among various growth traits were also estimated (Table 2**)**. All the coefficients were significant ($p \leq 0.01$) and positive, indicating that traits had good predictability, which could be useful for selection. Low to moderate correlations were observed between juvenile body weights with market age body weight (0.10 - 0.55) while higher correlations (0.63 - 0.95) were observed thereafter. The Kaiser-Meyer Olkin test for sample adequacy was found to have a value of 0.898. A value of more than 0.80 is considered to be excellent as far as sample adequacy is concerned. The Bartlett's test of sphericity was significant (Chi square=9461.46; p=0.000). As an outcome, the significance of the correlation matrix as indicated by both tests suggested that our dataset meets the requirements for factor or component analysis.

In present investigation, communalities for growth traits are given in Table 3. Communalities are basically proportions of variance in original variables and in this study; it ranged from 0.072 (for CW) to 0.948 (for BW16). Different components with respect to the growth traits in the experimental flock are given in Table 4. Components were selected on the basis of Eigen values (more than 1), which shows variability accounted by each factor out of the total variability. This extraction of components was in accordance with the Kaiser Rule Criterion (Johnson and Wichern, 2007).

Table 2: Phenotypic correlations among various body weights in Aseel native chicken

	CW	BW2	BW4	BW6	BW8	BW 10	BW 12	BW 14	BW 16	BW 18	BW 20
CW	1.00										
BW2	0.19**	1.00									
BW4	0.14**	0.69**	1.00								
BW6	0.07**	0.61**	0.83**	1.00							
BW8	0.10**	0.48**	0.68**	0.81**	1.00						
BW10	0.08**	0.47**	0.66**	0.80**	0.89**	1.00					
BW12	0.06**	0.45**	0.62**	0.77**	0.82**	0.92**	1.00				
BW14	0.10**	0.35**	0.55**	0.68**	0.80**	0.86**	0.90**	1.00			
BW16	0.12**	0.31**	0.51**	0.64**	0.75**	0.82**	0.86**	0.95**	1.00		
BW18	0.12**	0.25**	0.45**	0.55**	0.67**	0.74**	0.79**	0.88**	0.94**	1.00	
BW20	0.10**	0.28**	0.45**	0.55**	0.63**	0.73**	0.78**	0.86**	0.91**	0.95**	1.00

**P≤0.01

Table 3: Communalities influence various body weights in Aseel native chicken

Traits	Initial	Extraction	Loading Factor (PC 1)	Loading Factor (PC 2)
CW	1.000	0.072	0.011	0.267
BW2	1.000	0.753	0.128	0.858
BW4	1.000	0.847	0.375	0.840
BW6	1.000	0.848	0.547	0.741
BW8	1.000	0.790	0.729	0.509
BW10	1.000	0.878	0.803	0.483
BW12	1.000	0.889	0.850	0.408
BW14	1.000	0.935	0.933	0.255
BW16	1.000	0.948	0.957	0.180
BW18	1.000	0.907	0.949	0.084
BW20	1.000	0.873	0.930	0.093

Table 4: Different components with respect to body weights in experimental flock of Aseel native chicken

Component	Total Variance Explained								
	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.317	66.514	66.514	7.317	66.514	66.514	5.906	53.688	53.688
2	1.424	12.947	79.461	1.424	12.947	79.461	2.835	25.772	79.461
3	0.998	9.077	88.538						
4	0.492	4.473	93.011						
5	0.275	2.497	95.508						
6	0.141	1.286	96.794						
7	0.128	1.163	97.957						
8	0.101	0.920	98.877						
9	0.049	0.444	99.321						
10	0.042	0.385	99.706						
11	0.032	0.294	100.000						

Alternatively, the components could be chosen based on a scree plot. Figure 1 depicts the components that can be considered up to the bent elbow. The two common factors (or components) were taken with Eigen values 7.31 (PC1) and 1.42 (PC2), which collectively explained 79.46% of the total variability present in the dataset. The first component explained 66.51% variability and was highly correlated with BW8, BW10, BW12,

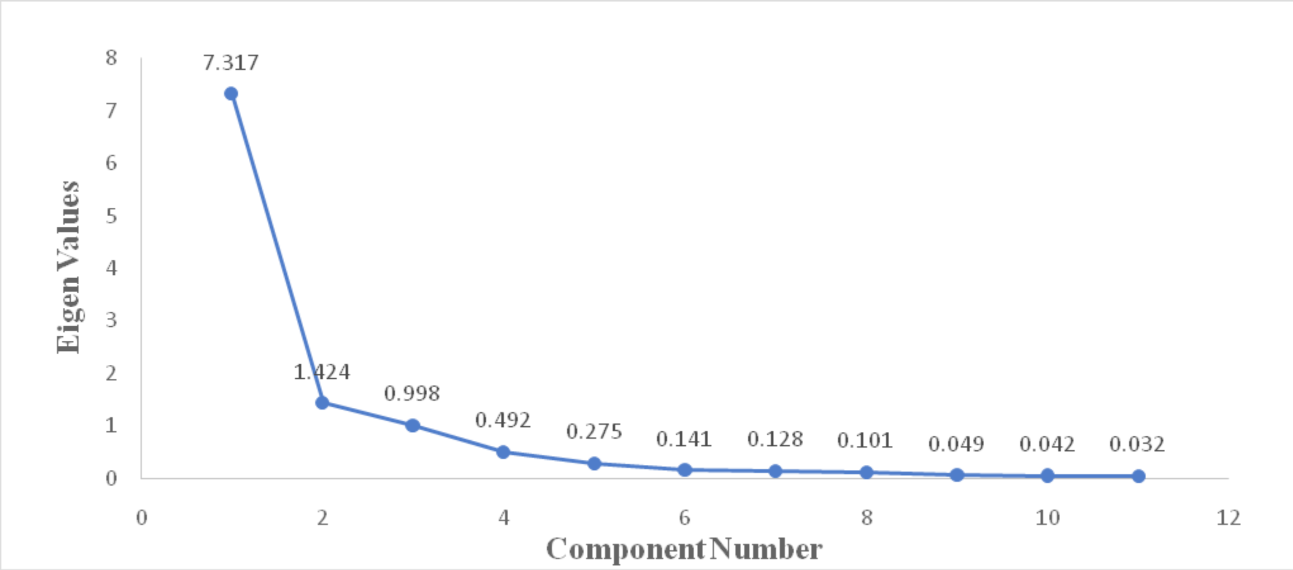

Fig. 1: Scree plot showing components and the corresponding Eigen values

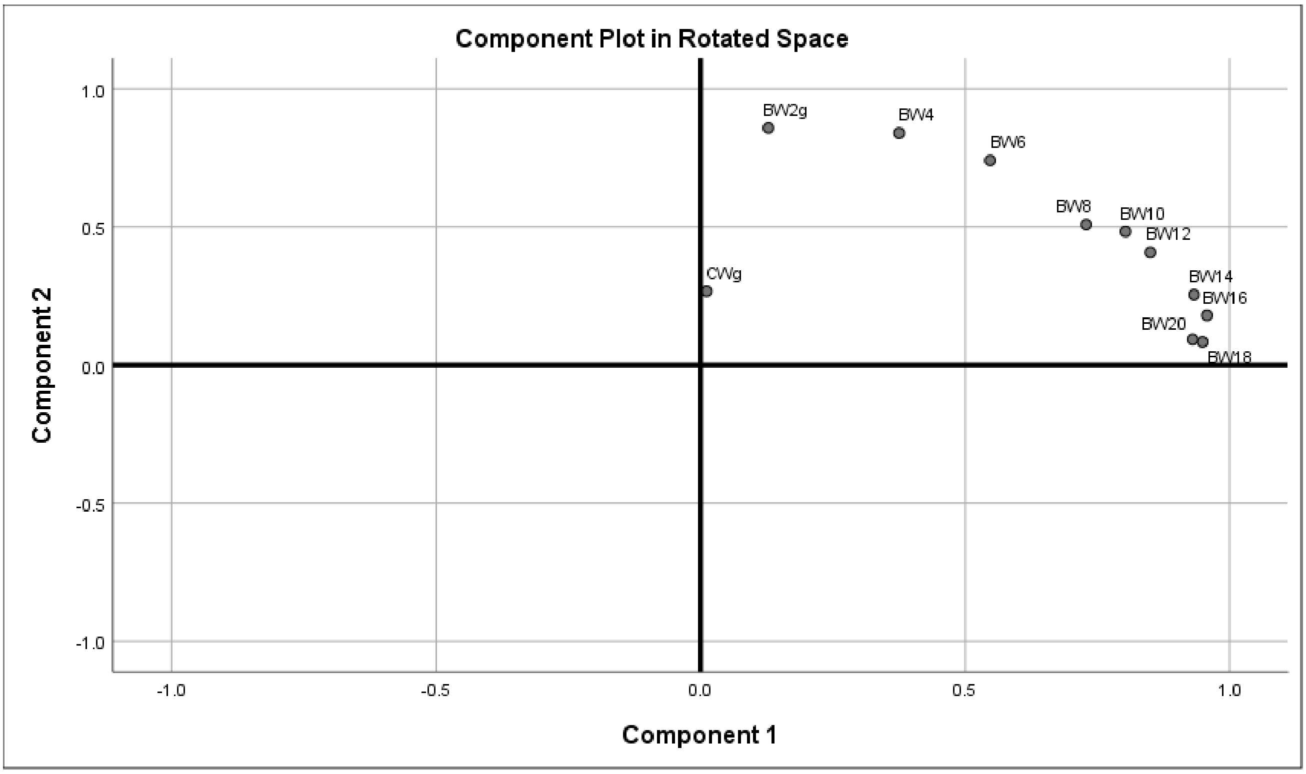

Fig. 2: A component plot in rotated space showing distinct body weights in Aseel native chicken.

BW14, BW16, BW18 and BW20 while the second component accounts for 12.94% variability and highly correlated with BW2, BW4, BW6 and BW8. As a result, seven of the eleven body weight traits, associated with PC1, may be used to predict body weight at 20 weeks, the market age of Aseel native chicken. Figure 2 depicts the component plot of two components in a rotated space.

In Aseel, Haunshi *et al.* (2011), Jha *et al.* (2013) and Pandey *et al.* (2022) have reported lower 20-week body weight than the present estimates. Contrarily, higher 20-week body weight was reported by Rajkumar *et al.* (2017) in Aseel. The differences in body weights reported in different reports might be attributed to the differences in the genetic background of various stocks studied, as well as to the environmental variables such as feed, pathological conditions, and other factors that existed throughout the investigation. Low to moderate correlation was observed between juvenile body weights with market age body weight (0.099 - 0.54) while higher correlations (0.63 - 0.95) were observed thereafter. Higher genetic correlations have been reported between adjacent body weights as compared to distant body weights. Dalal *et* *al.*, (2019) also observed similar trend among the growth traits. Number of researchers viz., Ajayi *et al.*, (2008), Udeh and Ogbu, (2011), Egena *et al.*, (2014) and Kumar *et al.*, (2022) found strong positive correlations between body weights and measurements, suggesting that body measurements may be used to predict body weight. In present study, two common factors (or components) were taken with Eigen values 7.31 (PC1) and 1.42 (PC2). Consistent with the current results, two principal components that explained the greatest variation in the morphological traits were extracted from several breeds of chicken by Udeh and Ogbu, (2011), Egena *et al.*, (2014), Amao *et al.*, (2018), Saikhom *et al.*, (2018) and Kumar *et al.*, (2022). Present investigation is among the first few studies concluding component analysis of body weight traits in a native breed with such a large quantum of data being maintained in any improvement program. In the absence of any report on this aspect in Aseel native chicken, the results of PCA could not be compared. Although, the PCA has been used to determine the phenotypic relationships between body conformation and body weight (Pinto *et al.*, 2006; Yakubu *et al.*, 2009; Udeh and Ogbu, 2011; Egena *et al.*, 2014; Amao, 2018) and to characterize the phenotypic characteristics of chickens using various morphometric traits (Saikhom *et al.*, 2017, 2018; Dalal *et al.*, 2020; Kumar *et al.*, 2022). It has also been used with essentially the same goals in other poultry species as well viz., ducks (Ogah *et al.*, 2009; Maharani *et al.*, 2019), and turkeys (Ogah *et al.*, 2011; Dalton *et al.*, 2017).

CONCLUSION

Present investigation revealed that all of the correlation coefficients among body weights were highly significant (pd”0.01) and positive, indicating that the traits had good predictability and could be useful for selection. Low to moderate phenotypic correlation is observed between juvenile body weight with market age body weight (0.10 - 0.55) while higher correlations (0.63 - 0.95) were observed thereafter. The selected two components, PC1 and PC2, collectively explain the 79.46% of the total variability present in the dataset. The first component explained 66.51% variability while the second component accounts for 12.94% variability. PCA was found to be very useful in reducing the number of traits or the dimension of data and seven (BW8, BW10, BW12, BW14, BW16, BW18 and BW20) out of eleven body weight traits, associated with PC1, may be used to predict body weight at 20 weeks, the market age of Aseel native chicken.

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REFERENCES

Ajayi, F.O., Ejiofor, O. and Ironkwe, M.O. 2008. Estimation of body weight from linear body measurements in two commercial meat-type chicken. *Global Journal of Agricultural Science*, **7**: 57-59.

Amao, S.R. 2018. Application of principal component analysis on the body morphometric of Nigerian indigenous chickens reared intensively under southern guinea savanna condition of Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries*, **10**: 1-12.

Bartlett, M.S. 1950. Tests of significance in factor analysis. *British Journal of Psychology*, **3**: 77-85.

Basic Animal Husbandry Statistics (BHAS). 2019. Ministry of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. (www.dahd.nic.in.).

Brody, S. 1964. Bioenergetics and growth; with special reference to the efficiency complex in domestic animals. Hafner Press, Reinhold, New York, USA.

Dalal, D.S., Ratwan, P. and Yadav, A.S. 2019. Genetic evaluation of growth, production and reproduction traits in Aseel and Kadaknath chickens in agro climatic conditions of northern India. *Biological Rhythm Research*, **53**: 40-49.

Dalal, D.S., Ratwan, P., Malik, B.S., Patil, C.S. and Kumar, M. 2020. Principal component analysis of morphological traits of synthetic White Leghorn chicken. *Indian Journal of Animal Science*, **90**: 1551-1555.

Dalton, H.A., Wood, B.J., Widowski, T.M., Guerin, M.T. and Torrey, S. 2017. An analysis of beak shape variation in two ages of domestic turkeys (*Meleagris gallopavo*) using landmark-based geometric morphometrics. *PLoS One*, **12**: e0185159.

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

Girija, S., Tyagi, J.S., Mariappan, A.K., Faslu Rahman, A.T., Sharma, S., Singh, T., Srivastava, V. and Kolluri, G. 2023. Studies on production and biochemical profile in indigenous and exotic chicken challenged with velogenic Newcastle disease virus (vNDV). *Indian Journal Poultry Science*, **58**: 191-194.

Haunshi, S., Niranjan, M., Shanmugam, M., Padhi, M.K., Reddy, M.R., Sunitha, R. and Panda, A.K. 2011. Characterization of two Indian native chicken breeds for production, egg and semen quality, and welfare traits. *Poultry Science*, **90**: 314-320.

Jha, D.K., Prasad, S., Soren, S.K. and Bharti, A. 2013. Production performance of indigenous chicken in intensive farming systems. *Indian Journal of Poultry Science*, **48**: 105-108.

Johnson, R.A. and Wichern, D.W. 2007. Applied multivariate statistical analysis. Prentice Hall International. INC., New Jersey.

Kaiser, H.F. 1960. The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, **20**: 141-151.

Kumar, A. 2022. Genetic analysis of Body weights and Growth Trends in Aseel Native Chicken. *M.V.Sc. Thesis*, Deemed University IVRI, Izatnagar.

Kumar, M., Dahiya, S., Ratwan, P. and Sheoran, N. 2022. Evaluation of morphological traits in Aseel and Kadaknath breeds under backyard poultry farming using principal component analysis. *Turkish Journal of Veterinary & Animal Science*, **46**: 356-365.

Kumar, S. and Pandey, M. 2021. Developing crosses for backyard production as per location and farmer's preference. In: *Specialized Training Course on "Backyard Poultry Farming"*, ICAR-CARI, Izatnagar (ISBN No. 978-93-5457-311-8), pp 59-67.

Maharani, D., Hariyono, D.N., Putra, D.D., Lee, J.H. and Sidadolog, J.H. 2019. Phenotypic characterization of local female duck populations. *Indonesian Journal of Asia-Pacific Biodiversity*, **12**: 508-514.

Nayak, N., Bhanja, S. K., Eaknath, B., Chakurkar, Sahu, A. R. and Kumar, S. 2021. Effect of mid-embryonic thermal conditioning on zootechnical performance, immune-competence and expression profiling of HSP70 gene in backyard chicken variety. *Indian Journal of Poultry Science*, **56**: 253-259.

Ogah, D.M. 2011. Assessing size and conformation of the body of Nigerian indigenous turkey. *Slovak Journal of Animal Science*, **44**: 21-27.

Ogah, D.M., Alaga, A.A. and Momoh, M.O. 2009. Principal component factor analysis of the morpho-structural traits of Muscovy duck. *International Journal of Poultry Science*, **8**: 1100-1103.

Pandey, M., Kumar, S., Chandrahas, Kumar, A., Chaudhari, C.P., Kanarkhedkar, H.L. and Meena, R. 2022. Comparative study of growth and layer economic traits in Aseel and Kadaknath chicken breeds under intensive rearing system. *The Pharma Innovation Journal*, SP-**11**: 1553-1557.

Pinto, L.F.B., Packer, I.U., De Melo, C.M.R., Ledur, M.C. and Coutinho, L.L. 2006. Principal components analysis applied to performance and carcass traits in the chicken. *Animal Research*, **55**: 419-425.

Pundir, R.K., Singh, P.K., Singh, K.P. and Dangi, P.S. 2011. Factor analysis of biometric traits of Kankrej cows to explain body conformation. *Asian-Australasian Journal of Animal Science*, **24**: 449-456.

Rajkumar, U., Haunshi, S., Paswan, C., Raju, M.V.L.N., Rao, S.R. and Chatterjee, R.N**.** 2017. Characterization of indigenous Aseel chicken breed for morphological, growth, production, and meat composition traits from India. *Poultry Science*, **96**: 2120-2126.

Saikhom, R., Sahoo, A.K., Taraphder, S., Pan, S., Sarkar, U., Ghosh, P.R. and Baidya, S. 2017. Principal component factor analysis of morpho-structural traits of Haringhata Black chickens. *Indian Journal of Animal Health*, **56**: 211-218.

Saikhom, R., Sahoo, A.K., Taraphder, S., Pan, S., Sarkar, U., Ghosh, P.R. and Baidya, S. 2018. Principal component analysis of morphological traits of Haringhata Black chickens in an organized farm. *Exploratory Animal and Medical Research*, **8**: 64-68.

Singh, A. (2023). Livestock Production Statistics of India - 2023. https://www.researchgate.net/publication/376799772_Livestock_Production_Statistics_of_India_-_2023. PDF Accessed March 11, 2023.

Singh, P., Kumar, S., Singh, H. N., Singh, D. P., Jaiswal, G. and Meena, S. R. 2009. Genetics of immunocompetence traits in Kadaknath native chicken. *Indian Journal of Poultry Science*, **44**: 173-176.

SPSS Statistical Package for Social Sciences. 2007. SPSS Inc., 444 Michigan Avenue, Chicago, IL, USA.

Udeh, I. and Ogbu, C.C. 2011. Principal component analysis of body measurements in three strains of broiler chicken. *Science World Journal*, **6**: 11-14.

Yakubu, A., Kuje, D. and Okpeku, M. 2009. Principal components as measures of size and shape in Nigerian indigenous chickens. *Thai Journal of Agricultural Science*, **42**: 167-176.