Principal Component Analysis of Biometric Traits in Guilan Native Cattle of Iran

Research Article

M. Golshani Jourshari[1], A.A. Shadparvar[1], N. Ghavi Hossein-Zadeh[1*], F. Rafeie[2], M.H. Banabazi[3,4] and A.M. Johansson[4]

[1] Department of Animal Science, Faculty of Agricultural Science, University of Guilan, Rasht, Iran
[2] Department of Agricultural Biotechnology, Faculty of Agricultural Science, University of Guilan, Rasht, Iran
[3] Department of Animal Biotechnology, Animal Science Research Institute of Iran (ASRI), Agricultural Research Education and Extension Organization (AREEO), Karaj, Iran
[4] Department of Animal Breeding and Genetics, Swedish University of Agricultural Science, Uppsala, Sweden

Received on: 24 Oct 2020
Revised on: 11 Apr 2021
Accepted on: 1 May 2021
Online Published on: Mar 2022

*Correspondence E-mail: nhosseinzadeh@guilan.ac.ir

Online version is available on: www.ijas.ir

ABSTRACT

In this study, 230 heads of Guilan native cows were phenotypically evaluated for 29 traits. Descriptive statistics were obtained per each level of sex (male and female), two levels of the genetic group (straight bred native and crossbred of the native by Holstein), and four levels of genetic groups × sex interaction. The results showed that the crossbred cows had dairy conformation while the type of Guilan native cows was meat-oriented. A distinctive feature of native cattle compared to cross and other breeds are the presence of withers, which is often seen in males and rarely in females. The phenotypic correlation coefficients of 25 attributes were calculated. There were 270 positive and 30 negative coefficients. Correlation coefficients ranged from -0.5 (thigh girth and fore teat length) to 0.95 (thigh girth and front leg length). The principal component analysis was performed to find the variables explaining the maximum variance in the main set of variables. The first and second components accounted for 57.17 and 11.53 percent of the total variance, respectively. Seven components accounted near to 90 percent of the total variance. Traits consist of width and environment of the chest, height in the hip area (rump), head length and hip to pin distance, height in stature area, depth and girth of abdominal, hip-width (hip to hip distance), front leg length, body length, and neck girth were more important for the first component, which is important in terms of bulk, size, length, width, height, and body growth as a result of meat production.

KEY WORDS biometry, Guilan cattle, principal component analysis.

INTRODUCTION

Native breeds are considered the national capital of any country and their preservation is of great value and importance. Native animals are continued to survive and reproduce by overcoming adverse environmental conditions after thousands of years of natural selection. The preservation and reproduction of native breeds in each country as a national asset are greatly valuable and important. The vast land of Iran, due to its special geographical conditions, has diverse climates, and in such circumstances, natural and artificial choices have led to the emergence of a variety of talented domesticated animals in this country. In most cases, natural selection is made against economic traits in native animals that train in adverse environmental conditions and cause these animals to fail to produce as much as the animals selected under favorable environmental conditions. The native cattle of Guilan have a medium size and large chip and withers, animals that belong to the group of Indian subcontinent cows (*Bos indicus*) and are seen in various colors from black to yellow and henna. It is believed that these cows were brought to Iran by about 9000 BC. This breed is dual purpose and is much better in meat quality and carcass drop compared to the foreign breeds such as Holstein and Simmental and is more welcomed. A noteworthy feature of this breed is the presence of withers, which are found in most native males and are less common in females. The meat of withers has 40 to 60 percent fat and is very tasty, as it is often sold at almost double the price.

Biometric traits are also used for the comparison of growth in different individuals. In addition to weight measurements, they also describe an individual or population in a better way than the conventional methods of weighing and grading (Pundir *et al.* 2011). Phenotypic characterization is used to identify and document diversity within and between distinct breeds, based on their observable attributes. The measurement of genetic relationships between breeds and genetic heterozygosity within breeds is the task of molecular characterization (FAO, 2012). Characterization of the breed is the first approach to the sustainable use of animal genetic resources. Phenotypic characterization is used to identify and document within and between breed variation of distinct breeds on their observable attributes (Dietl *et al.* 2005; Vohra *et al.* 2015). However, factor analysis using principal component analysis (PCA) is a valuable refinement statistical tool in multivariate methodology that is of use when characteristics are correlated (Morrison, 1976). PCA converts one main group of variables into another group of main components, which are a linear combination of the main variables. In addition in a data set with correlations or covariances, PCA is useful as a way to extract new components from the main variables that express the most variance. Principle component analysis is an extensive statistical method used to reduce data with different dimensions (variables) using their linear composition, which is known as the principal components (PCs). The new predicted variables (principal components) are unrelated and are programmed in such a way that the first few components retain the greatest variances in the main variables. Therefore, PCA is useful in situations where the variables are correlated with each other and can be used to analyze data or to construct predictive models. Principal component analysis can also reveal important features of the data such as outliers and departures from a multi normal distribution (Schlegal, 2017). One of the main benefits of PCA is that each PC describes a percentage of the total variance (Savegnago *et al.* 2011). Factor analysis assumes that the variance of a variable can be divided into two parts (Johnson and Wichern, 1982). The first part is called the common variance (communality factor) that is shared by other variables included in the model. The estimate of communality for each variable measures the proportion of variance of that variable explained by all the other factors jointly. The second part is called a specific variance (unique factor) as it is specific to a particular variable and includes the error variance (Pundir *et al.* 2011). Factor analysis deals only with the common variance of the observed variables. However, the PCA considers both the total variance and the unique variance. The main purpose of the PCA is that the maximum variance in the main set of variables with the least number of related variables is allocated and Identifies outlier data and individuals. PCA assumes that the unique variance represents a small fraction of the total variance (Savegnago *et al.* 2011). The aim of this study was to identify Guilan native cattle with meat production potential using the main factors influencing meat production instead of measuring all traits in evaluating meat production.

MATERIALS AND METHODS

In this study, 230 native cattle registered in Guilan province, which belonged to eight herds covered by registration and record-keeping and had production and ancestors records and preferably had a minimum relationship, type traits related to meat production quantity were measured. The 29 evaluated traits were: body-color, horn length, horn diameter, head length, head width, ear height, neck length, neck girth, stature height, withers height, withers width, chest girth, chest width, abdomen depth, abdomen girth, body length, rump height, front leg length, rear leg length, thigh width, thigh girth, pin-pin distance, pin-hip distance, hip-hip distance, bodyweight, testis environment, testis height, front teat length, rear teat length. Initially, body dimensions were entered in Excell 97 software, and data higher and lower than the three standard deviations from the mean were removed from the analysis as outlier data. The collected data were analyzed using SAS 9.1 software for descriptive statistics and R 3.62 program for PCA (SAS, 2003).Because all the animals had a pedigree, an attempt was made to measure the adult animals. Initially, data higher and lower than the three standard deviations from the mean were removed as outlier data. To identify the main effects, the Reg procedure was used to separate the groups in expressing the mean of the measured traits in the following models. The model used was regulated by considering the significant constant effect for the group (cross and native), sex (male and female), and group × sex. The following statistical models were used:

$$Y_{ijk} = \mu + Type_i + \left(\sum\nolimits_1^n TRAITS\right)_j + e_{ijk}$$

$$Y_{jkl} = \mu + Sex_j + \left(\sum\nolimits_1^n TRAITS\right)_k + e_{jkl}$$

$$Y_{ijkl} = \mu + Type_i * Sex_j + \left(\sum_1^n TRAITS\right)_k + e_{ijkl}$$

Where:
Y: dependent trait (bodyweight).
μ: mean.
Type: purity effect.
Sex_j: gender (male or female) effect.
$Type_i \times Sex_j$: interaction effect of purity and sex.
TRAITS: effect of 28 independent traits.
e_{ijk}: effect of the error.

The means procedure was used to calculate the descriptive statistics and the corr procedure of the SAS 9.1 program was used to calculate the correlation coefficients (SAS, 2003). In the next step, using the Reg procedure, the effects of Breed group, gender, and group × gender were used to fit the constant effects of weight, which did not have a significant effect due to the removal of outlier data, which reported in the research on Pundir *et al.* (2011) too. However, due to the process of presenting data reports, the effects mentioned in the SAS 9.1 program have been analyzed separately and the descriptive statistics of the results have been presented in Table 1.

RESULTS AND DISCUSSION

The observed morphometric characteristics show that the native cows of Guilan are small and have a compact body with small to medium dimensions. The native cow has long withers and chips that belong to the group of Indian cows (*Bos indicous*) and is found in a variety of colors from black to yellow to henna (Tavakkolian, 2000). In general, the body size of native and Holstein cross was higher than the Guilan native cows, so that the mean height in the cross and native cows was 118.12 and 109.12 cm, and the body length was 141.06 and 124.72 cm, respectively. It shows the height and elongation of the body of the cross compared to the Guilan native breed. Comparing body height and length with the results of Bene *et al.* (2007). In Hungarian Simmental cattle, Hereford, Aberdeen Angus, Red Angus, Lincoln Red, Shaver, Charolais, Limousin, Blonde d'Aquitaine, Guilan native cows are smaller and in comparison with the results of Pundir *et al.* (2011) for Kankrej cattle and Chandran *et al.* (2018) on Gangatiri native cows, Guilan native cow is smaller but it was larger than dairy breeds such as Indian Kosali in the study of Jain *et al.* (2018) and White Fulani in the study of Yakubu *et al.* (2009) and Tonga in the study of Parés-Casanova and Mwaanga (2013). Compared to the study of Chandran *et al.* (2018) in Gangatiri and Kosali cows, the height in the stature and the length of the body were approximately the same, which was not the same as the results of the present study. The coefficient of variation (CV) in both traits in the Guilan cross was higher than the native cattle of Guilan, which could be due to the different percentage of purity in cross cows, which means that by increasing the percentage of exotic germplasm, phenotype and genotype are more similar to Holstein breed. The CV of traits was less in the research of Pundir *et al.* (2011) in Kankrej breed, so it can be concluded that the diversity in the native breed of Guilan is higher than Kankrej breed. Also, the body height in male and female cows was 114.53 and 108.73 cm and the body length were 130.65 and 125.08 cm, respectively. The highest height in male cows was 117.67 cm and the lowest in native cows was 109.29 cm and the body length was 140.91 and 122.79 cm in the same two groups, respectively (Table 1). In other words, the native-Holstein cross was larger in size than the purebred native breeds of Guilan. A noteworthy feature of native cows is the presence of withers, which are common in native male cows and are rarely seen in females.

The meat in this area has 40 to 60 percent fat and is very tasty. The average height of withers in males and females was 16.90 and 9.75 cm, respectively, and its width was 71.54 and 49.25 cm. The coefficient of variation in the height of the withers indicates the existence of more variation in the height compared to other traits.

All dimensions in common traits in both sexes were higher in male animals. The CV in some traits such as length and diameter of the horn was high, which could be due to the lack of choice for these traits or the greater compatibility of these traits with the environment, which corresponds to the results of Pundir *et al.* (2011).

Phenotypic correlation

The correlation coefficients between the studied traits are presented in Table 2. In total, 300 correlation coefficients (in all compounds) were estimated. There were 270 positive coefficients and 30 negative coefficients. The correlation coefficients ranged from a minimum value of -0.5 (thigh girth and teat length) to a maximum value of 0.95 (thigh girth and front leg length). Height at the stature had the highest correlation with body length (0.77) and the lowest correlation with head width (-0.22), which was consistent with the results of Pundir *et al.* (2011). The correlation coefficient of chest girth and back leg length was 0.83. Withers width coefficient was calculated to be 0.21 with head width and 0.86 for hip-hip. The minimum body length correlation coefficient was with head width (-0.1) and body length and Chest girth coefficient were 0.89.

The highest correlation was calculated between live weight and chest circumference 0.9597 and the lowest correlation between horn diameter and hip-width was 0.3698.

Table 1 Mean (cm) and coefficient (%) of variation in the biometric traits of native cattle in Guilan

Trait	Type		Sex		Type × sex			
	Cross mean(C.V)	Native mean(C.V)	Male mean(C.V)	Female mean(C.V)	Cross-male mean(C.V)	Cross-female mean(C.V)	Native-male mean(C.V)	Native-female mean(C.V)
Stature	118.12(13.08)	109.05(9.79)	114.53(12.19)	108.73(10.22)	117.67(12.87)	118.36(13.49)	114.14(11.84)	107.29(8.54)
Front leglength	74.17(18.54)	64.62(12.18)	69.14(14.49)	64.92(14.8)	74.33(16.98)	74.08(19.64)	68.11(12.67)	63.42(11.59)
Rump height	123.79(9.85)	111.38(8.19)	113.99(11.69)	112.88(8.73)	125.32(8.48)	123.07(10.59)	111.52(11.2)	111.20(7.05)
Rear leg length	71.35(12.59)	66.80(8.67)	69.65(9.61)	66.77(9.72)	71.82(12.7)	71.13(12.81)	69.24(8.59)	66.04(8.49)
Thigh width	26.09(7.74)	23.28(9.15)	24.85(8.65)	23.38(10.09)	25.88(7.84)	26.20(7.94)	24.52(8.65)	22.72(8.32)
Thigh girth	63.00(9.03)	52.06(11.35)	57.03(10.28)	52.96(14.54)	63.38(6.07)	62.79(10.59)	55.00(8.85)	50.67(11.74)
Chest width	59.34(18.37)	53.91(12.08)	55.16(15.25)	54.44(13.87)	57.86(20.31)	60.04(17.77)	54.78(13.14)	53.57(11.8)
Abdomen depth	62.80(13.81)	57.25(15.09)	57.73(21.81)	58.14(12.71)	61.10(6.71)	63.54(15.79)	57.22(24.1)	57.28(11.07)
Body length	141.06(27.64)	124.72(19.55)	130.65(24.17)	125.08(21.4)	140.91(27.32)	141.13(28.37)	129.13(22.69)	122.79(18.3)
Chest girth	153.00(18.46)	142.24(12.33)	145.79(15.25)	142.94(13.66)	150.73(17.34)	154.04(19.24)	145.34(14.42)	141.06(11.6)
Abdomen girth	181.51(18.99)	165.22(14.01)	164.16(17.21)	168.58(15.04)	171.45(14.72)	186.13(20.17)	162.95(17.79)	165.91(12.8)
Neck length	33.21(19.48)	29.50(16.61)	29.29(18.98)	30.35(17.56)	31.21(14.74)	34.26(20.78)	28.77(20.16)	29.67(15.5)
Neck girth	70.17(22.39)	66.72(16.98)	77.99(19.19)	63.33(13.96)	82.82(19.39)	63.55(17.23)	77.10(18.47)	63.56(13.04)
Ear height	17.48(12.36)	16.79(11.2)	17.48(10.13)	16.62(11.97)	17.63(7.77)	17.39(14.78)	17.50(10.69)	16.53(11.25)
Horn length	20.79(14.77)	22.30(19.33)	21.41(15.97)	22.32(20.07)	19.75(15.14)	22.29(12.07)	22.08(15.4)	22.32(20.83)
Horn diameter	18.35(12.37)	16.61(20.23)	20.66(10.31)	14.98(12.42)	19.75(5.97)	16.36(11.8)	21.02(11.08)	14.82(12.21)
Withers height	-	14.25(37.68)	16.79(29.6)	9.75(20.72)	-	-	16.90(29.82)	9.75(20.72)
Withers width	-	63.59(24.88)	71.78(18.45)	49.25(19.03)	-	-	71.54(18.79)	49.25(19.03)
Head length	44.44(17.53)	40.86(14.66)	43.07(17.02)	40.68(15.29)	46.63(13.81)	43.30(19.19)	42.37(16.9)	40.31(13.79)
Head width	18.22(16.14)	19.01(162.02)	25.74(211.58)	16.40(15.37)	18.64(12.82)	18.02(17.81)	27.88(221.41)	16.12(13.83)
Weight	336.93(28.7)	236.65(29.19)	251.87(39.12)	251.51(30.39)	323.00(29.24)	343.53(28.99)	234.57(39.49)	236.25(25.66)
Pin pin	23.07(29.95)	19.81(27.81)	18.96(31.54)	20.67(28.4)	20.50(28.73)	24.41(29.25)	18.74(31.7)	20.13(26.83)
Hip hip	39.47(21.64)	34.13(16.26)	33.31(18.58)	35.32(18.6)	37.23(14.5)	40.54(23.73)	32.50(18.46)	34.53(15.55)
Pin hip	44.22(18.84)	38.61(13.83)	39.83(17)	39.27(15.97)	44.55(15.67)	44.07(20.54)	38.83(15.89)	38.44(13.27)
Front teat length	4.67(21.2)	3.93(26.46)	-	4.09(26.41)	-	4.67(21.2)	-	3.92(26.79)
Rear teat length	4.17(24.7)	3.73(22.52)	-	3.83(23.76)	-	4.17(24.7)	-	3.74(22.99)
Testis height	14.36(12.05)	14.45(16.33)	14.43(15.25)	-	14.36(12.05)	-	14.45(16.33)	-
Testis environment	31.93(7.8)	29.84(46.95)	30.30(40.96)	-	31.93(7.8)	-	29.84(46.95)	-

The highest number of negative correlations was related to hip-width with other traits and the highest number of the positive coefficient was related to the height of the stature with other traits.

The correlation coefficients between the traits increase the probability of correct prediction of the traits (Pundir *et al.* 2011).

Analysis of the principle components

Principal component analysis can also reveal important features of the data such as outliers and departures from a multi normal distribution (Schlegal, 2017).

Figure 1 shows the distribution of individuals in the two principal components of the first and second, as well as the distribution of both males and females. Discharged animals are also identified in Figure 1. Table 3 shows the eigen values and PCA for meat traits.

The eigenvalues and the proportion of eigenvalues in variance are reduced from left to right, which was consistent with the results of Babajani *et al.* (2017), Pundir *et al.* (2011). Thus, the first special value with the largest proportion, 57.17% and the second eigenvalue 11.15% explain the highest part of the total phenotypic variance, which in the research of Babajani *et al.* (2017) 31.84 and 21.34 and Pundir *et al.* (2011) 38.89 and 19.68, for the first and second components, respectively. By comparing the correlation coefficients, it can be seen that the correlation between the traits that have the highest coefficient in the first component is high.

The second component explains the most uncalculated variance. It should be noted traits that are highly correlated with the first component are not strongly correlated with the second component. This rule also applies to other components.

Table 2 Coefficients of correlation between traits

Trait	**Stature**	**Front leg length**	**Rump height**	**Rear leg length**	**Thigh width**	**Thigh girth**	**Chest width**	**Abdomen depth**	**Body length**	**Chest girth**	**Abdomen girth**	**Neck length**	**Neck girth**	**Ear height**	**Horn length**	**Horn diameter**	**Withers height**	**Withers width**	**Head length**	**Head width**	**Pin pin**	**Hip hip**	**Pin hip**	**Front teat length**	**Rear teat length**
Stature	-	0.66	0.68	0.72	0.32	0.47	0.76	0.64	0.77	0.73	0.6	0.35	0.66	0.4	0.27	0.44	0.31	0.73	0.42	-0.2	0.49	0.58	0.47	-0.01	0.33
Front leglength		-	0.95	0.78	0.26	0.05	0.41	0.35	0.67	0.71	0.53	0.31	0.36	0.54	0.68	0.26	0.14	0.69	0.39	-0.2	0.77	0.46	0.63	0.02	0.07
Rump height			-	0.77	0.25	0.21	0.51	0.48	0.74	0.67	0.62	0.42	0.54	0.43	0.6	0.38	0.29	0.71	0.52	-0.2	0.77	0.51	0.6	0.04	0.11
Rear leglenght				-	0.66	0.03	0.58	0.47	0.8	0.83	0.45	0.29	0.52	0.61	0.52	0.4	0.45	0.73	0.27	-0	0.5	0.48	0.79	0.35	0.39
Thigh width					-	0.01	0.41	0.14	0.33	0.42	-0.1	0.22	0.31	0.36	0.21	0.35	0.24	0.38	-0.3	0.07	0.26	0.18	0.39	0.42	0.48
Thigh girth						-	0.35	0.42	0.18	0.08	0.53	0.07	0.65	-0.2	0.02	0.59	-0	0.22	0	-0.2	0.2	0.31	-0.1	-0.5	-0.1
Chest width							-	0.85	0.83	0.72	0.57	0.41	0.5	0.3	0.19	0.61	0.7	0.76	0.53	-0.1	0.61	0.76	0.49	0.2	0.52
Abdomen depth								-	0.81	0.61	0.72	0.44	0.41	0.17	0.35	0.68	0.75	0.57	0.59	-0.1	0.53	0.67	0.48	-0.1	0.25
Body length									-	0.89	0.68	0.38	0.52	0.61	0.48	0.62	0.76	0.79	0.63	-0.1	0.59	0.78	0.79	0.23	0.38
Chest girth										-	0.67	0.11	0.37	0.75	0.6	0.49	0.53	0.81	0.44	0.01	0.6	0.78	0.89	0.31	0.45
Abdomen girth											-	-0	0.41	0.34	0.56	0.48	0.34	0.55	0.57	-0.1	0.53	0.61	0.57	-0.1	0.1
Neck length												-	0.3	-0.1	0.11	0.23	0.4	0.21	0.4	0.29	0.37	0.22	0.14	0.1	0.36
Neck girth													-	0.04	-0.1	0.56	0.34	0.63	0.26	-0.1	0.23	0.5	0.31	0.08	0.32
Ear height														-	0.6	0.18	0.26	0.35	0.21	0.07	0.26	0.36	0.69	0.37	0.23
Horn length															-	0.32	0.08	0.26	0.12	0.08	0.61	0.29	0.64	-0.1	-0.1
Horn diameter																-	0.54	0.59	0.04	-0.2	0.52	0.72	0.43	-0.2	0.06
Withers height																	-	0.51	0.59	0.13	0.25	0.63	0.58	0.4	0.45
Withers width																		-	0.41	-0.2	0.71	0.86	0.68	0.17	0.4
Head length																			-	0.12	0.34	0.48	0.4	0.29	0.33
Head width																				-	-0.3	0.03	0.31	0.6	0.65
Pin pin																					-	0.64	0.46	-0.1	0.07
Hip hip																						-	0.7	0.13	0.44
Pin hip																							-	0.46	0.5
Front teat length																								-	0.8
Rear teat length																									-

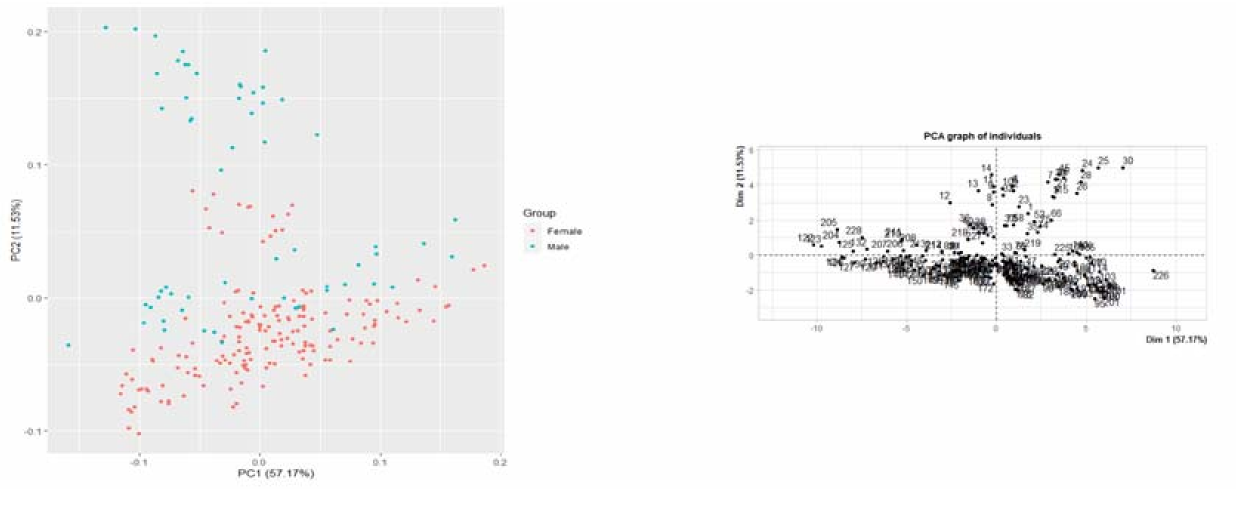

Figure 1 Distribution of individuals in the principle component 1 and 2 (right) and gender (left)

Table 3 Eigenvalue, relative and cumulative variance of biometric traits in native cattle of Guilan

Item	Principal component analysis (PCA)																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Eigenvalue	13.15	2.65	1.49	1.24	0.84	0.69	0.56	0.51	0.35	0.23	0.20	0.17	0.15	0.14	0.12	0.11	0.10	0.08	0.06	0.06	0.05	0.03	0.02
Variance.percent	57.17	11.53	6.50	5.41	3.63	3.02	2.45	2.20	1.51	1.01	0.87	0.75	0.65	0.59	0.54	0.47	0.41	0.36	0.28	0.25	0.21	0.12	0.08
cuMulative.variance.percent	57.17	68.70	75.20	80.61	84.24	87.26	89.71	91.91	93.42	94.43	95.30	96.04	96.69	97.28	97.82	98.29	98.70	99.06	99.34	99.59	99.80	99.92	100

The third to seventh components explain 6.5, 5.41, 3.63, 3.02, and 2.44% of the total variance, respectively. In total, the first seven components explain 89.7% of the total variance. The other principal components explain very little variance and from 11^{th} PC explain less than one percent of the variance, so instead of using 23 PC to explain the changes, it is best to use the first and second components that express the most phenotypic changes.

Taking advantage of the results of such analyzes, easy calculations, and results are obtained by spending less time and money (Babajani *et al.* 2017). Therefore, the first two main components can be used to evaluate and determine the selection index to improve meat production traits in the native cattle of Guilan.

Thus, it can be stated that most of the main variables show a high correlation with the first principle component. Gradually, the correlations between the principal components and variables as well as the weight coefficients of the variables on the principal components are reduced so that in the final components all variables have equal or close to zero coefficients.

Therefore, animals are selected based on which group of variables they belong to, not based on the type of trait (Pinto *et al.* 2006). These variables are shown in underline in Table 4. Figures 2 and 3 show the contribution of traits in the first and second principal components, respectively. Also, the joint contribution of the first and second principal components are indicated in Figure 4. Variables of chest width, chest girth, stature, head length and distance from hip to pin, height at the rump, depth and girth of the abdomen, pelvic width (distance from hip to hip), length of the front leg, body length, length of the rear leg and the neck girth is more important for the first component. These areas are very important in bulk, size, length, width, and height of the body and therefore meat production.

In the PC_2, the width and length of the withers, horn diameter and neck girth show more correlation with the principal component. These traits are mostly related to the skeletal condition and age and trait characteristics of the animal. As can be seen, the correlation between the PCs and variables as well as the weight coefficients of the variables on the main components gradually decreases.

Table 4 Correlation between biometric traits and main components in native cattle of Guilan

Trait	Prin1	Prin2	Prin3	Prin4	Prin5	Prin6	Prin7
Stature	0.9523611	0.0579739	0.0367756	0.1285535	0.0092831	0.017263	-0.0603259
Front leglength	0.8598108	0.1034951	-0.2889608	-0.1973473	-0.181536	0.0192127	-0.0425029
Rumpheight	0.8931364	-0.1203495	-0.2257474	0.0230241	0.0715696	-0.0922876	0.1077849
Rear leglength	0.8304136	-0.0761033	-0.3058754	0.3180112	-0.0240024	0.0555111	0.0856723
Thighwidth	0.5462904	-0.2552292	-0.2618141	0.6430765	0.1285773	-0.133586	0.1630415
Thighgirth	0.8252771	-0.1246158	-0.259576	0.1403285	0.1405075	0.1218626	0.0423893
Chest width	0.9596109	-0.0983217	0.066994	-0.0562071	0.0435185	-0.0099101	-0.0443918
Abdomen depth	0.8895899	-0.2739275	0.1849642	-0.0276043	0.0010231	-0.008314	0.0180699
Body length	0.8576362	0.1677891	-0.0421074	-0.3638664	-0.0855922	-0.0029951	-0.0398798
Chest girth	0.9549214	-0.1102192	0.1515293	-0.0063452	0.0154349	-0.0039479	-0.1009526
Abdomen girth	0.8807095	-0.2287268	0.1976742	-0.0036069	0.1531942	-0.071889	-0.0191401
Neck length	0.6861807	-0.2307281	0.229315	0.062642	-0.282565	0.1376597	0.3978856
Neck girth	0.7309653	0.4094148	0.1131292	0.0800006	0.1942414	-0.1102812	-0.3560886
Ear height	0.6152176	0.2669913	-0.3494598	-0.3386064	-0.1796221	-0.167432	0.1368838
Horn length	0.2842896	-0.1007542	0.8402141	0.0213839	0.1343374	-0.231793	0.1410661
Horn diameter	0.5238775	0.5530832	-0.0142748	0.4029882	-0.0076439	-0.229923	-0.153171
Withers height	0.2577231	0.9016651	0.1231416	0.041643	0.0909986	0.1456256	0.1993666
Withers width	0.246187	0.9019742	0.1252258	0.0164527	0.083542	0.1406714	0.2143262
Head length	0.8999277	0.1376001	-0.0245039	-0.1790165	-0.0533335	-0.0189567	-0.066674
Head width	0.5241872	0.0007779	0.2956795	0.3133829	-0.5579145	0.3626485	-0.2355524
Pin pin	0.6253149	-0.1929837	-0.026147	-0.1498444	0.4624268	0.5118431	-0.047582
Hip hip	0.8654587	-0.2604703	0.1142661	-0.2189904	0.0469906	-0.0510863	0.0254531
Pin hip	0.8997483	-0.03256	-0.0218856	-0.1664689	-0.1189657	-0.2036222	0.0075228

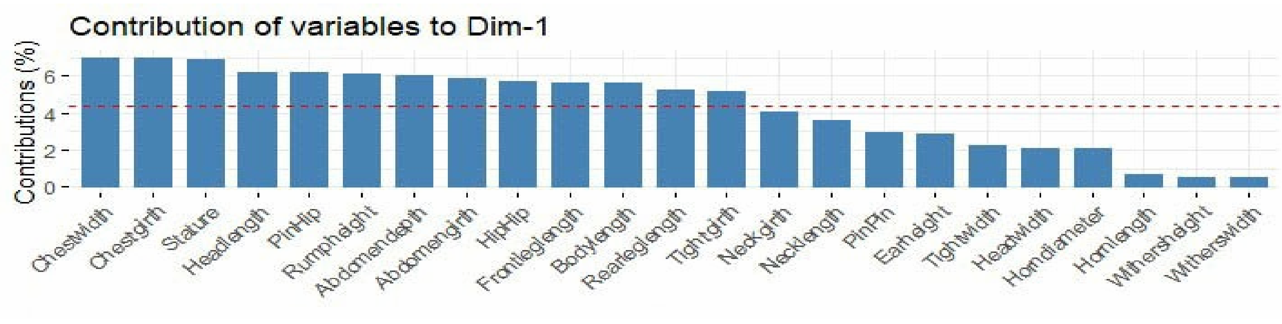

Figure 2 Contribution of biometric traits in the first principal component

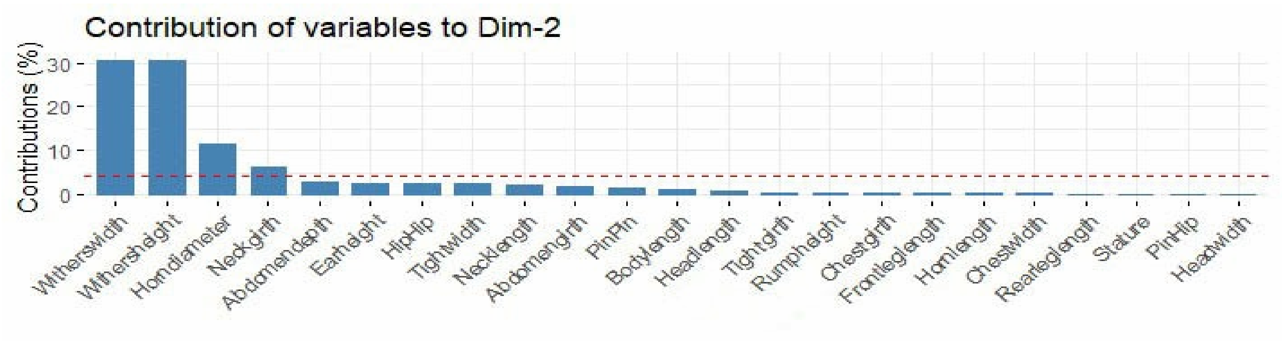

Figure 3 Contribution of biometric traits in the second principal component

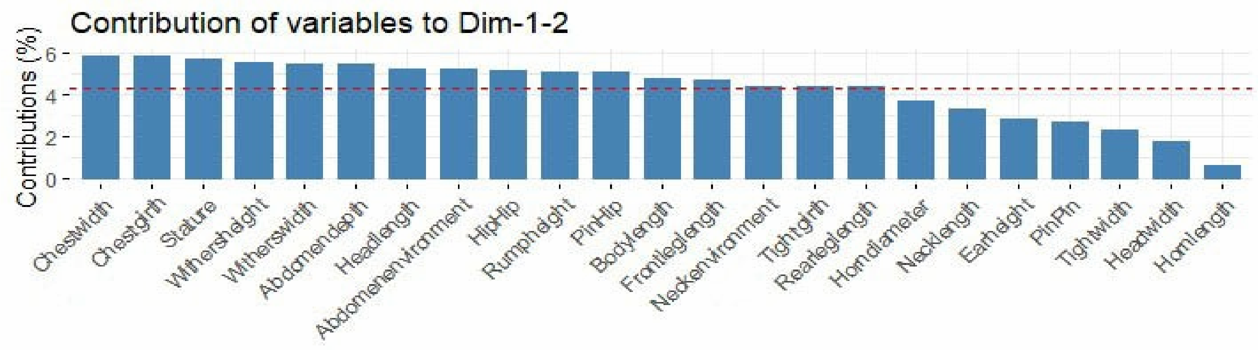

Figure 4 Contribution of traits in the first and second principal components

Therefore, animals are selected based on which group of variables they are in, not on the type of trait (Babajani *et al.* 2017).

In total, the first and second components, width and environment of the chest, stature, width, and length of the withers, depth of abdomen, head length, abdomen girth, hip to hip, height at the rump, pin to hip, body length, front leg length and girth of the neck can be used as the main traits in expressing Guilan native breed characteristics. In this case, the selection index not only facilitates the weight coefficients but also estimates it in comparison with the restraint, which facilitates the selection index with 23 traits compared to when it is defined based on 2 PCs. When the correlation coefficients between the variables are higher, they cause correlated variables and have a great impact on the PCs, but which of the components is most effective will depend on the correlation between the PCs and the main variables.

CONCLUSION

Analysis of the main components is an interesting tool for evaluating and understanding the whole variance, and in a group of correlated traits, it causes a sharp decrease in the number of traits studied, therefore, the use of this method can be a good indicator.

ACKNOWLEDGEMENT

The authors want to acknowledge the University of Guilan and Agriculture Jihad Organization of Guilan for financial support of this research. Also, the Swedish University of Agricultural Science was acknowledged for supporting this study within the framework of a joint international research plan between the University of Guilan and the Swedish University of Agricultural Science.

REFERENCES

Babajani S., Alijani S. and Olyayee M. (2017). Principal component analysis of internal egg quality and some performance traits of Azarbayjan Native Chickens. *Res. Anim. Prod.* **8,** 175-183.

Bene S., Nagy B., Nagy L., Kiss B., Polgár J.P. and Szabó F. (2007). Comparison of body measurements of beef cows of different breeds. *Arch. Tierz.* **4,** 363-373.

Chandran P.C., Dey A., Kamal R., Kumar P. and Karan D. (2018). Production and reproduction performance of Gangatiri cattle in middle Gangetic plains of Bihar. *Indian J. Anim. Sci.* **89,** 298-303.

Dietl G., Hoffmann S. and Reinsch N. (2005). Impact of trainer and judges in the mare performances test of warm blood horses. *Arch. Tierz.* **48,** 113-120.

FAO. (2012). Phenotypic Characterization of Phenotypic Resources. Animal Production and Health Guideline No.11. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, Rome, Italy.

Jain A., Barwa K., Singh M., Mukherjee K., Jain T. M.S., Tantla Raja K.N. and Sharma A. (2018). Physical characteristics of Kosali breed of cattle in its native tract. *Indian J. Anim. Sci.* **88,** 1362-1365.

Johnson R.A. and Wichern D.W. (1982). Applied Multivariate Statistical Analysis. Prentice-Hall, Inc., Hoboken, New Jersey.

Morrison D.F. (1976). Multivariate Statistical Methods. McGraw Hill Company, New York, USA.

Parés-Casanova P.M. and Mwaanga E.S. (2013). Factor analysis of biometric traits of Tonga cattle for body conformation characterization. *Glob. J. Multidisciplin. Appl. Sci.* **1,** 41-46.

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. *Anim. Res.* **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 confirmation. *Asian Australasian J. Anim. Sci.* **24,** 449-456.

SAS Institute. (2003). SAS®/STAT Software, Release 9.1. SAS Institute, Inc., Cary, NC. USA.

Savegnago R.P., Caetano S.L., Ramos S.B., Nascimento G.B., Schmidt G.S., Ledur M.C. and Munari D.P. (2011). Estimates of genetic parameters, and cluster and principal components analyses of breeding values related to egg production traits in a White Leghorn population. *Poult. Sci.* **90,** 2174-2188.

Schlegal A. (2017). Principal Component Analysis With R Example. Available at: https://aaronschlegel.me/principal-component-analysis-r-example.html.

Tavakkolian J. (2000). Genetic Resources of Native Farm Animals in Iran. Animal Science Research Institute of Iran Publication, Karaj, Iran.

Vohra V., Niranjan S.K., Mishra A.K., Jamuna V., Chopra A., Sharma N. and Jong D.K. (2015). Phenotypic characterization and multivariate analysis to explain body confirmation in lesser known buffalo (*Bubalus bubalis*) from North India. *Asian Australasian J. Anim. Sci.* **28,** 311-317.

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