Jurnal Veteriner
pISSN: 1411-8327; eISSN: 2477-5665
Terakreditasi Nasional, Dirjen Penguatan Riset dan Pengembangan,
Kemenristek Dikti RI S.K. No. 36a/E/KPT/2016

Juni 2024 Vol. 25 No. 1 : 225-234
DOI: 10.19087/jveteriner.2024.25.2.225
online pada http://ojs.unud.ac.id/index.php/jvet

Principal Component Analysis (PCA) of Body Measurements and Its Relationship with Body Weight in Jowo Super (Bangkok × Layer) Chicken

[ANALISIS KOMPONEN UTAMA (AKU) UKURAN TUBUH DAN HUBUNGANNYA DENGAN BOBOT BADAN PADA AYAM JOWO SUPER (BANGKOK × PETELUR)]

Mohammad Hasil Tamzil[1]*, Widya Pintaka Bayu Putra[2]

[1]Faculty of Animal Science, University of Mataram
Majapahit Rd. No. 62, Mataram,
West Nusa Tenggara, Indonesia 83125
[2]Research Center for Applied Zoology,
Research Organization for Life Sciences,
National Research and Innovation Agencey (BRIN)
Bogor-Jakarta Rd. Km. 46. Cibinong,
Bogor, West Java, Indonesia 16911

Email: emhatamsil@yahoo.com

ABSTRACT

The aim of this study was aimed to determine the total variation of the body weight (g) by using principal components analyses (PCA) of body measurements (cm) in 156 Joper (Bangkok × Layer) crossbred chickens consisting of 60 males and 96 females. In total twelve traits including body weight (BW), head circumference (HC), neck length (NL), wings length (WL), back length (BL), chest circumference (CC), chest width (CW), femur length (FL), tibia length (TiL), shank length (SL), shank circumference (SC) and third toe length (TL) were measured in each bird. The PCA of body measurements was performed by using a SPSS 16.0 package. Results determined three PC's in each sex group based on the body measurements. Five body measurements of WL, BL, FL, TiL and SL were included in the first component (PC1) in both sex group which were able to explain the BW variation by 76% in male and 61% in female. The first three PC explained 67.78% and 65.93% of total variance of the morphostructure of male and female birds, respectively. The Kaiser-Meyer-Olkin (KMO) value in both sex group was 0.80 which indicated the results of PC analyse were accurate. In conclusion, the body measurements of PC1 were influenced to BW of birds study.

Keywords**:** Crossbred chickens, Indonesia, PCA, Body measurements, Body weight

ABSTRAK

Tujuan penelitian adalah untuk mengetahui variasi bobot badan (g) dengan menggunakan Analisis Komponen Utama (AKU) ukuran tubuh (cm) pada 156 ekor ayam Joper (60 jantan dan 96 betina). Peubah yang diamati adalah: Bobot badan (BB), lingkar kepala (LK), panjang leher (PL), panjang sayap (PS), panjang punggung (PP), lingkar dada

(LiD), lebar dada (LD), panjang tulang paha (PTp), panjang tibia (PT), panjang shank (PS), lingkar shank (LS) dan panjang jari ketiga (PJk) yang diukur pada setiap ayam sampel. AKU ukuran tubuh dilakukan menggunakan paket SPSS 16.0. Hasil penelitian menunjukkan bahwa terdapat tiga komponen utama (KU) di setiap kelompok jenis kelamin. Lima ukuran tubuh PS, PP, PTp, PT dan PS dimasukkan dalam komponen utama (KU1) pada kedua kelompok jenis kelamin dan mampu menjelaskan variasi BB sebesar 76% pada pada ayam jantan dan 61% pada ayam betina. Tiga KU pertama menjelaskan masing-masing 67,78% dan 65,93% dari total varians morfostruktur ayam jantan dan betina. Nilai Kaiser-Meyer-Olkin (KMO) pada kedua jenis kelamin adalah 0,80 yang menunjukkan hasil analisis KU akurat. Kesimpulannya, ukuran tubuh KU1 berpengaruh terhadap bobot badan ayam yang diteliti.

Kata kunci: Ayam persilangan, Indonesia, PCA, ukuran tubuh, berat badan

INTRODUCTION

Poultry is one of the livestock animals which is widely kept by the farmers in the world for meat and egg productions. Recently, a lot of crossbred chickens have been developed in each country mainly to improve the production traits (Islam and Nishibori, 2010). In Indonesia, a crossbred chicken of Joper (Jowo Super) or Kampung Super has been developed from the crossbreeding of Bangkok roaster and layer hen since 1990 to improve meat production (Wibowo, 2013). Bangkok is a fighting type of rooster with a body weight of 3.01 ± 0.41 kg at 11.60 ± 2.69 months of age (Putra, 2018). The average weight of slaughter and carcass and also the percentage of carcass and average daily gain (ADG) of Joper chicken were reported 873.8-1242.2 g; 489.4-824.2 g, 56-68% and 15.53 g/day, respectively (Munira *et al.,* 2016; Jacob *et al.,* 2019; Sejati *et al.,* 2019). In adition, Joper chickens under intensive system able to reach 1877.00 ± 67.87 kg of body weight and 2.70 ± 0.02 of feed conversion ratio (Abadi *et al.,* 2022). Tamzil *et al.* (2020) reported that Joper chickens had the phenotypic characteristics of brown feather, yellow shank, red lobe, white skin, yellow beak and pea comb shape.

Evaluation of the morphostructure of Joper chickens is important to development of a standard breed in the future.A Principal component analysis (PCA) has been used to evaluate the morphostructure of indigenous chickens in Nigeria (Yakubu *et al.,* 2009; Vincent and Araku, 2017; Yakubu and Ari, 2018; Amao 2018), India (Saikhom *et al.,* 2018), Ethiopia (Negash, 2021) and Indonesia (Irmaya *et al.,* 2021; Maharani *et al.,* 2021). In addition, many studies have been worked with PCA to evaluate the morphostructure of many commercial chicken breeds such as Broiler (Udeh and Ogbu, 2011), White Leghorn (Dalal *et al.,* 2020) and Broiler crosses (Akporhuarho and Omoikhoje, 2017).

The PC analyses was determined the main components in chicken that influenced to body shape, body size and body weight (Yakubu *et al.,* 2009; Akporhuarho and Omoikhoje, 2017; Yakubu and Ari, 2018; Negash, 2021). Hence, the main (first) components of body measurements in chicken can be used as the selection criteria. This study was aimed to perform PCA in body measurements of Joper chickens managed with an intensive management system. The results of this study can be used as the early information to improve the Joper's performance in the future.

RESEARCH METHODS

Birds and research site

Total 156 Joper chickens that produced from crossbreeding (F1) between Bangkok cocks and Layer hen (ISA Brown)

were used as the experimental animals. The birds sample at 13 weeks of age were consisted of 60 males and 96 females. The birds were kept at Sasaka Utama Farm. This farm located at Lingsar Village, West Lombok Regency, West Nusa Tenggara of Indonesia with the altitude of 97 m above sea level. Thus, the farm situated at longitude 1150.46' to 1160.28' E and latitude 80.12' to 80.55' S. The air temperature was ranged about 21.03 to 32.75 °C with relative humidity about 82.75% and rainfall about 2099.04 mm/year.

Birds Management

The day old chick (DOC) of crossbred chickens were bought from Wonokoyo Farm, East Java, Indonesia. The DOC were raised at brooder cage along two weeks. Afterthat, birds were kept at the colony cage (10 birds/m^2) along 11 weeks with the rice husk for litter. A rice bran and commercial concentrate were given to the birds with the proportion of 0% : 100% (0-3 weeks of age), 10% : 90% (4 weeks of age), 20% : 80% (5 weeks of age), 30% : 70% (6 weeks of age), 40% : 60% (7 weeks of age), 50% : 50% (8 weeks of age), 60% : 40% (9 weeks of age) and 70% : 30% (10-13 weeks of age), respectively. The feed contain in commercial concentrate consisted of water (12%), crude protein (21%), crude fat (4%), crude fiber (4.5%), calcium (0.9-1.1 %) and phospor (0.7-0.9%).The water was given *ad libitum* with a New Castle disease (ND) vaccination. The birds management in Sasaka Utama Farm was maintained under low feed cost and inappropriate energy level.

Birds Measurements

The body weight (BW) data (g) was taken using a digital weighing scale in birds at 13 weeks of age. A total of 11 parameter body size were measured (cm) including head circumference (HC), neck length (NL), wings length (WL), back length (BL), chest circumference (CC), chest width (CW), femur length (FL), tibia length (TiL), shank length (SL), shank circumference (SC) and third toe length (TL) were measured in each bird according to Djego *et al.* (2019) and Trisiwi *et al.* (2017) as ilustrated in Figure 1.

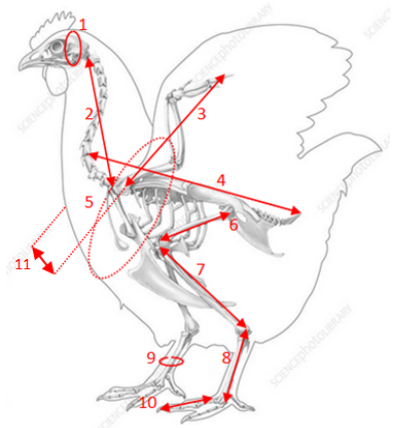

Figure 1. The scheme of body measurements in a chicken included of head circumference (1), neck length (2), wings length (3), back length (4), chest circumference (5), femur length (6), tibia length (7), shank length (8), shank circumference (9), third toe length (10) and chest width (11).

The HC was measured at the highest part of the head by wrapping the measuring tape. The NL was measured from the bone in of *cervical vertebrae* to *caudales vertebrae* using a caliper. The WL was measured from the *humerus* bone to the tip of the *phalanges* using a measuring tape. The BL was measured from the base of the neck to the base of the tail using a measuring tape. The CC was measured as

circumference of the body at the tip of the *pectus* (hind breast) using a measuring tape. The CW was measured as the distance from the left *sternum* to the right (the widest) using a caliper. The FL was measured from the mid region of *coxa* (hip bone) to *genu* (knee) using a caliper.The TiL was measured from the *patella* to the tip of the *tibia* bone using a caliper.The SL was measured along the *tarsometatarsus* bone using a caliper. The SC was measured as a circumference at the center of *tarso-metatarsus* bone (shank) using a caliper. The TL was measured from the base to the tip of the third toe using a caliper. The scheme of body measurements in chicken was ilustrated in Figure 1.

Data Analysis

Data collected were subjected to descriptive statistics of the Statistical Packages for Social Sciences (SPSS) software (SPSS, 2011). The relationships between BW and body measurements were determined using the correlation procedure. The principal component analysis (PCA) was described as a method for transforming the variables in a multivariate dataset into new variables, which are uncorrelated with each other and account for decreasing proportions of the total variance of the original variables. The mathematical model of PCA according to Ojonegecha *et al.* (2020) as follows: $PC_p = a_{1p}X_1 + a_{2p}X_2 + \ldots + a_{np}X_n$ where, PC_p is the p^{th} principal component, a_{np} is the n^{th} vector eigen of the p^{th} principal component and X_n is the n^{th} observed variables.

Kaiser-Meyer-Olkin (KMO) test of sampling adequacy and Bartlett's test of sphericity were conducted to establish the validity of the data set KMO's measure determines whether the common factor model is appropriate. The KMO and Bartlett's test should be >0.50 and <0.01, respectively for a satisfactory factor analysis to proceed. Despite this, simple and multiple linear regressions were performed in this study for identified the accuracy in each principal component (PC) when used as BW predictors. This analysis is important to evaluate PC1 in related to body weight of birds. The linear regression equation with the PC variable according to Ojonegecha *et al.* (2020) as follows: $BW = a + B_iPC_i + \ldots + B_nPC_n$ where, BW is the body weight, a is the regression intercept and B_i is the i^{th} partial regression coefficient of the i^{th} principal component (PC_i).

RESULTS AND DISCUSSION

Table 1. Descriptive statistics of body weight and body measurements in the crossbred Chicken

Sex / Parameter	Means	SD	CV (%)	Min.	Max.
Male (N = 60)					
Body weight (g)	1359.10	181.06	0.13	995.00	1914.00
Head circumference (cm)	11.98	0.58	0.05	10.50	13.40
Neck length (cm)	18.54	1.95	0.10	12.10	23.70
Wings length (cm)	21.33	1.10	0.05	19.30	24.40
Back length (cm)	17.15	1.28	0.07	14.00	20.00
Chest circumference (cm)	33.87	2.27	0.07	28.40	40.00
Chest width (cm)	6.27	0.64	0.10	4.60	8.22
Femur length (cm)	9.58	0.78	0.08	8.10	11.60
Tibia length (cm)	13.39	0.86	0.06	12.00	15.60
Shank length (cm)	8.74	0.92	0.10	7.30	13.50
Shank circumference (cm)	4.30	0.28	0.06	3.70	4.90
Third toe length (cm)	7.04	0.64	0.09	3.80	8.10

Continued Table 1. Descriptive statistics of body weight and body measurements in the crossbred Chicken

Female (N = 96)					
Body weight (g)	1068.69	152.19	0.14	554.00	1357.00
Head circumference (cm)	11.21	0.50	0.04	9.80	12.50
Neck length (cm)	17.63	1.49	0.08	11.40	20.30
Wings length (cm)	19.38	1.24	0.06	16.30	24.10
Back length (cm)	16.05	1.46	0.09	12.40	20.10
Chest circumference (cm)	31.19	2.22	0.07	20.20	36.00
Chest width (cm)	5.74	0.52	0.09	4.40	6.87
Femur length (cm)	8.80	0.73	0.08	6.40	10.90
Tibia length (cm)	11.93	0.78	0.07	9.50	14.40
Shank length (cm)	7.55	0.59	0.08	5.80	9.60
Shank circumference (cm)	3.84	0.30	0.08	3.00	4.80
Third toe length (cm)	6.20	0.46	0.07	5.00	7.50

Note: N: number of animal; SD: standard deviation; CV: coefficient of variation; Min.: minimum value; Max.: maximum value

Commonly, the average BW in males was higher than females as shown in Table 1. The moderate CV value (0.10-0.20) was showed in BW. Mostly the body measurements of birds study have low CV value (<0.10). However, NL, CW and SL measurements have the similar CV value in male chicken (0.10). The highest Pearson's coefficient of correlation (r) value in male and female birds were showed between BW-TiL (0.80) and BW-CC (0.74), respectively (Table 2).

Table 2. Pearsons coefficient of correlation among variables in male (above diagonal) and female (under diagonal) Joper chickens

Variable	BW	HC	NL	WL	BL	CC	CW	FL	TiL	SL	SC	TL
Body weight (BW)	-	0.58**	0.28*	0.69**	0.44**	0.77**	0.59**	0.67**	0.80**	0.60**	0.59**	0.46**
Head circumference (HC)	0.68**	-	0.13	0.43**	0.26*	0.47**	0.48**	0.46**	0.49**	0.42**	0.50**	0.32**
Neck length (NL)	0.22*	0.32**	-	0.10	0.06	0.37**	0.23*	0.22*	0.39**	0.15	0.32**	0.20*
Wings length (WL)	0.59**	0.59**	0.26*	-	0.46**	0.60**	0.41**	0.58**	0.60**	0.46**	0.53**	0.44**
Back length (BL)	0.44**	0.35**	0.06	0.48**	-	0.22*	0.13	0.49**	0.51**	0.45**	0.22*	0.27*
Chest circumference (CC)	0.74**	0.55**	0.19	0.46**	0.28*	-	0.47**	0.50**	0.66**	0.54**	0.45**	0.33**
Chest width (CW)	0.56**	0.37**	0.30**	0.13	0.05	0.50**	-	0.47**	0.47**	0.32**	0.48**	0.26*
Femur length (FL)	0.46**	0.27*	0.04	0.39**	0.26*	0.40**	0.22*	-	0.59**	0.56**	0.51**	0.24*
Tibia length (TiL)	0.67**	0.56**	0.23*	0.63**	0.43	0.55**	0.39**	0.54**	-	0.58**	0.43**	0.49**
Shank length (SL)	0.63**	0.63**	0.10	0.60**	0.50**	0.47**	0.35**	0.48**	0.70**	-	0.22*	-0.16
Shank circumference (SC)	0.46**	0.44**	0.29*	0.39**	0.13	0.38**	0.26*	0.26*	0.30**	0.36**	-	0.47**
Third toe length (TL)	0.46**	0.49**	0.26*	0.67**	0.25*	0.31**	0.23*	0.24*	0.41**	0.49**	0.45**	-

*(P<0.05); **(P<0.01)

Meanwhile, the lowest r value was showed in BL-NL (0.06) in male and female birds. A total of three (3) principal components (PC's) were obtained in birds study as shown in Table 3.

Table 3. Total variance explained and rotated component matrix in the body measurements of Jowo Super (Joper) chicken

Body measurements	Male				Female			
	PC1	PC2	PC3	EC	PC1	PC2	PC3	EC
Head circumference	0.47	0.44	0.25	0.47	0.49	0.53*	0.35	0.65
Neck length	-0.07	0.75*	0.05	0.57	-0.14	0.73*	0.20	0.59
Wings length	0.69*	0.22	0.41	0.70	0.75*	0.50	0.04	0.80
Back length	0.79*	-0.20	0.22	0.72	0.75*	0.02	-0.03	0.57
Chest circumference	0.49	0.65*	0.12	0.67	0.36	0.24	0.68*	0.66
Chest width	0.30	0.64*	0.18	0.53	-0.06	0.27	0.83*	0.77
Femur length	0.72*	0.35	0.13	0.66	0.55*	-0.11	0.48	0.55
Tibia length	0.67*	0.46	0.28	0.73	0.67*	0.19	0.50	0.74
Shank length	0.80*	0.32	-0.40	0.90	0.75*	0.21	0.37	0.74
Shank circumference	0.28	0.53	0.53*	0.64	0.19	0.65*	0.22	0.50
Third toe length	0.13	0.16	0.92*	0.89	0.48	0.67*	-0.02	0.68
Eigenvalues	3.36	2.39	1.70	-	3.10	2.16	2.00	-
Variance (%)	30.59	21.72	15.47	-	28.14	19.60	18.19	-
Cumulative (%)	30.59	52.31	67.78	-	28.14	47.74	65.93	-
KMO	0.80				0.84			
Barlett's test	0.00				0.00			

Note: PC: principal component; EC: extraction communalities; KMO: Kaiser-Meyer-Olkin value; *main component

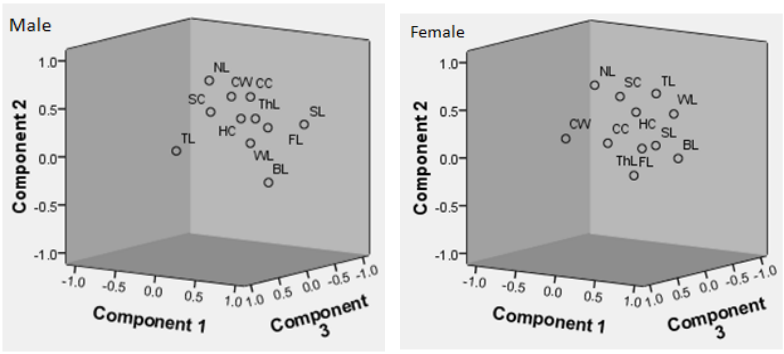

Figure 2. Component plot of body measurements in Jowo Super (Joper) chicken

The component plot of body measurements in Joper chickens was ilustrated in figure 2. The first component (PC1) in male and female birds were consisted of WL, BL, FL, TiL, and SL and these measurements were explained about 30.59% in male and 28.14% in female of the total variance of bird's morphostructure. However, about 67.78% in male and 65.93% in female of the total variance of bird's morphostructure were explained by all PC's. The results of PCA in the present study was accurate and signed by Kaiser-Meyer-Olkin (KMO) value more than 0.50 and significant of Bartlett's test ($P<0.01$). In addition, three PC's in Joper chicken were influenced the body weight about 79% in male and 73% in female as shown in Table 4.

Table 4. Total variance explained and rotated component matrix in the body measurements of many chicken breeds from previous studies

Breeds	Sex	Origin	N	$N_{morph.}$	N_{PC}	PC1 (%)	Total (%)	Reference
Normal Feathered	Mixed	Nigeria	125	8	3	73.94	87.84	Yakubu *et al.* (2009)
Frizzled	Mixed	Nigeria	51	8	3	74.68	89.20	Yakubu *et al.* (2009)
Arbor Acre	Mixed	Nigeria	60	7	2	40.58	64.96	Udeh and Ogbu (2011)
Marshall	Mixed	Nigeria	60	7	3	38.24	74.76	Udeh and Ogbu (2011)
Ross	Mixed	Nigeria	60	7	3	39.04	85.24	Udeh and Ogbu (2011)
♂Broiler × ♀Local	Male	Nigeria	30	7	3	28.20	62.27	Akporhuarho and Omoikhoje (2017)
♂Broiler × ♀Local	Female	Nigeria	84	7	3	21.44	54.27	Akporhuarho and Omoikhoje (2017)
♂Local × ♀Broiler	Male	Nigeria	30	7	3	37.25	70.24	Akporhuarho and Omoikhoje (2017)
♂Local × ♀Broiler	Female	Nigeria	84	7	3	26.16	56.63	Akporhuarho and Omoikhoje (2017)
Normal Feathered	Mixed	Nigeria	97	7	2	72.97	87.09	Vincent and Araku (2017)
Naked Neck	Mixed	Nigeria	59	7	3	77.09	90.91	Vincent and Araku (2017)
Local*	Mixed	Nigeria	300	9	2	65.44	83.14	Amao (2018)
Sasso	Mixed	Nigeria	50	8	3	67.20	87.37	Yakubu and Ari (2018)
Kuroiler	Mixed	Nigeria	50	8	3	86.09	93.89	Yakubu and Ari (2018)
Fulani	Mixed	Nigeria	50	8	2	62.05	78.85	Yakubu and Ari (2018)
Haringhata Black	Mixed	India	113	6	2	63.63	77.93	Saikhom *et al.* (2018)
White Leghorn	Mixed	India	-	12	1	75.31	75.31	Dalal *et al.* (2020)
Yoruba*	Mixed	Nigeria	96	6	6	37.11	85.03	Akuntunde *et al* (2021)
Local	Male	Ethiopia	134	4	2	45.33	81.92	Negash (2021)
Local	Female	Ethiopia	487	4	3	38.27	93.61	Negash (2021)
Marshall Broiler*	Mixed	Nigeria	96	6	6	38.51	82.52	Akuntunde *et al* (2021)
Black Kedu*	Male	Indonesia	10	11	4	44.44	84.19	Maharani *et al.* (2021)
Black Kedu*	Female	Indonesia	32	11	4	41.48	72.99	Maharani *et al.* (2021)
Gaga*	Male	Indonesia	18	11	3	47.40	68.77	Maharani *et al.* (2021)
Gaga*	Female	Indonesia	30	11	4	31.50	67.86	Maharani *et al.* (2021)
Merawang*	Male	Indonesia	10	11	5	25.65	91.56	Maharani *et al.* (2021)
Merawang*	Female	Indonesia	30	11	4	30.38	67.83	Maharani *et al.* (2021)
Nunukan*	Male	Indonesia	10	11	3	58.89	84.35	Maharani *et al.* (2021)
Nunukan*	Female	Indonesia	30	11	4	38.95	72.77	Maharani *et al.* (2021)
Pelung*	Male	Indonesia	10	11	4	38.53	84.87	Maharani *et al.* (2021)
Pelung*	Female	Indonesia	30	11	3	47.40	68.77	Maharani *et al.* (2021)

Note: N: number of bird; $N_{morp.}$: number of morphometrics; N_{PC}: number of principal component; *included body weight variable in PCA

The average BW of Joper chicken (13 weeks of age) in this study was 1359.10 ± 181.06 g (male) and 1068.69 ± 152.19 g (female). Interestingly, the average BW in Joper chickens was higher than another Indonesian native chicken (16 weeks of age) of Kampung (1261.01 ± 62.28 g), Sentul (1187.36 ± 85.95 g) and Merawang (1071.14 ± 161.78 g) breeds (Irmaya *et al.,* 2021). In addition, the average BW in Indonesian Naked-neck chicken was 927.00 ± 183.00 g (Susanti and Sopiyana, 2014) and lower than Joper chickens in the present study. In this study, the PC1 of male Joper chicken was described about 30.59% of the total variance of morphostructure and close to mixed-sex chicken of Marshall (38.24%) and Ross (39.04%) Yoruba (37.11%); female chicken of native Ethiopian (38.27%), Gaga (31.50%), Merawang (30.38%), Nunukan (38.95%) and male chicken of crossbred (Local cock × Broiler hen) of Nigeria (37.25%) and Pelung (38.53%) as shown in Table 4. Meanwhile, about 28.14% of total variance of morphostructure was described by PC1 in female Joper chicken and close to crossbred Broiler cock × Local hen (28.20% in male and 21.44% in female), female crossbred Local cock × Broiler hen (26.16%) and male Merawang (25.65%) as shown in Table 4. Three PCA in Joper chicken were

described about 60% of total variance of morphostructure and close to mixed-sex of Arbor Acre (64.96%), male crossbred of Broiler cock × Local hen (62.27%), Gaga (68.77% in male and 67.86% in female), female Merawang (67.83%) and female Pelung (68.77%) chickens as shown in Table 4. Commonly, three PC's of body measurements in Joper chicken were conducted to a high R^2 value (0.60-0.80) for explaining the BW as shown in Table 5.

Table 5. The relationship between principal components and body weight in Joper chicken

Sex / Component	Equation	R^2	SE
Male			
PC1	BW = 40.07 (PC1) - 1688.05	0.76	90.21
PC1; PC2	BW = 30.06 (PC1) + 14.06 (PC2) - 1801.01	0.78	85.64
PC1; PC2; PC3	BW = 25.97 (PC1) + 11.74 (PC2) + 18.13 (PC3) - 1923.74	0.79	84.59
Female			
PC1	BW = 35.06 (PC1) - 1128.66	0.61	95.22
PC1; PC2	BW = 26.30 (PC1) + 16.96 (PC2) - 1383.90	0.64	92.05
PC1; PC2; PC3	BW = 14.55 (PC1) - 1.21 (PC2) + 34.48 (PC3) - 1420.95	0.73	81.15

Note: BW: body weight; PC: pricipal component; R^2: coefficient of determination; SE: standard error of regression

However, Dudusola *et al.* (2021) reported that three PC's of body measurements were given a very high R^2 value (0.80-1.00) for explaining BW in Marshal (85%) and indigenous Nigerian (94%) chickens. The difference of the results study compared to the previous study can be caused by genetic, environment, measurement and management factors. In the future, the body measurements of PC1 can be used for morphometrical selection to develop general performance of Joper chickens.

The crossbreeding with a commercial (exotic) breed was improved the BW of chicken because of hybrid vigor effect (Isa *et al.,* 2020). By introducing new genes and new genotypes into the population, crossbreeding may improve total genetic diversity (Fulla, 2022). In addition, the sex dimorphism effect was occured in the chicken with the heavier body weight in male rather than in female (Sola-Ojo *et al.,* 2011). Hence, the Joper chickens were developed in Indonesia as the final stock for meat production purpose. However, body measurements of WL, BL, FL, TL and SL were observed as the PC1 in male and female of Joper chickens. In male Joper chickens, body measurements of NL, CC, CW and SC, TL were described as PC2 and PC3, respectively. While, HC, NL, SC, TL and CC, CW were described as PC2 and PC3 for female Joper chickens, respectively. In this study, the PC1 of body measurements had the relationship with body weight of male (76%) and female (61%) of Joper chickens.

CONCLUSION

Overall the BW and body measurements of Joper cocks were higher than Joper hens. The PCA analysis in this study was accurate with KMO = 0.80 and significant Bartlett's test ($P<0.01$). Three PC's of body measurements were described about 60-70% of total variance of morphostructure in Joper chicken. In addition, about 28-30% of BW in Joper chicken can be explained by PC1.

SUGESTION

Hence, five body measurements on PC1 such as WL, BL, FL, TL and SL were recommended for morphometrical selection to develop the body size or body shape and BW in male and female of Joper chickens.

ACKNOWLEDGMENTS

Acknowledgments are conveyed to Sasaka Utama Farm which has facilitated this research.

CONFLICT OF INTEREST

The authors declare that they had no conflict of interest.

REFERENCES

Akintunde AO, Toye AA, Ademola AA. 2021. Principal component analysis of body measurements in two genotypes of chickens fed graded levels of *Moringa oleifera* seed meal. *J Anim Prod Res* 33: 1-13.

Akporhuarho PO, Omoikhoje SO. 2017. Principal component analysis of body weight and biometric traits of F1 crossbred of exotic Broilers × Local chickens. *Niger J Sci Environ* 15: 94-103. DOI: 10.5987/UJ-NJSE.17.137.1

Amao SR. 2018. Application of principal component analysis on the body morphometric of Nigerian indigenous chickens reared intensively under Southern Guinea savanna condition of Nigeria. *J Environ Issues and Agriculture in Developing Countries* 10: 1-12.

Dalal DS, Ratwan P, Malik BS, Patil CS, Kumar M. 2020. Principal component analysis of morphological traits of synthetic White Leghorn chicken. Indian *J Anim Sci* 90: 1551-1555.

Djego Y, Kihe JN, Pangestuti HT. 2019. Efek komposisi genotip dari ayam ras petelur, kate dan lokal sabu terhadap sifat-sifat pada bobot badan dan ukuran tubuh. *Jurnal Nukleus Peternakan* 6: 20-25. DOI: https://doi.org/10.35508/nukleus.v6i1.1890

Dudusola IO, Bashiru HA, Adewuyi AA. 2021. Analysis of morphometric traits in heterogenous population of adult guinea fowl (*Numida meleagris*). *Niger J Anim Prod* 48: 6-17. DOI: https://doi.org/10.51791/njap.v48i2.2925

Irmaya D, Depison, Gushairiyanto. 2021. Quantitative characteristic of Indonesian native chickens at the age of 4 months. *Lives Anim Res* 19:108-119.

Islam MA, Nishibori M.. 2010. Crossbred chicken for poultry production in the tropics. *Poult Sci* 47: 271-279. DOI:https://doi.org.10.2141/jpsa.010033

Isa AM, Sun Y, Shi L, Jiang L, Li Y, Fan J, Wang P, Ni A, Huang Z, Ma H, Li D, Chen J. 2020. Hybrids generated by crossing elite laying chickens exhibited heterosis for clutch and egg quality traits. *Poult Sci* 99: 6332-6340.

Jacob CCRL, Jein SKS, Cherlie, MST, Linda MST. 2019. Appearance of super native chicken production through addition of Gedi leaf juice (*Abelmochus manihot L. medik*) in drinking water. *Zootec* 39: 362-370. DOI: https://doi.org/10.35792/zot.39.2.2019.25545

Maharani D, Mustofa F, Sari APZNL, Fathoni A, Sasongko H, Hariyono DNH. 2021. Phenotypic characterization and principle component analyses of indigenous chicken breeds in Indonesia. *Veterinary World*14:1665-1676. DOI:10.14202/vetworld.2021.1665-1676

Munira SLO, Nafiu, Tasse AM. 2016. Performans ayam kampung super pada pakan yang disubsitusi dedak padi fermentasi dengan fermentor berbeda. *Jurnal Ilmu Ternak Tropis*3:21-29. DOI: http://dx.doi.org/10.33772/jitro.v3i2.1683

Negash F. 2021. Application of principal component analysis for predicting body weight of Ethiopian indigenous chicken populations. *Trop Anim Health Prod* 53:104. https://doi.org/10.1007/s11250-020-02526-w

Ojonegecha AC, Musa AA, Okoh JJ, Okolo FA, Emmanuel AT, Efienokwu J. 2020. Principal component analysis of body measurements of Yankassa sheep in Anyigba, Kogi state, Nigeria. *Anim Vet Sci* 8: 45-50. https://doi.org.10.11648/j.avs.20200802.12

Sejati GCS, Arifin HD, Mudawaroch RE. 2019. Produktivitas ayam kampung super (Joper): pengaruh lisin dan metionin. *Jurnal Riset Agribisnis & Peternakan* 4: 43-51.

Sola-Ojo FE, Ayorinde KL, Bolu SAO, Toye AA, Kayode RMO, Alli OI, Adeyemi KD, Gomina P. 2011. Sexual dimorphism in growth traits and carcass characteristics in the Nigerian Fulani Ecotype chicken. *Am-Euras J Sustain Agric* 5: 371-377.

SPSS. (Statistical Package for Social Sciences). 2011. SPSS Inc., Chicago, IL60611.

Susanti T, Sopiyana S. 2014. Growth and body measurements characteristics of Naked Neck chicken as a local chicken genetic resources in Indonesia. *Proceeding.* National Seminar of Animal Husbandry and Veterinary Technology. Malang, Indonesia. August 12-14, 2014. Hlm. 532-537.

Tamzil MH, Indarsih B, Ichsan M, Jaya NS. 2020. Phenotypic characteristics of Super Kampong chickens raised asmeat producers. *Inter J Poult Sci* 19:524-530. DOI: 10.3923/ijps.2020.524.530 URL: https://scialert.net/abstract/?doi=ijps.2020.524.530

Trisiwi HF.. 2017. Pengaruh level protein pakan pada masa pertumbuhan terhadap penampilan pada awal peneluran ayam betina hasil persilangan ayam Kampung jantan dan ayam ras Petelur betina. *Jurnal Ilmu dan Teknologi Hasil Ternak* 12: 61-68. DOI:https://doi.org/10.21776/ub.jitek.2017.012.02.1.

Udeh I, Ogbu CC. 2011. Principal component analysis of body measurements in three strains of Broiler chicken. *Science World Journal* 6: 11-14. www.scienceworldjournal.org

Vincent ST, Araku JO. 2017. Collinearity diagnoses and and correction in predictive models of Nigerian local chicken of two genotypes using principal component analysis. *Glob J Anim Sci Res* 5: 1-13.

Wibowo A. 2013. Budidaya ayam Jowo Super (Joper) pedaging. http://www.pertanian.magelangkota.go.id. Accessed on May 26. 2022.

Yakubu A, Ari MM. 2018. Principal component and discriminant analyses of body weight and and conformation traits of Sasso, Kuroiler and indigenous Fulani chickens in *Nigeria.J Anim. Plant Sci* 28: 46-55.

Yakubu A, Kuje D, Okpeku M. 2009. Principal compoenents as measures size and shape in Nigerian indigenous chickens. *Thai J Agric Sci* 42: 167-176.