

BUKTI KORESPONDENSI AVR

BUKTI KORESPONDENSI DENGAN PENGELOLA JURNAL Tahun 2022 dengan Judul:
"Morphometric Traits of Imported Rabbits and Their Progenies".

No.	Tanggal	Keterangan
1.	13 April 2022	[AVR] Submission Acknowledgement for submitting the manuscript, "Morphometric traits of imported rabbits and their progenies" to Journal of Advanced Veterinary Research.
2.	20 Mei 2022	[AVR] Editor Decision: a decision regarding our submission to Journal of Advanced Veterinary Research, "Morphometric traits of imported rabbits and their progenies". the decision is: Revisions Required
3.	21 Mei 2022	Sutopo: we have revised the manuscript according to reviewer comments, and the responses are marked in yellow colour attached manuscript file and figure
4.	4 Juni 2022	[AVR] Editor Decision: a decision regarding our submission to Journal of Advanced Veterinary Research, "Morphometric Traits of Imported Rabbits and Their Progenies". The editor are pleased to inform me that our manuscript, "Morphometric Traits of Imported Rabbits and Their Progenies" has been accepted for publication in Journal of Advanced Veterinary Research.
5.	4 Juni 2022	[AVR] New notification from Journal of Advanced Veterinary Research: I have been added to a discussion titled "UNCORRECTED PROOF" regarding the submission "Morphometric Traits of Imported Rabbits and Their Progenies".



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[AVR] Submission Acknowledgement

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Prof. Mahmoud Rushdi <ed... Wed, Apr 13, 11:55 AM
to me

Dear Dr. Sutopo Sutopo:

Thank you for submitting the manuscript, "Morphometric traits of imp rabbits and their progenies" to Journal of Advanced Veterinary Rese. With the online journal management system that we are using, you v able to track its progress through the editorial process by logging in t journal web site:

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Editor-In-Chief Prof. ... Fri, May 20, 12:58 AM
to Setiaji, Lestari, Kurnianto, me

Dr. Setiaji, Lestari, Kurnianto, Sutopo Sutopo:

We have reached a decision regarding your submission to Journal o
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and their progenies".

Our decision is: Revisions Required

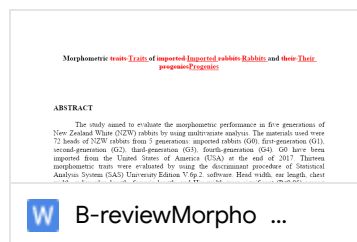
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B-reviewMorpho ...



dr sutopo <drsutopo36@g...
to Editor-In-Chief

Sat, May 21, 5:43 PM

1 **Morphometric ~~traits~~ Traits of imported ~~Imported rabbits~~ Rabbits and their ~~Their~~**
2 **progenies Progenies**
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7 **ABSTRACT**
8

9 The study aimed to evaluate the morphometric performance in five generations of New
10 Zealand White (NZW) rabbits by using multivariate analysis. The materials used were 72 heads
11 of NZW rabbits from 5 generations: imported rabbits (G0), first-generation (G1), second-
12 generation (G2), third-generation (G3), fourth-generation (G4). G0 have been imported from
13 the United States of America (USA) at the end of 2017. Thirteen morphometric traits were
14 evaluated by using the discriminant procedure of Statistical Analysis System (SAS)
15 University Edition V.6p.2. software. Head width, ear length, chest width, radius-ulna length,
16 femoris length, and Hip width were significant ($P < 0.05$) among generations. Radius-ulna
17 length, femoris length, and hip width showed the greatest contribution as distinguishing factors
18 between generations based on canonical structure. Imported rabbits confirmed specific
19 characteristics in morphometric traits, which differed from their progenies.
20

21 **Keywords:** Canonical structure, Discriminant procedure, Multivariate analysis, New Zealand
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Introduction

Rabbit is the potential animal to be developed in Indonesia. Rabbits have high prolificacy, fecundity, profitability, short generation interval, and high feed conversion efficiency (Lebas *et al.*, 1997; Daader *et al.*, 2016). Most of ~~the~~ rabbits raised by ~~the~~ farmers in Indonesia have been imported from Europe and the United States of America. One of the imported commercial breeds is New Zealand White (NZW), Rex, California, Satin, Hayla and Hycle.

Evaluation is important for assessing the adaptability of imported rabbit and their progenies. Growth, reproductive, carcass, and physiological traits were commonly used for evaluation programs (Marai *et al.*, 2005; Zerrouki *et al.*, 2008; Fathi *et al.*, 2017; Jimoh and Ewoula, 2018). Facts on morphometrics traits are an essential element of comparative studies of development. Morphometrics lets in the rigorous quantitative analysis of variants in organismal size and shape, and ~~is increasingly being~~ utilized increasingly in developmental contexts (Klingenberg, 2002). The study of the morphometric traits to evaluate among generations is limited. This study was conducted to evaluate the morphometric performance in five generations of NZW rabbits through multivariate analysis.

Material and methods

The data was obtained from 72 heads of NZW rabbits from 5 generations: imported rabbit (G0) (n=7), first-generation (G1) (n=17), second-generation (G2) (n=20), third-generation (G3) (n=16), fourth-generation (G4) (n=15). G0 have been imported to Indonesia from the American Rabbits Breeder Association (ARBA), United States of America (USA) at the end of 2017. G1 was the progenies of G0, G2 was the progenies of G1, and so on. The rabbits were raised in an intensive rearing system. The ~~unsex~~ rabbits with more than 12 months old were chosen. The morphometric evaluation was performed by measuring a total of 13 quantitative characteristics. ~~(Figure 1)~~. Morphometric traits measured ~~are comprising~~ ~~1)~~included head length (HL), ~~2)~~head width (HW), ~~3)~~ear length (EL), ~~4)~~ear width (EW), ~~5)~~ chest circumference (CC), ~~6)~~chest depth (CD), ~~7)~~chest width (CW), ~~8)~~radius-ulna length (RU), ~~9)~~femoris length (FM), ~~10)~~tibia length (TB), ~~11)~~humerus length (HM), ~~12)~~hip width (HP), and ~~13)~~body length (BL). The descriptive statistic of morphometric data is presented in Table 1.

Statistical analysis

Morphometric data was analyzed using Statistical Analysis System (SAS) University Edition V.6p.2. software (SAS, 2014). One-Way ANOVA was used for analyzing the effect of generation on body morphometric traits. Duncan's multiple ranges was used at 5% of probability. Discriminant analysis was performed to determine discriminant variables, canonical structure, mahalanobis distance, and distribution mapping among generations. The variance components are the discrimination from individual structure of canonical and distance of mahalanobis. The model was as follow:

$$C = \mu + \mu_0 y_0 + \mu_1 y_1 + \mu_2 y_2 + \mu_3 y_3 + \mu_4 y_4$$

Where; $\mu_0, \mu_1, \mu_2, \mu_3,$ and μ_4 are the estimate of canonical coefficients, and $y_0, y_1, y_2, y_3,$ and y_4 indicated the generations of NZW rabbits.

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100 Results

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102 The least-square means (LSM) and their standard deviations (SD) for the morphometric
103 traits of NZW rabbits according to generations are presented in Table 2. A significant
104 difference ($P < 0.05$) between different generations was observed for HW, EL, CW, RU, FM,
105 and HP. G0 showed the highest of HW, CW, RU, FM, and HP, whereas G2 ~~has had~~ the highest
106 of EL. G0 was similar with G1 for HW, EL, and CW; with G2 for CW, FM, HP; with G3 and
107 G4 for EL, CW, and FM.

108 Table 3. presented eigenvalues, and their contribution in each factor. The eigenvalues
109 of the three factors were 0.43, 0.36, and 0.28, and cumulative variations were 0.31, 0.61, and
110 0.82, respectively for the first, second and third factors. Table 4. shows the canonical analysis
111 based on morphometric traits, allowing identification of canonical variables (CAN1, CAN2,
112 and CAN 3). The greatest contribution in each canonical was FM, HP, and RU, respectively
113 for CAN1, CAN2, and CAN 3.

114 Distance of Mahalanobis between the populations are presented in Table 5. The longest
115 distance showed between G2 and G3. ~~Figure Fig. 21.~~ shows the same morphometric traits of
116 G1, G2, G3, and G4 were similar to each other but different with G0.

118 Discussion

119
120 Based on the LSM, HW, RU, and HP have become the most prominent traits for which
121 distinguish between imported breed and their progenies. This difference can be associated with
122 the influence of environment, feed quality, and management techniques (Elamin *et al.*, 2012;
123 Arandas *et al.*, 2017). On the other hand, HL, EW, CC, CD, TB, HM, and BL were not different
124 between generations. CD, TB, and BL were similar; CC and HM were longer; HL and EW
125 were shorter compared with morphometric of NZW reported by Brahmantiyo *et al.* (2021) in
126 Indonesian Research Institute for Animal Production, Ciawi, Bogor, West Jawa.

127 Third factors of eigenvalue explained the highest total variance (82%) of morphometric
128 traits. Setiaji *et al.* (~~2013~~2012), studied morphometric traits on Flemish Giant, English Spot,
129 Angora, and Rex breeds of rabbits, found three factors that explained 84% of the total variation.
130 The result was within range of total variance for morphometric traits reported in other species
131 (Yakubu *et al.*, 2011; Ajayi *et al.*, 2012; Birteeb *et al.*, 2013) in goat, chicken, and sheep,
132 respectively. RU, FM, and HP showed the greatest contribution in the three canonical variables.
133 This suggests that three traits are important in defining generational patterns (Yang *et al.*,
134 2006). That was different with the greatest contribution EL, CC, BL reported by Setiaji *et al.*
135 (~~2013~~2012) in grouping four breeds of rabbit.

136 The result of Mahalanobis distance indicates that despite belonging to the same rabbit
137 breed and same farm, there are differences among generations. The sensitivity and specificity
138 of Mahalanobis distance were calculated for the results of the discrimination of morphometric
139 traits in the validation group across generations (Rossi *et al.*, 2010). Furthermore, the progeny
140 with the shortest distance to G0 was G1, and due to the fact that G1 got a large direct genetic
141 effect from the G0. Whereas, the longest was between G0 and G2. G2 of NZW rabbits have
142 not adapted well to the environment and nutritional conditions. Then in G3 and G4 have been
143 adapted well with the results that the morphometric traits were nearly the same to which of G0.

144 As shown in ~~Figure Fig. 21,~~ highlighting a connection the NZW rabbits between
145 generations was observed. Morphological similarity showed possibility of close relationships
146 among generations (Hamilton *et al.*, 2005). In this study, G0 located on top side showed the
147 small size category, in which it differed from their progenies.
148

149 **Conclusions**

150 Imported rabbit showed different characteristic in morphometric and was classified into
151 small size category which differed from their progenies. The longest genetic distance was
152 shown between imported and second-generation progeny. Radius-ulna length, femur length,
153 and hip width showed the greatest contribution as distinguishing factors between generations.
154

155 **Conflict of interest**

156 The authors declare that they have no conflicts of interest.
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165 **References**

- 166
167 Ajayi, O.O., Adeleke, M.A., Sanni, M.T., Yakubu, A., Peters, S.O., Imumorin, I.G., Ozoje,
168 M.O., Ikeboi, C.O.N., Adebambo, O.A., 2012. Application of principal component and
169 discriminant analyses to morpho-structural indices of indigenous and exotic chickens
170 raised under intensive management system. *Tropical Animal Health and Production* 44,
171 1247-1254. DOI 10.1007/s11250-011-0065-1
- 172 Arandas, J.K.G., Vieira da Silva, N.M., Nascimento, R.B., Filho, E.C.P., Brasil, L.H.A.,
173 Riberio, M.N., 2017. Multivariate analysis as a tool for phenotypic characterization of
174 an endangered breed. *Journal of Applied Animal Research* 45, 152-158.
175 <http://dx.doi.org/10.1080/09712119.2015.1125353>
- 176 Birteeb, P.T., Peters, S.O., Yakubu, A., Adeleke, M.A., Ozoje, M.O., 2013. Multivariate
177 characterisation of the phenotypic traits of Djallonke and Sahel sheep in Northern Ghana.
178 *Tropical Animal Health and Production* 45, 267-274. DOI 10.1007/s11250-012-0211-4
- 179 ~~Brahmantiyo, B., Martojo, H., Mansjoer, S.S., Raharjo, Y.C., 2006. Estimation of genetic
180 distance of rabbit by morphometric analysis. *Indonesian Journal of Animal and Veteriner
181 Sciences* 11, 206-214. DOI: 10.14334/jitv.v11i3.527~~
- 182 Brahmantiyo, B., Nuraini, H., Putri, A.W., Mel, M., Hidayat, C., 2021. Phenotypic and
183 morphometric characterization of Hycleo, Hyla and New Zealand White Rabbits for
184 KUAT hybrid (tropical adaptive and superior rabbit). *Sarhad Journal of Agriculture* 37,
185 09-15. <https://dx.doi.org/10.17582/journal.sja/2021/37.s1.09.15>
- 186 Daader, A.H., Yousef, M.K., Abdel-Samee, A.M., Abd El-Nou, S.A., 2016. Recent trends in
187 rabbit does reproductive management: special reference to hot regions. In: *Proceeding of
188 the 11th World Rabbit Congress 15-18 June 2016, Qingdao, China*, pp. 149-166.
- 189 Elamin, K.M., Yousif, I.A., Ahmed, M.K.A., Mohammed, S.A., Eldar, A.A.T., 2012.
190 Estimation of genetic, phenotypic and environmental parameters of morphometric traits
191 in Sudanese rabbit. *Asian Journal of Animal Sciences* 6, 174-181. DOI:
192 10.3923/ajas.2012.174.181
- 193 Fathi, M., Abdelsalam, M., Al-Homidan, I., Ebied, T., El-Zarei, M., Abou-Emera, O., 2017.
194 Effect of probiotic supplementation and genotype on growth performance, carcass traits,
195 hematological parameters and immunity of growing rabbits under hot environmental
196 conditions. *Animal Science Journal* 88, 1644-1650. <https://doi.org/10.1111/asj.12811>
- 197 Hamilton, P.B., Stevens, J.R., Holz, P., Boag, B., Cooke, B., Gibson, W.C., 2005. The
198 inadvertent introduction into Australia of *Trypanosoma nabiasi*, the trypanosome of the

199 European rabbit (*Oryctolagus cuniculus*), and its potential for biocontrol. *Molecular*
200 *Ecology* 14, 3167-3175. <https://doi.org/10.1111/j.1365-294X.2005.02602.x>

201 Jimoh, O.A., Ewoula, E.O., 2018. Thermophysiological traits in four exotic breeds of rabbit at
202 least temperature-humidity index in humid tropics. *The Journal of Basic and Applied*
203 *Zoology* 78, 18. <https://doi.org/10.1186/s41936-018-0031-9>

204 Klingenberg, C.P., 2002. Morphometrics and the role of the phenotype in studies of the
205 evolution of developmental mechanisms. *Gene* 287, 3-10.
206 [https://doi.org/10.1016/S0378-1119\(01\)00867-8](https://doi.org/10.1016/S0378-1119(01)00867-8)

207 Lebas, F., Coudert, P., de Rochambeau, H., Thebault, R.G., 1997. The rabbit-Husbandry,
208 health and production: Food and Agriculture Organization of The United Nations.
209 [http://www.cuniculture.info/Docs/Documentation/Publi-Lebas/1990-1999/1997-Lebas-](http://www.cuniculture.info/Docs/Documentation/Publi-Lebas/1990-1999/1997-Lebas-&-al-The-rabbit-Husbandry-health-and-production.pdf)
210 [&-al-The-rabbit-Husbandry-health-and-production.pdf](http://www.cuniculture.info/Docs/Documentation/Publi-Lebas/1990-1999/1997-Lebas-&-al-The-rabbit-Husbandry-health-and-production.pdf). (accessed 8 November 2021).

211 Marai, I.F.M., Habeeb, A.A.M., Gad, A.E., 2005. Tolerance of imported rabbits grown as meat
212 animals to hot climate and saline drinking water in the subtropical environment of Egypt.
213 *Animal Science* 81, 115-123. <https://doi.org/10.1079/ASC41710115000>.

214 Rossi, E.E., Silveira Jr, L., Pinheiro, A.L.B., Zamuner, S.R., Aimbire, F., Maia, M., Pacheco,
215 M.T.T., 2010. Raman spectroscopy for differential diagnosis of endophthalmitis and
216 uveitis in rabbit iris in vitro. *Experimental Eye Research* 91, 362-368.
217 <https://doi.org/10.1016/j.exer.2010.06.005>

218 SAS, SAS/STAT., 2014. User's guide. Version 13.2. Cary: SAS Institute Inc.
219 <https://support.sas.com/documentation/onlinedoc/ets/132/etshpug.pdf>. (accessed 6
220 November 2021).

221 Setiaji, A., Sutopo, S., Kurnianto, E., 2012. Morphometric characterization and genetic
222 distance among four breeds of rabbit (*Oryctolagus cuniculus*). *Animal Production* 14,
223 92-98.

224 Yakubu, A., Salako, A.E., Imumorin, I.G., 2011. Comparative multivariate analysis of
225 biometric traits of West African Dwarf and Red Sokoto goats. *Tropical Animal Health*
226 *and Production* 43, 561-566. DOI: 10.1007/s11250-010-9731-y

227 Yang, Y., Mekki, D.M., Lv, S.J., Yu, J.H., Wang, L.Y., Wang, J.Y., Xie, K.Z., Dai, G.J., 2006.
228 Canonical correlation analysis of body weight, body measurement and carcass
229 characteristics of Jinghai Yellow Chicken. *Journal of Animal and Veterinary advances*
230 5, 980-984. <https://medwelljournals.com/abstract/?doi=javaa.2006.980.984>

231 Zerrouki, N., Hannachi, R., Lebas, F., Berchiche, M., 2008. Productivity of rabbit does of white
232 population in Algeria. In: *Proceeding of the 9th World Rabbit Congress 10-13 June 2008,*
233 *Verona, Italy*, pp. 1643-1647.

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Table 1. Descriptive statistic for morphometric data of New Zealand White rabbits

Trait ¹ (cm)	N ²	Minimum	Maximum	Mean	SD ³
HL	72	8.69	13.34	10.85	0.88
HW	72	4.41	6.35	5.36	0.41
EL	72	9.20	12.80	11.20	0.76
EW	72	5.40	7.30	6.52	0.36
CC	72	34.4	44.80	39.05	2.32
CD	72	7.99	11.83	10.14	0.86
CW	72	8.58	12.67	10.34	0.86
RU	72	7.95	12.10	9.55	0.80
FM	72	11.73	16.90	14.13	0.92
TB	72	12.25	16.60	15.04	0.89
HM	72	9.16	12.30	10.79	0.66
HP	72	9.34	13.93	12.07	0.95
BL	72	33.31	41.10	37.53	1.59

256 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
257 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
258 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length. ²N:
259 number of rabbits measured. ³SD: standard deviation.

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Table 2. Least square means of morphometric traits at different generations

Traits ¹ (cm)	Generations ²				
	G0	G1	G2	G3	G4
HL	10.35 ± 1.08	10.88 ± 1.01	11.00 ± 0.85	10.53 ± 0.52	11.11 ± 0.99
HW	5.74 ± 0.24 ^a	5.49 ± 0.43 ^{ab}	5.30 ± 0.28 ^b	5.31 ± 0.45 ^b	5.26 ± 0.46 ^b
EL	10.60 ± 0.65 ^b	11.14 ± 0.78 ^{ab}	11.41 ± 0.73 ^a	11.27 ± 0.67 ^{ab}	11.09 ± 0.85 ^{ab}
EW	6.72 ± 0.29	6.42 ± 0.49	6.58 ± 0.36	6.51 ± 0.19	6.53 ± 0.34
CC	39.80 ± 0.69	39.68 ± 2.64	39.44 ± 2.41	38.36 ± 1.92	38.37 ± 2.34
CD	10.38 ± 0.26	9.96 ± 0.75	10.22 ± 0.87	9.99 ± 1.01	10.34 ± 0.93
CW	10.98 ± 0.81 ^a	10.34 ± 0.51 ^{ab}	10.58 ± 0.83 ^{ab}	9.95 ± 1.02 ^b	10.26 ± 0.90 ^{ab}
RU	10.55 ± 1.03 ^a	9.65 ± 0.91 ^b	9.48 ± 0.74 ^b	9.18 ± 0.59 ^b	9.64 ± 0.72 ^b
FM	14.65 ± 0.68 ^a	13.72 ± 0.79 ^b	14.22 ± 0.73 ^{ab}	14.18 ± 0.93 ^{ab}	14.27 ± 1.21 ^{ab}
TB	15.22 ± 0.14	15.07 ± 0.84	15.32 ± 0.80	14.85 ± 0.99	14.80 ± 1.01
HM	10.90 ± 1.27	10.84 ± 0.59	10.72 ± 0.71	10.70 ± 0.47	10.90 ± 0.74
HP	13.14 ± 0.59 ^a	11.77 ± 0.96 ^b	12.37 ± 0.91 ^{ab}	12.07 ± 0.56 ^b	11.76 ± 1.18 ^b
BL	37.55 ± 1.35	37.80 ± 1.62	37.88 ± 1.71	37.79 ± 1.12	36.48 ± 1.67

292 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
293 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
294 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.

295 ²G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4:
296 fourth-generation.

297 ^{a-b}Means within the same row having different upper case letters differ significantly (P<0.05)
298 between generations.

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Table 3. Eigenvalues, and its contribution in each factor

Factors	Eigenvalues	Proportion variation (%)	Cumulative Cumulative variation (%)
First	0.43	0.33	0.31
Second	0.36	0.27	0.61
Third	0.28	0.22	0.82

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Table 4. Canonical structure for each morphometric traits

Traits ¹	CAN 1	CAN 2	CAN 3
HL	0.12	-0.24	0.43
HW	-0.35	0.43	0.11
EL	0.02	-0.29	-0.21
EW	0.24	0.29	-0.04
CC	-0.31	0.24	0.17
CD	0.27	0.13	0.19
CW	-0.01	0.44	0.32
RU	-0.05	0.56	0.49
FM	0.42	0.26	-0.11
TB	-0.11	0.21	0.02
HM	0.01	0.04	0.23
HP	0.14	0.62	-0.26
BL	-0.39	0.13	-0.43

374 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
375 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
376 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.
377 [Add abbreviation for CAN](#)

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Table 5. Distance of Mahalanobis, based on morphometric traits of NZW rabbits between generations

Generations ¹	G0	G1	G2	G3	G4
G0	1.00				
G1	0.13	1.00			
G2	0.22	0.18	1.00		
G3	0.16	0.19	0.41	1.00	
G4	0.14	0.07	0.35	0.25	1.00

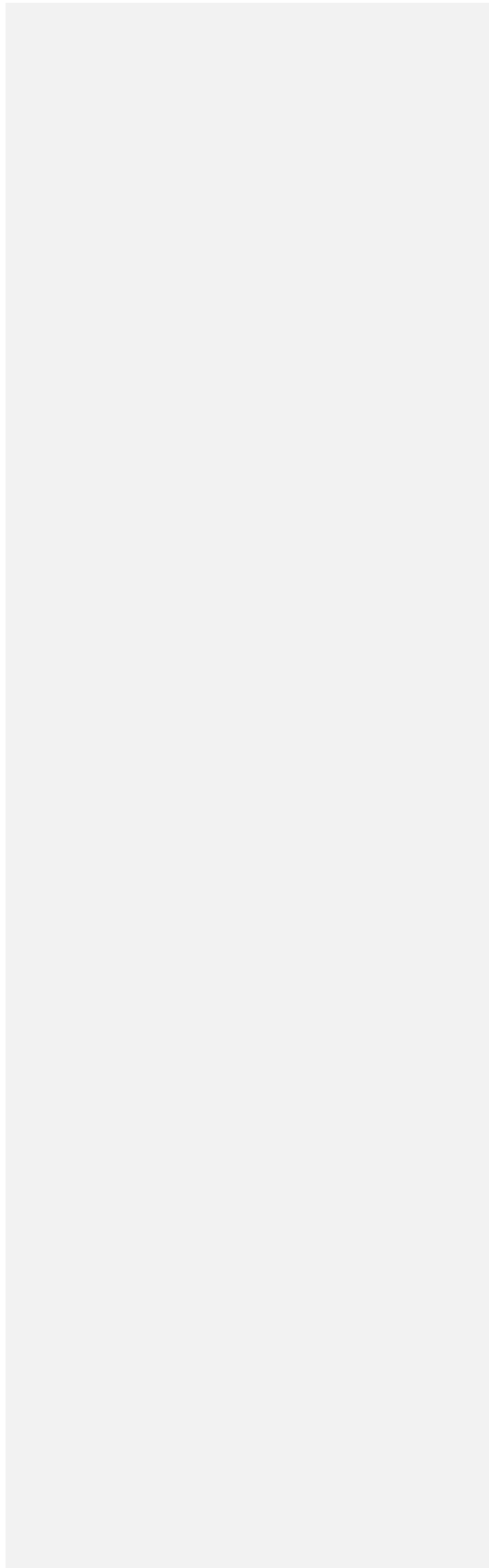
¹G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4: fourth-generation.

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Figure Legends

~~Figure 1: Morphometric traits of rabbits (Brahmantyo, 2006).~~

~~Figure Fig. 21: Scattering diagram of five generations based on canonical structure of the morphometric traits.~~





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Editor-In-Chief Prof. ... Fri, May 20, 12:58 AM
to Setiaji, Lestari, Kurnianto, me

Dr. Setiaji, Lestari, Kurnianto, Sutopo Sutopo:

We have reached a decision regarding your submission to Journal of Advanced Veterinary Research, "Morphometric traits of imported rabbits and their progenies".

Our decision is: Revisions Required

Please respond to the reviewers comments in the attached file.

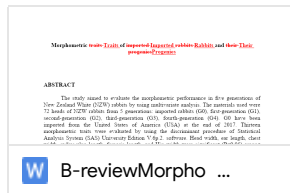
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B-reviewMorpho ...



dr sutopo <drsutopo36@g... Sat, May 21, 5:43 PM
to Editor-In-Chief

Dear Prof Mahmoud Rushdi

Thank you for your suggestion,
we have revised the manuscript according to reviewer comments, and the

1 **Morphometric Traits of Imported Rabbits and Their Progenies**

2
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51 **ABSTRACT**

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The study aimed to evaluate the morphometric performance in five generations of New Zealand White (NZW) rabbits by using multivariate analysis. The materials used were 72 heads of NZW rabbits from 5 generations: imported rabbits (G0), first-generation (G1), second-generation (G2), third-generation (G3), fourth-generation (G4). G0 have been imported from the United States of America (USA) at the end of 2017. Thirteen morphometric traits were evaluated by using the discriminant procedure of Statistical Analysis System (SAS) University Edition V.6p.2. software. Head width, ear length, chest width, radius-ulna length, femoris length, and Hip width were significant ($P < 0.05$) among generations. Radius-ulna length, femoris length, and hip width showed the greatest contribution as distinguishing factors between generations based on canonical structure. Imported rabbits confirmed specific characteristics in morphometric traits, which differed from their progenies.

Keywords: Canonical structure, Discriminant procedure, Multivariate analysis, New Zealand White.

99 **Introduction**

100

101 Rabbit is the potential animal to be developed in Indonesia. Rabbits have high
102 prolificacy, fecundity, profitability, short generation interval, and high feed conversion
103 efficiency (Lebas *et al.*, 1997; Daader *et al.*, 2016). Most of rabbits raised by farmer in
104 Indonesia have been imported from Europe and the United States of America. One of the
105 imported commercial breeds is New Zealand White (NZW), Rex, California, Satin, Hayla and
106 Hycole.

107 Evaluation is important for assessing the adaptability of imported rabbit and their
108 progenies. Growth, reproductive, carcass, and physiological traits were commonly used for
109 evaluation programs (Marai *et al.*, 2005; Zerrouki *et al.*, 2008; Fathi *et al.*, 2017; Jimoh and
110 Ewoula, 2018). Facts on morphometrics traits are an essential element of comparative studies
111 of development. Morphometrics let in the rigorous quantitative analysis of variants in
112 organismal size and shape and utilized increasingly in developmental contexts (Klingenberg,
113 2002). The study of the morphometric traits to evaluate among generations is limited. This
114 study was conducted to evaluate the morphometric performance in five generations of NZW
115 rabbits through multivariate analysis.

116

117 **Material and methods**

118 The data was obtained from 75 heads of NZW rabbits from 5 generations: imported
119 rabbit (G0) (n=7), first-generation (G1) (n=17), second-generation (G2) (n=20), third-
120 generation (G3) (n=16), fourth-generation (G4) (n=15). G0 have been imported to Indonesia
121 from the American Rabbits Breeder Association (ARBA), United States of America (USA) at
122 the end of 2017. G1 was the progenies of G0, G2 was the progenies of G1, and so on. The
123 rabbits were raised in an intensive rearing system. The age of rabbits chosen was more than
124 12 months old. The morphometric evaluation was performed by measuring a total of 13
125 quantitative characteristics. Morphometric traits measured included head length (HL), head
126 width (HW), ear length (EL), ear width (EW), chest circumference (CC), chest depth (CD),
127 chest width (CW), radius-ulna length (RU), femoris length (FM), tibia length (TB), humerus
128 length (HM), hip width (HP), and body length (BL). The descriptive statistic of morphometric
129 data is presented in Table 1.

130

131 **Statistical analysis**

132 Morphometric data was analyzed using Statistical Analysis System (SAS)
133 University Edition V.6p.2. software (SAS, 2014). One-Way ANOVA was used for analyzing
134 the effect of generation on body morphometric traits. Duncan's multiple ranges was used at 5%
135 of probability. Discriminant analysis was performed to determine discriminant variables,
136 canonical structure, mahalanobis distance, and distribution mapping among generations. The
137 variance components are the discrimination from individual structure of canonical and distance
138 of mahalanobis. The model was as follow:

139
$$C = \mu + \mu_0 y_0 + \mu_1 y_1 + \mu_2 y_2 + \mu_3 y_3 + \mu_4 y_4$$

140 Where; $\mu_0, \mu_1, \mu_2, \mu_3,$ and μ_4 are the estimate of canonical coefficients, and $y_0, y_1, y_2, y_3,$ and
141 y_4 indicated the generations of NZW rabbits.

142

143 **Results**

144

145 The least-square means (LSM) and their standard deviations (SD) for the morphometric
146 traits of NZW rabbits according to generations are presented in Table 2. A significant
147 difference ($P < 0.05$) between different generations was observed for HW, EL, CW, RU, FM,

148 and HP. G0 showed the highest of HW, CW, RU, FM, and HP, whereas G2 had the highest of
149 EL. G0 was similar with G1 for HW, EL, and CW; with G2 for CW, FM, HP; with G3 and G4
150 for EL, CW, and FM.

151 Table 3. presented eigenvalues, and their contribution in each factor. The eigenvalues
152 of the three factors were 0.43, 0.36, and 0.28, and cumulative variations were 0.31, 0.61, and
153 0.82, respectively for the first, second and third factors. Table 4. shows the canonical analysis
154 based on morphometric traits, allowing identification of canonical variables (CAN1, CAN2,
155 and CAN 3). The greatest contribution in each canonical was FM, HP, and RU, respectively
156 for CAN1, CAN2, and CAN 3.

157 Distance of Mahalanobis between the populations are presented in Table 5. The longest
158 distance showed between G2 and G3. Fig. 1. shows the same morphometric traits of G1, G2,
159 G3, and G4 were similar to each other but different with G0.

160

161 Discussion

162

163 Based on the LSM, HW, RU, and HP have become the most prominent traits for which
164 distinguish between imported breed and their progenies. This difference can be associated with
165 the influence of environment, feed quality, and management techniques (Elamin *et al.*, 2012;
166 Arandas *et al.*, 2017). On the other hand, HL, EW, CC, CD, TB, HM, and BL were not different
167 between generations. CD, TB, and BL were similar; CC and HM were longer; HL and EW
168 were shorter compared with morphometric of NZW reported by Brahmantiyo *et al.* (2021) in
169 Indonesian Research Institute for Animal Production, Ciawi, Bogor, West Jawa.

170 Third factors of eigenvalue explained the highest total variance (82%) of morphometric
171 traits. Setiaji *et al.* (2012), studied morphometric traits on Flemish Giant, English Spot, Angora,
172 and Rex breeds of rabbits, found three factors that explained 84% of the total variation. The
173 result was within range of total variance for morphometric traits reported in other species
174 (Yakubu *et al.*, 2011; Ajayi *et al.*, 2012; Birteeb *et al.*, 2013) in goat, chicken, and sheep,
175 respectively. RU, FM, and HP showed the greatest contribution in the three canonical variables.
176 This suggests that three traits are important in defining generational patterns (Yang *et al.*,
177 2006). That was different with the greatest contribution EL, CC, BL reported by Setiaji *et al.*
178 (2012) in grouping four breeds of rabbit.

179 The result of Mahalanobis distance indicates that despite belonging to the same rabbit
180 breed and same farm, there are differences among generations. The sensitivity and specificity
181 of Mahalanobis distance were calculated for the results of the discrimination of morphometric
182 traits in the validation group across generations (Rossi *et al.*, 2010). Furthermore, the progeny
183 with the shortest distance to G0 was G1, and due to the fact that G1 got a large direct genetic
184 effect from the G0. Whereas, the longest was between G0 and G2. G2 of NZW rabbits have
185 not adapted well to the environment and nutritional conditions. Then in G3 and G4 have been
186 adapted well with the results that the morphometric traits were nearly the same to which of G0.

187 As shown in Fig. 1, highlighting a connection the NZW rabbits between generations
188 was observed. Morphological similarity showed possibility of close relationships among
189 generations (Hamilton *et al.*, 2005). In this study, G0 located on top side showed the small
190 size category, in which it differed from their progenies.

191

192 Conclusions

193 Imported rabbit showed different characteristic in morphometric and was classified into
194 small size category which differed from their progenies. The longest genetic distance was
195 shown between imported and second-generation progeny. Radius-ulna length, femur length,
196 and hip width showed the greatest contribution as distinguishing factors between generations.

197

198 **Conflict of interest**

199

200 The authors declare that they have no conflicts of interest.

201

202 **Acknowledgments**

203

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208 **References**

209

210 Ajayi, O.O., Adeleke, M.A., Sanni, M.T., Yakubu, A., Peters, S.O., Imumorin, I.G., Ozoje,
211 M.O., Ikeboi, C.O.N., Adebambo, 2012. Application of principal component and
212 discriminant analyses to morpho-structural indices of indigenous and exotic chickens
213 raised under intensive management system. *Tropical Animal Health and Production* 44,
214 1247-1254. DOI 10.1007/s11250-011-0065-1

215 Arandas, J.K.G., Vieira da Silva, N.M., Nascimento, R.B., Filho, E.C.P., Brasil, L.H.A.,
216 Riberio, M.N., 2017. Multivariate analysis as a tool for phenotypic characterization of
217 an endangered breed. *Journal of Applied Animal Research* 45, 152-158.
218 <http://dx.doi.org/10.1080/09712119.2015.1125353>

219 Birteeb, P.T., Peters, S.O., Yakubu, A., Adeleke, M.A., Ozoje, M.O., 2013. Multivariate
220 characterisation of the phenotypic traits of Djallonke and Sahel sheep in Northern Ghana.
221 *Tropical Animal Health and Production* 45, 267-274. DOI 10.1007/s11250-012-0211-4

222 Brahmantiyo, B., Nuraini, H., Putri, A.W., Mel, M., Hidayat, C., 2021. Phenotypic and
223 morphometric characterization of Hycole, Hyla and New Zealand White Rabbits for
224 KUAT hybrid (tropical adaptive and superior rabbit). *Sarhad Journal of Agriculture* 37,
225 09-15. <https://dx.doi.org/10.17582/journal.sja/2021/37.s1.09.15>

226 Daader, A.H., Yousef, M.K., Abdel-Samee, A.M., Abd El-Nou, S.A., 2016. Recent trends in
227 rabbit does reproductive management: special reference to hot regions. In: *Proceeding of*
228 *the 11th World Rabbit Congress 15-18 June 2016, Qingdao, China*, pp. 149-166.

229 Elamin, K.M., Yousif, I.A., Ahmed, M.K.A., Mohammed, S.A., Eldar, A.A.T., 2012.
230 Estimation of genetic, phenotypic and environmental parameters of morphometric traits
231 in Sudanese rabbit. *Asian Journal of Animal Sciences* 6, 174-181. DOI:
232 10.3923/ajas.2012.174.181

233 Fathi, M., Abdelsalam, M., Al-Homidan, I., Ebied, T., El-Zarei, M., Abou-Emera, O., 2017.
234 Effect of probiotic supplementation and genotype on growth performance, carcass traits,
235 hematological parameters and immunity of growing rabbits under hot environmental
236 conditions. *Animal Science Journal* 88, 1644-1650. <https://doi.org/10.1111/asj.12811>

237 Hamilton, P.B., Stevens, J.R., Holz, P., Boag, B., Cooke, B., Gibson, W.C., 2005. The
238 inadvertent introduction into Australia of *Trypanosoma nabiasi*, the trypanosome of the
239 European rabbit (*Oryctolagus cuniculus*), and its potential for biocontrol. *Molecular*
240 *Ecology* 14, 3167-3175. <https://doi.org/10.1111/j.1365-294X.2005.02602.x>

241 Jimoh, O.A., Ewoula, E.O., 2018. Thermophysiological traits in four exotic breeds of rabbit at
242 least temperature-humidity index in humid tropics. *The Journal of Basic and Applied*
243 *Zoology* 78, 18. <https://doi.org/10.1186/s41936-018-0031-9>

244 Klingenberg, 2002. Morphometrics and the role of the phenotype in studies of the evolution of
245 developmental mechanisms. *Gene* 287, 3-10. [https://doi.org/10.1016/S0378-](https://doi.org/10.1016/S0378-1119(01)00867-8)
246 [1119\(01\)00867-8](https://doi.org/10.1016/S0378-1119(01)00867-8)

247 Lebas, F., Coudert, P., de Rochambeau, H., Thebault, R.G., 1997. The rabbit-Husbandry,
248 health and production: Food and Agriculture Organization of The United Nations.
249 <http://www.cuniculture.info/Docs/Documentation/Publi-Lebas/1990-1999/1997-Lebas->
250 [&-al-The-rabbit-Husbandry-health-and-production.pdf](http://www.cuniculture.info/Docs/Documentation/Publi-Lebas/1990-1999/1997-Lebas-&-al-The-rabbit-Husbandry-health-and-production.pdf).

251 Marai, I.F.M., Habeeb, A.A.M., Gad, A.E., 2005. Tolerance of imported rabbits grown as meat
252 animals to hot climate and saline drinking water in the subtropical environment of Egypt.
253 *Animal Science* 81, 115-123. <https://doi.org/10.1079/ASC41710115000>.

254 Rossi, E.E., Silveira Jr, L., Pinheiro, A.L.B., Zamuner, S.R., Aimbire, F., Maia, M., Pacheco,
255 M.T.T., 2010. Raman spectroscopy for differential diagnosis of endophthalmitis and
256 uveitis in rabbit iris in vitro. *Experimental Eye Research* 91, 362-368.
257 <https://doi.org/10.1016/j.exer.2010.06.005>

258 SAS, SAS/STAT., 2014. User's guide. Version 13.2. Cary: SAS Institute Inc.
259 <https://support.sas.com/documentation/onlinedoc/ets/132/etshpug.pdf>.

260 Setiaji, A., Sutopo, Kurnianto, E., 2012. Morphometric characterization and genetic distance
261 among four breeds of rabbit (*Oryctolagus cuniculus*). *Animal Production* 14, 92-98.

262 Yakubu, A., Salako, A.E., Imumorin, I.G., 2011. Comparative multivariate analysis of
263 biometric traits of West African Dwarf and Red Sokoto goats. *Tropical Animal Health*
264 *and Production* 43, 561–566. DOI: 10.1007/s11250-010-9731-y

265 Yang, Y., Mekki, D.M., Lv, S.J., Yu, J.H., Wang, L.Y., Wang, J.Y., Xie, K.Z., Dai, G.J., 2006.
266 Canonical correlation analysis of body weight, body measurement and carcass
267 characteristics of Jinghai Yellow Chicken. *Journal of Animal and Veterinary advances*
268 5, 980-984. <https://medwelljournals.com/abstract/?doi=javaa.2006.980.984>

269 Zerrouki, N., Hannachi, R., Lebas, F., Berchiche, M., 2008. Productivity of rabbit does of white
270 population in Algeria. In: *Proceeding of the 9th World Rabbit Congress* 10-13 june 2008,
271 Verona, Italy, pp. 1643-1647.

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297 Table 1. Descriptive statistic for morphometric data of New Zealand White rabbits

Trait ¹ (cm)	N ²	Minimum	Maximum	Mean	SD ³
HL	72	8.69	13.34	10.85	0.88
HW	72	4.41	6.35	5.36	0.41
EL	72	9.20	12.80	11.20	0.76
EW	72	5.40	7.30	6.52	0.36
CC	72	34.4	44.80	39.05	2.32
CD	72	7.99	11.83	10.14	0.86
CW	72	8.58	12.67	10.34	0.86
RU	72	7.95	12.10	9.55	0.80
FM	72	11.73	16.90	14.13	0.92
TB	72	12.25	16.60	15.04	0.89
HM	72	9.16	12.30	10.79	0.66
HP	72	9.34	13.93	12.07	0.95
BL	72	33.31	41.10	37.53	1.59

298 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
 299 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
 300 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length. ²N:
 301 number of rabbits measured. ³SD: standard deviation.

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Table 2. Least square means of morphometric traits at different generations

Traits ¹ (cm)	Generations ²				
	G0	G1	G2	G3	G4
HL	10.35 ± 1.08	10.88 ± 1.01	11.00 ± 0.85	10.53 ± 0.52	11.11 ± 0.99
HW	5.74 ± 0.24 ^a	5.49 ± 0.43 ^{ab}	5.30 ± 0.28 ^b	5.31 ± 0.45 ^b	5.26 ± 0.46 ^b
EL	10.60 ± 0.65 ^b	11.14 ± 0.78 ^{ab}	11.41 ± 0.73 ^a	11.27 ± 0.67 ^{ab}	11.09 ± 0.85 ^{ab}
EW	6.72 ± 0.29	6.42 ± 0.49	6.58 ± 0.36	6.51 ± 0.19	6.53 ± 0.34
CC	39.80 ± 0.69	39.68 ± 2.64	39.44 ± 2.41	38.36 ± 1.92	38.37 ± 2.34
CD	10.38 ± 0.26	9.96 ± 0.75	10.22 ± 0.87	9.99 ± 1.01	10.34 ± 0.93
CW	10.98 ± 0.81 ^a	10.34 ± 0.51 ^{ab}	10.58 ± 0.83 ^{ab}	9.95 ± 1.02 ^b	10.26 ± 0.90 ^{ab}
RU	10.55 ± 1.03 ^a	9.65 ± 0.91 ^b	9.48 ± 0.74 ^b	9.18 ± 0.59 ^b	9.64 ± 0.72 ^b
FM	14.65 ± 0.68 ^a	13.72 ± 0.79 ^b	14.22 ± 0.73 ^{ab}	14.18 ± 0.93 ^{ab}	14.27 ± 1.21 ^{ab}
TB	15.22 ± 0.14	15.07 ± 0.84	15.32 ± 0.80	14.85 ± 0.99	14.80 ± 1.01
HM	10.90 ± 1.27	10.84 ± 0.59	10.72 ± 0.71	10.70 ± 0.47	10.90 ± 0.74
HP	13.14 ± 0.59 ^a	11.77 ± 0.96 ^b	12.37 ± 0.91 ^{ab}	12.07 ± 0.56 ^b	11.76 ± 1.18 ^b
BL	37.55 ± 1.35	37.80 ± 1.62	37.88 ± 1.71	37.79 ± 1.12	36.48 ± 1.67

334 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
 335 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
 336 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.

337 ²G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4:
 338 fourth-generation.

339 ^{a-b}Means within the same row having different upper case letters differ significantly (P<0.05)
 340 between generations.

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369 Table 3. Eigenvalues, and its contribution in each factor

Factors	Eigenvalues	Proportion variation (%)	Cumulative variation (%)
First	0.43	0.33	0.31
Second	0.36	0.27	0.61
Third	0.28	0.22	0.82

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415 Table 4. Canonical structure for each morphometric traits

Traits ¹	CAN 1	CAN 2	CAN 3
HL	0.12	-0.24	0.43
HW	-0.35	0.43	0.11
EL	0.02	-0.29	-0.21
EW	0.24	0.29	-0.04
CC	-0.31	0.24	0.17
CD	0.27	0.13	0.19
CW	-0.01	0.44	0.32
RU	-0.05	0.56	0.49
FM	0.42	0.26	-0.11
TB	-0.11	0.21	0.02
HM	0.01	0.04	0.23
HP	0.14	0.62	-0.26
BL	-0.39	0.13	-0.43

416 ¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest
 417 Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris
 418 Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.
 419 CAN 1: first canonical; CAN 2: second canonical; CAN 3: third canonical.

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451 Table 5. Distance of Mahalanobis, based on morphometric traits of NZW rabbits between
452 generations

Generations ¹	G0	G1	G2	G3	G4
G0	1.00				
G1	0.13	1.00			
G2	0.22	0.18	1.00		
G3	0.16	0.19	0.41	1.00	
G4	0.14	0.07	0.35	0.25	1.00

453 ¹G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4:
454 fourth-generation.

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495 **Figure Legends**

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497 **Fig. 1.** : Scattering diagram of five generations based on canonical structure of the
498 morphometric traits.

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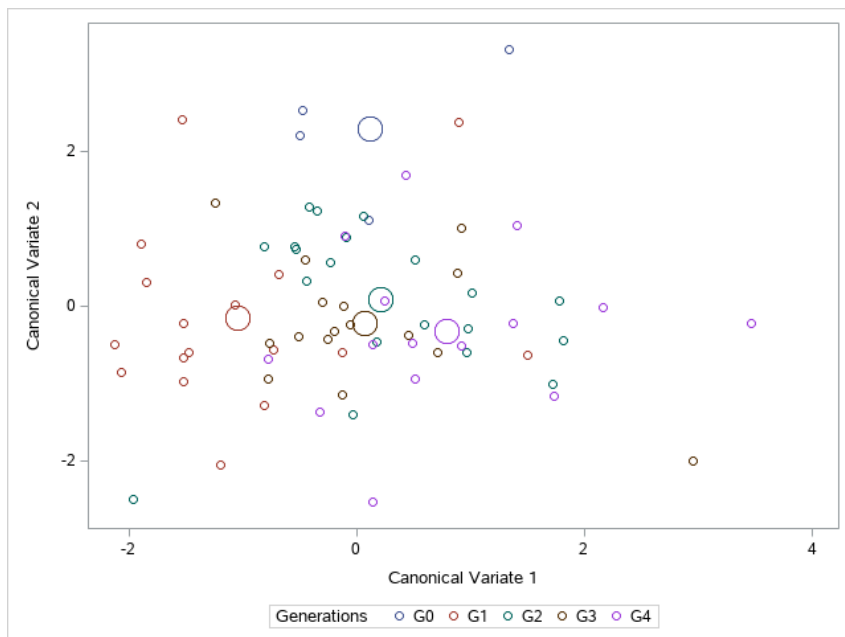


Fig. 1. Scattering diagram of five generations based on canonical structure of the morphometric traits.



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Editor-In-Chief Prof. M ... Sat, Jun 4, 3:38 AM
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Morphometric Traits of Imported Rabbits and Their Progenies

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Abstract



The study aimed to evaluate the morphometric performance in five generations of New Zealand White (NZW) rabbits by using multivariate analysis. The materials used were 72 heads of NZW rabbits from 5 generations: imported rabbits (G0), first-generation (G1), second-generation (G2), third-generation (G3), fourth-generation (G4). G0 have been imported from the United States of America (USA) at the end of 2017. Thirteen morphometric traits were evaluated by using the discriminant procedure of Statistical Analysis System (SAS) University Edition V.6p.2. software. Head width, ear length, chest width, radius-ulna length, femoris length, and Hip width were significant ($P < 0.05$) among generations. Radius-ulna length, femoris length, and hip width showed the greatest contribution as distinguishing factors between generations based on canonical structure. Imported rabbits confirmed specific characteristics in morphometric traits, which differed from their progenies.

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KEYWORDS

Canonical structure, Discriminant procedure, Multivariate analysis, New Zealand White.

INTRODUCTION

Rabbit is the potential animal to be developed in Indonesia. Rabbits have high prolificacy, fecundity, profitability, short generation interval, and high feed conversion efficiency (Lebas *et al.*, 1997; Daader *et al.*, 2016). Most of rabbits raised by farmer in Indonesia have been imported from Europe and the United States of America. One of the imported commercial breeds is New Zealand White (NZW), Rex, California, Satin, Hayla and Hycole.

Evaluation is important for assessing the adaptability of imported rabbit and their progenies. Growth, reproductive, carcass, and physiological traits were commonly used for evaluation programs (Marai *et al.*, 2005; Zerrouki *et al.*, 2008; Fathi *et al.*, 2017; Jimoh and Ewoula, 2018). Facts on morphometrics traits are an essential element of comparative studies of development. Morphometrics let in the rigorous quantitative analysis of variants in organismal size and shape and utilized increasingly in developmental contexts (Klingenberg, 2002). The study of the morphometric traits to evaluate among generations is limited. This study was conducted to evaluate the morphometric performance

in five generations of NZW rabbits through multivariate analysis.

MATERIALS AND METHODS

The data was obtained from 75 heads of NZW rabbits from 5 generations: imported rabbit (G0) ($n=7$), first-generation (G1) ($n=17$), second-generation (G2) ($n=20$), third-generation (G3) ($n=16$), fourth-generation (G4) ($n=15$). G0 have been imported to Indonesia from the American Rabbits Breeder Association (ARBA), United States of America (USA) at the end of 2017. G1 was the progenies of G0, G2 was the progenies of G1, and so on. The rabbits were raised in an intensive rearing system. The age of rabbits chosen was more than 12 months old. The morphometric evaluation was performed by measuring a total of 13 quantitative characteristics. Morphometric traits measured included head length (HL), head width (HW), ear length (EL), ear width (EW), chest circumference (CC), chest depth (CD), chest width (CW), radius-ulna length (RU), femoris length (FM), tibia length (TB), humerus length (HM), hip width (HP), and body length (BL). The descriptive statistic of morphometric data is presented in Table 1.

Statistical analysis

Morphometric data was analyzed using Statistical Analysis System (SAS) University Edition V.6p.2. software (SAS, 2014). One-Way ANOVA was used for analyzing the effect of generation on body morphometric traits. Duncan’s multiple ranges was used at 5% of probability. Discriminant analysis was performed to determine discriminant variables, canonical structure, mahalanobis distance, and distribution mapping among generations. The variance components are the discrimination from individual structure of canonical and distance of mahalanobis. The model was as follow:

$$C = \mu + \mu_0 y_0 + \mu_1 y_1 + \mu_2 y_2 + \mu_3 y_3 + \mu_4 y_4$$

Where; $\mu_0, \mu_1, \mu_2, \mu_3,$ and μ_4 are the estimate of canonical coefficients, and $y_0, y_1, y_2, y_3,$ and y_4 indicated the generations of NZW rabbits.

RESULTS

The least-square means (LSM) and their standard deviations (SD) for the morphometric traits of NZW rabbits according to generations are presented in Table 2. A significant difference ($P < 0.05$) between different generations was observed for HW, EL, CW, RU, FM, and HP. G0 showed the highest of HW, CW, RU, FM, and HP, whereas G2 had the highest of EL. G0 was similar with G1 for HW, EL, and CW; with G2 for CW, FM, HP; with G3 and G4 for EL, CW, and FM.

Table 3. presented eigenvalues, and their contribution in each factor. The eigenvalues of the three factors were 0.43, 0.36, and 0.28, and cumulative variations were 0.31, 0.61, and 0.82, respectively for the first, second and third factors. Table 4. shows the canonical analysis based on morphometric traits, allowing identification of canonical variables (CAN1, CAN2, and CAN 3). The

Table 1. Descriptive statistic for morphometric data of New Zealand White rabbits

Trait ¹ (cm)	N ²	Minimum	Maximum	Mean	SD ³
HL	72	8.69	13.34	10.85	0.88
HW	72	4.41	6.35	5.36	0.41
EL	72	9.2	12.8	11.2	0.76
EW	72	5.4	7.3	6.52	0.36
CC	72	34.4	44.8	39.05	2.32
CD	72	7.99	11.83	10.14	0.86
CW	72	8.58	12.67	10.34	0.86
RU	72	7.95	12.1	9.55	0.8
FM	72	11.73	16.9	14.13	0.92
TB	72	12.25	16.6	15.04	0.89
HM	72	9.16	12.3	10.79	0.66
HP	72	9.34	13.93	12.07	0.95
BL	72	33.31	41.1	37.53	1.59

¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length. 2N: number of rabbits measured. 3SD: standard deviation.

Table 2. Least square means of morphometric traits at different generations

Traits ¹ (cm)	Generations ²				
	G0	G1	G2	G3	G4
HL	10.35 ± 1.08	10.88 ± 1.01	11.00 ± 0.85	10.53 ± 0.52	11.11 ± 0.99
HW	5.74 ± 0.24 ^a	5.49 ± 0.43 ^{ab}	5.30 ± 0.28 ^b	5.31 ± 0.45 ^b	5.26 ± 0.46 ^b
EL	10.60 ± 0.65 ^b	11.14 ± 0.78 ^{ab}	11.41 ± 0.73 ^a	11.27 ± 0.67 ^{ab}	11.09 ± 0.85 ^{ab}
EW	6.72 ± 0.29	6.42 ± 0.49	6.58 ± 0.36	6.51 ± 0.19	6.53 ± 0.34
CC	39.80 ± 0.69	39.68 ± 2.64	39.44 ± 2.41	38.36 ± 1.92	38.37 ± 2.34
CD	10.38 ± 0.26	9.96 ± 0.75	10.22 ± 0.87	9.99 ± 1.01	10.34 ± 0.93
CW	10.98 ± 0.81 ^a	10.34 ± 0.51 ^{ab}	10.58 ± 0.83 ^{ab}	9.95 ± 1.02 ^b	10.26 ± 0.90 ^{ab}
RU	10.55 ± 1.03 ^a	9.65 ± 0.91 ^b	9.48 ± 0.74 ^b	9.18 ± 0.59 ^b	9.64 ± 0.72 ^b
FM	14.65 ± 0.68 ^a	13.72 ± 0.79 ^b	14.22 ± 0.73 ^{ab}	14.18 ± 0.93 ^{ab}	14.27 ± 1.21 ^{ab}
TB	15.22 ± 0.14	15.07 ± 0.84	15.32 ± 0.80	14.85 ± 0.99	14.80 ± 1.01
HM	10.90 ± 1.27	10.84 ± 0.59	10.72 ± 0.71	10.70 ± 0.47	10.90 ± 0.74
HP	13.14 ± 0.59 ^a	11.77 ± 0.96 ^b	12.37 ± 0.91 ^{ab}	12.07 ± 0.56 ^b	11.76 ± 1.18 ^b
BL	37.55 ± 1.35	37.80 ± 1.62	37.88 ± 1.71	37.79 ± 1.12	36.48 ± 1.67

¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.

²G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4: fourth-generation.

^{a,b}Means within the same row having different upper case letters differ significantly ($P < 0.05$) between generations.

Table 3. Eigenvalues, and its contribution in each factor.

Factors	Eigenvalues	Proportion variation (%)	Cumulative variation (%)
First	0.43	0.33	0.31
Second	0.36	0.27	0.61
Third	0.28	0.22	0.82

Table 4. Canonical structure for each morphometric traits

Traits ¹	CAN 1	CAN 2	CAN 3
HL	0.12	-0.24	0.43
HW	-0.35	0.43	0.11
EL	0.02	-0.29	-0.21
EW	0.24	0.29	-0.04
CC	-0.31	0.24	0.17
CD	0.27	0.13	0.19
CW	-0.01	0.44	0.32
RU	-0.05	0.56	0.49
FM	0.42	0.26	-0.11
TB	-0.11	0.21	0.02
HM	0.01	0.04	0.23
HP	0.14	0.62	-0.26
BL	-0.39	0.13	-0.43

¹HL: Head Length; HW: Head Width; EL: Ear Length; EW: Ear Width; CC: Chest Circumference; CD: Chest Depth; CW: Chest width; RU: Radius-ulna Length; FM: Femoris Length; TB: Tibia Length; HM: Humerus Length; HP: Hip Width; BL: Body Length.
CAN 1: first canonical; CAN 2: second canonical; CAN 3: third canonical.

Table 5. Distance of Mahalanobis, based on morphometric traits of NZW rabbits between generations.

Generations ¹	G0	G1	G2	G3	G4
G0	1				
G1	0.13	1			
G2	0.22	0.18	1		
G3	0.16	0.19	0.41	1	
G4	0.14	0.07	0.35	0.25	1

¹G0: imported rabbits; G1: first-generation; G2: second-generation; G3: third-generation; G4: fourth-generation.

greatest contribution in each canonical was FM, HP, and RU, respectively for CAN1, CAN2, and CAN 3.

Distance of Mahalanobis between the populations are presented in Table 5. The longest distance showed between G2 and G3. Fig. 1. shows the same morphometric traits of G1, G2, G3, and G4 were similar to each other but different with G0.

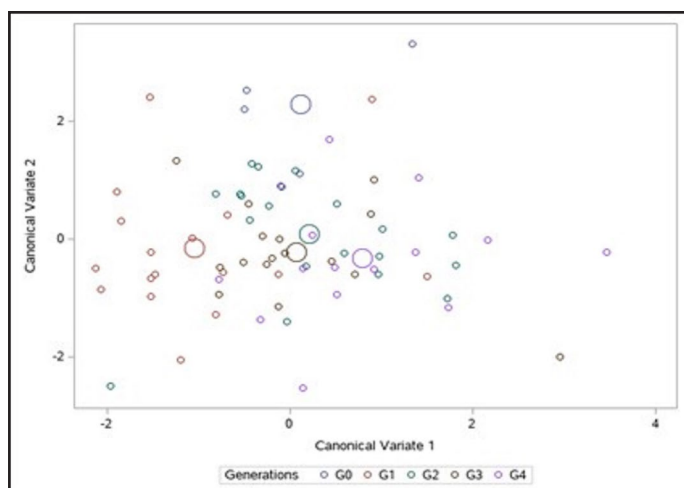


Fig. 1. Scattering diagram of five generations based on canonical structure of the morphometric traits.

DISCUSSION

Based on the LSM, HW, RU, and HP have become the most prominent traits for which distinguish between imported breed and their progenies. This difference can be associated with the influence of environment, feed quality, and management techniques (Elamin *et al.*, 2012; Arandas *et al.*, 2017). On the other hand, HL, EW, CC, CD, TB, HM, and BL were not different between generations. CD, TB, and BL were similar; CC and HM were longer; HL and EW were shorter compared with morphometric of NZW reported by Brahmantiyo *et al.* (2021) in Indonesian Research Institute for Animal Production, Ciawi, Bogor, West Jawa.

Third factors of eigenvalue explained the highest total variance (82%) of morphometric traits. Setiaji *et al.* (2012), studied morphometric traits on Flemish Giant, English Spot, Angora, and Rex breeds of rabbits, found three factors that explained 84% of the total variation. The result was within range of total variance for morphometric traits reported in other species (Yakubu *et al.*, 2011; Ajayi *et al.*, 2012; Birteeb *et al.*, 2013) in goat, chicken, and sheep, respectively. RU, FM, and HP showed the greatest contribution in the three canonical variables. This suggests that three traits are important in defining generational patterns (Yang *et al.*, 2006). That was different with the greatest contribution EL, CC, BL reported by Setiaji *et al.* (2012) in grouping four breeds of rabbit.

The result of Mahalanobis distance indicates that despite belonging to the same rabbit breed and same farm, there are

differences among generations. The sensitivity and specificity of Mahalanobis distance were calculated for the results of the discrimination of morphometric traits in the validation group across generations (Rossi *et al.*, 2010). Furthermore, the progeny with the shortest distance to G0 was G1, and due to the fact that G1 got a large direct genetic effect from the G0. Whereas, the longest was between G0 and G2. G2 of NZW rabbits have not adapted well to the environment and nutritional conditions. Then in G3 and G4 have been adapted well with the results that the morphologic traits were nearly the same to which of G0.

As shown in Fig. 1, highlighting a connection the NZW rabbits between generations was observed. Morphological similarity showed possibility of close relationships among generations (Hamilton *et al.*, 2005). In this study, G0 located on top side showed the small size category, in which it differed from their progenies.

CONCLUSION

Imported rabbit showed different characteristic in morphometric and was classified into small size category which differed from their progenies. The longest genetic distance was shown between imported and second-generation progeny. Radius-ulna length, femur length, and hip width showed the greatest contribution as distinguishing factors between generations.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

- Ajayi, O.O., Adeleke, M.A., Sanni, M.T., Yakubu, A., Peters, S.O., Imumorin, I.G., Ozoje, M.O., Ikeboi, C.O.N., Adebambo, 2012. Application of principal component and discriminant analyses to morpho-structural indices of indigenous and exotic chickens raised under intensive management system. *Tropical Animal Health and Production* 44, 1247-1254. DOI 10.1007/s11250-011-0065-1
- Arandas, J.K.G., Vieira da Silva, N.M., Nascimento, R.B., Filho, E.C.P., Brasil, L.H.A., Riberio, M.N., 2017. Multivariate analysis as a tool for phenotypic characterization of an endangered breed. *Journal of Applied Animal Research* 45, 152-158. <http://dx.doi.org/10.1080/09712119.2015.1125353>
- Birteeb, P.T., Peters, S.O., Yakubu, A., Adeleke, M.A., Ozoje, M.O., 2013. Multivariate characterisation of the phenotypic traits of Djallonke and Sahel sheep in Northern Ghana. *Tropical Animal Health and Production* 45, 267-274. DOI 10.1007/s11250-012-0211-4
- Brahmantiyo, B., Nuraini, H., Putri, A.W., Mel, M., Hidayat, C., 2021. Phenotypic and morphometric characterization of Hycle, Hyla and New Zealand White Rabbits for KUAT hybrid (tropical adaptive and superior rabbit). *Sarhad Journal of Agriculture* 37, 09-15. <https://dx.doi.org/10.17582/journal.sja/2021/37.s1.09.15>
- Daader, A.H., Yousef, M.K., Abdel-Samee, A.M., Abd El-Nou, S.A., 2016. Recent trends in rabbit does reproductive management: special reference to hot regions. In: *Proceeding of the 11th World Rabbit Congress 15-18 June 2016, Qingdao, China*, pp. 149-166.
- Elamin, K.M., Yousef, I.A., Ahmed, M.K.A., Mohammed, S.A., Eldar, A.A.T., 2012. Estimation of genetic, phenotypic and environmental parameters of morphometric traits in Sudanese rabbit. *Asian Journal of Animal Sciences* 6, 174-181. DOI: 10.3923/ajas.2012.174.181
- Fathi, M., Abdelsalam, M., Al-Homidan, I., Ebied, T., El-Zarei, M., Abou-Emera, O., 2017. Effect of probiotic supplementation and genotype on growth performance, carcass traits, hematological parameters and immunity of growing rabbits under hot environmental conditions. *Animal Science Journal* 88, 1644-1650. <https://doi.org/10.1111/asj.12811>
- Hamilton, P.B., Stevens, J.R., Holz, P., Boag, B., Cooke, B., Gibson, W.C., 2005. The inadvertent introduction into Australia of *Trypanosoma nabiasi*, the trypanosome of the European rabbit (*Oryctolagus cuniculus*), and its potential for biocontrol. *Molecular Ecology* 14, 3167-3175. <https://doi.org/10.1111/j.1365-294X.2005.02602.x>
- Jimoh, O.A., Ewoula, E.O., 2018. Thermophysiological traits in four exotic breeds of rabbit at least temperature-humidity index in humid tropics. *The Journal of Basic and Applied Zoology* 78, 18. <https://doi.org/10.1186/s41936-018-0031-9>
- Klingenberg, 2002. Morphometrics and the role of the phenotype in studies of the evolution of developmental mechanisms. *Gene* 287, 3-10. [https://doi.org/10.1016/S0378-1119\(01\)00867-8](https://doi.org/10.1016/S0378-1119(01)00867-8)
- Lebas, F., Coudert, P., de Rochambeau, H., Thebault, R.G., 1997. The rabbit-Husbandry, health and production: Food and Agriculture Organization of The United Nations. <http://www.cuniculture.info/Docs/Documentation/Public-Lebas/1990-1999/1997-Lebas-&-al-The-rabbit-Husbandry-health-and-production.pdf>.
- Marai, I.F.M., Habeeb, A.A.M., Gad, A.E., 2005. Tolerance of imported rabbits grown as meat animals to hot climate and saline drinking water in the subtropical environment of Egypt. *Animal Science* 81, 115-123. <https://doi.org/10.1079/ASC41710115000>.
- Rossi, E.E., Silveira Jr, L., Pinheiro, A.L.B., Zamuner, S.R., Aimbire, F., Maia, M., Pacheco, M.T.T., 2010. Raman spectroscopy for differential diagnosis of endophthalmitis and uveitis in rabbit iris in vitro. *Experimental Eye Research* 91, 362-368. <https://doi.org/10.1016/j.exer.2010.06.005>
- SAS, SAS/STAT., 2014. User's guide. Version 13.2. Cary: SAS Institute Inc. <https://support.sas.com/documentation/onlinedoc/ets/132/etshpug.pdf>.
- Setiaji, A., Sutopo, Kurnianto, E., 2012. Morphometric characterization and genetic distance among four breeds of rabbit (*Oryctolagus cuniculus*). *Animal Production* 14, 92-98.
- Yakubu, A., Salako, A.E., Imumorin, I.G., 2011. Comparative multivariate analysis of biometric traits of West African Dwarf and Red Sokoto goats. *Tropical Animal Health and Production* 43, 561-566. DOI: 10.1007/s11250-010-9731-y
- Yang, Y., Mekki, D.M., Lv, S.J., Yu, J.H., Wang, L.Y., Wang, J.Y., Xie, K.Z., Dai, G.J., 2006. Canonical correlation analysis of body weight, body measurement and carcass characteristics of Jinghai Yellow Chicken. *Journal of Animal and Veterinary advances* 5, 980-984. <https://medwelljournals.com/abstract/?doi=javaa.2006.980.984>
- Zerrouki, N., Hannachi, R., Lebas, F., Berchiche, M., 2008. Productivity of rabbit does of white population in Algeria. In: *Proceeding of the 9th World Rabbit Congress 10-13 June 2008, Verona, Italy*, pp. 1643-1647.