Prediction of Californian rabbits body weight from their body characteristics in Egypt

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Abstract: The present study was planned to analysis the different live body characteristics of the weanlings and adult of Californian rabbits which reared at the breeding unit of the Department of Hygiene and Preventive Medicine, Faculty of Veterinary Medicine, Kafrelshiekh University, Egypt. A total number of 36 Californian rabbits {16 weanlings (8-does and 8-bucks) with an average age of 35 days and 16 adults (8-does and 8-bucks) with an average age of 10 months} were used in this study to determine five body measurements (BMs), namely; Body length (BL), Head length (HL), Chest girth (CG), Ear length (EL) and Tail length (TL). Under this experiment, There was a highly significant difference in measured values between the weanlings and the adults in BW and all BMs except in the TL. On the other side, there was no significant difference in measured values between does and bucks in BW and all BMs, Although, the rabbit does showed slightly lower numerical values than bucks. The correlation matrix showed high, positive and significant values ($P<0.01$) among all studied traits and the highest coefficient were recorded between BW and CG ($r=0.939$). The findings of the regression coefficients revealed that, the CG was the best predictor of BW, contributing 95% of total variability. Finally, the obtained results revealed that the rabbit body measurements could be helpful in the rabbit selection for breeding and market live weight prediction and for genetic improvement.

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1. Introduction

Rabbits are fast growing animals with high reproductive potentials due to its short gestation period, early sexual maturity and ability to re-mate shortly after kindling. These characters confer on rabbits a potential to cover the shortage of animal protein in developing countries. The practical potential of rabbit meat in supplying the world's protein needs has been reported **(Rao *et al.,* 1977).** On the basis of body weight, the rabbits can be selected for growth (**Hassan *et al.,* 2012).** There is an indirect method to select the rabbit for growth depending on the ease of taking the measurements and how these measurements can predict its body weight (mass) **(Zergaw *et al.,* 2017).** One of these substitutes is the use of linear measurements **(Orheruata and Olutogun, 1994).** As,linear measurements have provided the information on animal morphology and have helped in making decisions on commercialization **(Osario *et al.,* 2002).** Morphometric traits in some cases can be more reliable than modern weighing machines as the latter can give biased measurements caused by gut fullness **(Obike *et al.,* 2010).** Genotype exerted significant influence ($p<0.05$) on body weight and other morphometric traits examined with cross bred NZR x CH genotype showing a superior performance on ear length, breast girth, and body length with pure bred NZR x NZR genotype showing supremacy in body weight and trotter length, thus implying a bigger size advantage over its contemporaries **(Onasanya *et al.,* 2017).**

The increase in body size or weight is one of the important criteria to select the rabbits as meat animals. Usually body weight is used to evaluate body development in the animals **(De-Brito *et al.,* 2002).** This way can't be isn't practiced by rabbit producers in the field due to non-availability of weighting balance. The different body parts develop at varying rates and these changes determine the shape, conformation and body proportion of the animal at a given time **(Olutogun *et al.,* 2003).** In meat animals, linear body measurements are important traits which can be used as a means for describing the size and shape of farm animals. Largely, body mass and shape can be estimated quantitatively by scale weights and generally described by visual appraisal giving rise to objective scores and such description as blocky, range of compact etc.. Surprisingly, there is a little information on linear body measurements of domestic rabbits in Egypt. The relationships among carcass measurements or linear measurements are finally established through the examination of computed regressions between them. These regression models can be used for evaluating the body weight of any animal, feeding optimization, skeletal size determination, live body weight gain, reproductive performance, optimum age for slaughtering, carcass characters and selection criteria **(Blasco and Gomex, 1993).**

Rabbit linear body measurements have been used to characterize breeds, evaluate breed performance, predict live body weight of the animal **(Ibe and Ezekwe, 1994)**, judgement on animal health, their feed managements, reproduction, performance and marketing of their products **(Mayaka, *et al.*, 1995).** The economic value of animals is determined visually in our local markets due to lack of scales, and such assessment doesn't reveal the actual economic value of the most of animals in compared to the assessment depending on the analysis of relationships among the different live body measurements.

The study of the sexual dimorphic could aid in the selection process in rabbits. Selection of the standard procedure for rabbit breeding and husbandry purposes can be decided on the study of body measurements and weights for both sexes of rabbits. Local rabbit breeds of Egypt had not been fully characterized. Accordingly, this study was aimed to analysis the live body characteristics of the weanlings and adult rabbits to achieve the actual economic value of the local rabbits on a scientific basis.

2. Material and Methods

Animals, housing and management: The present study was started in September 1, 2016 and planned to analysis the different live body characteristics of the weanlings and adult of Californian rabbits which reared at the breeding unit of the Department of Hygiene and Preventive Medicine, Faculty of Veterinary Medicine, Kafrelshiekh University, Egypt. A total number of 36 Californian rabbits {16 weanlings (8-does and 8-bucks) with an average age of 35 days and 16 adults (8-does and 8-bucks) with an average age of 10 months} were used in this study. These animals were housed individually in commercial hutches (60 x 55 x 40cm) provided with separate and clean facilities for feeding and watering (automatic nipple drinker). Each rabbit was vaccinated by; Cunipravac RHD (inactivated vaccine against hemorrhagic disease, HIPRA company) (0.5 ml S/C), formalized polyvalent rabbit pasteurellosis vaccine (Veterinary Serum and Vaccine Research Institute. Cairo, Egypt) (2ml S/C) and Ivermectin 1% against Mange (Memphis for Pharmaceuticals and Chemical Industries, Egypt) (0.2ml S/C).

The cages were cleaned daily from dropping (urine and feces). All rabbits were kept under identical care and the same hygienic environmental conditions. Under this experiment, the rabbits were fed on a pelleted commercial ration (18% crude protein, 10.19% crude fiber, 2.8% crude fat and 2635 kcal/kg) (Supervisor Company, Egypt). The feed was provided twice daily at 8 a.m. and 5 p.m., while drinking water was provided 3 times/day at 8 a.m., 4 and 12 p.m to provide a clean and fresh water. The Rabbitry was naturally ventilated through windows and provided with automatically controlled side exhaustion fans.

Measurements: In the early morning and before feed distribution for animals, the following body measurements were taken by the same person to avoid variations in values according to **Shawulu & Ajayi (2011);** the body weight (BW) was recorded in kilograms (kg) using a 10-kg weighing scale and according to **Chineke (2005)** by using a plastic tape; the following body characteristics were taken; body length (BL) is the horizontal distance from the front point of the withers to the pin bone (base of tail); head length (HL) is the distance from in-between the ears to the tip of the nose; ear length (EL) is the distance from the base of attachment of the ear to the head to the tip of the ear; tail length (TL) is the distance from the base of the tail to its apex and chest girth (CG) is measured as body circumference just behind the forelimbs.

Statistical analysis:

Table 1. Analytical models used in the Statistical analysis of this study.

I- Statistical model:	II- Generalized prediction model:
$Y_{ijk} = \mu + A_i + S_j + e_{ijk}$	$Y_i = a + \sum b_i X_i + e_i$
Where:	Where:
Yijk =estimated value for the BW or BMs	Yi =Dependent variable (BW)
μ = Population means	a= Intercept in the Y-axis
Ai = Fixed effect of age	bi =Partial regression coefficients
Sj =Fixed effect of sex	Xi = Independent variable (BMs)
eijk= Residual error	ei = Random error, which is identically, independently and normally distributed with zero mean and constant variance.

The obtained data were subjected to one-way ANOVA, Pearson's correlation coefficient were estimated using the General Linear Mode (GLM model) and two analytical models were used as shown in table 1.

3. Results and Discussion

The result presented in Table 2 showed that the measured values for BW and BMs of rabbits based on age. All body characteristics measured except TL showed significantly (P<0.05) higher values in the adults than the weanlings. These findings may be attributed to the age difference as age has been considered a major determinant of body weight and skeletal size of meat animals **(Salako, 2004; Ebegbulem *et al.*, 2011; Henry *et al.*, 2011).** If the age increases, the growth rate will increase resulting in an increasing in the body and skeletal size. Therefore, the adult animals produce a better meat values than very young one. But, there was no significant difference (P>0.05) observed in TL between the two different ages. This result may be explained by some body parts after a certain age in the life showed a genetic improvement.

Table 2. Values (Means ± S.E) of body weight and linear body measurements of different ages Californian rabbits

TL	HL	CG	EL	BL	BW	Age
8.35 ±0.16 [a]	10.59 ±0.11 [b]	21.20 ±0.32 [b]	10.70 ±0.12 [b]	25.49 ±0.33 [b]	2.38 ±0.05 [b]	**Growers** (N=16)
8.80 ±0.23 [a]	11.61 ±0.22 [a]	25.09 ±0.35 [a]	11.44 ±0.19 [a]	28.86 ±0.49 [a]	3.04 ±0.07 [a]	**Breeders** (N=16)

*Means which superscript with different small letters (a, b, c…) within the same column differ significantly at (P<0.05).

Regarding the sex difference, the data for BW and BMs of rabbits were presented in Table 3. The obtained results showed that, there was no significant (P>0.05) difference in all body characteristics studied between does and bucks. However, the does showed slightly lower numerical values in the body characteristics than bucks. These findings are in agreement with that reported by **Hassan and Ciroma (1992) and Onasanya *et al.* (2017)** who mentioned that sexual dimorphism evidently (p<0.05) influenced body weight with bucks showing supremacy in body weight indicating that bucks are bigger and heavier than the does. A positively high (p<0.01) and significant (p<0.05) relationships were established between body weight and other examined morphometric traits across all ages. On contrary, **Ebegbulem *et al.* (2011)** reported the non-significant differences in traits between both sexes are in tandem

Table 3. Values (Means ± S.E) of body weight and linear body of measurements of different sexes Californian rabbit.

Sex	BW	BL	EL	CG	HL	TL
Males (N=16)	2.77±0.11 [a]	27.77 ±0.64 [a]	11.28 **±0.20** [a]	23.16 **±0.54** [a]	11.16 **±0.23** [a]	8.51 **±0.27** [a]
Females (N=16)	2.67 **±0.09** [a]	26.81 **±0.49** [a]	10.94 **±0.16** [a]	23.11 **±0.53** [a]	11.07 **±0.19** [a]	8.61 **±0.15** [a]

*Means which superscript with different small letters (a, b, c…) within the same column differ significantly at (P<0.05).

The correlation analysis in BW is presented in table 4. The result of the correlation analysis in BW showed a highly positive correlation (ranging from 0.728-0.939) with all measured BMs, except TL which has a moderate correlation of 0.438 with BW (P<0.05). The high positive correlation between BW and the BMs suggest that selection for any of the body traits will lead to an increased BW in Californian rabbits. The magnitude of association of BW especially with CG, BL, HL, and EL indicates that these body traits are complementary and they represent a good body shape. Therefore, selection for any of the body traits would lead to an increasing in overall meat productivity of the rabbit. This result is in agreement with the reports of **Chineke (2000)** who reported a correlation coefficient range of 0.765-0.948 among body traits in rabbits and the results reported by **Tiamiyu *et al.* (2000)** and **Atansuyi *et al.* (2011)** who reported high positive correlation coefficient range of 0.89-0.98 between BW and EL, BL, and CG in rabbits.

Table 4. Correlation coefficient matrix of body weight and linear body measurements of different ages Californian rabbits

	BW	HL	BL	CG	EL	TL
HL	0.807^{**}					
BL	0.843^{**}	0.732^{**}				
CG	0.939^{**}	0.570^{**}	0.631^{**}			
EL	0.728^{**}	0.857^{**}	0.725^{**}	0.462^{*}		
TL	0.438^{*}	0.409^{*}	0.162	0.260	0.375	

* Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.

Under this study, a moderate positive correlation was observed between BW & TL (r = 0.438), HL & TL (r = 0.409) and CG & EL (r = 0.462). A low but positive correlation was observed between TL and BL, CG, and EL with coefficients of 0.162, 0.260, and 0.375 respectively. These results indicate that, the selection for any of these body traits will lead to a slow increasing in the other over many generations. The trend of correlation between TL and other BMs is at variance with the observation of **Henry *et al.* (2011)** in grass cutter and **Zergaw *et al.* (2017)** in Ethiopian goats.

A multiple regression analysis was used to determine the body traits combinations for best predictor of BW as shown in Table 5. A positive and significant relationship was observed between BW and the all values of measured BMs. The obtained results showed that CG contributed 95% of the total variability in BW and therefore is the best predictor of BW at any age in rabbits. TL, HL and EL are also good predictors of BW in rabbits having 77%, 58% and 57% contributions, respectively. These body traits would be useful in situations of unavailable scales, for proper appraising and evaluating of the rabbit. The high percentage of prediction of BW by CG is in agreement with some previous reports in rabbits **(Chineke, 2000; Atansuyi *et al.*, 2011; Isaac *et al.*, 2011)**. The positive values in the relationship between the body traits suggest that the BW is directly affected by any change in the BMs. Finally, selection and breeding for any of the BMs especially HG will lead to a corresponding increasing in BW of rabbits.

Table 5. Regression equation relating body weight and linear body measurements of different ages Californian rabbits.

BW =	-3.340	+0.0562 BL	+ 0.0636 EL	+ 0.094 CG	+ 0.0648 HL	+ 0.0838 TL
R= 0.943,		**R. sq =91.5%,**			**R. sq (adj) =88.2%**	

Analysis of variance (ANOVA)

P	F	MS	SS	DF	Source
0.00	68.76	2.309	7.097	5	Regression
		0.019	0.722	37	Error (residual)
				42	Total

4. Conclusion

From the obtained results, it could be concluded that the age of the rabbits is better than sexual dimorphism in predicting BW and BMs. BW was highly positively correlated with CG, BL, and HL which are good indicators of the body shape. Finally, CG can be used for body weight prediction and genetic improvement in local rabbit breeds of Egypt. Therefore, the using of linear body measurements for describing and evaluating body size would overcome any problem associated with visual evaluation.

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