Egypt. Poult. Sci. Vol. (45) (III) : (203-221) (2025) (2505-1330)

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

POSSIBILITIES OF PREDICTING MEAT QUANTITY AND BONE FROM SOME LIVE BODY MEASUREMENTS IN RABBITS

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Received :29/6/2025 Accepted : 2/8/2025

ABSTRACT: Possibilities of predicting meat quantity and with little of bone from non-offensive and non-exhaustive in vivo Linear Measures were examined using 103 males produced from a population of endogenous Egyptian Baladi (Black and Red), and their reciprocal crosses with the acclimatized New Zealand White rabbits in Egypt. Linear non-offensive, morphometric measures included body length (BL); chest transverse width (CW); thigh circumference (TC) and hind foot length (FL) at 12 Wks. In addition, two body weights were recorded: body weight at 12 weeks of age (BW12) and Preslaughter live body weight at 16 weeks of age (PLBW).

The model of multiple regression analysis for meat quantity and bone weight (BW) based on non-offensive in vivo linear measures recorded a significant (P< 0.001) for meat weight (MW) meaning that the model of (MW) is generally efficient from the statistical point of view on doing the desirable prediction, while it seemed to be non-significant in case of predicting (BW). The scatter plot of the data reveals that the relationship between the dependent and the independent variables is (as presumably assumed); tend to be linear with a tendency of the dependent variables to generally increase as the bulk values of the regressor increase (positive). When considering the ratio of variability of the model (regressors) is responsible for (R-square = 70 % for MW), prediction of MW % based on non- invasive in vivo Linear Measures individually (R2 = 66.8 to 67.8 %); or simultaneously (R2 = 70 %) was likewise reasonably possible, a low estimate was recorded for BW.

The Pearson correlation coefficients between the variables were statistically significant at (P < 0.01), with values ranging from 0.392 to 0.735. According to the Mallows C(p) statistic, Models 4, 5, and 6 for meat weight showed the most balanced performance, with R^2 values of approximately 0.689 and C(p) values ranging from 3 to 7. Notably, these models consistently included key predictors such as FL12 (Hind foot length), TC12 (thigh circumference), and PLBW (preslaughter live body weight), highlighting their significant contribution to prediction accuracy.

Conclusively**,** these findings underscore the value of multi-criteria model evaluation in animal breeding research and support the integration of statistical rigor in phenotypic selection strategies.

Keywords: Body length; Chest; Thigh; Meat and Bon weight; Backward multiple regression

INTRODUCTION

Body weight and linear body measurements are commonly used to characterize rabbit breeds and to assess variations in body size and shape (Shahin & Hassan, 2000). The authors also noted that these findings underscore the value of multi-criteria model evaluation in animal breeding research and support the integration of statistical rigor in phenotypic selection strategies. That linear relationships among predictor variables referred to as multicollinearity can affect model interpretations. In addition, such measurements are utilized to estimate carcass composition and body weight (Oliveira et al., 2005). Fernandez and Fraga (1996) stated that commercial carcass cutting techniques are simpler to perform compared to the direct determination of total lean content. Linear regression analysis remains one of the most commonly applied statistical methods, as it explores linear and additive relationships between variables. Udeh (2013) reported that Multicollinearity arises when two or more independent variables capture similar underlying information, which can result in unstable and unreliable estimates in multiple regression analysis. This issue can be effectively addressed by applying techniques such as ridge regression or principal component analysis, both of which help to substantially reduce multicollinearity. Multiple regression analysis has been employed to examine the complex relationships between body weight and various morphometric traits (Yakubu et al., 2012). However, the reliability of this approach may be compromised in the presence of multicollinearity among the predictor variables. While weighing scales are routinely used in organized livestock production systems to measure body weight, such equipment is often unavailable in field conditions or remote rural areas. Consequently, it becomes essential to develop practical alternatives, such as estimating body weight from linear body measurements using simple, low-cost tools like a measuring tape (Assan, 2013). Mallows' Cp selection is a model of selection technique that, like the Adjusted R^2 (ADJRSQ) method, evaluates multiple regression models; however, it relies on the Mallows' Cp statistic as the selection criterion, ranking models in ascending order of Cp values. In the context of smallholder livestock and poultry production systems where weighing scales are often unavailable there is a growing need for objective methods to describe and evaluate body weight and conformation traits. In this regard, morphometric characteristics, particularly linear body measurements, have drawn sustained interest in animal production as alternative indicators of productivity or as predictors of traits that are not easily measurable (Sapriyantono et al., 2012).

The first main objective is to determine the best set of parameters bi, such that the model explains/predicts experimental values of the dependent variable (Meat and Bone weight) as accurately as possible [i.e. calculated values of ýj should be very close to experimental values yj so that (yj- ýj)2 is minimum].The second objective is to judge whether the model itself is adequate to fit the observed experimental data (i.e. whether the chosen models significant and indicates the correct linear mathematical form of it), as well as to derive regression equations to estimate meat and bone weight in the carcass and it's in rabbits.

MATERIALS AND METHODS

Study location:

This experiment was carried out at the Experimental Rabbitry, Animal Production Research Institute, Agriculture Research Center, Sakha, Kafr El-Sheikh Governorate, Egypt, over two consecutive years.

Management of Animals:

One hundred and three male rabbits made up from seven mating groups, 60 males and 173 females aged 4 months were available for the study. The large numbers of sires and dams is due to not all the animals produced are evaluated and a sample of the produced males are drawn herein by random. Rabbits were lodged growing batteries in groups of five in universal galvanized wire cages arranged back to back in single-tier batteries provided with feeders and automatic nipple drinkers. All rabbits were fed on the same commercial pelleted grower diet containing approximately 17% crude protein, 2.39% crude fat and 12.8% crude fiber with digestible energy of 2550 kcal/kg diet. Feed and water were provided *ad libitum* all day long. All animals were reared under similar environmental, managerial lighting regimen in addition to hygienic treatment and conditions.

Traits measured:

Linear non-offensive, morphometric measures included body length (BL); chest transverse width (CW); thigh circumference (TC) and hind foot length (FL) at 12 Wks. Body weights included: Body weight at 12 weeks of age (BW12) and Preslaughter live body weight at 16 weeks of age (PLBW). Carcass traits evaluated included four months weight of the eviscerated carcass (forelegs, the thoracic cage with loin and hind legs; skinned Head; edible parts (spleen, kidneys, lungs and heart). The dissection of carcasses was carried out following the standard methodology proposed by Blasco and Ouhayoun (1996). After slaughtering and bleeding, carcasses were skinned and eviscerated. The reference carcass was considered without the skin, head, distal parts of the legs, and viscera.

Each carcass was then divided into the main commercial joints: hind legs, forelegs, and the thoracic cage with loin. From each joint, the soft tissues (muscles) were carefully separated manually from the skeletal tissues (bones). Muscle and bone weights were individually recorded using a precision balance. The evaluated rabbit population structure (Sire breed; dam breed; codes and numbers of progeny mating group) were presented in Table 1.

Statistical analysis:

The data were analysed to obtain least squares and compare means based on the procedure GLM of SAS (2005), as the following model:

$Y_{ijkl} = \mu + MG_i + SE_j + P_k + e_{ijkl}$

Where: Y_{ijkl}= The observed on the ijklmth animal; μ= The overall mean; MG_i= the fixed effect of the ith mating groups; SE_j= the fixed effect of the jth season of birth; P_k= A fixed effect of the kth parity and e_{ijkl}.

Data of in vivo linear measurements including chest transverse width (CW), thigh circumference (TC), hind foot length (FL), body length (BL), and body weight at 12 weeks of age (BW12) were used as predictor variables. Saleable carcass weights of male rabbits at four months of age were considered as response variables. The data were analyzed using the following regression model in SAS (2005).

$Y = a+b_1X_1+b_2X_2+ ... +bpXp+ e$

Where: Y= the dependent variable (experimental value of the male rabbit saleable carcass weights at four months of age in grams); a= intercept/constant; Xp= the pth independent variable (in vivo non-offensive Linear Measures) i.e. Body weight; Body length; Chest transverse width; Thigh circumference and Hind foot length; at 12 Wks. of age. b1, b2, ...,bP= the pth partial regression coefficients of Y on Xp's; and e = error term and is assumed to be normally independently distributed with mean = 0 and variance = $\sigma 2e$.

The regression analysis was performed using the Proc REG procedure of SAS (2005), in A Population of Baladi Rabbits and their reciprocal Crosses with New-Zealand White Rabbits using OLS approach.

Detecting multicollinearity:

To indicate multicollinearity, a high degree ofcorrelation among the independent variables, as among the considered predictors in the present study, tolerance value and variance inflation factor value (VIF) were calculated according to Montgomery (2001). The presence of linear relationships among predictor variables is termed multicollinearity (Shahin& Hassan 2000).

RESULTS AND DISCUSSION

From Table 2, the mean of meat and bone weight of the whole carcass weight (g.) ranged between 420 to 900 g. for meat and from 10 to 185 g. for bone weight. (average = 599.29 ± 6.86 and 80.92 ± 2.73, resp.). However, the body weight at 12 wks. of age in our study was the highest (CV % = 22.40) that has a high variability that selection can be done, and second highest was Preslaughter live body weight at 16 weeks of age, (CV% = 8.01) variable; while hind foot length at 12 Wks. (m.) is the lower variable regressor (CV% = 7.05). The mean body weight of rabbits at 12 Wks. of age, stated by Shehab El-Din et al. (2024) was 1554.80 g. which had the lower variability (9.37 %). While Gharib et al. (2020) observed that body weight of rabbits at 12 Wks. of age was 1240.61 g.) had the highest variability (22.32 %) and the lower variable (7.10 %) by body length. However, the mean body weight of rabbits at 6 months of age, stated by Udeh (2013) was 2.05 kg. which (Body weight of rabbits) had the highest variability (14.8 %), followed by heart girth (8 %), and at least by body length (4.96 %).

Furthermore, Silva et al. (2008) reported that live weight ranged from 1,200 to 3,410 g, with a coefficient of variation (CV) of 23.9%. On average, meat and bone weights were 781 g and 160 g, respectively, with CVs of 31.5% and 23.8%. Loin length varied between 11.4 and 12.4 cm, showing CVs ranging from 14.2% to 15.2%. Also Shahin & Hassan (2002) reported that body weight of rabbits was more variable than any other body measurements. While Hassan et al. (2012) reported high coefficient of variation for body weight and height at withers and moderate for heart girth. "The observed differences in the coefficients of variability for body trait among the studied animals may reflect variations in environmental conditions to which the animals were exposed. This is consistent with the findings of Udeh (2013), who reported that environmental factors play a significant role in shaping phenotypic variability.

From table 3, the only significant was the season effect (P≤ 0.05) on bone weight, while none of the fixed factors that characterized the studied population showed any significant effects (P≥ 0.05) on the dependent variable (both Meat and bone weight variables). On the other hand, most of the SE of the means are within acceptable ranges. Some combinations of measurements such as retail cut weights or length measurements are necessary to predict lean percentage in the carcass, (Yalçın et. Al., 2006). Fernandez and Fraga (1996) stated that, commercial cutting techniques are easier to carry out than the determination of total lean content in the carcass and reported that the mean values for slaughter weight was, 1,722, and carcass weights 841 (48.8 %) without its giblets. our study was similar to those described by some researchers (Ouyed and Brun, 2008; Hanaa et al., 2014 and Amira El-Deighadi et al., 2021), and lower than those reported by others (Dal Bosco et al., 2002; Trocino et al., 2003). These differences might be due to the country, slaughter age, breeding, weaning age and feeding conditions (Fernandez and Fraga, 1996). To increase the slaughter weight of rabbits, heavier genotypes could be used, or the age of slaughter could be delayed. Slaughtering rabbits at heavier weights could increase all of the desirable characteristics such as the weight of joints.

From Table 4, the correlation coefficients (r) among the studied variables (meat and bone weight, Y; body weight at 12 weeks of age, X1; body length, X2; chest transverse width, X3; thigh circumference , X4; hind foot length , X5; and preslaughter live body weight, X6) are presented. There was a high positive correlation among the independent regressors (X's), except for hind foot length (X5), which showed a significant correlation with preslaughter live body weight (r = 0.392, P < 0.01), while it exhibited no significant and only weak correlations with the other regressors. This indicates a high level of predictability among the studied variables. Our findings are consistent with those reported by other researchers (Hanaa et al., 2014; Rotimi et al., 2021; Amira El-Deighadi et al., 2021). Rotimi et al. (2021) in NZW at 12 wks of age, observed had high and positive phenotypic correlation coefficient values (r), with values ranging from r = 0.623 (between BW and BL) to r = 0.786 (between BW and TC). Akinsola, et al. (2014) observed that the strong association between body weight and body measurements could serve as a valuable selection criterion, as the positive correlations among these traits indicate that they may be influenced by the same genetic factors (pleiotropy). A similar observation was reported by Udeh (2013) in Chinchilla breed at 16 wks. of age (0.85 – 0.84), and Yakubu and Ayoade (2009) in Chinchilla X New Zealand white rabbits. However, the weaker the correlation between the independent variable (FL vs all other regressors and the other variables), involved in the regression analysis the more strength is the model chosen. The Higher these correlations are the greater the chance to get Multicollinearity to the extent the model is no more reliable unless some of these highly correlated variables are removed from the model. This explains why the best model was contained with FL variable. These values of high product moment correlation coefficients among the independent variables may necessitate evaluating the Multicollinearity of the chosen model.

It could be extrapolated from Table 5 that regression model is significant (P<0.01); for the dependent variable (Meat weight) which means that it is efficient in expressing the relation between the dependent and the regressors/independent variables. while it detected no sig. for the other dependent var. (Bone weight). The value of R^2 (0.70) is also reasonable and revealed that 70 % of the variability of the dependent (Meat weight) are explained by the involved independent variables and putting in mind the that 30 % are explained by other variables); while 8 % only of the variability of the dependent variable (Bone) are explained by the same independent (regressors) involved. Silva et al. (2008) found that the regression models for meat and bone weight as dependent variables were statistically significant (P < 0.01). The coefficient of determination (R^2) values was 0.801 for meat weight and 0.714 for bone weight, indicating strong model fit. Similar findings were reported by other researchers, including Montes-Vergara et al. (2020) and Andrea et al. (2022), confirming the reliability of such predictive relationships.

From the OLS ANOVA (Table 6), the first and second models of Meat weight are significant (P< 0.001) while the first model only for Bone weight is the same (P< 0.05) which may mean that the in vivo non-offensive Linear regressors are quite suitably and reliably chosen for predicting the dependent variable (Meat and Bone weights). The whole model value of R-square (the amount of trait variability that is justified by the applied model), is extremely high that ranged from (0.63 – 0.68) for Meat and low which ranged from (0.063 - 0.077) for Bone, that convenient when considering a polygenic trait like Bone weight. The most important regressor in these two models of Meat weight is the preslaughter live body weight. which is responsible for 0.637 of the whole explained variance of the full model 68.9 % that responsible for 0.923 of the whole variance of Meat weight variable, followed by hind foot length at 12 Wks. of age which is responsible for 0.065 of the whole Var. that adding more 4.49 % to the variance of the whole model; pursued by thigh circumference at 12 Wks. of age 68.5 % that sharing by 0.005 % of the total variance. However, in case of the first model of Bone weight is very low (0.063), while it is sharing with 0.81 % of its whole var. (0.077) with the BL12 followed by TC12 that adding 0.108 to the variance of the first model. As regard to the last result these regressors chest transverse width (CW), or body length (BL) or thigh circumference (TC) at 12 Wks. of age and BW12, adding these regressors caused a lot of nuisance in predicting Meat Weight Var. and has a awfully demoted and downgraded the value of adjusted R-Squared may indicate collinearity of this variable which will be checked latter using variance inflation factor (VIF) and the tolerance value.

Therefore and judging only for now from R-Squared and Adjusted R-Squared, the efficient model, the second model with the best R-Squared (Table 6) which is significant (P< 0.001), while it was the first model (in case of Bone weight) with a sig. (0.05). This implies that Meat and Bone weight of rabbits could be predicted with a high degree of accuracy from the linear measures (preslaughter live body weight, hind foot length and body length). Based on these results, it is advisable to rely on simpler models that include only the primary predictors. These models provide a high level of explanatory power while avoiding the risk of over fitting or introducing unnecessary complexity, a similar conclusion observed by Obike et al. (2010), Oke et al. (2011), Udeh (2013) and Sam et al. (2020).

Table (7) represents regression parameters, parameters of t-value and its significance test, confidence intervals and collinearity statistics for the evaluated predictors for Meat Weight. From the full model (1), the significant regression parameters are the constant (P< 0.0001), and coefficient of foot length and Pre-Slaughter (P< 0.001). The model extrapolated from this regression analysis at this case can be (Y = -224.81 + 1.96 X5 + 0.364 X6). However, the (b's) of Body weight and Length at 12 Wks. was irrationally negative which is not realistically expected from a biological point of view. However, the standard errors of the parameter estimates were relatively high which means fluctuations and non-homogeneity of the values in the evaluated population. Yet, this result is expected since the evaluated population is from variant and disparate genetic groups (two native breeds; New-Zealand Whites and paternal crosses with the standard breed). Nevertheless, the small drawn sample size (N = 103 representing of seven different genetic groups), led to the difficult to extrapolate separate picture for every homogeneous genetic group. As far to collinearity diagnostic statistics, the tolerance did not reach the border of <0.10; and this makes it easy to declare collinearity for any of the regressors involved in the model. BUT again the highest tolerance value (0.817, the best) was for the foot length followed by Pre-Slaughter. When considering the variance-inflation factors (VIF), where collinearity is declared when VIF > 10. VIF gave same conclusions extracted when applying Tolerance criterion. From the second model (model II, CW was removed), the non-significant regression coefficients, unexpectedly, the body Weight (P< -0.63); BL (P< -0.219 and TC (P<1.05). The model extrapolated from this regression analysis at this case can be (Y = - 224.46 + 1.96 X5 + 0.364 X6). However, the b's of Body length at 12 Wks. And BW12, besides its insignificance, were irrationally negative which is not realistically expected from a biological point of view. However, the standard errors of the parameter estimates, as in case of full model, were relatively high. As far to collinearity diagnostic statistics, the tolerance did not reach the border of <0.10; and this makes it easy to declare collinearity for any of the regressors involved in the model. BUT again the highest tolerance value (0.825, the best) was for the foot length followed Pre-Slaughter. When considering the variance-inflation factors (VIF), gave same conclusions extracted when applying Tolerance criterion.

As regard to the third model (model III, Body Length and TC were removed), the significant regression coefficients, as mentioned before. The model extrapolated from this regression analysis at this case can be (Y = -235.43 + 1.95 X5 + 0.37X6). However, the standard errors, and for both tolerance and (VIF) of the collinearity diagnostic were as mentioned before.

Model four (4), Body Weight and length, and chest width were removed), the body weight expresses regression coefficients, as mentioned before. The model extrapolated from this regression analysis at this case can be (Y = - 223.79 + 1.927 X5 + 0.362 X6). However, the standard errors, and for both tolerance and (VIF) of the collinearity diagnostic were as mentioned before. Model 5, the best model which contained the Foot Length and Pre-Slaughter regressors, while the other regressors are removed from the model. The model extrapolated from this regression analysis at this case can be (Y = - 205.81 + 1.98 X5 + 0.36 X6). However, the standard errors of the parameter estimates, as in case of full model, were relatively high which yet again means fluctuations and non-homogeneity of the values in the evaluated population. As far to collinearity diagnostic statistics, the tolerance did not reach the border of <0.10; and this makes it difficult to declare collinearity for any of the regressors involved in the model. When considering the variance-inflation factors (VIF), where collinearity is declared when VIF > 10. The values are best when they are smaller than that border. Applying these rules, VIF gave same conclusions extracted when applying Tolerance criterion. A similar observation were found by Michalik et al. (2006), Montes-Vergara et al. (2020), Sam et al. (2022) and Andrea et al. (2022). As we see from Table (7) that represents regression parameters, parameters t-value and its significance test, confidence intervals and collinearity statistics for the evaluated predictors for Bone Weight. There are six models that we can be extrapolate the best one. This sixth one is the best that the significant regression parameters are the constant (P< 0.001), and Body length (BL) in spite of its irrationally negative and insignificance coefficient. The model extrapolated from this regression analysis at this case can be (Y = 132.18 – 0.179 X2).

Mallows' statistic, C(p), for different regression models as a method for better model selection alongside R-Square (R^2) values, for saleable carcass via some in vivo non-offensive Linear Measures is presented in Table 8. The regression analysis aimed at predicting meat weight in crossbred rabbits using in vivo body measurements showed considerably stronger results than those for bone weight. Several models yielded relatively high R-Square (R^2) values, reaching up to 0.689, indicating that nearly 69% of the variation in meat weight could be explained by combinations of morphometric predictors. Models such as Model 4, Model 5, and Model 6 demonstrated R^2 values close to or equal to 0.689 with low Mallows' C(p) values (ranging from 3.0 to 7.0), suggesting a good balance between model complexity and accuracy.

The high predictive performance of these models supports the hypothesis that meat yield in rabbits is strongly associated with external linear body traits. Key contributors across the top-performing models include thigh circumference (TC12), hind foot length (FL12), and preslaughter live body weight

(PLBW), which are known to be reliable indicators of muscle mass distribution.

Conversely, models with high C(p) (e.g., >100) and moderate-to-low R^2 (e.g., 0.250 or less) indicate poor model performance despite fewer predictors. This supports findings of Montes-Vergara et al. (2020) and Michalik et al. (2006) who emphasized the inefficiency of such models in both explanatory and predictive contexts.

The regression analysis conducted to predict bone weight in crossbred rabbits using in vivo linear body measurements has revealed a consistently weak predictive performance. Across all examined models, R-Square (R^2) values remained notably low, generally falling below 0.08. This indicates that less than 8% of the variation in bone weight could be explained by the selected body traits, such as body length (BL12), chest transverse width (CW12), hind foot length (FL12), and thigh circumference (TC12). Although a few models showed acceptable Mallows' C(p) values (e.g., C (p= 5 to 7), these values are not sufficient to justify their utility because the overall explained variance is minimal. A low C(p) with a low R^2 only indicates model simplicity, not effectiveness. This suggests that the linear measurements selected do not capture the key sources of biological variation in bone mass. A similar observation by Andrea et al. (2022) and Montes-Vergara et al. (2020).

CONCLUSION

In conclusion, combining Mallows' C(p) and R-Square is effective for selecting efficient predictors of saleable carcass in crossbred rabbits. Models using key morphometric traits like FL12 (Hind foot length), TC12 (thigh circumference, and PLBW (preslaughter live body weight) showed strong performance, while those predicting bone weight were less reliable, highlighting the need for improved variables.

Table (1): Structure Sire breed; dam breed; progeny mating group code and its slaughter males No.

Sire Breed	Dam Breed	Progeny Mating Group Code‡	Slaughtered Males Number
NZW†	NZW	11	29
BR	BR	66	7
BB	BB	44	11
BR	NZW	61	19
BB	NZW	41	17
NZW	BR	16	9
NZW	BB	14	11
Total evaluated juveniles			103

† New-Zealand White (denoted 1) = NZW or 11; Baladi Red (denoted 4) = BR or 44; Baladi Black (denoted 6) = BB or 66 for straight Breds. ‡ in mating groups sire breed is preceding dam breed. Valid N (number of observations list wise) = 82

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Table (2): Some descriptive statistics of the variables included in the study for the evaluated rabbit population.

Variables	Mean	Std. Error	Std. Dev.	Min.	Max
Body Weight at 12 week (g.)	1179.39	26.695	264.270	580	1990
Preslaughter Live Body Weight at16 week (g.)	1629.29	13.176	130.435	1455	2230
Meat Weight (g.)	599.29	6.863	67.941	420	900
Bone Weight (g.)	80.92	2.731	27.039	10	185
Body Length at 12 week (m.)	287.69	2.353	22.693	235	330
Chest Transverse Width at 12 week (m.)	135.38	1.830	17.651	100	175
Thigh Circumference at12 week (m.)	113.33	1.471	14.187	75	150
Hind Foot Length at 12 week (m.)	108.82	0.796	7.675	90	130

Table (3): Estimates of marginal means and Least Squire Means (resultant out of ANOVA†); Std. deviation of the dependent variable (Meat and Bone Weight) as affected by different levels of the fixed effects.

Factor Level	N	Dependent Variable Meat Weight (g.) Mean	Std. Error	STD	95% Confidence Interval Lower	Upper	Dependent Variables Bone Weight (g.) Mean	Std. Error	STD	95% Confidence Interval Lower	Upper
Mating Group				ns					ns		
11 NZ x NZ	25	605.40	12.16	61.963	583.15	630.28	78.20	3.63	18.364	71.25	86.13
14 NZ x BB	13	608.08	17.29	59.285	575.00	643.18	67.31	5.16	18.665	57.15	77.91
16 NZ x BR	5	607.00	15.48[b]	34.387	575.00[b]	633.33[b]	72.00	5.19[b]	11.511	62.50[b]	82.50[b]
41 BB x NZ	15	585.00	11.91	46.980	562.36	609.99	99.33	9.48	37.743	82.67	118.05
44 BB x BB	8	608.13	39.75	104.469	535.06	689.42	78.13	7.13	19.628	65.00	93.00
61 BR x NZ	24	592.29	10.67	51.478	570.94	612.62	82.29	6.68	34.007	69.60	95.45
66 BR x BR	8	600.00	48.38	138.022	516.88	705.90	81.25	3.46	9.910	74.29	87.77
Season1				ns					* (0.028)		
Automn	4	576.25	11.84[b]	24.958	552.50[b]	599.00[b]	115.00	22.28[b]	47.081	85.00[b]	165.66[b]
Winter	68	600.88	7.68	64.095	586.04	616.32	80.59	3.18	25.547	74.77	87.03
Spring	26	598.65	15.97	82.056	571.16	631.08	76.54	4.78	24.810	67.69	86.46
Parity				ns					ns		
First	71	606.48	8.37	71.146	589.35	622.67	80.99	3.24	26.681	75.07	87.82
Second	20	572.75	12.68	59.371	549.17	600.77	84.00	6.65	31.145	72.33	97.50
Third	7	602.14	14.61[b]	37.954	573.00[b]	630.00[b]	71.43	6.55[b]	17.491	56.24[b]	83.57[b]

[A] Based on modified population marginal mean.

†ANOVA in the light of the low population size did not reveal any significance and most of the interaction are not even estimable.

Table (4): Explains the correlation coefficients (r) among the studied variables.

Variables	BW12	BL12	CW12	TC12	FL12	PLBW
Body Weight at 12 week (BW12)	1					
Body Length at 12 (BL12)	.674**	1				
Chest Transverse Width at 12 (CW12)	.631**	.623**	1			
Thigh Circumference at12 (TC12)	.680**	.735**	.622**	1		
Hind Foot Length at 12 (FL12)	.183	.151	.176	.149	1	
Preslaughter live body weight at 16 week (PLBW)	.204*	.011	.046	.095	.392**	1

Table (5): Least squares Conjoint multiple regression analysis of variance (ANOVA†) for the evaluated rabbit population.

	Meat Weight				Bone Weight				
Source	DF	S. Sq.	M Sq.	Pr > F	DF	S. Sq.	M Sq.	F	Pr >F
Model	4	238157	59539	***	3	3659.525	1219.842	2.13	0.103
Error	75	107523	1433.638		76	43459	571.832		
Corrected Total	79	345680			79	47119			

Table 5. Cont.

Meat Weight					Bone Weight				
Mean	CV	R-Sq.	Adj R-Sq	MSE	Mean	C V	R-Sq.	Adj R-Sq	MSE
600.5	6.305	0.7	0.672	37.863	78.125	30.61	0.08	0.041	23.913

Table (6): Mean squares of Ordinary Least Squares (OLS ANOVA) analysis of variance for different regression models for Meat and Bone carcass Weight Dependent Variables) via some in vivo non-offensive Linear Measures (regressors) of the evaluated crossbred rabbit population of Baladi (Black or Red) and their reciprocal crosses with New-Zealand White Rabbits using backward method.

Meat Weight						Bone Weight					
Model	DF	Model R^2	ΔR^2	C(P)	Pr > F	Model	DF	Model R^2	C(P)	ΔR^2	Pr > F
a + PLBW	1	0.637	0.923	9.292	<.0001	a + BL12	1	0.063	-1.423	0.811	0.025
a + PLBW + FL12	2	0.682	0.065	0.747	0.002	a + BL12 + TC12	2	0.071	-0.088	0.108	0.408
a + PLBW+ FL12 +TC12	3	0.685	0.005	1.879	0.348	a + BL12 + TC12+FL12	3	0.078	1.413	0.081	0.475
a + PLBW + FL12 +TC12 + CW12	4	0.689	0.006	3.007	0.347						

BL12 =Body length, CW12 =Chest Transverse Width, TC12 =Thigh circumference, FL12 = Hind foot Length at 12 Wks. and PLBW =preslaughter live body weight at 16 weeks of age.
ΔR^2= Variable responsible of variance,

Table (7): All attainable ordinary Least Squares (OLS **ANOVA**) Regression Models' parameters, t-value significance test, confidence intervals and collinearity statistics for the evaluated predictors {constant and *in vivo* non-offensive Linear Measures (regressors)} of the evaluated saleable carcass using backward method (For Meat and Bone Weight).

(**Meat**) **Model (1)** ANOVA								
F = 31.84 ***				R^2 = 0.668				
		(Constant)	BW12 (X1)	BL 12 (X2)	CW 12 (X3)	TC12 (X4)	FL12 (X5)	PLBW (X6)
Unstandardized Coefficients	B/Constant	-224.813	-0.015	-0.065	0.016	0.472	1.961	0.364
	Std. Error	86.912	0.024	0.291	0.324	0.463	0.584	0.034
Beta (Standardized Coefficients)		---------	-0.057	-0.022	0.004	0.099	0.223	0.715
T		-2.587	-0.615	-0.223	0.048	1.020	3.358	10.637
Sig.		**	-----------	-----------	-----------	----------	***	***
95.0% CI	Lower	-397.587	-0.062	-0.644	-0.628	-0.449	0.800	0.296
	Upper	-52.038	0.033	0.514	0.659	1.393	3.121	0.432
Collinearity Statistics	Tolerance	-----------	0.414	0.376	0.502	0.380	0.817	0.799
	VIF	-----------	2.416	2.662	1.99	2.632	1.224	1.252
Model (2)								
F = 38.66 ***				R^2 = 0.690				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	-224.461	-0.014	-0.062		0.477	1.963	0.364
	Std. Error	86.106	0.023	0.284		0.451	0.578	0.034
Standardized Coefficients		-----------	-0.056	-0.021		0.100	0.223	0.715
T		-2.607	-0.632	-0.219		1.058	3.397	10.732
Sig.		**	-----------	-----------		-----------	***	***
95.0% CI	Lower	-395.606	-0.059	-0.627		-0.419	0.815	0.297
	Upper	-53.316	0.031	0.503		1.373	3.112	0.432
Collinearity Statistics	Tolerance	-----------	0.451	0.390		0.397	0.825	0.805
	VIF	-----------	2.215	2.562		2.521	1.213	1.243
Model (3)								
F = 48.839 ***				R^2 = 0.689				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	-235.431	-0.016		0.427		1.952	0.366
	Std. Error	69.648	0.21		0.386		0.527	0.033
Standardized Coefficients		------------	-0.063		0.09		0.222	0.717
T		-3.380	-0.77		1.106		3.410	11.007
Sig.		***	----------		-----------		***	***
95.0% CI	Lower	-373.842	-0.57		-0.34		0.814	0.3
	Upper	-97.02	0.025		1.194		3.09	0.432
Collinearity Statistics	Tolerance	-----------	0.522		0.536		0.831	0.831
	VIF	-----------	1.915		1.867		1.203	1.203

Table (7): Cont.

Model (4)								
F = 65.219 ***				R^2 = 0.668				
		(Constant)	BW12 (X1)	BL 12 (X2)	CW 12 (X3)	TC12 (X4)	FL12 (X5)	PLBW (X6)
Unstandardized Coefficients	B/Constant	-223.79				0.227	1.927	0.362
	Std. Error	67.833				0.285	0.570	0.033
Standardized Coefficients		-------------				0.048	0.219	0.711
T		-3.299				0.796	3.38	11.025
Sig.		***				----------	***	***
95.0% CI	Lower	-358.572				-0.340	0.794	0.297
	Upper	-89.007				0.794	3.06	0.428
Collinearity Statistics	Tolerance	-----------				0.976	0.834	0.845
	VIF	-----------				1.024	1.199	1.183
Model (5)								
F = 97.909 **				R^2 = 0.685				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	-205.806					1.983	0.363
	Std. Error	63.833					0.565	0.033
Standardized Coefficients		------------					0.226	0.713
T		-3.224					3.510	11.089
Sig.		***					***	***
95.0% CI	Lower	-332.622					0.861	0.298
	Upper	-78.991					3.105	0.428
Collinearity Statistics	Tolerance	----------					0.847	0.847
	VIF	----------					1.181	1.81
(Bone) Model (1) ANOVA								
F = 0.598				R^2 = 0.04				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	109.824	.009	-.286	-.074	.133	.151	.013
	Std. Error	62.029	.017	.208	.231	.331	.417	.024
Standardized Coefficients		--------	.091	-.237	-.048	.069	.042	.061
T		1.771	.551	-1.378	-.321	.403	.362	.519
Sig.		----------	--------	---------	----------	-----------	------------	---------------
95.0% CI	Lower	-13.485	-0.024	-0.7	-0.534	-0.524	-0.677	-0.036
	Upper	233.133	0.043	0.127	0.385	0.79	0.979	0.061
Collinearity Statistics	Tolerance		0.414	0.376	0.502	0.38	0.817	0.799
	VIF		2.416	2.662	1.99	2.632	1.224	1.252
Model (2)								
F = 0.704				R^2 = 0.039				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	108.150	.008	-.299		.111	.138	.013
	Std. Error	61.490	.016	.203		.322	.413	.024
Standardized Coefficients		-----------	.075	-.248		.058	.039	.065
T		1.759	.482	-1.476		.346	.335	.551
Sig.		------------	-----------	---------		---------	----------	-----------
95.0% CI	Lower	-14.068	-0.024	-0.703		-0.529	-0.682	-0.035
	Upper	230.368	0.04	0.104		0.751	0.959	0.062
Collinearity Statistics	Tolerance		0.451	0.39		0.397	0.825	0.805
	VIF		2.215	2.562		2.521	1.213	1.243
Model (3)								

F = 0.861				R^2 = 0.038				
		(Constant)	BW12 (X1)	BL 12 (X2)	CW 12 (X3)	TC12 (X4)	FL12 (X5)	PLBW (X6)
Unstandardized Coefficients	B/Constant	116.284	0.008	-0.293		0.111		0.016
	Std. Error	56.213	0.016	0.201		0.32		0.022
Standardized Coefficients		------------	0.076	-0.243		0.058		0.079
T		2.069	0.49	-1.459		0.347		0.737
Sig.		*	-----------	------------		-----------		----------
95.0% CI	Lower	4.572	-0.024	-0.693		-0.525		-0.028
	Upper	227.996	0.04	0.106		0.748		0.061
Collinearity Statistics	Tolerance		0.452	0.394		0.397		0.941
	VIF		2.214	2.541		2.521		1.062
Model (4)								
F = 1.118				R^2 = 0.036				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	115.732	0.01	-0.258				0.017
	Std. Error	55.912	0.015	0.172				0.022
Standardized Coefficients		-----------	0.095	-0.214				0.081
T		2.07	0.657	-1.498				0.758
Sig.		*	----------	-----------				-------------
95.0% CI	Lower	4.635	-0.02	-0.599				-0.027
	Upper	226.829	0.039	0.084				0.061
Collinearity Statistics	Tolerance		0.515	0.533				0.943
	VIF		1.942	1.877				1.06
Model (5)								
F = 1.471				R^2 = 0.032				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	99.508		-0.18				0.02
	Std. Error	50		0.125				0.021
Standardized Coefficients		---------		-0.15				0.098
T		1.99		-1.442				0.944
Sig.		*		------------				------------
95.0% CI	Lower	0.175		-0.429				-0.022
	Upper	198.841		0.068				0.063
Collinearity Statistics	Tolerance	1.0		1.0				
	VIF	1.0		1.0				
Model (6)								
F = 0.2.05				R^2 = 0.022				
		(Constant)	(X1)	(X2)	(X3)	(X4)	(X5)	(X6)
Unstandardized Coefficients	B/Constant	132.176		-0.179				
	Std. Error	36.078		0.125				
Standardized Coefficients				-0.149				
T		3.664		-1.433				
Sig.		***		-----------				
95.0% CI	Lower	60.51		-0.427				
	Upper	203.841		0.069				
Collinearity Statistics	Tolerance			1.0				
	VIF			1.0				

Dependent Variable: Meat and Bone Weights; Predictors/Independent Variables: (Constant), BW12(X1) =Body Weight, BL12(X2) =Body length, CW12(X3) =Chest Transverse Width, TC12(X4) =Thigh circumference and FL12(X5) = Hind foot Length at 12 Wks. and PLBW(X6) =preslaughter live body weight at 16 weeks of age

Table (8): Mallows' statistic C(p), for different regression models Compared with R-Square values for selecting the best model predicting salable carcass Percent via some in vivo non-offensive Linear Measures.

			Dependent Variable (Meat Weight)						
Var.no.	R-Sq.	C(p)	Intercept	BW12	BL12	CW12	TC12	FL12	PLBW
1	0.637	9.2924	-59.14	.	.	.	.	.	0.41
1	0.250	100.0539	145.85	.	.	.	.	4.18	.
1	0.018	154.5474	529.19	.	.	.	0.63	.	.
1	0.011	156.1576	549.13	.	.	0.38	.	.	.
1	0.004	157.6783	545.49	.	0.19	.	.	.	.
1	0.004	157.8535	582.44	0.01	.	.	.	.	.
2	0.682	0.7469	-195.43	.	.	.	.	1.92	0.36
2	0.644	9.6586	-99.57	.	.	.	0.39	.	0.40
2	0.641	10.2595	-114.14	.	0.19	.	.	.	0.41
2	0.641	10.3842	-87.09	.	.	0.23	.	.	0.40
2	0.637	11.2864	-60.37	0.00	.	.	.	.	0.40
2	0.255	100.8439	115.27	.	.	.	0.34	4.11	.
2	0.250	101.9534	138.72	.	.	0.08	.	4.15	.
2	0.250	102.0493	146.66	0.00	.	.	.	4.19	.
2	0.250	102.0507	148.47	.	-0.01	.	.	4.19	.
2	0.020	156.0839	557.66	.	-0.19	.	0.85	.	.
2	0.019	156.3251	522.57	.	.	0.14	0.52	.	.
2	0.018	156.4985	529.31	0.00	.	.	0.67	.	.
2	0.011	158.1241	548.28	0.00	.	0.36	.	.	.
2	0.011	158.1524	545.98	.	0.02	0.37	.	.	.
2	0.005	159.4587	550.12	0.01	0.14	.	.	.	.
3	0.685	1.8793	-220.80	.	.	.	0.29	1.86	0.36
3	0.683	2.4654	-221.07	.	0.10	.	.	1.87	0.36
3	0.682	2.5541	-205.49	.	.	0.11	.	1.88	0.36
3	0.682	2.6643	-192.22	0.00	.	.	.	1.94	0.36
3	0.646	11.1207	-100.78	-0.01	.	.	0.54	.	0.40
3	0.644	11.6024	-102.66	.	.	0.07	0.34	.	0.40
3	0.644	11.6432	-105.20	.	0.03	.	0.35	.	0.40
3	0.642	11.9848	-121.64	-0.01	0.25	.	.	.	0.41
3	0.642	12.0760	-112.43	.	0.13	0.13	.	.	0.40
3	0.641	12.2003	-86.22	-0.01	.	0.28	.	.	0.40
3	0.262	101.3280	161.88	.	-0.34	.	0.74	4.16	.
3	0.258	102.2333	112.44	-0.01	.	.	0.50	4.14	.
3	0.256	102.6749	118.37	.	.	-0.12	0.43	4.13	.
3	0.251	103.8621	151.06	.	-0.07	0.13	.	4.16	.
3	0.251	103.8935	139.10	0.00	.	0.11	.	4.16	.
3	0.250	104.0486	147.86	0.00	-0.01	.	.	4.19	.
3	0.022	157.5823	556.55	.	-0.25	0.22	0.75	.	.
3	0.020	158.0774	556.98	0.00	-0.18	.	0.86	.	.
3	0.019	158.2111	521.65	0.00	.	0.16	0.57	.	.
3	0.011	160.1239	547.68	0.00	0.00	0.35	.	.	.

Table 8. Cont.

			Dependent Variable (Meat Weight)						
Var.no.	R-Sq.	C(p)	Intercept	BW12	BL12	CW12	TC12	FL12	PLBW
4	0.689	3.0065	-224.66	-0.01	.	.	0.47	1.89	0.36
4	0.685	3.8353	-212.11	.	-0.06	.	0.36	1.87	0.36
4	0.685	3.8605	-219.64	.	.	-0.04	0.32	1.87	0.36
4	0.685	4.0445	-231.24	-0.01	0.17	.	.	1.89	0.36
4	0.684	4.2426	-205.22	-0.01	.	0.18	.	1.89	0.36
4	0.683	4.4411	-219.98	.	0.08	0.05	.	1.86	0.36
4	0.647	12.9485	-106.49	-0.01	.	0.13	0.46	.	0.40
4	0.646	13.0385	-114.19	-0.01	0.08	.	0.46	.	0.40
4	0.644	13.5994	-105.05	.	0.02	0.07	0.32	.	0.40
4	0.644	13.6566	-121.34	-0.01	0.18	0.18	.	.	0.41
4	0.263	103.0356	155.59	-0.01	-0.31	.	0.81	4.18	.
4	0.262	103.3253	161.68	.	-0.33	-0.02	0.75	4.16	.
4	0.258	104.1737	114.53	-0.01	.	-0.07	0.54	4.15	.
4	0.251	105.8381	149.15	0.00	-0.06	0.14	.	4.17	.
4	0.022	159.5385	554.70	0.00	-0.24	0.23	0.77	.	.
5	0.689	5.0013	-225.35	-0.01	.	0.02	0.46	1.89	0.36
5	0.689	5.0062	-223.96	-0.01	0.00	.	0.48	1.89	0.36
5	0.685	5.8290	-212.41	.	-0.05	-0.02	0.37	1.88	0.36
5	0.685	5.9412	-230.18	-0.01	0.14	0.10	.	1.87	0.36
5	0.647	14.9152	-114.67	-0.01	0.05	0.11	0.42	.	0.40
5	0.263	105.0338	155.67	-0.01	-0.31	0.01	0.81	4.17	.
6	0.689	7.0000	-223.83	-0.01	-0.01	0.02	0.47	1.89	0.36
			Dependent Variable (Bone Weight)						
Var.no.	R-Sq.	C(p)	Intercept	BW12	BL12	CW12	TC12	FL12	PLBW
1	0.063	-1.42	154.98	.	-0.27	.	.	.	.
1	0.024	1.65	106.53	.	.	-0.21	.	.	.
1	0.017	2.24	92.54	-0.01	.	.	.	.	.
1	0.014	2.45	101.81	.	.	.	-0.21	.	.
1	0.007	3.03	52.44	.	.	.	.	.	0.02
1	0.002	3.43	62.65	.	.	.	.	0.14	.
2	0.071	-0.09	158.30	.	-0.37	.	0.23	.	.
2	0.070	0.01	129.29	.	-0.27	.	.	.	0.02
2	0.070	0.04	130.70	.	-0.28	.	.	0.26	.
2	0.063	0.57	154.96	.	-0.26	-0.01	.	.	.
2	0.063	0.58	154.91	0.00	-0.27	.	.	.	.
2	0.033	2.97	79.13	.	.	-0.22	.	.	0.02
2	0.030	3.22	83.82	.	.	-0.23	.	0.23	.
2	0.029	3.33	108.21	0.00	.	-0.16	.	.	.
2	0.026	3.54	64.66	-0.01	.	.	.	.	0.02
2	0.026	3.57	110.18	.	.	-0.18	-0.07	.	.
2	0.023	3.78	74.86	.	.	.	-0.22	.	0.02
2	0.021	3.91	71.92	-0.01	.	.	.	0.20	.
2	0.020	3.97	102.04	-0.01	.	.	-0.12	.	.
2	0.018	4.15	82.54	.	.	.	-0.22	0.19	.
2	0.007	5.01	48.83	.	.	.	.	0.05	0.01

Table 8. Cont.

			Dependent Variable (Bone Weight)						
Var.no.	R-Sq.	C(p)	Intercept	BW12	BL12	CW12	TC12	FL12	PLBW
3	0.078	1.41	134.78	.	-0.38	.	0.23	0.25	.
3	0.077	1.45	134.70	.	-0.36	.	0.21	.	0.01
3	0.073	1.78	118.88	.	-0.28	.	.	0.18	0.01
3	0.073	1.81	158.61	.	-0.35	-0.06	0.26	.	.
3	0.072	1.85	156.94	0.00	-0.36	.	0.25	.	.
3	0.070	2.00	129.00	.	-0.26	-0.02	.	.	0.02
3	0.070	2.01	128.64	0.00	-0.26	.	.	.	0.02
3	0.070	2.02	130.17	.	-0.27	-0.03	.	0.26	.
3	0.070	2.04	130.19	0.00	-0.28	.	.	0.26	.
3	0.063	2.57	155.00	0.00	-0.26	-0.01	.	.	.
3	0.038	4.60	79.92	-0.01	.	-0.17	.	.	0.02
3	0.035	4.83	70.28	.	.	-0.23	.	0.14	0.01
3	0.034	4.86	84.41	-0.01	.	-0.18	.	0.24	.
3	0.034	4.86	82.77	.	.	-0.18	-0.08	.	0.02
3	0.031	5.12	87.39	.	.	-0.19	-0.08	0.23	.
3	0.030	5.25	74.09	-0.01	.	.	-0.13	.	0.02
3	0.029	5.32	109.33	0.00	.	-0.15	-0.02	.	.
3	0.027	5.46	57.63	-0.01	.	.	.	0.10	0.02
3	0.025	5.61	80.84	-0.01	.	.	-0.13	0.21	.
3	0.024	5.71	68.51	.	.	.	-0.22	0.10	0.02
4	0.080	3.22	124.26	.	-0.37	.	0.21	0.18	0.01
4	0.080	3.26	133.85	.	-0.36	-0.08	0.26	0.26	.
4	0.079	3.32	132.57	0.00	-0.37	.	0.25	0.25	.
4	0.079	3.33	134.55	.	-0.34	-0.07	0.24	.	0.01
4	0.078	3.36	132.54	0.00	-0.35	.	0.24	.	0.01
4	0.073	3.76	118.19	.	-0.26	-0.03	.	0.19	0.01
4	0.073	3.77	157.48	0.00	-0.35	-0.06	0.27	.	.
4	0.073	3.77	117.98	0.00	-0.27	.	.	0.18	0.01
4	0.070	4.00	128.61	0.00	-0.25	-0.02	.	.	0.02
4	0.070	4.02	129.96	0.00	-0.27	-0.03	.	0.26	.
4	0.040	6.44	70.47	-0.01	.	-0.17	.	0.15	0.01
4	0.038	6.59	81.18	0.00	.	-0.16	-0.03	.	0.02
4	0.036	6.72	73.85	.	.	-0.19	-0.08	0.14	0.01
4	0.035	6.85	85.57	0.00	.	-0.17	-0.03	0.24	.
4	0.031	7.15	66.55	-0.01	.	.	-0.13	0.12	0.02
5	0.082	5.06	123.31	.	-0.35	-0.08	0.25	0.20	0.01
5	0.081	5.12	121.66	0.00	-0.36	.	0.24	0.19	0.01
5	0.080	5.20	132.19	0.00	-0.35	-0.07	0.28	0.26	.
5	0.079	5.27	132.79	0.00	-0.34	-0.06	0.26	.	0.01
5	0.073	5.76	117.69	0.00	-0.26	-0.03	.	0.19	0.01
5	0.040	8.43	71.73	0.00	.	-0.16	-0.03	0.15	0.01
6	0.083	7.00	121.30	0.00	-0.34	-0.07	0.27	0.20	0.01

BW12 =Body Weight, BL12 =Body length, CW12 =Chest Transverse Width, TC12 =Thigh circumference, FL12 =Hind Foot Length at 12 Wks. and PLBW =preslaughter live body weight at 16 weeks of age.

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الملخص العربى

إمكانية التنبؤ بكمية اللحوم والعظام من خلال بعض قياسات الجسم الحي فى الأرانب

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تمت دراسة إمكانيات التنبؤ بكمية اللحم وكمية قليلة من العظام باستخدام القياسات الجسمية الخطية غير التداخلية، وذلك على عينة مكونة من 103 ذكور ناتجة من سلالة الأرانب البلدي المصري المحلي (الأسود والأحمر)، وتهجيناتها المتبادلة مع سلالة الأرانب النيوزيلندية البيضاء المتأقلمة. شملت القياسات الجسمية الخطية غير التداخلية طول الجسم (BL)، عرض الصدر (CW)، محيط الفخذ (TC)، وطول القدم الخلفية (FL) عند عمر 12 أسبوعًا بالإضافة إلى ذلك، تم تسجيل وزنين للجسم: وزن الجسم عند 12 أسبوعًا (BW12)، ووزن الجسم قبل الذبح عند 16 أسبوعًا (PLBW). أظهرت نتائج تحليل الانحدار المتعدد لوزن اللحم ووزن العظام استنادًا إلى القياسات الخطية الحية غير التداخلية دلالة إحصائية عالية ($P < 0.001$) فيما يتعلق بوزن اللحم، مما يشير إلى كفاءة النموذج (MW) من منظور إحصائي في تحقيق تنبؤ موثوق به. في المقابل، لم يظهر النموذج دلالة إحصائية عند التنبؤ بوزن العظام (BW).
أوضحت مخططات التشتت للبيانات أن العلاقة بين المتغيرات التابعة والمستقلة كانت - كما هو مفترض - علاقة خطية، مع اتجاه المتغيرات التابعة للزيادة كلما زادت القيم الإجمالية للمتغيرات المستقلة (اتجاه إيجابي).
عند النظر إلى نسبة التباين التي يفسرها النموذج ($R^2 = 70\%$ بالنسبة لوزن اللحم)، فإن التنبؤ بنسبة وزن اللحم اعتمادًا على القياسات الحية الخطية كان ممكنًا بدرجة معقولة سواء عند استخدام المتغيرات بشكل فردي (R^2) يتراوح بين (66.8% و67.8%) أو بشكل جماعي ($R^2 = 70\%$) بينما تم تسجيل تقدير منخفض للتنبؤ بوزن العظام.
كما أظهرت معاملات الارتباط بيرسون بين المتغيرات دلالة إحصائية عالية ($p < 0.01$) ، حيث تراوحت القيم بين 0.392 و0.735.
وفقًا لإحصائية Mallows C(p) ، أظهرت النماذج رقم 4 و5 و6 الخاصة بوزن اللحم أفضل توازن في الأداء، حيث سجلت قيم R^2 تقارب 0.689، وقيم C(p) تراوحت بين 3 الى7 وقد تميزت هذه النماذج باحتوائها المستمر على متغيرات تنبؤية رئيسية مثل طول القدم الخلفية (FL12)، محيط الفخذ (TC12) والوزن الحى قبل الذبح عند 16 أسبوعًا(PLBW) مما يبرز دورها البارز في تعزيز دقة التنبؤ.
التوصية:
تؤكد هذه النتائج على قيمة تقييم النموذج متعدد المعايير في أبحاث تربية الحيوان وتدعم دمج الدقة الإحصائية في استراتيجيات الانتخاب الظاهري.