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EVALUATION OF PRODUCTIVE PERFORMANCE IN SYNTHETIC MATERNAL LINE (APRI RABBITS) UNDER EGYPTIAN CONDITIONS

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ABSTRACT

Synthetic lines have been developed in hot climate countries over the last few decades through selection for specific goals such as APRI rabbits, and depending on their specialisation. These lines perform better than the standard of the original breeds, and contemporary production tends to rely on them. The aim of the study was to identify and explain genetic parameters in synthetic maternal line (APRI rabbits) under Egyptian conditions. The Derivative Free Restricted Maximum Likelihood Animal Model (MTDFREML) was used to assess data on body weights (BW) at 4, 8, and 12 weeks, also daily gains (DG) at 4-8, 8-12 and 4-12 weeks. Highest heritability (h^2) estimate for BW was at 4 weeks (0.10), while the lowest estimate was at 12 weeks (0.03). The highest estimate (0.08) was for h^2 of DG at 4-8 weeks, while the lowest estimate was for DG at 8-12 weeks (0.02). All genetic correlations ($r_{g)}$) between BW at different ages were moderate to high and positive. Estimates of r_g for DG ranged from low to high and were positive, with the exception of (-0.84) between 4-8 and 8-12 weeks. BW and DG at different intervals had significance and the highest was value in the first parity. BW and DG were significantly different in different seasons (P <0.05), with the highest value in autumn. Litter size at birth (LSB) caused significant changes in BW (P<0.05). Moreover, LSB had a significant impact on DG at 8-12 and 4-12 weeks, but not at 4-8 weeks.

INTRODUCTION

The APRI line was established by mating Baladi Red (BR) bucks to V line does, resulting in F1, F2, and F3 generations, with selection beginning at this generation **(Youssef *et al.*, 2008)**. Synthetic lines have been developed in hot climate countries during the last few decades through selection for specific goals **(Youssef *et al.*, 2008; Khalil, 2010)**. These lines perform better than the standard of the original breeds, depending on their specialisation, and contemporary production tends to rely on them. The degree of selection, heritability, and standard deviation of the traits are all directly linked to the response to selection (**Falconer and Mackay, 1996**). One of the key factors determining the profit function is post-weaning average body weights and average daily increase. Understanding post-weaning body weights and growth is critical. Although the rabbit's pre-weaning environment and genotype have an impact on post-weaning growth performance. It also has a significant impact on performance. Various genetic and non-genetic variables such as parity, season and litter size at birth influence a rabbit's post-weaning growth. To estimate genetic parameters for examined traits without bias in predictions, environmental effects must be considered in the model analysis **(El-Deghadi, 2005)**. Changes in heritabilities estimations between

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researches can be related to differences in study design, rabbit breeds maintained under certain environmental conditions for a set amount of time and the length of time, the size of the data, and the statistical methodologies utilized all play a role **(El-Zanfaly, 1996)**. The implementation of a typical litter animal model is effective for partitioning phenotypic variations due to direct additive genetics and environmental consequences inside litter (residual) **(Youssef *et al.*, 2009)**. Quantitative techniques are used in animal genetic improvement programmes to aid the selection of the finest animals based on their breeding values in order to genetically improve their production and reproductive efficiency **El-Deghadi, (2019).** The goal of this study was to evaluate and explain genetic parameters such as heritability, common litter effect, genetic and phenotypic correlations, and breeding value in synthetic maternal line (APRI rabbits) under Egyptian conditions, as well as to determine fixed effects such as parity, season, and litter size at birth.

MATERIALS AND METHODS

APRI line a maternal line rabbit is an improved line rabbit breed bred at the Animal Production Research Institute's Gemmayzeha experimental rabbitery (APRI). APRI line data on body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, were collected during three seasons (autumn, winter, and spring). Breeding does and bucks were housed separately in single-tier batteries with feeding and mechanical nipple drinkers in individual welded wire cages. At 25 days after fruitful mating, rabbit doe houses were equipped with nest boxes. The rabbits were all fed the same commercial pelleted diet, which contained 18% protein, 2.39 percent crude fat, and 12.8 percent crude fiber. Water and food were available throughout the day. Four weeks after kindling, the litter was weaned. Before each kindling, the cages of the entire group of animals were cleaned and disinfected on a regular basis. Throughout the study, animals were given the same medications and were kept under the same management and environmental circumstances.

Statistical Analysis

APRI line data were collected on 666 bunnies from 130 does and 17 sires. Starting with the mixed model procedure (Co) variance matrix, the REML method of the VARCOMP procedure of **SAS,** 2003 was used to create the REML variance matrix for each of the analyzed traits. The more accurate and trustworthy estimates of multi trait animal model variance and covariance components were estimated using these beginning values. The Derivative Free Restricted Maximum Likelihood Animal Model (MTDFREML) of **Boldman *et al.* (1995)** was used to assess data on body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks. The model used to analyze the data included fixed effects like as parity, season, and litter size at birth, as well as additive genetic and common litter effects (as random effects).

The animal model employed was as follows:

$$y = X_b + Z_a u_a + Z_c u_c + e.$$

Where:

y = vector of observations on animal for body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, b = vector of fixed effects including parity (3 levels), season (3 levels) and litter size at birth and (7 levels); u_a = vector of random additive genetic effects of the animal for the i^{th} trait; u_c = vector of random common litter effect (doe-parity combination); e = vector of random error; X, Z_a and Z_c are incidence matrices relating records of i^{th} trait to the fixed, random animal and random common litter effects; respectively. MTDFREML evaluates also the proportions of additive genetic effects (heritability; h^2_a, common litter effects (c^2), and error (e^2). The heritability in the narrow sense (h^2_a) is computed as: $h^2_a = (\sigma^2_a / (\sigma^2_a + \sigma^2_c + \sigma^2_e))$. Where: σ^2_a = additive genetic variance, σ^2_c = common litter variance, and σ^2_e = error variance.

Breeding Values (BV), Standard Error (SE), and Accuracy Ranges (RI)

The same software uses the (co) variances matrix derived *via* MTDFREML analysis to forecast breeding values, their accuracies (r_{Ai}), and standard errors (SE_{Ai}). The BLUP accuracies for each subject were calculated using Henderson's equation (**Henderson, 1973**).

RESULTS AND DISCUSSION

Heritability

Estimates of heritability for all traits ranged from 0.03 to 0.10, with the highest estimate for body weight at 4 weeks (0.10) and the lowest estimate for body weight at 12 weeks (0.03). As well as the highest estimate was for daily gains at 4 to 8 weeks (0.08) and the lowest estimate was for daily gains at 8 to 12 weeks (0.02) in Table 1. Low heritability values for these traits suggest that crossbreeding between breeds or lines, rather than selection, might be a better way to enhance growth traits. This result close to **El-Deghadi (2005)** who found the heritability estimate of body weight was higher at younger ages of 4 and 8 weeks (0.23 and 0.15, respectively) than at later ages of 12 weeks (0.00). She concluded that heritability estimates between 4 and 8 weeks of age are moderate. These moderate heritability estimates suggest that at 4 and 8 weeks, the response to body weight selection is promising. Individual weight does not appear to be a good selection trait due to weak heritability estimates. Heritabilities for post-weaning daily gain throughout various intervals were estimated to be quite low, ranging from 0.02 to 0.08. **El-Amin *et al.* (2011),** who found that in the first generation of Sudanese rabbits, estimates of heritability based on paternal half sib analysis ranged from 0.211 to 0.372 for body weight at different ages (6 to 15 weeks). The heritability estimates for the second generation ranged from 0.085 to 0.295 for body weight at different ages (6 to 15 weeks), indicating that they were low to moderate. **Minguez *et al.* (2015)**, reported that heritability estimates for weaning weight, slaughter weight, and average daily gain were 0.07± 0.00, 0.19±0.00, and 0.21±0.00, respectively. The small marginal posterior standard deviations were notable; this was due to the large number of records. **El-Deighadi and Ibrahim (2017)** reported that at 4, 6, 8, 10, and 12 weeks of age, that heritability estimates for body weights were low to moderate, ranging from 0.13 to 0.20. Heritability estimates for growth rate during the study periods were low and inconsistent, ranging from 0.06 to 0.13. **El-Deghadi and Ibrahim (2018)** reported that, individual body weight at 4, 6, 8, 10, and 12 weeks of age was estimated to be 0.06, 0.18, 0.26, 0.11 and 0.10. **Abdel-Kafy *et al.* (2021)** reported that heritabilities estimates for body weights and relative growth rate were generally moderate and ranged from 0.10 to 0.24. **Rym Ezzeroug *et al.* (2020)** revealed that heritability estimates for growth traits were low, with 0.033 for weaning weight and 0.059 for fattening period weight. As well as these results are lower than those of **Intear, (2021)** who found that the heritability values for body weight at weaning, weight at slaughter and daily growth from weaning to slaughter weight in V line rabbits were 0.46, 0.32, and 0.43. On other hand **Ajayi *et al.* (2014)**, reported that the estimated heritability for individual body weight at weaning and at 12 weeks was 0.02 ± 0.05 and 0.46 ± 0.26, respectively. They suggested that variances from other results could be due to differences in genotypes, geography, environmental factors, and sample sizes. **Garcia and Argente (2020)** reported on a wide variety of heritability estimations (0.03 to 0.48 for weaning weight

Table 1. Shows heritability (h^2), common litter effect (c^2), and error (e^2) estimates for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks of APRI rabbit, with standard errors

Traits	h^2 ± SE	c^2 ± SE	e^2 ± SE
BW4	0.10 ± 0.09	0.47 ± 0.06	0.42 ± 0.07
BW8	0.04 ± 0.08	0.31 ± 0.06	0.66 ± 0.06
BW12	0.03 ± 0.09	0.36 ± 0.07	0.61 ± 0.06
DG4-8 weeks	0.08 ± 0.10	0.34 ± 0.06	0.58 ±0.07
DG8-12 weeks	0.02 ± 0.06	0.25 ± 0.05	0.73 ± 0.05
DG4-12 weeks	0.07 ± 0.10	0.34 ± 0.06	0.59 ± 0.07

and 0.06 to 0.67 for slaughter weight). The heritability estimates for growth rate, on the other hand, show a narrow range (0.12 to 0.34) and a moderate average value (0.22).

Common-Litter Effect (c^2)

Weaning body weight had a bigger (0.47) common litter impact (c^2) than that of an elder. It steadily reduced as the rabbits grew older, 0.31 and 0.36 in Table 1 demonstrating that rabbits began to show their genetic capacities; also, its variances are increasing, whereas maternal effects are reducing. As well as the common litter effect for daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks were moderate, with 0.34, 0.25, and 0.34, respectively. This result is in agreement with **El-Deighadi and Ibrahim (2017)** reported that, in comparison to later age, c^2 of body weight at weaning was higher (0.69). It slowly decreased as individuals grew older 0.54, 0.44, 0.37 and 0.32 at 6, 8, 10 and 12 weeks of age. Between weaning weight and 6 weeks, the c^2 of growth rate were larger than all other times. **El-Deghadi and Ibrahim, (2018)** reported that the estimate of $\mathbf{c^2}$ when compared to the phenotypic variance for body weight at weaning was larger than at other ages, indicating that common-litter effects at weaning are highly variable. The greater estimate was attributed to litters being nursed by the same dam and reared in the same cage, as well as a rapid decrease in the maternal or common-litter effect as the animals got older. At 4, 6, 8, 10, and 12 weeks of age, the percentages were 74%, 46%, 34%, 41, and 35%, respectively. Also, the common litter influence of body weight and relative growth rate were big as weaning then progressively dropped as the rabbit grew older at 20 weeks of age, according to **Abdel-Kafy *et al.* (2021)**. On the other hand the common litter effect, according to **Minguez *et al.* (2015)**, includes factors related to each female's pregnancy and birth, such as uterine environment, milk production, and maternal behavior, but not the litter size in which each rabbit was born, as this effect was included as a covariate in the model. In rabbits, a significant portion of phenotypic variation in growth and feed efficiency is a result of environmental factors connected to the dam or the litter; hence the estimates for c^2 were larger than the heritability estimate. Also, **Rym Ezzeroug *et al.* (2020)** showed that the common environmental effect of litter, which was 0.636 for weaning weight and 0.381 for fattening phase weight, explained the majority of phenotypic variance.

Genetic Correlations (r_g)

In respect to other traits, the importance of biological and economic relationships among the investigated traits is easily understood. All genetic correlations between body weights at different ages were moderate to high and positive, with 0.27 between body weights at 4 weeks and 8 weeks, 0.84 between body weights at 8 weeks and 12 weeks, and 0.44 between body weights at 4 weeks and 12 weeks. Estimates of $\mathbf{r_g}$ for daily gain ranged from low to high and were positive, with the exception of -0.84 between DG4-8 and DG 8-12 weeks, 0.64 between DG4-8 and DG 4-12 weeks, and 0.13 between DG8-12 and DG 4-12 weeks in Table 2. As improving body weight at any stage leads to improvements in growth traits at future stages, the genetic correlations among growth traits suggest that selection can be used at any step of the post-weaning period. This conclusion is consistent with the range of reviewed estimates obtained by **El-Deghadi (2005)** who showed all the probable genetic associations between body weights at different ages were determined to be low or high and positive, r_g estimates for post-weaning daily gain were generally low, moderate, or high, and all were positive. **El-Amin *et al.* (2011)** found that the genetic correlations among the growth traits in the first generation were all positive, however were low to moderate between weights at younger ages, but rather high between weights at older ages. These correlations, on the other hand, were often high in the second generation. According to **Ajayi *et al.* (2014),** genetic correlations with weekly body weight from birth to week 12 ranged from low (0.09) to very high (1.00). **El-Deghadi and Ibrahim (2018)** found r_G estimates ranged from 0.37 to 0.91 for all conceivable genetic correlations between body weights at different ages. **Rym Ezzeroug *et al.* (2020)** showed that the genetic correlations for weight at weaning were positive and highly correlated with weight at slaughter (0.611). Also, the genetic connections between growth parameters, according to **Garcia and Argente (2020)** are positive and highly correlated with weight at slaughter, ranging from 0.61 to 0.74. The genetic association between growth rate and weight at slaughter is stronger than the genetic correlation between growth rate and weight at weaning (0.56 vs. 0.31).

Common-Litter Correlations ($\mathbf{r_C}$)

The common litter correlation ($\mathbf{r_C}$) estimations were moderate to high and positive, with 0.59, 0.81 and 0.40 between body weights at 4 weeks and 8 weeks, between body weights at 8 weeks and 12 weeks, and between body weights at 4 weeks and 12 weeks, respectively. $\mathbf{r_C}$ estimations were high and positive, with 0.57 and 0.64 between DG4-8 and DG 4-12 weeks and between DG8-12 and DG 4-12 weeks but were negative (-0.18) between DG4-8 and DG 8-12 weeks in Table 2. These conclusions are in agreement with **El-Deghadi (2005)** who revealed that correlations between body weight and daily body increase were usually positive and moderate to high in magnitude. These estimations ranged from 0.85 to 0.94 for body weight records and 0.41 to 0.94 for daily growth records. **El-Deghadi and Ibrahim (2018)** reported that all of the possible genetic correlations between body weights at different ages were positive, with r_C estimates ranging from 0.53 to 0.94 for the majority of them. They suggested obtaining unbiased estimates of genetic, phenotypic, and environmental correlations, common environmental influences must be incorporated in the model of estimation of variance and covariance components.

Phenotypic Correlations ($\mathbf{r_p}$)

Table 2 shows that all feasible phenotypic correlations estimated among different body weights were positive and moderate to high, with 0.62, 0.67, and 0.31 between body weights at 4 weeks and 8 weeks, 8 weeks and 12 weeks, and 4 weeks and 12 weeks, respectively. r_p estimations were also

Table 2. Shows genetic (r_g), common-litter (r_C), environmental (r_e) and phenotypic (r_p) correlations estimates for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks of APRI rabbit, with standard errors

Traits	r_g ± SE	r_c ± SE	r_e± SE	r_p
BW4 & BW8	0.27 ± 0.99	0.59 ± 0.99	0.74 ± 0.05	0.62
BW8 & BW12	0.84 ± 0.57	0.81± 0.06	0.56 ± 0.04	0.67
BW4 & BW12	0.44 ± 0.90	0.40 ± 0.12	0.21 ± 0.09	0.31
DG4-8 & DG8-12	-0.84 ± 0.10	-0.18 ± 0.16	-0.37 ± 0.05	-0.33
DG4-8 & DG4-12	0.64 ± 0.92	0.57 ± 0.11	0.40 ± 0.04	0.46
DG8-12 & DG4-12	0.13 ±0.11	0.64 ± 0.10	0.69 ± 0.03	0.64

moderate to high and positive, with 0.46 and 0.64 between DG4-8 and DG 4-12 weeks and between DG8-12 and DG 4-12 weeks, respectively, but negative with -0.33 between DG4-8 and DG 8-12 weeks. In reality, in the current studies, moderate or high and positive estimations of phenotypic correlation between body weights and daily gains at different ages give rabbit breeders a significant benefit in their culling decisions and management. These conclusions are in agreement with **El-Deghadi, (2005)** who found that the r_P between records of different post-weaning body weights and daily gains at various age stages was mainly positive and of moderate to high amplitude. Estimates r_P varied from 0.63 to 0.82 between records of post-weaning body weights, and from 0.42 to 0.89 between records of post-weaning daily growth. **El-Amin *et al.* (2011)** reported in both generations, the phenotypic correlations between growth traits were high (> 0.5). According to **El-Deghadi and Ibrahim (2018**), r_p between bodies' weights at different ages were positive, moderate to high magnitude, and ranging from 0.48 to 0.82. **Rym Ezzeroug *et al.* (2020)** showed that the phenotypic correlations for weight at weaning were positive and highly correlated with weight at slaughter (0.631).

Environmental Correlations (r_e)

Table 2 reveals that the estimations of environmental correlations were moderate to high and positive, with 0.74, 0.56, and 0.21 between body weights at 4 weeks and 8 weeks, 8 weeks and 12 weeks, and 4 weeks and 12 weeks, respectively. The r_e estimates were moderate to high and favorable, with 0.40 and 0.69 between DG4-8 and DG 4-12 weeks and DG8-12 and DG 4-12 weeks, respectively, but negative with -0.37 between DG4-8 and DG 8-12 weeks. Some estimates of r_G and r_E are different in magnitude, or even in sign, from others. Genetic and environmental sources of variation affect the characters through different physiological mechanism **(Falconer, 1989)**. A large difference, and particularly a difference in signs, showed that there is a genetic and environmental source of variation in these characters. This conclusion is consistent with the range of reviewed estimates obtained by **El-Deghadi, (2005)** observed that the estimates of r_e between various body weights were high and positive. Estimates of r_e ranged from 0.55 to 0.93 for body weight records and 0.46 to 0.87 for post-weaning daily gain records. **El-Amin *et al.*, (2011)** showed that the environmental influences on both generations' growth features positive and extremely high (approaching one). **El-Deghadi and Ibrahim (2018)** found that r_e estimations were moderate to high, positive, and ranged from 0.21 to 0.82 between body weight records.

Breeding Value

The breeding values and accuracy ranges for body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, are shown in Table 3. The breeding values for all traits were lower than those reported by **Moustafa (2014),** for weaning weight, slaughter weight, and daily weight gain, the ranges of transmitting ability for all animals measured for growth traits were 512, 878, and 22.4, respectively. At 4, 6, 8, 10, and 12 weeks of age, **El-Deighadi and Ibrahim (2017)** found that estimations of all progeny breeding value for body weight varied from -0.244 to 0.389, -0.245 to 0.362, -0.259 to 0.346, -0.195 to 0.235, and -0.233 to 0.265 g, respectively. At 4, 6, 8, 10, and 12 weeks of age, the ranges of breeding values declined (0.633, 0.607, 0.605, 0.403, and 0.498 g, respectively). Furthermore, their accuracy was great. Variations in breeding values can lead to the correct culling decision and the selection of the best rabbits from those with high estimations of breeding values for growth traits.

Parity Effect

Table 4 shows that the variations in body weight in different intervals were highly significant ($P < 0.05$), with the largest value of body weight in the first parity (455.56, 1064.57, and 1871.03 g at 4, 8, and 12 weeks, respectively). The first parity's distinction may be related to the small number of litters in it, which causes weight increase. As well as, in the first parity, the largest averages and significant daily gains were between 4 and 8 weeks and 4 to 12 weeks (21.75 and 25.28), respectively, but the effect of parity was not significant between 8 and 12 weeks. Unlike **Desouky *et al.* (2021)**, who found extremely, significant ($P<0.05$) changes in body weight across age intervals; this is the finding in this study obtained. The third parity had the heaviest body weight at 4, 8, and 12 weeks, and body weight gain at 4-8, 8-12 and 4-12 weeks, respectively. In the first parity, the lowest body weight and body weight gain at 4-6, 6-12 and 4-12 weeks were recorded. As well as the parity order was shown to be significantly ($P\leq0.05$) affecting weaning weight, slaughter weight, and daily gain from weaning to slaughter weight in V line rabbits, the parity effect revealed a propensity for weaning weight to increase until the sixth parity according to **Intear (2021)**. Parity order, on the other hand, had no significant effect on most rabbit post-weaning growth traits, according to **Moustafa (2014)**.

Season effect

In different seasons, body weights at 4, 8, and 12 weeks of age were significantly different ($P<0.05$), having the highest body weight value in the autumn (460.60, 1091.31, and 1879.70 g at 4, 8, and 12 weeks, respectively). The biggest averages and significant daily gains in the autumn were between 4 and 8 weeks and 4 to 12 weeks (22.5 and 25.34, respectively), but the effect of seasons was significant between 8 and 12 weeks, while the largest averages in the winter were between 8 and 12 weeks (29.96) in Table 4. This could allude to the quantity and nutritional worth of the available greens at the time of use, as well as the moderate weather experienced throughout these months. Through the quantity and quality of directly ingested food usage throughout the post-weaning period, these variables may have an effect on rabbit weaning weight, amount of milk provided by suckling dams, and growth performance at later ages. These results are in agreement with **(El-Maghawry, 1999; Soliman *et al.*, 1999; Enab *et al.*, 2000; El-Deghadi, 2005)**. On the other hand **Desouky *et al.* (2021)** found a substantial change in body weight due to the seasons

Table 3. Shows the breeding values (BV), standard error (SE), and accuracy ranges (RI) for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks in the APRI rabbit.

Traits	Min			Max			Range		
	BV	SE	RI	BV	SE	RI	BV	SE	RI
BW4, g	-105.39	54.82	0.33	115.33	72.40	0.70	220.72	17.58	0.37
BW8, g	-33.42	33.60	0.17	35.66	37.45	0.47	69.08	3.85	0.30
BW12, g	-23.44	30.69	0.13	20.55	32.69	0.37	43.99	2.00	0.24
DG4-8 weeks, g	-1.56	1.27	0.24	2.12	1.50	0.57	3.68	0.23	0.33
DG8-12 weeks, g	-0.94	0.90	0.18	0.98	1.06	0.45	1.92	0.09	0.27
DG4-12 weeks, g	-0.72	0.88	0.14	0.14	0.94	0.38	1.43	0.06	0.24

Table 4. Shows the actual means and standard errors (SE) for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, as influenced by parity, season, and litter size at birth of APRI rabbit.

The effects	BW4, g	BW8, g	BW12, g	DG4-8, g	DG8-12, g	DG4-12, g
	Means ± SE	Means ± SE	Means ± SE	Means ± SE	Means ± SE	Means ± SE
Parity						
1	455.56 ± 4.65^{a}	1064.57 ±10.80^{a}	1871.03 ± 12.34^{a}	21.75±0.32^{a}	28.80±0.36	25.28±0.19^{a}
2	448.58 ± 4.83^{a}	992.58 ± 11.20^{b}	1817.62 ± 12.82^{b}	19.43±0.33^{b}	29.47±0.37	24.45±0.20^{b}
3	413.06 ± 5.14^{b}	931.11 ± 11.97	1745.76 ± 13.66^{c}	18.50±0.35^{b}	29.09±0.39	23.80±0.2^{c}
Season						
Autumn	460.60 ± 5.09^{a}	1091.31 ±11.68^{a}	1879.70 ± 13.39^{a}	22.52±0.34^{a}	28.15±0.38^{a}	25.34±0.21^{a}
Winter	445.31 ± 4.05^{b}	983.20 ± 9.30^{b}	1821.94 ± 10.74^{b}	19.21±0.27^{b}	29.96±0.31^{b}	24.58±0.16^{b}
Spring	404.77 ± 5.80^{c}	918.20 ± 13.32	1719.90 ± 15.38^{c}	18.33±0.39^{b}	28.63±0.44^{b}	23.49±0.24^{c}
Litter size at birth						
≥ 4	482.81 ±12.76^{a}	1056.41 ±31.04^{ab}	1835.63 ± 34.42^{a}	20.49±0.91	27.83±0.97^{c}	24.16±0.53^{b}
5	475.6 ± 9.56^{a}	1025.96 ±23.26^{ab}	1866.66 ± 25.79^{a}	19.64±0.68	30.22±0.72^{ab}	24.84±0.39^{ab}
6	448.46 ± 7.08^{b}	1014.38 ±17.22^{ab}	1860.53 ± 19.09^{a}	20.20±0.50	30.21±0.54^{a}	25.21±0.29^{ab}
7	450.44 ± 6.21^{b}	1013.19 ±15.11^{ab}	1815.23 ± 16.76^{a}	20.10±0.44	28.64±0.47^{ab}	24.37±0.25^{ab}
8	433.08 ± 6.36^{bc}	1004.30 ±15.46^{ab}	1847.05 ± 17.14^{a}	20.38±0.45	30.09±0.48^{ab}	25.24±0.23^{a}
≤ 9	418.33 ± 4.99^{c}	967.77 ± 12.14^{b}	1757.56 ± 13.46^{b}	19.63±0.36	28.21±0.38^{c}	23.92±0.21^{b}

impact at all measurement periods. Rabbits had the heaviest live body weights in the spring, while the lightest live body weights were observed in the summer. While there was no statistically significant difference in body weight gain between seasons, there was a non-significant difference in body weight gain across seasons. In the spring, the best weight growth was reported at 4-8, 8-12, and 4-12 weeks of age, respectively. In the summer, the lowest weight gains were recorded during 4-8, 8-12, and 4-12 weeks of age, respectively. **Intear (2021)** reported that weaning weight, slaughter weight and daily growth from weaning to slaughter weight in V line rabbits were significantly varied ($P \leq 0.001$) in different months, for weaning weight, slaughter weight, and daily gain, the lowest averages denote rabbits born in July and August, while the highest averages denote rabbits born in November, and March.

Litter Size at Birth Effect

The differences in body weight due to litter size at birth were significant ($P<0.05$), with the maximum body weight values for 4 to 6 litter (482.81, 1056.41 and 1866.66) at 4, 8, and 12 weeks, respectively, and decreasing with large litters. In addition, the influence of litter size at birth was significant for daily gains between 8 and 12 weeks and 4 to 12 weeks, but not for daily gains between 4 and 8 weeks in Table 4. These findings correspond with **El-Deghadi (1996)**, who found that litter size had a highly significant effect on body weight at 8 and 12 weeks in New Zealand White and Californian rabbits, and that less weight was connected to larger litter size. As a result, the effect of litter size on kindling must be addressed while making selection decisions. In every age group, **Szendroe *et al.* (1996)** found a negative connection between litter size and body weight (3, 6, 10 and 12 weeks).

They also found that the size of the litter at birth had a minor impact on male body weight at 16 weeks of age. From 12 to 16 weeks of age, the litter size had no effect on daily gain, according to the same author. Body weight and daily increase of rabbit's breastfed in tiny litters were maximum until a particular litter size was reached (≤ 4 or 5 for N-line; ≤ 7 for Z-line and ≤ 6 for G-line) and thereafter reduced. With V Line rabbits, **Ghada (2018)** observed that those born in large litters have lower body weight at weaning than those born in small litters. According to **Intear (2021)**, there were highly significant differences ($P \leq 0.001$) in body weight at weaning between litter sizes born a live (BW4). There was a clear trend that BW4 decreased as the number of kits born alive increased. There were also significant differences in body weight at slaughter (BW9) between the various litter sizes born alive, with rabbits raised in litters of 8 kids having the best BW9 and those raised in litters of ≥10 bunnies having the lowest.

Conclusion

Because body weights and daily growth have low heritability values, crossbreeding between the same lines or different breeds, rather than selection, may be a better strategy to improve body weights and daily gains. Since the APRI line rabbit contains 50% Egyptian strain (Baldi Red) genes that are more acclimated to Egyptian climatic conditions and 50% V Line, a maternal line that was selected for litter size at weaning. It may cross with Baldi Red or V Line again in order to benefit from their features. Moderate or high and positive estimations of phenotypic correlation between body weights and daily gains at different ages give rabbit breeders a significant benefit in their culling decisions and management. The most important non-genetic parameters impacting body weights and daily gains were parity, season, and litter size at birth.

As a result, these effects must be taken into account in the model analysis in order to estimate genetic parameters for the traits being researched without biasing predictions.

REFERENCES

Abdel-Kafy, E.; El-Deighadi, A.S.; Shabaan, H.M.; Ali, W.H.A.; Sabra, Z.E.A. and Farid, A. (2021). Genetic Evaluation of Growth Traits in New Synthetic Rabbit Line in Egypt. Open J. Agric. Res., 1: 62-73.

Ajayi, B.A.; Oseni, S.O. and Popoola, M.A. (2014). Heritability estimates and genetic correlations of some reproductive traits in heterogeneous rabbit population in South-west Nigeria**.** Trop. Anim. Prod. Invest., 17 (1): 52-57.

Boldman, K.G.; Kriese, L.A.; Van Vleck, L.D.; Van Tassell, C.P. and Kachman, S.D. (1995): A manual for use of MTDFREML. A set of programs to obtain estimates of variances and covariances [DRAFT]. U.S. Dept. Agric., Agric. Res. Service, USA.

Desouky, A.T.; El-Gendi, G.M.; Iraqi, M.M. and Rashad, S.A. (2021). Influence of genotypes, season of birth, parity order and the interactions between them on litter traits and body weight measurements of rabbits. Annals Agric. Sci., Moshtohor, 59 (2): 399-408.

El-Amin, K.M.; Yousif, I.A.; Elkhairey, M.A. and Mekki, D.M. (2011). Heritability estimates and genetic correlations for post-weaning body weight traits in Sudanese rabbits. Livestock Res. Rural Develop., 23: 11.

El-Deghadi, A.S. (1996). Genetic and phenotypic analysis for fur traits in rabbits. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Banha Branch, Egypt.

El-Deghadi, A.S. (2005). Genetic evaluation for some productive traits in rabbits. Ph.D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Banha Branch, Egypt.

El-Deighadi, A.S. and Ibrahim (2017). Genetic aspects of post-weaning for growth traits in New Zealand white rabbits. Egypt. J. Rabbit Sci., 27 (2): 507-521**.**

El-Deghadi, A.S. and Ibrahim (2018). Selection indices for improving body weight in gabali rabbits. Egypt. Poult. Sci., 38 (IV): 1115-1126.

El-Deghadi, A.S. (2019). Factors affecting milk production and using application selection indices to improve productive traits of does in New Zealand white rabbits. Egypt. J. Rabbit Sci., 29 (1): 61-78.

El-Maghawry, A.M. (1999). Genetic effects on some doe productivity in New Zealand White and Californian rabbits raised in Egypt. Egypt. J. Rabbit Sci., 9 (2): 179-195.

El-Zanfaly, E.S. (1996). Genetic and phenotypic analysis for some reproductive traits in rabbits. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Banha branch, Moshtohor. Egypt.

Enab, A.A.; El-Weshahy, O.A. and Abdou, F.H. (2000). Genetic analysis of some economic traits in rabbits, Egyptian J. Rabbit Sci., 10 (2): 327-339.

Falconer, D.S. (1989). Introduction to Quantitative Genetics. 3rd Ed., Longman, London, UK.

Falconer, D.S. and Mackay, T.F.C. (1996). Introduction to Quantitative Genetics, 4th Ed. Longmans Green. Harlow, Essex, UK.

Ghada, M.M. (2018). Genetic evaluation for paternal line of rabbit (Alexandria line) under selection for daily weight gain. M.Sc., Fac. Agric. Poult. Prod. Dept., Alex. Univ., Egypt.

García, M.L. and Argente, M.J. (2020). The Genetic Improvement in Meat Rabbits See discussions, stats, and author profiles for this publication at: https:// www.researchgate.net/publication/346205479.

Henderson, C.R. (1973). Sire Evaluation and Genetic Trends. In: Proc. Anita. and Genet. Symp. In Honor JL Lush.: 10-41.

Intear, M.A. (2021). Genetic study a maternal line of rabbits under Egyptian environmental conditions, Ph.D. Thesis, Fac. Agric., Alex. Univ., Alex., Egypt.

Khalil, M.H. (2010). Programs established to synthesize new lines of rabbits in hot climate countries. A review article presented in 6th Inter. Rabbit Conf., 1-4 Feb., Assuit, Egypt.

Moustafa, H.A. (2014). Genetic evaluation of some economic traits in a maternal line of rabbits, Ph.D. Thesis, Fac. Agric., Alex. Univ., Alex., Egypt.

Mınguez, C.; Sanchez, J.P.; El-Nagar, A.G.; Ragab, M. and Baselga, M. (2015). Growth traits of four maternal lines of rabbits found on different criteria: comparisons at foundation and at last periods after selection**.** J. Anim. Breed. Genet. ISSN: 0931-2668.

Rym Ezzeroug, R.B.; Maria, J.A.; Ali, B.; Samir, D.; Zoulikha, B.; Djamal, T.; Nassima, B. and Maria de la Luz García (2020). Genetic correlations for reproductive and growth traits in rabbits. Can. J. Animal Sci., 100**.**

SAS., 2003. SAS Online Doc 9.13 SAS Institute Inc., Cary, NC, USA.

Soliman, F.N.K.; El-Sheikh, A.I. and Mandour, M.A. (1999). Effects of restricted feeding time, season and sex on postweaning performance of New Zealand White rabbits. Egypt. Poult. Sci., 19 (II): 407-418.

Szendroe, Z.S.; Nemeth-Biro, E.; Radnai, I.; Milisits, G. and Zimanyi, A. (1996). Connection between reproductive performance and productive lifetime of rabbit doe. 6th World Rabbit Congress, Toulouse, France, 2: 123-126.

Youssef, Y.K.; Iraqi, M.M.; El-Raffa, A.M.; Afifi, E.A.; Khalil, M.H.; García, M.L. and Baselga, M. (2008). A joint project to synthesize new lines of rabbits in Egypt and Saudi Arabia: emphasis for results and prospects. In Proc.: 9th World Rabbit Congress, 10-13 June, Verona, Italy**,** 1637-1642.

Youssef, Y.M.K.; Farid, A.; Gad-Alla, S.A. and Abo-Warda, M.A. (2009). Genetic evaluation for post weaning body weight traits in three genetic groups of rabbits under Egyptian conditions, 5th Int. Poul. Conf., 10-13 March, Taba, Egypt.

الملخص العربي

تقييم الأداء الإنتاجي في الخط الأموى المستنبط (APRI) تحت الظروف المصرية

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تم تطوير الخطوط المستنبطة في البلدان ذات المناخ الحار على مدى العقود القليلة الماضية من خلال الانتخاب لأهداف محددة مثل أرانب (APRI). وحسب تخصصها، فإن أداء هذه السلالات أفضل من مستوى السلالات القياسية، ويميل الإنتاج المعاصر إلى الاعتماد عليها. ومن ثم كان الهدف من هذه الدراسة هو تقييم وشرح المعالم الوراثية في الخط المستنبط الأموى (APRI) تحت الظروف المصرية. تم استخدام النموذج الحيوانى بطريقة معظمة الأحتمال المعتمدة على حساب المشتقات التفاضلية (MTDFREML) للتقييم أوزان الجسم عند 4 و8 و12 أسبوعًا، وكذلك الزيادة اليومية من 8-4 و 12-8 و 12-4 أسبوعًا. كانت أعلى قيمة للمكافئ الوراثي عند 4 أسابيع (0.10)، بينما كان أقل قيمة عند 12 أسبوعًا (0.03). أعلى تقدير للمكافئ الوراثي للزيادة اليومية من 8-4 أسابيع (0.08)، بينما أقل قيمة من 12-8 أسبوعًا (0.02). كانت جميع قيم الارتباطات الوراثية بين أوزان الجسم في الأعمار المختلفة تتراوح بين متوسطة إلى عالية وإيجابية. وتراوحت قيم الارتباطات الوراثية للزيادة اليومية بين منخفضة إلى مرتفعة وكانت إيجابية، باستثناء الزيادة اليومية بين 8-4 و 12-8 أسبوعًا (0.84 -). كان تأثير البطن معنوى لأوزان الجسم والزيادة اليومية في الأعمار المختلفة وكانت أعلى قيم فى البطن الأولى. كانت توجد أختلافات معنوية لتأثيرالموسم لأوزان الجسم والزيادة اليومية في الأعمار المختلفة وكانت أعلى قيم فى الخريف. كانت توجد فروق معنوية لتأثيرعدد الخلفة عند الولادة فى وزن الجسم والزيادة اليومية من 8-12 و4-12 أسبوعًا، ولكن ليس له تأثير من 4-8 أسابيع.

الكلمات الإسترشادية: المكافىء الوراثى، الارتباطات الوراثية والمظهرية، البطن، الموسم، عدد الخلفة عند الولادة.

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