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GENETIC AND SOME PHYSIOLOGICAL EVALUATIONS OF DOE AND BODY CONDITION TRAITS FOR THE APRI RABBITS

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ABSTRACT: This study was conducted on 330 records from 110 does of APRI rabbits to make a genetic evaluation for some doe traits included litter traits (litter size at birth; LSB, and at weaning; LSW, Litter weight at birth; LWB, and at weaning; LWW), milk yield traits during (the 1st week; MY7, the 2nd week; MY14, the 3rd week; MY21, the 4th week; MY28 of lactation, and total milk yield; TMY), and body condition score traits (body condition score at mating; BCSM, and after kindling; BCSK). This was besides the physiological evaluation for does body condition through some blood parameters which were taken at mating and after kindling as indicators for does body condition and health. Heritability estimates for litter traits were relatively low ranged from 0.08 to 0.14. Estimates of h^2 for milk yield traits were low ranged from 0.03 to 0.12. Values of h^2 for BCSM, and BCSK were low 0.03 and 0.01 respectively. Repeatability estimates for litter traits were low to moderate ranged from (0.09 to 0.15). Repeatability estimates for milk yield traits were low ranged from (0.03 to 0.12). Genetic correlations between LSB and LSW, LSB and LWB, LWB and LWW were positive and (0.89, 0.31, and 0.37) respectively. Positive genetic correlations among milk yield at the 2nd, 3rd, 4th week of lactation and total milk yield were detected. A negative strong genetic correlation (-0.78) was detected between milk yield during the 1st and 3rd weeks of lactation. The genetic trend for litter traits had fluctuations with year-season levels. A high value of genetic trend for LSW was detected which increases with the Spring season. Milk yield at the 1st, 2nd, 3rd, 4th weeks of lactation and total milk yield increased 74.66, 98.99, 110.24, 90.54, and 370.84 (g), respectively by the increasing of litter size at lactation week with one bunny. Total protein, albumin, and globulin levels were significantly ($P \leq 0.001$) decreased after kindling. But, the albumin/globulin ratio was significantly ($P \leq 0.001$) increased after kindling. Glucose and urea levels were insignificantly decreased by increasing the parity; the estradiol hormone was insignificantly increased by increasing the parity.

Conclusively**,**Low estimates of h^2 for doe litter, milk, and body condition score traits in APRI rabbits reflected that these rabbits were highly affected by non-additive genetic effects. Achieving high progress in such traits requires improving management and environmental conditions. The moderate estimate of repeatability for LSW (0.15) indicated that this trait could be improved through selection depending on little records. Milk yield traits at the 2nd week could be effective to improve total milk yield in these rabbits and accordingly improving litter weight at weaning. The high value of genetic trend for LSW which increases with the Spring season in the two years of study reflects the improvement of the performance of APRI rabbits does. Litter size at the week of lactation had a significant ($P < 0.01$) effect on all milk yield traits under study. Total protein, globulin, and albumin levels are good indicators for does body condition and health.

Keywords: APRI, Rabbits, Genetic evaluation, Genetic trend, physiological.

INTRODUCTION

APRI rabbits were established by crossing Baladi Red bucks with does of V line to produce the first generation (½B½V). After that, it followed by two generations of inter-semating to achieve stability in rabbits' performance (Youssef *et al.,* 2008b, Abou Khadiga *et al.,* 2010 a & b). Studies concerning the genetic analysis of new synthetic lines of rabbits in hot climate countries were scarce; (Khalil *et al*., 2002). More studies were needed to know the performance of this line of rabbits. Doe productivity traits such as litter sizes, litter weights, and milk yield traits were considered selection aims and criteria in improving maternal rabbit lines (Baselga, 2004). Thus, studying and genetic evaluation of such traits is important to stand on the effective way of improving these traits.

Body condition of rabbits does at mating and after kindling represented in does body condition score (BCS) and some physiological and blood parameters like (Estradiol, Urea, Glucose, Albumin, and Total Protein) are good indicators of the health of does. So, body condition score could be used as a criterion in farm management (Rosell and De La Fuente, 2008). It is important in selecting rabbits does for production. The body condition score (BCS) of rabbits does should be taken into account in practice, for example, before the start of a new cycle, as a reason for culling and also, in the field of research (Cardinali *et al*., 2007).

Therefore, the aims of this study were to (1) Make a genetic evaluation for the productive performance of APRI rabbits does to offer more updated data for these does of a synthetic maternal line of rabbits raised in Egypt by the following: (a) Estimating the variance components and genetic parameters including heritability, repeatability, and genetic correlations for the studied litter and milk yield traits such as (litter size at birth (LSB); litter size at weaning (LSW) ; Litter weight at birth (LWB); Litter weight at weaning (LWW); milk yield (MY), during the 1st, 2nd, 3rd, and 4th week of lactation, and total milk yield (TMY), during the whole 4 weeks), (b) Estimating genetic trends for litter traits under study by year-season to stand on the genetic changes and progress for these traits, (c) Studying the relation between litter size at lactation week and milk yield traits by regressing linearly milk production on litter size at different weeks of lactation, (2) Make an evaluation to APRI rabbits does body condition at mating and after kindling by (a) Evaluating the body condition score (BCS) of APRI rabbits does at mating and after kindling, genetically by estimating variance components and genetic parameters for this trait at the two times and (b) Making a physiological evaluation for does at mating and after kindling by estimating some blood parameters at the two times (Estradiol, Urea, Glucose, Albumin, and Total Protein) as an indicator to their body condition and health.

MATERIALS AND METHODS

Animals

APRI rabbits were new established Egyptian maternal line. These rabbits resulted from crossing Egyptian Baladi Red (BR) and Spanish line (V) rabbits in 2002 at Sakha experimental station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

This study was conducted at the experimental Rabbitry Farm, Animal Production Research Institute, Agriculture Research Center, in the Gemizah station of researches, El-Gharbiah Governorate, Egypt. This study was carried out for two sequential years with a total of 330 litters produced from 110 does and 37 sires of APRI rabbits. Rabbits were kept individually in wire cages (60x50x35 cm) provided with feeders, automatic water nipple drinkers for all times. APRI rabbits were kept under the same conditions and fed *ad-libitum* on a concentrated commercial pelleted feed containing 17% crude protein, 12.3% crude fiber with digestible energy of 2550 kcal/kg diet. Fresh, clean water was available to rabbits through nipples at all times. The does were meted naturally with starting at the age of 6 months. The does were palpated after 12 days from mating to verify pregnancy or not.

Traits

The studied traits were litter traits (litter size at birth; LSB, litter size at weaning; LSW, Litter weight at birth; LWB, Litter weight at weaning; LWW), milk yield traits (milk yield during the first week of lactation (g ⁄week); MY7, milk yield, during the second week; MY14, milk yield during the third week; MY21, milk yield during the fourth week; MY28, total milk yield; TMY, during the whole 4 weeks of lactation), and does body condition traits (does body condition score at mating; BCSM, and does body condition score after kindling; BCSK).

Measurement methods for traits

Litter weights at birth and weaning were taken using a digital scale in grams. Milk yield (g) was calculated as an average of the differences between the weight of both does and bunnies before and after suckling weekly till weaning. Total milk production (g), during the whole four weeks of lactation was calculated.

The body condition score was based on a feeling by hand for the loin and rump regions and classified to wide, intermediate, and poor (Bonanno *et al.*, 2005). This depends on a feeling by hand for bone protrusions and the fullness of muscles. This trait is a threshold trait that takes three degrees of score “1” expresses on wide, score “2” indicates to intermediate and score “3” is for poor body condition. This trait was taken on every APRI rabbit doe twice at mating and after kindling.

Measurement of some biochemical parameters

These parameters aim to evaluate APRI rabbit does body condition physiologically at mating and after kindling as indicators of the health of does at the two times. A total 30 samples of blood parameters were taken from five does for three sequential parities for each doe at mating and after kindling and included (serum levels of total protein, albumin, globulin, urea, glucose, and estradiol).

Blood samples were collected from the marginal ear vein in the tubes with heparin immediately at mating, and after kindling in order to evaluate the previous parameters. Serum levels of total protein and albumin were determined according to Henry (1964), and Doumas *et al.*, (1971), respectively, using commercial kits (Diamond diagnostics). The globulin value was obtained by subtracting the value of albumen from the corresponding value of total protein. The urea-N level was determined using commercial kits (Diamond diagnostics) according to the method of Patton and Crouch (1977), while total cholesterol and triglyceride levels were determined according to Richmond (1973) and Fassati and Prencipe (1982). The serum level of

Estradiol was measured using Coat-A-Count Estradiol (PITKE2-10, 2009-07-16) radioimmunoassay kits according to the method of Cuilleron and Forest (1990).

Statistical analysis

Statistical analysis of litter and milk traits

Litter and milk traits data analyzed included animal ID (Doe), parity, and year-season. The multi-trait animal model was used to analyze the data according to (Boldman *et al.*, 1995). Variance and covariance obtained by the REML method of VARCOMP procedure (SAS, 2003) were used as starting values (guessed values) for the estimation of variance and covariance components. The following animal model was used:

$Y = X_b + Z_a u_a + Z_{pe} u_{pe} + e$

Where: Y= The vector of observation for the i^{th} trait; b= The vector of fixed effects (parity, 3 levels, and year-season combination, 6 levels) for the i^{th} trait; u_a= The vector of random animal effect for the i^{th} trait; u_{pe}= The vector of random permanent environmental effect for the i^{th} trait; e= The vector of random residual effect for i^{th} trait; and X_b, Z_a, and Z_{pe} are incidence matrices relating records to fixed, animal, and permanent environmental effects, respectively.

Statistical analysis of body condition traits

The same model but in a form of a single trait threshold model also used in analyzing does body condition traits BCSM and BCSK using the Gibbs program of the statistical program package BLUPF90 (Misztal *et al.*, 2016), which uses a Bayesian approach in order to obtain variance components and genetic parameters. After 10,000 Gibbs samples were discarded as burn-in, 100,000 samples then were used to estimate posterior means, standard deviations, and standard errors for variance components, heritability, and repeatability.

Estimation of genetic trends for litter traits

The genetic trend of litter traits in this study calculated as the regression of the mean of the predicted breeding values on year-season and then, plotted in Figures 1 and 2.

Estimation of litter size effect on milk yield using linear regression coefficient (b)

Linear regression coefficient (b) of milk production at a certain week of lactation on their litter size at that week in APRI rabbits were estimated using REG procedure (SAS, 2003). These linear regressions were plotted in Figures 3, 4, 5, 6, and 7.

Estimation of parity effect on biochemical parameters

Effect of parity on serum total protein, albumin (A), globulin (G) levels and albumin/globulin (A/G) ratio, serum Glucose, Urea, and Estradiol of doe Apri rabbits at mating and after kindling were analyzed using ANOVA procedure (SAS, 2003).

RESULTS AND DISCUSSION

1- Means and coefficient of variations:

Means, standard deviations (SD), and coefficients of variation (CV %) for different litter and milk yield traits in APRI rabbits were presented in Table 1. Means of litter size and litter weight traits at different ages in this study were 5.45 for LSB, 3.85 for LSW, 362.11 (g) for LWB, and 1545.49 (g) for LWW. These values were in the ranges reported by Abou-Khadiga *et al.*, (2012) on APRI rabbits. Means of litter weight traits at birth and weaning age in this study were lower than those reported by Abou

Khadiga *et al.*, (2010a) on line V rabbits. Means of litter traits in this study were lower than those reported by Amira El-Deghadi (2019a), and Mahmoud and Walid, (2020) on NZW rabbits. It was, also lower than values reported by Rabie *et al.,* (2019) on a crossbred of line V and Gabali rabbits.

The mean total milk yield in the present study was 2779.99 (g). This value was in the range reported by Abou-Khadiga *et al.*, (2012) on APRI rabbits. However, the values of means for different milk yield traits in the present study were lower than those obtained by Amira El-Deghadi, (2019a); Amira El-Deghadi, (2019b); and Mahmoud and Walid (2020) on NZW rabbits. The results in Table 1 showed that the milk yield increases through the weeks of lactation and reached a peak at the third week (908.03) g, then it decreases through the fourth week of lactation in which the lowest milk yield (390.75)g. Iraqi and Youssef (2006), Youssef *et al.,*(2008c), Iraqi (2008), Amira El-Deghadi (2019a), and Mahmoud and Walid (2020) showed the same trend, that the milk yield reaches the peak during the 3rd week of lactation and decreases with the 4th week of lactation. This may be due to the decline in the milk amount produced by the doe during late pregnancy as a result of suckling or dry ration consumed by the young rabbits (El-Maghawry *et al.*, 1993).

Coefficients of variation for litter traits in this study ranged from 36.00 to 42.31%. This was higher than that observed by Amira El-Deghadi, (2019a); and Mahmoud and Walid, (2020). This high variability may be due to some effects like the genetic make-up of the does, non-genetic factors (year-season, parity, and management).

Coefficients of variation for milk yield traits ranged from 38.81 to 60.64 %. These variations were higher than those detected by Iraqi and Youssef (2006), Amira El-Deghadi (2019a), and Mahmoud and Walid (2020). This indicated that milk yield in rabbits was subjected to many effects as genetic make-up of the does; non-genetic factors (litter size at birth, year-season, parity, and management).

2- Variance components (values and proportions):

Estimates of heritability, permanent environmental, residual effects, and repeatability estimates for doe, litter, and milk yield traits in APRI rabbits were showed in Table 2.

Heritability estimates (h^2_a):

Heritability estimates for litter traits under study were relatively low ranged from (0.08 to 0.14). This result was in the ranges obtained by Abou Khadiga *et al.,* (2012) on APRI rabbits, Amira El-Deghadi (2019a&b), on NZW rabbits. Estimates of h^2 for LSB and LSW in this study were low (0.10 and 0.14 respectively). These values were comparable to those obtained by Iraqi *et al.,* (2010) who obtained h^2 values 0.06 and 0.07 for LSB and LSW, respectively in a crossbreeding project of Egyptian Gabali breed with Spanish V-line rabbits. Heritability estimates for litter weight at birth and weaning in this study (0.08) were low, also. This value was in the ranges reported by Abou Khadiga *et al.*, (2010a) and Hassan *et al.*, (2015) on the same APRI rabbits under study. Hassan *et al.*, (2015) working on APRI rabbits found low heritability for litter weight traits ranged from (0.04 to 0.17) and suggested that these traits could be improved using family or within-family selection, which could be more effective than individual selection to improve these traits of APRI does of rabbits, under the Egyptian conditions. However, Mahmoud and Walid (2020) on NZW rabbits observed that h^2 for LSB, LSW, LWB and LWW were 0.05, 0.07, 0.14, and 0.06, respectively.

Heritability estimates for milk yield traits under the present study were low ranged from (0.03 to 0.12). This result was in the ranges obtained by Amira El-Deghadi (2019 a & b) who reported heritability estimates ranged from (0.07 to 0.15) and (0.06 to 0.25), respectively for the same traits in NZW rabbits. While, Mahmoud and Walid (2020) on NZW rabbits found that h^2 for MY7, MY14, MY21, MY28, and TMY traits were 0.08, 0.19, 0.22, 0.17, and 0.21, respectively. These estimates also were comparable to those obtained by Iraqi and Youssef (2006) and Iraqi *et al.,* (2010) who obtained h^2 values ranged from (0.001 to 0.04) and from (0.00 to 0.06) for milk yield traits in a crossbreeding project of Egyptian Gabali breed with Spanish V-line rabbits and in NZW rabbits respectively. Heritability estimates for milk yield traits in APRI rabbits of the present study were lower than those observed in studies in NZW rabbits. Estimates of heritability for milk yield in the 2nd and 4th week of lactation in the present study were the highest of milk yield traits (0.07 and 0.12). Thus, it is recommended that improvement of APRI does milk yield traits at that weeks could be effective to improve total milk yield in APRI rabbits, which caused to improve litter weight at weaning.

Low estimates of h^2 for traits under study may be due to high non-additive genetic effects for all litter and milk yield traits. Because of low heritability for traits under study, we can use crossbreeding programs to improve these traits. This is in agreement with Amira El-Deghadi (2019a). Also, improving management and environmental conditions would lead to good improvement in those traits.

Permanent Environmental effect (σ^2_{pe}):

The permanent environmental effects (σ^2_{pe}) for litter traits were low ranged from (0.01 to 0.03). These results were in the ranges of Iraqi *et al.*, (2010) and Amira El-Deghadi (2019a).

The permanent environmental effects (σ^2_{pe}) for milk yield traits ranged from (0.002 to 0.01). These values were in the ranges reported by Iraqi *et al.,* (2010). However, it was lower than those detected by Moura *et al.,* (1991); Iraqi and Youssef (2006) and Amira El-Deghadi (2019a) reported that the low values of permanent environmental effect may be attributed partially to the temporary environmental variation included management conditions, which could not be considered in statistical models.

Estimates of the permanent environmental effects (σ^2_{pe}) tended to be lower than h^2 for all studied traits. This result was in agreement with Nofal *et al.,* (2008), Youssef *et al.,* (2008a), Abou Khadiga *et al.,* (2010a).

Error proportion (σ^2_e):

Error proportions for litter traits under this study were high ranged from (0.85 to 0.91) as viewed in Table 2. Also, error proportions for milk yield traits were high ranged from (0.88 to 0.96). These results were in agreement with Iraqi and Youssef (2006). Similar results were observed by Iraqi and Youssef (2006), Hassan *et al.,* (2015), and Amira El-Deghadi (2019a).

Repeatability (R):

Repeatability estimates for litter traits in the present study were low to moderate ranged from (0.09 to 0.15). The moderate estimate of repeatability for LSW in the present study (0.15) indicates that we could depend on little records in selection for this trait. This trend was within the ranges of Amira El-Deghadi (2019a) on NZW rabbits. Repeatability estimates for litter weight at birth and weaning in this study (0.09) were lower than those reported by Abou Khadiga *et al.*, (2010a) and Abou Khadiga *et al.*, (2012) on the same breed.

Repeatability estimates for milk yield traits were low ranged from (0.03 to 0.12). These estimates were in the ranges of Iraqi and Youssef (2006). However, it was lower than those reported by Amira El-Deghadi (2019a). These low estimates of repeatability for most litter and milk yield traits in this study indicate that the assessment of several parities before selecting parents for these studied traits is necessary for effectiveness in selection.

Correlations

Genetic correlations (r_g):

Genetic correlation among litter traits in this study was positive ranged from 0.04 to 0.89, except this between LSB and LWW, it was negative (-0.06) as presented in Table 3. The genetic correlation between litter size traits (LSB and LSW) was positive and strong (0.89). This value was higher than that observed by Amira El-Deghadi (2019b), Rabie, *et al.,* (2019), and Mahmoud and Walid (2020). This positive genetic correlation between LSB and LSW indicates that selection for LSB would increase LSW as a correlated trait. The genetic correlation between LSB and LWB was positive and moderate (0.31). This estimate was lower than that reported by Amira El-Deghadi (2019b), and Mahmoud and Walid (2020). It was also, not in agreement with Rabie, *et al.,* (2019) who detected a negative genetic correlation between LSB and LWB (-0.29). Also, the genetic correlation between LWB and LWW was positive and medium (0.37). This value was higher than that observed by Mahmoud and Walid (2020) who find a positive genetic correlation between LWB and LWW (0.27). These positive genetic correlations indicate that these traits were controlled by the same genes and the improvement of one will lead to an improvement for the other. A negative correlation found between LSB and LWW in this study (-0.06). This result was not in agreement with Amira El-Deghadi (2019b). This negative genetic correlation means that an improvement in one of these traits would result in the deterioration of the other; this was in agreement with Sorhue *et al.*, (2014).

Genetic correlation between litter weight traits was positive and moderate (0.37). This result was in agreement with Amira El-Deghadi (2019b) who found a relatively similar estimate in NZW rabbits. Also, this result was comparable to that observed by Abou-Khadiga *et al.*, (2010a) who find a positive and strong genetic correlation also between LWB and LWW. This result indicated that making selection for LWB would lead to a correlated response and improvement in LWW because of this positive and moderate genetic correlation between the two traits in the present study.

Genetic correlation among milk yield traits presented in Table 3. The genetic correlation among all milk yield traits in this study was positive and weak to strong ranged from 0.09 to 0.95, except that observed between milk yield at first week with that at the third week and with total milk yield, it was negative and medium to strong (-0.78 & -0.24) respectively.

The strong and negative genetic correlation (-0.78) between milk yield, during the 1st and 3rd weeks of lactation in this study indicates that as milk production increased during the first week (because of increasing the activity of the mammary gland gradually), the milk production decreased during the 3rd week, because of the inhibition of the prolactin hormone by estrogens and progesterone, which due to that most of the does were in the late periods of pregnancy at that time (Lebas *et al.*, 1997) and the increase of dry ration consumed by the young simultaneously. These results were not in agreement with Amira El-Deghadi (2019b) and Mahmoud and Walid (2020) who found a positive genetic correlation among all milk yield traits. These results also, were not in agreement with Iraqi and Youssef (2006). The positive genetic correlation among milk yield at 2nd, 3rd, 4th week of lactation and total milk yield in the present study, means that improvement of one will lead to similar improvements in the other of these traits.

Permanent environmental correlations (r_{pe})

The permanent environmental correlation between litter weight traits was negative and strong (-0.91) as presented in Table 3. This result was the opposite of that observed by Abou-Khadiga *et al.*, (2010a) who find a positive permanent environmental correlation between LWB and LWW.

Permanent environmental correlations among milk yield traits were positive and medium to strong (0.26 to 0.86) as shown in Table 3, except that between the 1st week of lactation with the 4th week of lactation and with total milk yield(-0.33 and -0.38), respectively. These results were not in agreement with Iraqi and Youssef (2006).

Environmental correlations (r_e)

Environmental correlations (**r_e**) among litter traits under study were negative and weak to moderate (-0.21 to -0.41) except the correlation between LSB and LSW was positive and moderate (0.35) as shown in Table 3. The environmental correlations among litter size traits in this study were comparable to those reported by Sorhue *et al.*, (2013) using the sire and dam model and were not in agreement with Rabie *et al.*, (2019). The environmental correlation among milk yield traits was negative and weak to moderate (-0.01 to -0.47), except that between milk yield at 2nd, 3rd, and 4th weeks of lactation and total milk yield, it was positive (0.09 to 0.12). Also, there was a positive correlation between milk yield at 1st and milk yield at 2nd week of lactation (0.04). Generally, the positive environmental correlation between two traits indicates that there were common environmental influences on these traits (Sorhue *et al.*, 2013).

Phenotypic correlations (r_p)

The phenotypic correlation between LSB and LSW was negative (-0.01). This was the opposite of genetic correlation among the same traits, and disagreed with Amira El-Deghadi (2019b). However, the phenotypic correlation between LSB and litter weight traits was positive and medium (0.30 to 0.37) as shown in Table 3. In contrast, the phenotypic correlation between LSB and litter weight traits was positive and low (0.04 to 0.18). This was comparable to estimates reported by Amira El-Deghadi (2019b).

The phenotypic correlation among all milk yield traits in this study was negative and weak to moderate ranges between -0.02 and -0.48, except that between milk yield at the second, third, and fourth week with total milk yield it is positive and medium (0.10-0.12). These results disagreed with Amira El-Deghadi (2019b) and Mahmoud and Walid (2020) who found a positive phenotypic correlation among all milk yield traits.

3- Genetic trend for litter traits

Genetic trend estimates for doe litter traits were presented in Figures1 and 2. Genetic trend for litter size traits had fluctuations and changes with several year-season levels as shown in Figure 1. The genetic trend for litter size at birth was negative as viewed in Figure 1. However, it was positive for litter size at weaning. It was noticed that the genetic trend for LSW had higher value, which increases with the third season (the Spring) in the two years. This reflects the improvement of the performance of APRI rabbits does through increasing their mothering abilities, to take more care of their bunnies, during the suckling period year by year. This result was in agreement with that reported by Hanaa *et al.,* (2014) who found a positive and significant genetic trend for litter size at weaning of a maternal Line V.

Figure 2 showed that genetic trends for litter weight traits have fluctuations with different year-season levels and it seems to be negative. However, litter weight at weaning rises to be positive in the Spring of the second year. These results were comparable to and differ from that detected by Hassan *et al.,* (2015) for litter weight traits genetic trends in APRI rabbits. Differences in genetic trends between several studies may be because of different populations and conditions.

Genetic trend changes in Litter traits under study year-season fluctuations reflected seasonal largely variations in production. These fluctuations could be due to the variation in climatic conditions. This was in agreement with Abou-Khadiga *et al.,* (2010a) and Amira El-Deghadi (2019a).

4- Effect of litter size at lactation week on milk yield traits:

Table 4 and Figures 3, 4, 5, 6, and 7 showed the linear regression coefficient (b) of milk production at a certain week of lactation on their litter size at that week.

Results in Table 4 show that Litter size at the week of lactation has a significant (P <0.01) effect on all milk yield traits under study. This result was in agreement with EL Nagar *et al.,* (2014) who found that number born alive had significant effects on all milk yield traits. In the present study, milk yield at the 1st, 2nd, 3rd, 4th weeks of lactation and total milk yield increased 74.66, 98.99, 110.24, 90.54, and 370.84 grams, respectively by the increasing of litter size at lactation week with one bunny. This proved the positive relationship between litter size and milk production in maternal lines of rabbits and APRI rabbits as a synthetic maternal line in the present study. EL Nagar *et al.,* (2014) found that an increase in litter size by one kit born alive increased weekly milk yield by 49.21 g/week. Iraqi and Youssef (2006) reported that an increase in litter size by one bunny resulted in an increase by 42.9, 84.4, 102.4, 84.6, and 306.9 g of milk for the 1st, 2nd, 3rd, 4th week and total milk yield, respectively. Pascual *et al.,* (1996) found that milk yield was 32% higher for does with ten bunnies (P<0.01) than for does with 7-8 bunnies. Also, Theilgaard *et al.,* (2009) showed that milk yield was 49% higher for those does with nine bunnies (P<0.01) than for does with five bunnies.

5- Genetic evaluation of body condition traits

Body condition traits as well as body condition score at mating and after kindling. Heritability estimates for BCSM, and BCSK in APRI rabbits were low 0.03 and 0.01, respectively as shown in Table 5. There was no estimate for genetic parameters for these traits within the literature on rabbits to compare with. However, this estimate was comparable to that obtained on alternative animals like Cattle. Dal Zotto *et al.,* (2007), Bastin *et al*., (2010), and Loker *et al*., (2011) reported a moderate value (0.15-0.26) for the heritability of BCS in Cattle.

Also, these traits during this study as shown in Table 5 were low repeatable. This reflects that these traits were affected largely by environmental effects and management.

6- Physiological evaluation of body condition traits

The parameters were given in Tables 6 and 7 evaluate APRI rabbit does body condition physiologically at mating and after kindling as indicators of the health of does at the two times. The information in these tables shows the impact of parity on blood parameters embodies serum levels of (Total Protein, globulin, albumin, glucose, urea, and estradiol).

Results in Table 6 show an insignificant impact of parity on total protein, globulin, and albumin levels of does rabbits at mating. While, total protein, globulin, and albumin levels were considerably decreased after kindling. But, the A/G ratio was insignificantly increased at mating and considerably increased after kindling. These results of normal value are indicators for improvement parity of doe rabbits. These results were in agreement with Mizoguchi *et al.,* (2010) and Selmani *et al*., (2020). While, AL-Eissa (2011) reported that total protein, globulin, and albumin levels were considerably decreased in the pregnant rabbits as compared to non-pregnant rabbits.

Results in Table (7) showed that glucose and urea levels in doe rabbits were insignificantly decreased by increasing the parity; this may make a case for the homeostatic mechanisms that controlling the glycaemia, Cardinali *et al*., (2009) found that, glucose levels failed to show any significant variation. However, the estradiol hormone was insignificantly increased by increasing the parity. AL-Eissa (2011) reported that glucose level was considerably decreased at non-pregnant rabbits compared with pregnant rabbits.

CONCLUSION

Low estimates of h^2 for doe and body condition traits in APRI rabbits may be due to high non-additive genetic effects for these traits. In order to realize high progress in such traits, management and environmental conditions should be improved. The moderate estimate of repeatability for LSW in the present study indicates that we could depend on little records in selection for this trait. It was recommended that improvement of APRI does milk yield traits at 2^{nd} weeks could be effective to improve total milk yield in these rabbits which lead to improve litter weight at weaning. Litter size at the week of lactation had a significant (P <0.01) effect on all milk yield traits under study. Total protein, globulin, and albumin levels are good indicators for APRI does body condition and health.

Table (1): Means, standard deviations (SD), and coefficients of variation (CV %) for different studied traits in APRI rabbits.

Traits	Mean	Std Dev	CV%
Litter traits			
LSB (NO)	5.45	1.96	36.00
LSW (NO)	3.85	1.63	42.31
LWB (g)	325.35	132.39	40.69
LWW (g)	1545.49	639.91	41.40
Milk yield traits			
MY7 (g)	629.52	251.90	40.02
MY14 (g)	841.48	460.03	54.67
MY21 (g)	908.03	476.31	52.45
MY28 (g)	390.75	236.95	60.64
TMY (g)	2779.99	1078.80	38.81

N=330 records, LSB= Litter size at birth, LSW= Litter size at weaning, LWB= Litter weight at birth, LWW= Litter weight at weaning, MY7= Milk yield during the first week of lactation (g ⁄week), MY14= Milk yield during the second week, MY21= Milk yield during the third week, MY28= Milk yield during the fourth week, TMY= Total milk yield during the whole 4 weeks of lactation.

Table (2): Proportions ± its standard errors of additive genetic (h^2_a), permanent environmental effect (σ^2_{pe}), and error (σ^2_e) relative to the phenotypic variance, and repeatability (R) for litter traits in APRI rabbits.

Traits	h_a^2±SE	σ^2_{pe}±SE	σ^2_e±SE	R
Litter traits				
LSB	0.10±0.02	0.03±0.02	0.87±0.02	0.13
LSW	0.14±0.02	0.01±0.02	0.85±0.02	0.15
LWB	0.08±0.02	0.01±0.03	0.91±0.04	0.09
LWW	0.08±0.02	0.01±0.02	0.91±0.02	0.09
Milk yield traits				
MY7	0.05±0.001	0.01±0.001	0.94±0.002	0.06
MY14	0.07±0.001	0.01±0.001	0.93±0.002	0.08
MY21	0.05±0.001	0.01±0.001	0.94±0.001	0.06
MY28	0.12±0.001	0.002±0.001	0.88±0.001	0.12
TMY	0.03±0.001	0.004±0.001	0.96±0.001	0.03

Traits as defined in Table 1.

Table (3): Estimates of genetic (r_g), permanent environmental (r_{pe}), environmental (r_e), and phenotypic (r_p) correlations ± standard errors among reproductive traits in APRI rabbits.

Correlated traits	r_g	r_{pe}	r_e	r_p
Between LSB and:				
LSW	0.89 ±0.01	-0.50±0.01	0.35±0.01	-0.01
LWB	0.31±0.01	-0.02±0.01	-0.41±0.01	0.30
LWW	-0.06± 0.01	0.14±0.01	-0.29±0.09	0.37
Between LWB and:				
LSW	0.18±0.01	0.85±0.01	-0.12±0.05	0.08
LWW	0.37±0.01	-0.91±0.01	-0.15±0.13	0.10
Between LSW and:				
LWW	0.04±0.01	-0.91±0.01	-0.12±0.03	-0.19
Between MY7 and:				
MY14	0.09±0.01	0.34±0.11	0.04±0.001	0.04
MY21	-0.78±0.01	0.26 ±0.09	-0.47±0.001	-0.48
MY28	0.34±0.01	-0.33±0.14	-0.06±0.001	0.03-
TMY	-0.24±0.01	-0.38±0.08	-0.01±0.001	0.02-
Between MY14 and:				
MY21	0.37±0.01	0.86 ±0.16	-0.34±0.001	-0.29
MY28	0.95±0.01	0.51 ±0.24	-0.14±0.001	-0.04
TMY	0.37±0.01	0.40±0.11	0.10±0.001	0.11
Between MY21 and:				
MY28	0.16±0.01	0.47±0.17	-0.33 ±0.001	-0.28
TMY	0.36±0.01	-0.001±0.07	0.09±0.001	0.10
Between MY28 and:				
TMY	0.17±0.01	0.50±0.19	0.12±0.001	0.12

Traits as defined in Table 1.

Table (4): Actual means, and their coefficient of variation of litter size and estimates of the linear regression coefficient (b) of milk production at the certain week of lactation on their litter size at that week in APRI rabbits.

Trait	Mean of litter size	SD	CV	b
MY7	5.01	1.91	33.09	74.66**
MY14	4.82	2.03	42.13	98.99**
MY21	4.13	1.74	42.27	110.24**
MY28	3.83	1.64	42.67	90.54**
TMY	4.44	1.66	37.36	370.84**

Traits as defined in Table 1.
** = P<0.01

Table (5): Proportions ± its standard errors of additive genetic (h^2_a), permanent environmental effect (σ^2_{pe}), and error (σ^2_e) relative to the phenotypic variance, and repeatability (R) for body condition traits in **APRI** rabbits.

Traits	h_a^2±SE	σ^2_{pe}±SE	σ^2_e±SE	R
Body condition traits				
BCSM	0.03±0.01	0.04±0.01	0.93±0.01	0.07±0.01
BCSK	0.01±0.02	0.01±0.02	0.98±0.02	0.02±0.02

BCSM= Body condition score at mating and BCSK= Body condition score after kindling

Table (6): Effect of parity on serum total protein, albumin (A), globulin (G) levels, and albumin/globulin (A/G) ratio of does APRI rabbits.

Item	Total protein g/dl		Albumin (A) g/dl		Globulin(G) g/dl		A/G ratio	
	At mating	After kindling	At mating	After kindling	At mating	After kindling	At mating	After kindling
Parity effect								
1st parity:	5.91	5.82a	4.11	3.58a	1.79	2.25a	2.29	1.60
2nd parity:	5.32	4.45ab	3.92	3.28ab	1.40	1.17ab	2.80	2.80
3rd parity:	4.62	3.22b	3.43	2.56b	1.19	0.66b	2.88	3.87
S.E	± 0.5	± 0.41	± 0.39	± 0.24	± 0.26	± 0.24	± 0.31	± 0.24
Sig.	Ns	***	Ns	***	Ns	***	Ns	***

Ns=not significant ***P≤0.001

Table (7): Effect of parity on serum glucose, urea, and estradiol of does APRI rabbits.

Item	Glucose (mg/dl)		Urea (mg/dl)		Estradiol (pg/ml)	
	At mating	After kindling	At mating	After kindling	At mating	After kindling
Parity effect						
1st parity	117.08	104.52	52.50	66.37	3.88	3.84
2nd parity	102.64	97.88	61.35	62.05	3.93	4.95
3rd parity	97.04	48.34	59.84	56.00	4.86	5.16
S.E	7.51	7.49	5.41	6.06	0.33	0.41
Sig.	Ns	Ns	Ns	Ns	Ns	Ns

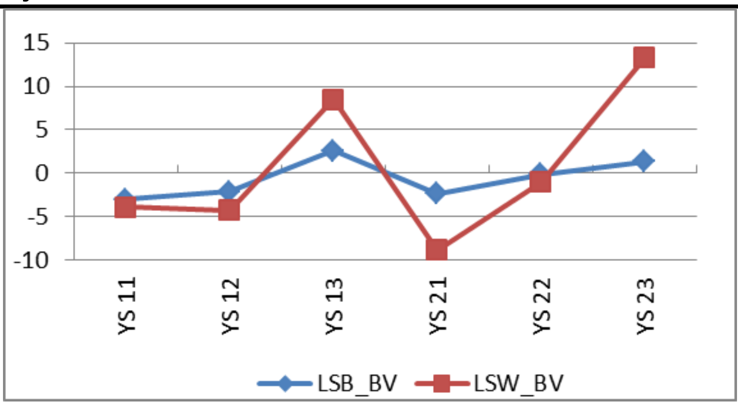

Fig (1): Genetic trend of litter size at birth and weaning changed by Year-season.

BV

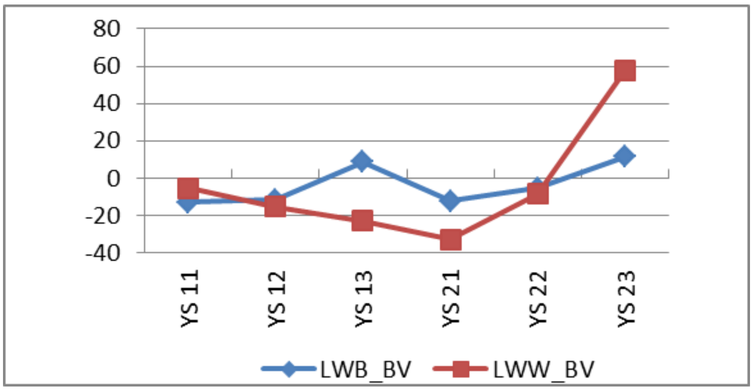

Fig (2): Genetic trend of litter weight at birth and weaning changed by Year-season.

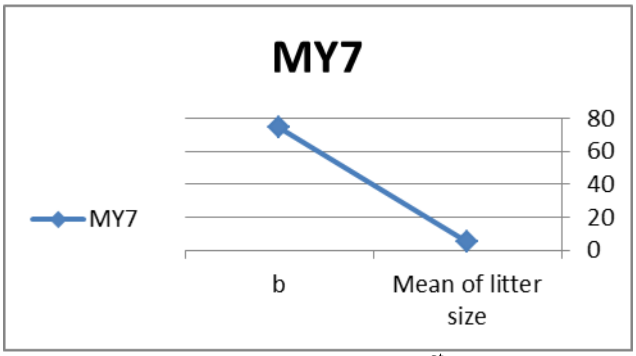

Fig (3): Regression of milk yield at 1st week on litter size

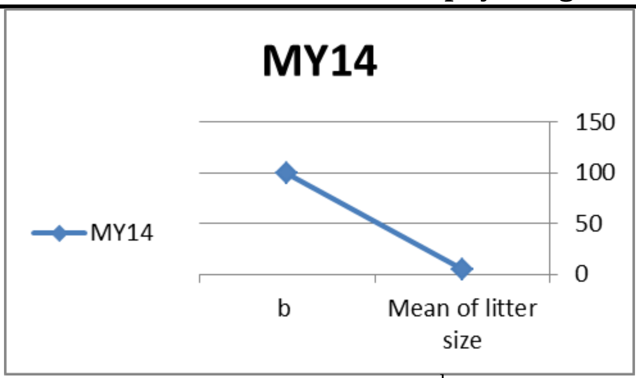

Fig (4): Regression of milk yield at 2nd week on litter size

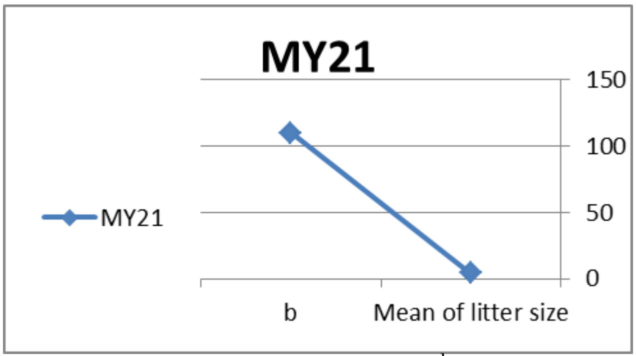

Fig (5): Regression of milk yield at 3rd week on litter size

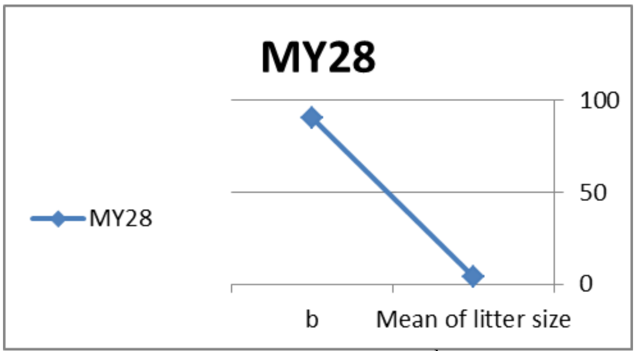

Fig (6): Regression of milk yield at 4th week on litter size

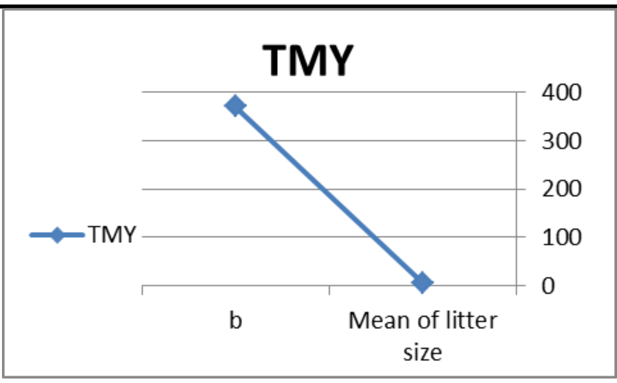

Fig (7): Regression of total milk yield on litter size

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الملخص العربى

التقييمات الوراثية وبعض التقييمات الفسيولوجية لصفات الأم وحالة الجسم فى الأرانب الأبرى

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أجريت الدراسة الحالية على 330 بطن من ١١٠أم من الأرانب الأبري وذلك لإجراء التقييم الوراثى لبعض صفات البطن (عدد الخلفة عند الميلاد، عدد الخلفة عند الفطام، وزن الخلفة عند الميلاد، وزن الخلفة عند الفطام)، صفات اللبن (إنتاج اللبن في الأسابيع الأول، الثانى، الثالث، الرابع، إنتاج اللبن الكلي)، صفات حالة الجسم (درجة حالة الجسم عند التلقيح، درجة حالة الجسم بعد الولادة). وذلك بالإضافة إلى أخذ بعض المعايير البيوكيميائية فى الدم عند التلقيح و بعد الولادة كمؤشر لصحة وحالة جسم أمهات الأرانب. من النتائج المتحصل عليها لوحظ أن قيم المكافئ الوراثى لصفات البطن منخفضة تتراوح بين (٠,٠٨ إلى ٠,١٤)، قيمة المكافئ الوراثى لصفات إنتاج اللبن منخفضة (٠,٠٣ إلى ٠,١٢). كانت قيم المكافئ الوراثى لصفات درجة حالة الجسم عند التلقيح، وكذلك بعد الولادة منخفضة (٠,٠٣ ، ٠,٠١). قيم المعامل التكرارى لصفات البطن منخفضة إلى متوسطة (٠,٠٩ إلى ٠,١٥). قيم المعامل التكرارى لصفات إنتاج اللبن منخفضة (٠,٠٣ إلى ٠,١٢). وجد أن قيم الارتباط الوراثى بين حجم الخلفة عند الميلاد و حجم الخلفة عند الفطام ، بين حجم الخلفة عند الميلاد و وزن الخلفة عند الميلاد، بين وزن الخلفة عند الميلاد ووزنها عند الفطام موجبة (٠,٨٩، ٠,٣١، ٠,٣٧) على التوالى. وجد أيضا أن الارتباط الوراثى بين صفات إنتاج اللبن في كل من الأسابيع الثانى، الثالث، الرابع مع صفة إنتاج اللبن الكلي إرتباط موجب .بينما يعتبر الارتباط الوراثى بين صفات إنتاج اللبن في كل من الأسابيع الأول مع الثالث هو إرتباط سلبى قوى (-٠,٧٨). يشهد الاتجاه الوراثى لكل من صفات حجم ووزن الخلفة تغيرات بتغير مستويات سنة وموسم الانتاج. يلاحظ أن الاتجاه الوراثى لحجم الخلفة عند الفطام يتجه نحو القيم الموجبة و يتزايد الاتجاه الوراثى لهذه الصفة لاعلي قيم خلال فصل الربيع في كلا العامين. يأخذ الاتجاه الوراثى لصفات وزن الخلفة قيم سلبية. بينما يزيد ويتغير الاتجاه الوراثى لوزن الخلفة عند الفطام ليأخذ قيما موجبة خلال فصل الربيع من العام الثانى. يؤثر حجم الخلفة فى خلال أسبوع إنتاج اللبن معنويا علي صفات إنتاج اللبن موضع الدراسة. يتزايد إنتاج اللبن خلال الاسابيع الاول، الثانى، الثالث، الرابع، وإنتاج اللبن الكلي بمعدل ٧٤,٦٦ ، ٩٨,٩٩، ١١٠,٢٤، ٩٠,٥٤، ٣٧٠,٨٤ جرامات علي التوالى بزيادة حجم الخلفة فى أسبوع إنتاج اللبن بمعدل أرنب واحد صغير. تنخفض مستويات البروتين الكلى، الألبيومين ، الجلوبيولين بصورة معنوية بعد الولادة. بينما تتزايد نسبة الألبيومين/ الجلوبيولين بعد الولادة. تتناقص مستويات الجلوكوز واليوريا بصورة غير معنوية بزيادة ترتيب البطن. بينما تتزايد مستويات هرمن الاستراديول بصورة غير معنوية بزيادة ترتيب البطن.

التوصية:

تعكس التقديرات المنخفضة لقيم المكافئ الوراثى لصفات البطن، صفات اللبن ، صفات حالة الجسم في أرانب الأبرى أن هذه الأرانب تأثرت بشدة بالتأثيرات الوراثية غير المضيفة. يتطلب تحقيق تحسين كبير في هذه الصفات تحسين الرعاية والظروف البيئية. يشير التقدير المتوسط للمعامل التكرارى لصفة حجم الخلفة عند الفطام (٠,١٥) إلى أنه يمكن تحسين هذه الصفة من خلال الانتخاب اعتمادًا على عدد سجلات قليلة. يمكن أن تكون صفة إنتاج اللبن في الأسبوع الثاني فعالة في تحسين إجمالي إنتاج اللبن في هذه الأرانب وبالتالى تحسين وزن الخلفة عند الفطام. تعكس القيمة العالية للاتجاه الوراثى لصفة حجم الخلفة عند الفطام والتي تزداد مع موسم الربيع في عامين متتاليين من الدراسة تحسن أداء أرانب الأبرى. حجم الخلفة في أسبوع الرضاعة له تأثير معنوي ($P < 0.01$) على جميع صفات إنتاج اللبن تحت الدراسة. تعد مستويات البروتين الكلي والجلوبيولين والألبومين مؤشرات جيدة لحالة الجسم وصحته.