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CHARACTERIZATION, GENETIC EVALUATION, AND GENETIC TRENDS FOR SOME REPRODUCTIVE TRAITS OF BALADI BLACK RABBITS DOES

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ABSTRACT:A total of 792 litters from 210 does of Baladi Black (BB) rabbits were considered to make characterization, and genetic evaluation for some doe traits, including litter traits (litter size at birth; LSB, litter size born alive; LSA, litter size at 21 days; LS21, litter size at weaning; LSW, Litter weight at birth; LWB, Litter weight at weaning; LWW, and the pre-weaning mortality rate; PWM), conception traits (number of services per conception; NSC, and gestation length; GL), and interval traits (kindling interval; KI and days open; DO). Heritability for litter traits was relatively low ranged from 0.08 to 0.14 except this for PWM it was moderate (0.15); h^2 for conception and interval traits were low ranged from 0.00 to 0.06. Repeatability (R) for litter traits were low to moderate ranged from 0.11 to 0.34; R estimates for PWM and LWB were higher than other traits (0.16 and 0.34) respectively; and R for conception and interval traits was low ranged from 0.01 to 0.11. Genetic correlations among litter traits were positive, and moderate to strong ranged from 0.23 to 0.92 except for this between LSB and LWW and this between LWB and PWM, it was negative -0.16 and -0.08 respectively. Genetic correlations among conception and interval traits were positive and very strong ranged from 0.68 to 1.00 except this between GL and NSC it was negative and strong (-0.77). The ranges of transmitting abilities (TA) for litter size traits ranged from 1.92 to 2.10 kits. Ranges of TA for litter weight traits ranged from 0.01 to 0.70 grams. The range of TA for PWM was 33.90%. Ranges of TA for conception traits were low, 0.08 days for GL and 0.11 (numbers) for NSC. The ranges of TA were 4.93 and 10.72 days for KI and DO respectively. The percentage of positive transmitting ability ranged from 30.95 to 53.81 for litter traits and from 50.00 to 51.90 for conception, and interval traits. The genetic trends for litter traits at different ages, conception and interval traits were low and had fluctuations by year-season which could be due to variation in climatic conditions.

Conclusively, Baladi Black rabbits' does have good potential reproduction. Most of doe reproductive traits of these rabbits were largely affected by environmental conditions which would be improved by improving environmental and management conditions. The moderate estimate of h^2 for PWM (0.15) and its range of transmitting ability (33.90%) suggest decreasing pre-weaning mortality by selection. Moderate estimates for PWM and LWB comparing with other traits (0.16 and 0.34) respectively suggests using culling and selection strategies. The negative genetic correlation between LSB and LWW (-0.16) should be taken into consideration when designing a breeding program for these rabbits. The perfect genetic correlation between KI and DO (1.00) reflected that these two traits could be indicators of each other when designing breeding programs.

Keywords: Baladi Black, Rabbits, characterization, Genetic evaluation, Genetic trend

INTRODUCTION

According to human preference for healthy and high-quality meat and the consumer’s needs, rabbit production becomes a real challenge for developing countries. Egyptian local strains of rabbits as **(**Baladi Red, Baladi Black, and Mountain rabbits Gabali) are distinguished by a long period of lifespan production compared to exotic breeds raised in Egypt (Khalil, 2002). Baladi Black which was produced at the research stations of the Animal Production Research Institute for more than 50 years and is the result of crossing Baladi rabbit with Flander Gray and then was selected for the black color was carried out. These rabbits are not high in the productive and reproductive performance, and productivity of milk (Khalil, 2002). Moreover, Baladi Black rabbits had a higher tolerance to climatic stress and disease resistance compared to the exotic breeds raised in Egypt**.**

The animal model is used widely in evaluating beef and dairy cattle, chickens, pigs, and rabbits genetically. This evaluation makes it too easy to put a suitable breeding program for improving the breeding stocks. To get the overall effect of the achieved genetic advancement and change in the longer term, it is possible to evaluate genetic trends across generations. A genetic trend is a compiling of average expected breeding values (EBV) per generation and indicates the direction of the modification across generations. It is often plotted on a graph and is useful to check whether there are unexpected deviations from linearity. The modification in the performance of a population over time has a genetic component and an environmental component. Thus, the annual phenotypic trend is the sum of genetic trends and environmental trends. More precisely, the genetic trend is the change in the additive genetic merit per year and the environmental trend is the remainder or the environmental change per year.

There is insufficient information about the reproductive performance of Baladi Black (BB) rabbits. The objectives of this study are to:(1) make characterization and evaluation for some economic, reproductive traits of a well-adapted local BB rabbits, (2) update information on this important rabbits for some reproductive traits included litter size at birth, litter size born alive, litter size at 21 days, and litter size at weaning, litter weight at birth, litter weight at 21 days, litter weight at weaning, pre-weaning mortality rate, gestation length, number of services per conception, kindling interval and days open. Moreover,(3) determine the genetic variance and permanent environmental effect of these commonly used measures of reproductive efficiency, and (4) estimate the genetic parameters including heritability, repeatability, and genetic correlations for these traits to offer more data for rabbit genetic improvement. Also, (5) make does evaluation by estimating does transmitting abilities for these traits, and (6) estimate genetic trends for these traits to stand on the genetic changes with the year and season of production. All of that aim to determine the appropriate breeding programs to improve these important local rabbits and keep on our genetic resources of local rabbits, in order to meet the needs of Egyptian people of good and high-quality rabbit meat.

MATERIALS AND METHODS

Animals

The present study was carried in the experimental rabbitry farm, Animal Production Research Institute, Agriculture Research Center, in Sakha, Kafr El-Sheikh Governorate, Egypt. This study was conducted for three sequential years with a total of 792 litters from 210 does fathered by 61 sires and mothered by 103 dams of Baladi Black (BB rabbits). Rabbits were kept individually in wire cages (60x50x35 cm^3) provided with feeders, automatic water nipple drinkers for all times. Animals were kept under the same conditions and fed adlibitum 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. Does were mated to sires naturally with starting at the age of six months. 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 born alive; LSA, litter size at 21 days; LS21, litter size at weaning; LSW, litter weight at birth; LWB, litter weight at weaning; LWW, and the pre-weaning mortality rate; PWM), conception traits (number of services per conception; NSC, and gestation length; GL), and interval traits (kindling interval, KI and days open, DO).

Statistical analysis

Data analyzed included animal ID (Doe), parity, and year-season. The multi-trait animal model was used to analyze the data according to the Wombat program (Meyer, 2018) in order to estimate variance components, genetic parameters, and make does evaluation by estimating transmitting abilities. Variance and covariance obtained by the REML method of VARCOMP procedure (SAS, 2002) 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, four levels, and year-season combination, nine 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.

Heritability (h^2) and repeatability (R) estimates were computed based on the following equations:

$h^2 = \sigma^2 a / \sigma^2 p$,

$R= \sigma^2 a + \sigma^2 pe / \sigma^2 p$, and

$\sigma^2 p = \sigma^2 a + \sigma^2 pe + \sigma^2 e$

Where, σ^2_p, σ^2_a, σ^2_{pe} and σ^2_e are total or phenotypic, direct additive genetic, permanent environmental and residual variances, respectively.

A general formula used to calculate genetic (r_g), permanent environmental (r_{pe}), environmental (r_e), and phenotypic (r_p) correlations among different traits was $r_{xy} = cov\ (xy)_{ij} / \sqrt{X_{ij}}\ \sqrt{Y_{ij}}$. Where, $cov\ (xy)_{ij}$ = the additive genetic (a), permanent environmental (pe), environmental (e), and phenotypic (p) co-variances between the first and second trait, X_{ij}= the additive genetic (a), permanent environmental (pe), environmental (e), and phenotypic (p) variances of the first trait, and Y_{ij} = the additive genetic (a), permanent environmental (pe), environmental (e), and phenotypic (p) variances of the second trait.

Does evaluation was achieved by estimating transmitting abilities for litter, conception, and interval traits using animal model through Restricted Maximum Likelihood (REML) of Wombat program (Meyer, 2018) using the same previous animal model explained above.

Genetic trends for traits under study were estimated according to Hassan *et al.* (2015) as the deviation of the mean of the breeding values of the group of rabbits females succeeded to reproduce under the environmental conditions they were subjected to, from the overall mean of the entire group of rabbits across all environmental situations breeding values. Moreover, the traits genetic trends were then plotted in graphs to explain the general trend of the change of a specific trait under different classes of the fixed effect under consideration (year-season, YRS).

RESULTS AND DISCUSSION

1- Means and coefficient of variations:

The means, their standard deviations (SD), and coefficients of variation for some reproductive traits in BB rabbits are presented in Table 1. Means of litter size and litter weight traits were in the range of most studies on the same rabbits (Khalil, 2002, Abdel-Kafy *et al.*, 2012 and Galal *et al*., 2013). But, it was lower than the ranges reported by Badawi and El-Aasar (2018). Periods of DO and KI were 25.5 and 56.8, respectively. This period of KI was in the range reported by (Khalil, 2002). These long reproductive intervals (Table 1) could be one of the limiting factors for the effective use of these Baladi Black rabbits on a large commercial scale in Egypt.

Coefficients of variation for all traits under study were moderate to high (29.36 to 84.74) except this for the GL trait, which was very low (2.44). The GL did not exhibit a great phenotypic variation. Coefficients of variation for litter traits at birth are lower than those at weaning. This may be attributed to the high maternal effect at suckling than at weaning (Khalil, 1993 and Abdel-Kafy *et al.,* 2012). Estimates of CV presented in Table 1 showed that there was high variability in DO than KI. This is may be because most of the variation is brought about the variation in DO. The high variability of most reproductive traits may reveal that BB rabbits could possibly constitute a rich genetic resource to work upon. The genetic improvement for BB rabbits can be achieved and this is in agreement with Abdel-Kafy *et al*. (2012). The high values of CV for traits in this study gave evidence to make an improvement of reproductive traits through phenotypic selection.

2- Variance components (values and proportions):

Heritability estimates (h^2):

Estimates of h^2 for litter traits, conception traits, and interval traits in this study are relatively low except h^2 of pre-weaning mortality is relatively moderate (Table 2). Estimates of h^2 for litter size and litter weight traits ranged from 0.08 to 0.14. These estimates are in the ranges of Rastogi *et al.* (2000) on NZW rabbits, SØrensen *et al.* (2001) on Danish White rabbits, Gharib (2008) on Baladi Red rabbits, and Abou Khadiga *et al.* (2010) on APRI and V-line rabbits. However, the estimates of h^2 for litter weight traits are lower than those obtained by Abdel-Kafy *et al*. (2012) on BB rabbits. In addition, h^2 estimates for all litter traits in this study are out of the ranges detected by Iraqi (2008), Gyovai, *et al.* (2010), Nagy *et al.* (2011), El-Deghadi (2019a), and El-Attrouny and Habashy (2020) for different breeds of rabbits. Low estimates of h^2 for litter traits under study showed that environmental conditions and non-additive genetic effects play a large role in doe litter traits in BB rabbits. This result was in agreement with the results obtained by Hassan *et al.* (2015) who detected the same for APRI rabbits.

The h^2 estimate of PWM is relatively moderate (0.15) in this study which was in agreement with the result reported by SØrensen *et al.* (2001) for the same trait. However, it is higher than the values detected by El-Deghadi (2019b) and El-Attrouny and Habashy (2020) for NZW rabbits. This estimate indicated that decreasing pre-weaning mortality could be realized by selection for decreasing PWM. Also, would be achieved through crossing with high productive local or exotic rabbits, group selection besides improving environmental conditions and management (Rashwan and Marai, 2000).

Estimates of h^2 for conception and interval traits in this study are low (0.00-0.06). These values are in the ranges obtained by Gharib (2008). A relatively similar estimate of heritability for kindling interval was reported by Baselga *et al.* (2003). Also, Kabir *et al.* (2014) detected low heritability for gestation length using sire components.

The low estimates of h^2 for most traits under study indicated that these traits are highly affected by the maternal and non-genetic effects. Such traits which had low h^2 did not support individual selection and reflect the low response to direct selection. Therefore, family and within-family selection could be applied for improving these traits. Also crossbreeding could be used and marker-assisted selection would be a good technique but unfortunately, it is still very expensive and not completely available under Egyptian conditions (Hassan *et al*. 2015).

Permanent Environmental effect (σ^2_{pe}): Permanent environmental effect estimates (σ^2_{pe}) given in Table 2 for litter size, litter weight, and pre-weaning mortality traits are low (0.01-0.10) except for litter weight at birth which had moderate estimate of 0.22. These low estimates could be attributed to environmental variations including climatic and managerial conditions. These results are comparable to other studies by Youssef *et al.* (2003) who showed low proportions of permanent environmental effect (0.05 to 0.14) in Baladi Red and NZW rabbits for litter traits. Iraqi *et al.* (2007) detected low to moderate estimates of permanent environmental effect for litter traits in Gabali rabbits (0.00-0.46). Abdel-Kafy *et al.* (2012) reported low values of permanent environmental effect for litter traits in BB rabbits (0.00-0.02). Moderate values of permanent environmental effect for LWB in this study rather than other traits could be due to the fact that LWB influenced by the maternal performance of the doe which is confirmed with those of Nofal *et al.* (2008), Youssef *et al.* (2008), and Abou- Khadiga *et al.* (2010).

The low estimate of permanent environmental effect for PWM in this study is in the range reported by SØrensen *et al.* (2001).

Estimates of permanent environmental effect for conception and interval traits in this study which presented in Table 2 are low (0.00-0.05). A low value of σ^2_{pe} was previously found for kindling interval (0.008) by Baselga *et al.*, (2003). In addition, these result agrees with those results reported by Gharib (2008) who reported low permanent environmental variance for doe reproductive traits in CAL and BR rabbits for NSC, DO, KI, and GL. Low estimates of permanent environmental effect (σ^2_{Pe}) in this study may be partially attributed to large temporary environmental variation (i.e. climatic, sanitary and managerial condition…etc.). Generally, small values of permanent environmental effect for most traits under study may be attributed to temporary environmental effects including (climatic, sanitary, management conditions….etc) which couldn't be considered in the statistical model (Iraqi *et al.*, 2003).

It is noticed that the estimates of the proportion of additive genetic effect in this study for litter traits and pre-weaning mortality were higher than permanent environmental effect except for LWB. This reflected the importance of permanent environmental effect for litter weight at birth which was attributed to the maternal effect comparable to the additive genetic effect.

Error proportion (σ^2_e):

Error proportions (σ^2_e) for all litter, conception, and interval traits are high ranged from 0.66 to 0.99 (Table 2). These estimates are in the ranges reported by Iraqi *et al.* (2003), Iraqi (2008), and El-Deghadi (2019b) on litter traits. These high estimates of error proportions (σ^2_e) for traits under study may be due to some factors that couldn’t be included in the statistical model.

Repeatability (R):

Repeatability estimates presented in Table 2 for all litter size traits under study were low to moderate (0.11-0.16). This is not completely in agreement with the results of Iraqi (2008) who reported 0.15 to 0.27 repeatability estimates for litter size traits in rabbits. Moreover, repeatability estimates for litter weight traits were low to moderate ranging between 0.12 and 0.34 (Table 2). There is a general trend noticed for these estimates, it decreased with the increase of age from birth till weaning. The repeatability value of LWB is higher than other traits. This would be a result of the higher values of permanent environmental effects for this trait (LWB) compared with the other traits. This trend agreed with the findings of Iraqi *et al.* (2007), Abou Khadiga *et al.* (2010), and El-Deghadi (2019a).

The repeatability estimate for pre-weaning mortality (PWM) is moderate (0.16) as shown in Table 2, which is relatively similar to that reported by SØrensen *et al.* (2001).

Estimates of repeatability for conception and interval traits were low (0.01-0.11). These estimates are in agreement with those reported by Gharib (2008). In contrast, Kabir *et al.* (2014) detected moderate repeatability for gestation length using sire components. It is noticed that litter traits are more repeatable than conception and interval traits.

Low repeatability for most of the traits under study required considering more litters and parities before selecting a doe for these traits. Therefore, selection of does for these traits based on a single production record would not be efficient. So, several parities and records should be assessed before selecting parents for these traits is necessary (Khalil 1994 and Hassan *et al.*, 2015).

Correlations:

Estimates of genetic (r_g), permanent environmental (r_{pe}), environmental (r_e), and phenotypic correlations (r_p) among the litter, conception, and interval traits in Baladi Black rabbits are presented in Table 3.

Genetic correlations (r_g):

Genetic correlations among all litter traits (litter size, litter weight, and pre-weaning mortality) are positive and moderate to very strong (0.23 - 0.92) except for the correlation between litter size at birth (LSB) and litter weight at weaning (LWW), it is negative and moderate (-0.16). LWW should be selected with caution as there is no assurance that improving litter size traits will result in a correspondingly positive improvement in the LWW of rabbits. Also, the correlation between LWB and PWM is negative and weak (-0.08). This negative genetic correlation should be taken into consideration when designing a breeding program. These results are comparable to those obtained by SØrensen *et al.* (2001), Iraqi *et al.* (2007), and El-Deghadi (2019b) for litter traits and Moustafa *et al.* (2014) among litter size traits. And this is opposite to the results reported by Abdel-Kafy *et al.* (2012) who found a negative correlation among litter traits, except the correlation between LSW and LS21 traits. The positive and moderate correlation between LSB and LSW in this study indicated that selection for LSB would improve LSW as a correlated trait. The moderate and high values of genetic correlations among litter size traits indicated that these traits are controlled by the same genes. The positive genetic correlation means that selection for one trait will lead to improvement of the other. The genetic correlations among litter weight traits were positive and moderate (0.45-0.46). This indicated that these traits are affected by the same genes. These values are somewhat lower than those reported by Abou-Khadiga *et al.* (2010). These differences may be due to the breed and environmental differences.

The genetic correlations among conception and interval traits in this study are positive and very strong (0.68-1.00) except between gestation length and the number of services per conception it was negative and strong (-0.77). Thus, indicated that bad does take many times to be pregnant and fertile takes also a longer time in its gestation length so those does could be culled. The highest and strongest genetic correlation between KI and DO (1.00) reflected that these two traits could be used as indicators of each other. So, breeders could take into consideration one of them on breeding programs. The improvement of one would lead confidentially to improvement of the other trait because of this high genetic correlation.

Permanent environmental correlations (r_{pe}):

Permanent environmental correlations (r_{pe}) among litter traits were positive and strong (0.51- 0.97) except that between

LSB and PWM it was negative and strong (-0.86). Also, there was a negative and strong permanent environmental correlation between LWB and PWM (-0.74). Permanent environmental correlation (r_{pe}) among litter weight traits was high (0.54-0.69). These values were somewhat comparable to those reported by Abou-Khadiga *et al.* (2010). A moderate to strong correlations were observed in this study among conception and interval traits ranged from 0.35 to1.00, except this between GL and NSC it was negative and strong (-0.77).

Environmental correlations (r_e):

Environmental correlations (r_e) among litter traits under study were positive and ranged from weak to strong (0.03-0.84) except the correlation between LWB and PWM was negative and weak (-0.10). 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. The environmental correlations among conception and interval traits were positive and weak among gestation length and other conception and interval traits (0.001-0.003). However, it was positive and moderate to strong among NSC and interval traits (0.44 - 0.52) and highly strong between the two interval traits KI and DO (0.96). Generally, the high positive environmental correlation between two traits indicated that there were strong environmental influences on these traits (Sorhue *et al.*, 2013).

Phenotypic correlations (r_p):

Phenotypic correlations (r_p) were relatively similar in values and trends to environmental correlations (r_e) among traits under study except that between LWB and LW21 it was moderate (0.42) however the environmental correlation (r_e) was weak (0.03). Also, the phenotypic correlation among GL and NSC was negative and weak (-0.009) however, the environmental correlation was positively low (0.003). The phenotypic correlation among litter size traits was positive ranged from moderate to strong (0.45-0.85) in this study. This result was comparable to the results obtained by SØrensen, *et al.* (2001), El-Deghadi (2019b), and Moustafa *et al.*, (2014). Phenotypic correlations between litter size traits and litter weight traits were positive and moderate to strong (0.22-0.59). This result was comparable to that reported by Egena *et al.* (2012) and El-Deghadi (2019b). Strong or moderate and positive estimates of phenotypic correlation in the present study among litter traits at different ages gave a considerable advantage for rabbit breeders in their management and culling decisions.

The environmental and phenotypic correlations for litter traits were favorable with genetic correlations. This result was in agreement with the findings of SØrensen *et al.* (2001). It was noticed from the previous results that litter size traits were positively, genetically, phenotypically, and environmentally correlated. These results were in agreement with SØrensen *et al.* (2001), Moustafa *et al.* (2014).

Transmitting abilities:

Minimum (Min.), maximum (Max.), ranges of does transmitting abilities, number of records with positive transmitting abilities, and its percentages for litter, conception, and interval traits in Baladi Black rabbits are presented in Table 4.

The ranges of transmitting abilities for litter size traits ranged from 1.92 to 2.10 kits. These estimates are lower than those reported by El-Raffa (2000) for LSB and LSW traits in V-line rabbits and also were lower than those obtained by Hassan *et al.* (2015) for the same traits in APRI rabbits. In addition, these ranges were relatively higher than those reported by El-Deghadi (2019a) on NZW rabbits and Moustafa *et al*. (2014) on the maternal line of rabbits (V-Line). Ranges of transmitting abilities for litter weight traits of BB rabbits in this study ranged from 0.01 to 0.70 grams. This variation gives the opportunity for culling and selecting rabbits does according to its transmitting abilities for these commercial traits (Moustafa *et al*., 2014). The range of doe transmitting ability for PWM was 33.90%. This is a high percentage, which gives the rabbit breeders a chance for selecting for decreasing PWM.

Moreover, ranges of transmitting abilities of does for conception traits were low and were 0.08 days for GL and 0.11 (numbers) for NSC. This reflects that these traits are low heritable. The ranges of doe transmitting abilities were 4.93 and 10.72 days for KI and DO respectively. This range of transmitting ability for in interval traits indicates that designing good programs of selection will lead to genetic gain.

The percentage of the positive transmitting ability estimate ranged from 30.95 to 53.81 for litter traits in BB rabbits. Also, it ranged from 50.00 to 51.90 for conception and interval traits in the present study. These values are in the ranges obtained by El-Deghadi (2019a) on NZW rabbits. These results indicate that if rabbit breeders use a good selection program, a good genetic gain would be achieved (Moustafa *et al*., 2014).

Genetic trends:

Estimates of genetic trends and their standard errors for litter, conception, and interval traits by year-season (YRS) were presented in Table 5 and figures 1, 2, and 3.

The estimates of genetic trends for litter size traits were positive and low in its values (0.02-0.04) rabbits /year-season except for the genetic trend for LSB it was negative and low in its magnitude (-0.01). These results were comparable to those detected by Moustafa *et al.* (2014) for litter size traits by year in V-line rabbits. The small values of genetic trends of litter traits in this study may be probably due to the low heritability estimated for litter size traits in the Baladi Black rabbits. Nagy *et al.* (2011) reported the same trend for the number born alive in Pannon White and Pannon Ka rabbits. Figure (1) showed the magnitude of genetic trends for litter size traits and pre-weaning mortality. It was noticed that litter size traits genetic trends were negative in the first year 2016 and tend to rise with the Autumn season of the year 2017 and the genetic trend for all litter size traits rise in low percent without negative trend except the genetic trend of LSB it takes a negative magnitude again at spring of the second year (2017) and after that, with the Autumn of the third year 2018 it tend to rise again taking a positive magnitude till the end of the year. In contrast, genetic trends for litter weight traits were low and negative for LWB and LWW (-0.001 and -0.01) grams/ year-season respectively except this for LW21 (0.01). These results were different and opposite completely of that observed by Abou-Khadiga *et al.* (2010). This difference in genetic trends throughout the studies may be attributed to different populations and surrounding conditions. Figure 2 showed the genetic trend for litter weight traits. The figure showed fluctuations in genetic trends by year-season for litter traits at different ages which could be due to variation in climatic conditions. This is in agreement with El-Deghadi (2019a).

The estimate of the genetic trend for PWM had a high and negative magnitude (-0.53) young rabbit/year-season. This indicated that pre-weaning mortality decreased by (0.53) bunny /year-season. Figure (1) showed that it had fluctuations that started with a negative magnitude in the Autumn of the first year (2016), then it rose taking positive magnitude with the Winter of the same year and become stable till the Winter of the second year (2017) it took a negative magnitude again till the Autumn of the third year (2018) and after that it rose taking a positive trend with the start of the Winter of the same year taking high and positive trend reached (1.7) young rabbit at the Spring of the same year. These fluctuations would be because of changes in management or disease outbreaks through different years which affected the maternal ability and sequent the pre-weaning mortality. So, to decrease PWM breeders should improve management. Also, these rabbits in the present study should be improved to improve their maternal ability in order to decrease PWM.

The genetic trend for conception and interval traits was positive and low (0.001-0.20). Figure (2) showed that genetic trends for conception traits (GL and NSC) were very low by year-season and had fluctuations.

CONCLUSION

Baladi Black rabbits' does have good potential reproduction. It is important to enlarge using these well-adapted local rabbits on a commercial level. Most of the doe reproductive traits of these rabbits had low heritability, repeatability, and genetic trends. Achieving good progress in these traits could be realized through improving the management and environmental conditions. Moreover, family and within-family selection could be applied to improve these traits. Also, crossbreeding could be used and marker-assisted selection would be a good technique, but on the other hand, it is still very expensive and not completely available in Egypt. Litter weight at birth and pre-weaning mortality could be improved by culling strategies of does because it had the highest repeatability estimates compared to other studied traits (0.34 and 0.16) respectively.

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

Traits	Mean	SD	CV%
Litter traits			
LSB (kit)	5.82	1.71	29.36
LSA (kit)	4.93	1.94	39.52
LS21(kit)	4.27	1.82	39.12
LSW (kit)	3.65	1.71	42.23
LWB (g)	285.40	102.69	35.98
LW21(g)	945.67	478.26	50.09
LWW(g)	1672.44	720.19	43.06
PWM	34.67	25.22	72.73
Conception traits			
NSC (NO)	1.46	0.71	48.52
GL (days)	31.31	0.77	2.44
Interval traits			
DO (days)	25.53	21.63	84.74
KI (days)	56.82	21.69	38.18

N=792 records for all litter and conception traits, and N= 576 records for interval traits
LSB= Litter size at birth, LSA= Litter size born alive, LS21= Litter size at 21 days, LSW= Litter size at weaning, PWM= Pre-weaning mortality, NSC= Number of services per conception, GL= Gestation length, DO= Days open, and KI= Kindling interval.

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

Traits	**h^2±SE**	**σ^2_{pe}±SE**	**σ^2_e±SE**	**R**
Litter traits				
LSB	0.13±0.04	0.03±0.04	0.85±0.05	0.15
LSA	0.08±0.03	0.03±0.04	0.89±0.05	0.11
LS21	0.11±0.04	0.03±0.04	0.86±0.05	0.14
LSW	0.14±0.04	0.03±0.04	0.84±0.05	0.16
LWB	0.12±0.04	0.22±0.06	0.66±0.06	0.34
LW21	0.09±0.04	0.10±0.05	0.81±0.06	0.19
LWW	0.09±0.04	0.03±0.04	0.89±0.05	0.12
PWM	0.15±0.04	0.01±0.04	0.84±0.06	0.16
Conception traits				
NSC	0.01±0.02	0.04±0.04	0.95±0.05	0.05
GL	0.004±0.02	0.002±0.04	0.99±0.04	0.01
Interval traits				
KI	0.05±0.03	0.05±0.04	0.90±0.05	0.10
DO	0.06±0.03	0.05±0.04	0.89±0.05	0.11

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 (SE) among reproductive traits in Baladi Black rabbits.

Correlated traits	**r_g**±SE	**r_{pe}**±SE	**r_e**±SE	**r_p**±SE
Between litter size at birth(LSB) and:				
Litter size born a live(LSA)	0.71±0.14	0.68±0.55	0.68±0.03	0.68±0.02
Litter size at 21 days (LS21)	0.49±0.17	0.84±0.62	0.58±0.03	0.57±0.03
Litter size at weaning (LSW)	0.27±0.20	0.97±0.86	0.46±0.04	0.45±0.03
Pre-weaning mortality (PWM)	0.51±0.17	-0.86±0.61	0.29±0.05	0.29±0.04
Litter weight at birth (LWB)	0.23±0.24	0.51±0.46	0.29±0.05	0.29±0.04
Litter weight at weaning(LWW)	-0.16± 0.27	0.88±0.99	0.24±0.05	0.22±0.04
Between litter weight at birth(LWB) and:				
Litter size at weaning (LSW)	0.34±0.22	0.71±0.52	0.34±0.05	0.35±0.04
Litter weight at 21 days (LW21)	0.46±0.24	0.54±0.24	0.03±0.01	0.42±0.03
Litter weight at weaning (LWW)	0.45±0.25	0.69±0.56	0.36±0.05	0.37±0.04
Pre-weaning mortality (PWM)	-0.08±0.23	-0.74±0.55	-0.10±0.05	-0.13±0.04
Between litter size at 21 days (LS21) and:				
Litter weight at weaning (LSW)	0.92±0.04	0.73±0.44	0.84±0.01	0.85±0.01
Between litter size at weaning (LSW) and:				
Litter weight at weaning (LWW)	0.37±0.21	0.85±0.52	0.61±0.03	0.59±0.03
Between gestation length (GL) and:				
Number of service per conception (NSC	-0.77±0.02	-0.96±0.04	0.003±0.05	-0.009±0.04
Kindling interval (KI)	0.70 ±0.02	0.96±0.04	0.003±0.05	0.04±0.04
Days open (DO)	0.68±0.03	0.96±0.04	0.001±0.05	0.05±0.04
Between the number of service per conception (NSC) and:				
Kindling interval (KI)	0.81±0.03	0.39±0.04	0.44±0.04	0.44±0.03
Days open (DO)	0.79±0.03	0.35±0.04	0.52±0.04	0.51±0.03
Between Kindling interval (KI) and:				
Days open (DO)	1.00±0.02	1.00±0.02	0.96±0.003	0.96±0.003

Table (4): Minimum (Min.), maximum (Max.), ranges of does transmitting abilities, number of records with positive transmitting abilities, and its percentages for litter, conception, and interval traits in Baladi Black rabbits.

Traits	Min.	Max.	Range	No. positive records	% Positive records
Litter traits					
LSB (kit)	-1.17	0.89	2.06	65	30.95
LSA (kit)	-0.95	1.15	2.10	105	50.00
LS21 (kit)	-0.87	1.05	1.92	110	52.38
LSW (kit)	-0.94	1.06	1.99	113	53.81
LWB (g)	-0.05	0.06	0.01	93	44.29
LW21 (g)	-0.01	0.02	0.03	104	49.52
LWW (g)	-0.24	0.46	0.70	86	40.95
PWM (%)	-13.70	20.20	33.90	91	43.33
Conception traits					
NSC (NO)	-0.04	0.06	0.11	106	50.48
GL (day)	-0.03	0.05	0.08	109	51.90
Interval traits					
KI (day)	-1.75	3.18	4.93	105	50.00
DO (day)	-4.56	6.16	10.72	107	50.95

N=210, Traits as defined in Table 1.

Table (5): Estimates of genetic trends ± (SE) for litter, conception, and interval traits by year-season.

Traits	Genetic trends ±SE
Litter traits	
LSB	-0.01±0.01
LSA	0.02±0.01
LS21	0.03±0.01
LSW	0.04±0.01
PWM	-0.53±0.21
LWB	-0.001±0.02
LW21	0.01±0.07
LWW	-0.01±0.11
Conception traits	
NSC	0.002±0.001
GL	0.001±0.001
Interval traits	
DO	0.20±0.07
KI	0.08± 0.03

Traits as defined in Table 1.

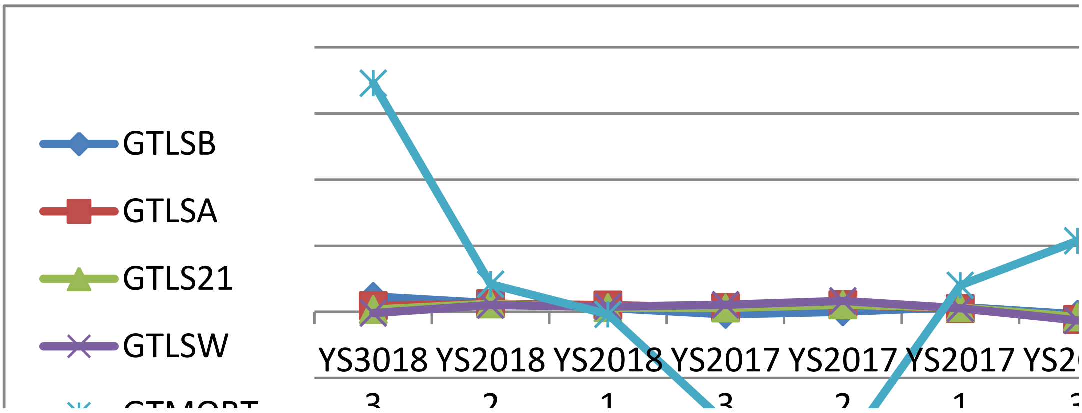


Figure (1): genetic trends for litter size traits and pre-weaning mortality by year-season

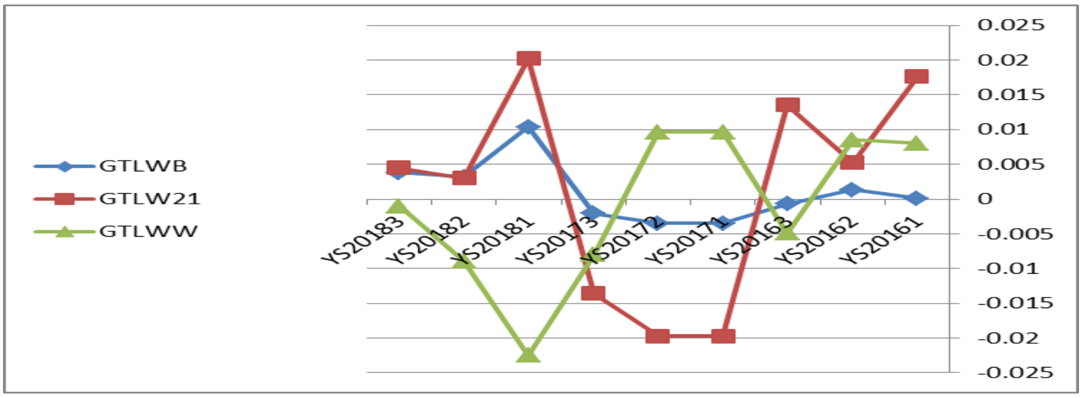


Figure (2): genetic trends for litter weight traits by year-season

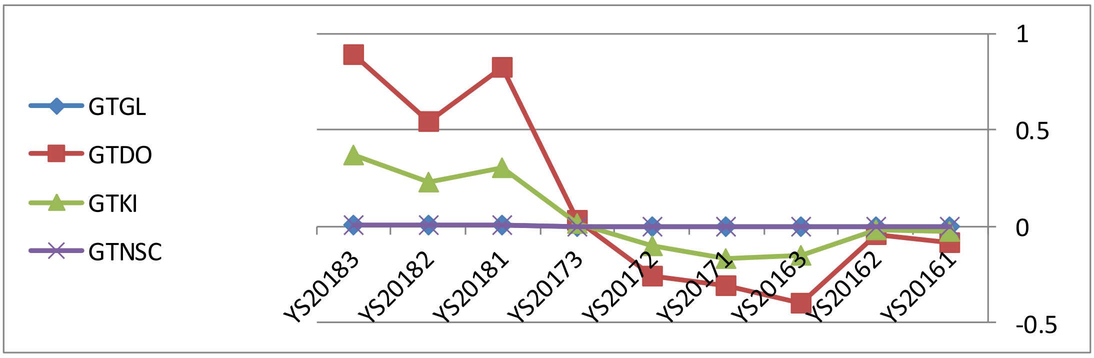
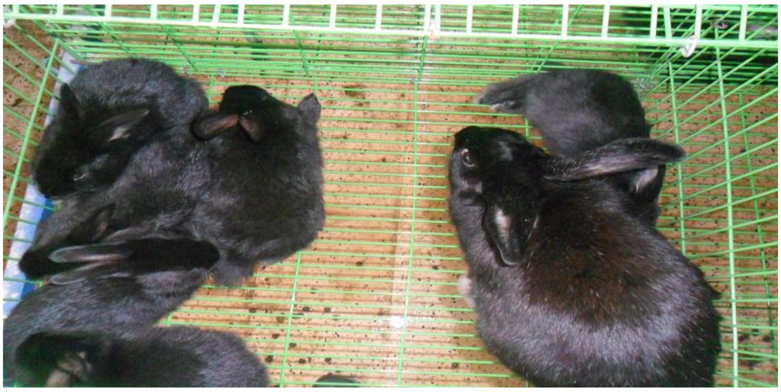


Figure (3): Genetic trends for conception and interval traits by year-season

Baladi Black female

Baladi Black male



Baladi Black female and its bunnies

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الملخص العربى

التوصيف والتقييم الوراثى والاتجاهات الوراثية لبعض الصفات التناسلية لإناث الأرانب البلدى الأسود

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أجريت الدراسة الحالية على ٧٩٢ بطن من ٢١٠ أنثى أرنب بلدى أسود لإجراء التوصيف والتقييم الوراثى لبعض الصفات التناسلية لاناث هذه الأرانب. تشمل هذه الصفات صفات البطن (عدد الخلفة عند الميلاد، عدد الخلفة المواليد أحياء، عدد الخلفة عند ٢١ يوم، عدد الخلفة عند الفطام، وزن الخلفة عند الميلاد، وزن الخلفة عند ٢١ يوم، وزن الخلفة عند الفطام، معدل النفوق قبل الفطام)، صفات الحمل (عدد مرات الخدمة اللازمة لحدوث الحمل، طول مدة الحمل)،صفات الفترة الفاصلة بين ولادتين (الفترة بين ولادتين، الفترة المفتوحة). لوحظ أن قيم المكافئ الوراثى لصفات البطن منخفضة تتراوح بين (٠,٠٨ إلى ٠,١٤)، قيمة المكافئ الوراثى لصفة معدل النفوق قبل الفطام متوسطة (٠,١٥). قيم المكافئ الوراثى لصفات الحمل وصفات الفترة الفاصلة بين ولادتين منخفضة تتراوح بين (٠,٠٠إلى ٠,٠٦). كانت قيم المعامل التكرارى لصفات البطن منخفضة إلى متوسطة تتراوح بين (٠,١١ إلى ٠,٣٤). وجد أن قيمة المعامل التكرارى لصفة وزن الخلفة عند الميلاد أعلي من باقى الصفات (٠,٣٤). قيمة المعامل التكرارى لصفات الحمل وصفات الفترة الفاصلة بين ولادتين منخفضة تتراوح بين (٠,٠١ إلى ٠,١١). الارتباط الوراثى بين صفات البطن قيمه موجبة ومتوسطة إلى قوية جدًا تتراوح بين (٠,٢٣ إلى ٠,٩٢) باستثناء الارتباط بين حجم الخلفة عند الميلاد ووزن الخلفة عند الفطام وكذلك أيضا الارتباط الوراثى بين وزن الخلفة عند الميلاد و معدل النفوق قبل الفطام كان الارتباط سلبى وضعيف (-٠,١٦) و(-٠,٠٨) علي التوالى. كانت الارتباطات الوراثية بين صفات الحمل وصفات الفترة الفاصلة بين ولادتين في هذه الدراسة موجبة وقوية جدًا تتراوح بين (٠,٦٨إلى١,٠٠) باستثناء الارتباط بين مدة الحمل و عدد مرات الخدمة اللازمة لحدوث الحمل فهي سلبية وقوية (-٠,٧٧). كان المدى لقيم المقدرة العبورية لصفات حجم الخلفة يتراوح بين ١,٩٢ إلى ٢,١٠ أرنب صغير، قيم المدى للمقدرة العبورية لصفات وزن الخلفة تتراوح بين ٠,٠١ إلى ٠,٧٠جرام . كان المدى لقيمة المقدرة العبورية لصفة معدل النفوق قبل الفطام ٣٣,٩٠% ، المدى لقيم المقدرة العبورية لصفات الحمل كان منخفضا ٠,٠٨ يوم لصفة طول مدة الحمل، ٠,١١ لصفة عدد مرات الخدمة الازمة لحدوث الحمل. لوحظ أن قيم المدي للمقدرة العبورية لصفات الفترة بين ولادتين، الفترة المفتوحة (٤,٩٣ و١٠,٧٢) على التوالى. كانت النسبة المئوية لعدد السجلات ذات القيم الموجبة للمقدرة العبورية تتراوح بين ٣٠,٩٥ إلى ٥٣,٨١ لصفات البطن و تتراوح بين ٥٠,٠٠ إلى ٥١,٩٠ لصفات الحمل ولصفات الفترة الفاصلة بين ولادتين على التوالى. تقديرات الاتجاهات الوراثية لصفات البطن عند الأعمار المختلفة وكذلك لصفات الحمل ولصفات الفترة الفاصلة بين ولادتين كانت منخفضة وبها تقلبات حسب موسم السنة وذلك بسبب اختلاث الظروف المناخية.

التوصية:

تتمتع أمهات الأرانب البلدى الأسود بإمكانيات جيدة فى التناسل. وتتأثر معظم الصفات التناسلية لأمهات هذه الأرانب بالعوامل البيئية والتى يمكن تحسينها من خلال تحسين الظروف البيئية والرعاية. تشيرقيمة المكافئ الوراثى المتوسطة (٠,١٥) والمدى للمقدرة العبورية (٣٣,٩٠%) لصفة معدل النفوق قبل الفطام إلى إمكانية خفض نسبة هذا النفوق عن طريق الانتخاب. كما تشير قيم المعامل التكرارى المتوسطة لصفتى معدل النفوق قبل الفطام ووزن الخلفة عند الميلاد (٠,١٦ ، ٠,٣٤) علي التوالى إلى امكانية استخدام سياسة الانتخاب والاستبعاد فى تحسين هاتين الصفتين. كما يجب أن يؤخذ فى الاعتبار الارتباط الوراثى السلبى بين حجم الخلفة عند الميلاد ووزنها عند الفطام (- ٠,١٦) عند وضع برامج التحسين الوراثى لهذه الارانب. يعكس الارتباط الوراثى التام بين صفة الفترة بين ولادتين، الفترة المفتوحة (١,٠٠) أن هاتين الصفتين يعتبرا مؤشرا لبعضهما البعض عند تصميم برامج التربية.