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GENETIC ANALYSIS OF SOME PRODUCTIVE AND REPRODUCTIVE TRAITS IN NEW ZEALAND WHITE RABBITS

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Abstract: A total of 625 progenies of New Zealand White rabbits, kept at Sakha Experimental Rabbits, Kafr-El-Sheikh, Government, belonging to Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt, during 2010-2017 were used to estimate the genetic parameters and phenotypic and genetic trends for some reproductive and productive traits. Traits studied were litter size at birth (LSB), litter weight at birth (LWB), kit body weight at 4 wk (BW4), body weight at 6 wk (BW6), body weight at 8 wk (BW8) and body weight at 10 wk or marketing weight (BW10). Data were analysed using a multivariate animal model. Direct heritability estimates were 0.05, 0.20, 0.23, 0.24, 0.31 and 0.34 for LSB, LWB, BW4, BW6, BW8 and BW10, respectively. All phenotypic and genetic correlations among traits studied were positive and ranged from 0.21 to 0.90 for phenotypic correlations and from 0.04 to 0.78 for genetic correlations. Annual phenotypic changes for LSB, LWB, BW4, BW6, BW8 and BW10 were positive and equal to 0.06, 15.96 g, 18.70 g, 23.15 g, 27.72 g and 50.69 g, respectively. Genetic changes for LSB, LWB, BW4, BW6, BW8, and BW10 were 0.20, 12.50 g, 14.20 g, 16.25 g, 20.09, and 40.10 g, respectively. The moderate estimates of heritability for body weights confirmed that improvement of these traits can be achieved by genetic selection. Positive and significant phenotypic and genetic trends for the studied traits implied that current breeding programmes are efficient in this rabbit population. Likewise, positive genetic trends along with positive genetic correlations among traits indicated that improvement of production and reproduction traits of New Zealand White rabbits seems feasible in selection programmes.

Key Words: Genetic evaluation, genetic trend, New Zealand White rabbits, performance traits.

INTRODUCTION

Egypt is the fourth country in rabbit production, with 70 thousand tons of carcass and 7.6 million head of rabbits (FAO, 2013). In Egypt, smallholders mainly carry out rabbit production, and according to the Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, 83.4% of rabbit production farms are located in the strip of Lower Egypt. Economic traits in rabbits, such as litter size at birth (LSB), litter weight at birth (LWB), and body weights at different ages are affected by non-genetic factors (year and month of birth, sex and dams' parity) and genetic effects. Estimates of heritability for LSB were very low and ranged from 0.01 to 0.08 (Rastogi *et al.*, 2000; Khattab *et al.*, 2006; Abdel-Kafy *et al.*, 2012; El-Deghadi, 2019; Rabie *et al.*, 2020), while heritability estimates for body weight at different ages were medium and ranged from 0.20 to 0.40 (Khattab *et al.*, 2006; Iraqi, 2008; El-Deghadi, 2019;

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Rabie *et al.*, 2020). Therefore, improvement of litter size at birth can be achieved through improved management and feeding system, while genetic improvement of body weight can be achieved through the selection of bucks and does.

The genetic trend is defined as a change in performance per unit of time due to a change in mean breeding value and it is derived by comparing the average levels in the doe population for each year. The understanding of trends in genetic progress will help establish future genetic direction by defining specific goals for profitable breeding. Therefore, in any genetic improvement programme, there is a need to track the results to evaluate their progress, make adjustments aiming to optimise genetic gain, and increase farm profitability in the future. One of the ways to monitor this is by assessing genetic trends over time, which evaluates the changes brought about by the selection process.

The present study aimed to (1) study some of the non-genetic factors affecting LSB, LWB and kit body weight at four (BW4), six (BW6), eight (BW8) and 10 (BW10), (2) estimate genetic parameters and (3) estimate phenotypic and genetic trends for the above traits studied in New Zealand White Rabbits (NZW), kept at Sakha Farm, belonging to the Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt.

MATERIALS AND METHODS

Data used in the present study were collected from a total of 625 progenies of New Zealand White (NZW) rabbits at the Sakha Experimental Farm, in Kafr-Sheikh Governorate, Egypt, from 2010 to 2017. This experimental station belongs to the Animal Production Research Institute, Agricultural Research Centre, Ministry of Agriculture, Dokki, Cairo, Egypt.

At the time of breeding, each doe was transferred to the cage of her assigned buck to be hand mated and returned to her cage after mating. Each doe was palpated 10 d thereafter to determine pregnancy and those that failed to conceive were returned to the same mating buck to be remated.

Kits were weaned at four weeks, sexed and transferred to standard progeny wire cages (equipped with feeding hoppers and drinking nipples) with groups of 3-4 per cage for the fattening period till 12 wk of age. All year round, rabbits were fed *ad libitum* on pelleted rations. Each pellet was 1 cm in length and 4 mm in diameter. The ration was composed of 16.3% crude protein (CP), 13.2 crude fibre and 2.5% fat (digestible energy=2600 kcal/kg ration). The ration ingredients were 32% barley, 21% wheat bran, 10% soya bean meal (44% CP), 22% hay, 6% berseem straw, 3% corticated cottonseed meal, 3% molasses, 1% limestone, 0.34% total salt, 0.3% minerals and vitamins, and 0.06% methionine.

Data included LSB, LWB, BW4, BW6, BW8 and BW10. The choice of fixed effects to be considered was made after testing whether the effects were statistically significant with a linear fixed effects model analysed with the GLM procedure of Statistical Analysis System (SAS, 2000) version 8.2. The final model of analysis for BW4, BW6, BW8 and BW10 included the fixed class effects of the birth year (eight levels) and month (12 levels), random genetic effect of the animal and random common environmental effect of litter. Dam's parity and sex had no significant effect on body weight at different ages and were excluded from the final models of analysis. The final model of analysis for LSB and LWB also included the fixed class effects of the year and month of kindling, parity of the individual doe and the random genetic effect of the doe and random permanent environmental effect of the individual doe.

The univariate genetic analysis was conducted using the multi-trait derivate free restricted maximum likelihood (MTDFREML) program of Boldman *et al.* (1995). In addition, bivariate or pairwise analyses were carried out for every pair of the studied traits. The models applied in pairwise analyses were those fitted for each of the traits in the univariate analyses.

The annual phenotypic changes for different traits studied were estimated using the linear regression of LSB, LWB, BW4, BW6, BW8 and BW10) on the year of kindling. Genetic trends were also obtained by regressing the means of predicted breeding values on the year of kindling.

RESULTS AND DISCUSSION

Means

The overall means, standard deviation (SD) and coefficient of variation (CV) for different traits studied are presented in Table 1. Moderate values of CV for LSB, LWB and body weights at different ages (22.25 to 35.03%, Table 1) confirm that these traits are subjected to many effects such as genetic makeup of the does, non-genetic effects (year-season, parity) and management of the flock. Moreover, the CV values indicate the higher variation between kits in body weight traits and these results reflect great variations in such economic traits.

Genetic parameter estimates

Estimates of h^2 for LSB, LWB, BW4, BW6, BW8 and BW10 were 0.05, 0.20, 0.23, 0.24, 0.31 and 0.34, respectively (Table 2). Low h^2 estimates for LSB may be due to the high phenotypic variance arising from large environmental variations. This therefore implies that much of the improvement in LSB could be attained by improving the production environment rather than genetic selection. Rastogi *et al.* (2000), in a study based on 1120 litters of the New Zealand White X Checkered Giant, concluded that the low heritability of litter size is further reflected in the low response to direct selection. Likewise, Abdel-Kafy *et al.* (2012) analysed 111 litters of Baladi Black and found that h^2 estimates for litter size at birth, litter size at 21 d and litter size at weaning were 0.03, 0.01, and 0.01, respectively. Besides, Garreau *et al.* (2000), Moura *et al.* (2001), Garcia and Baselga (2002a), Garcia and Baselga (2002b), Khattab *et al.* (2006), Youssef *et al.* (2008), El-Deghadi (2019), and Rabie *et al.* (2020) studied different breeds of rabbits and reported that h^2 estimates for LSB ranged from 0.01 and 0.153. The present estimates showed that h^2 estimates for body weights increased with increasing age. Anous (2001), in a study based on 193 Burundi local breed of rabbits in Egypt, found that h^2 estimates for body weights at 4, 6, 8 and 10 wk of age were 0.67, 0.819, 0.98 and 0.67, respectively. These results indicated that h^2 estimates for body weights increased with increasing age up to 8 wk of age, and which it decreased. Contrary to the results of this study, Anous (2001) concluded that selection for body weight at earlier ages may be a useful method for improving early rabbit growth.

The moderate estimates of h^2 for LWB, BW4, BW6, BW8 and BW10 (Table 2) indicated that improvement of body weight at one month, body weight at two months and weaning weight could be possible by selection in a short period and these traits could be used as selection criteria in NZW rabbits. Moreover, these results indicated that mass selection of does for litter weight at birth was more effective to improve pre-weaning traits in NZW rabbits. Besides, the moderate h^2 estimates of BW10 indicated that weaning weight is partly controlled by maternal effects, as the trait is affected by litter size, kit viability, mothering and milking ability as well.

Phenotypic correlation estimates among all different traits studied were significantly positive and ranged from 0.21 to 0.90 (Table 2). The present results indicated that heavy body litter weight at birth and heavy body weight at one month will give heavy body weight at marketing. Likewise, these results indicated the importance of permanent environmental effects on litter size at birth, litter weight at birth and kit body weights at different ages. The present estimates agree with those obtained in other breeds (Anous, 2001; Iraqi *et al.*, 2007; Youssef *et al.*, 2008; Rojan *et al.*, 2009; Egena *et al.*, 2012; Rabie *et al.*, 2020) and varied from 0.11 to 0.98.

Table 1: Mean, standard deviation (SD), and coefficient of variation (CV%) for litter size at birth (LSB), litter weight at birth (LWB), kit weight at one month (BW4), body weight at 6 wk (BW6), body weight at 8 wk (BW8), and body weight at 10 wk or marketing age (BW10) for New Zealand White rabbits.

Trait	N	Mean	SD	CV%
LSB	625	6.93	1.54	22.25
LWB (g)	625	361.55	108.58	35.03
BW4 (g)	625	372.88	109.70	29.42
BW6 (g)	625	533.26	153.12	28.71
BW8 (g)	625	723.01	214.56	29.68
BW10 (g)	625	1020.20	244.30	23.95

Table 2: Estimates of heritability±standard error (SE) (bold on diagonal), genetic correlations±SE (below diagonal), and phenotypic correlations (above diagonal) among litter size at birth (LSB), litter weight at birth (LWB), kit weight at one month (BW4), body weight at 6 wk (BW6), body weight at 8 wk (BW8), and body weight at 10 wk or marketing age (BW10).

Trait	LSB	LSW	BW1	BW2	BW3	BW4
LSB	**0.05±0.01**	0.2	0.23	0.30	0.21	0.23
LSW	0.04±0.01	**0.20±0.05**	0.40	0.45	0.45	0.56
BW4	0.04±0.01	0.14±0.02	**0.23±0.08**	0.34	0.60	0.66
BW6	0.12±0.02	0.20±0.01	0.50±0.09	**0.24±0.09**	0.89	0.88
BW8	0.15±0.09	0.24±0.09	0.56±0.09	0.70±0.09	**0.31±0.01**	0.90
BW10	0.35±0.10	0.34±0.0	0.45±0.09	0.78±0.09	0.70±0.02	**0.34±0.01**

Estimates of genetic correlations between LSB with LWB and BW4 were positive and low (0.04 and 0.04, respectively) (Table 2). Genetic correlations between LSB with BW6, BW8 and BW10 were positive and significant (P<0.01), being 0.12, 0.15, and 0.35, respectively (Table 2). The genetic correlation between LSB and other traits was not high. Therefore, these traits should be used in an index to improve the response to selection in litter weight at birth, which is the most important trait in the rabbit population. Moreover, the genetic correlations between body weights at different ages were positive and ranged from 0.14 and 0.78 (Table 2). The present results indicated that selection for heavier weights of birth in kits causes a correlated increase in body weight at one and two months and at weaning weight. Moreover, positive genetic correlations were found between body weight at one month and other traits, so weight at one month could be considered in the selection programme when the aim is to improve weaning weight at two months. A positive genetic correlation between weaning weight (as a selection criterion) and other body weight traits indicates that similar relative improvement could also be expected in all traits. Besides, selection for body weight at market age would be expected to improve the growth rate effectively. In other words, the genes that affect birth weight also influence BW4, BW6, BW8 and BW10. Moreover, a breeding programme using a selection index combining total litter weight at birth, weaning weight and body weight at marketing would be expected to optimise the overall improvement achieved in litter traits and growth rate. Similar results were reported by Bianospino *et al.* (2006) who worked on the growth, carcass and meat quality traits of straightbred and crossbred Botucatu rabbits. In line with the results of this study, Garreau *et al.* (2000) reported that the genetic correlation between LSB and growth traits was positive but low in the White Pannon breed, selected for growth rate. Garcia and Baselga (2002c) obtained a positive genetic correlation between litter size at weaning with weaning weight (0.049), but a negative genetic correlation with weight at slaughter (–0.025), in a line of rabbits selected on litter size at weaning for 21 generations. In contrast to the current results, Ezzeroug *et al.* (2020) estimated the genetic correlations between LSB with weaning weight and weight at the end of the fattening period were negative and high. Likewise, Gomez *et al.* (1998) reported a negative and low genetic correlation between LSB and individual weaning weight in a specialised dam line of rabbits. In this respect, Rojan *et al.* (2009) found that genetic correlation between weight at second and 8th wk of age was 0.892 and indicated that selection of body weight at the second week also improved the body weight at the 8th wk. The same authors also pointed out the synergistic control of the same additive genes for both traits. Anous (2001) analysed the data on Burundi local rabbits and found that genetic correlation among body weight at 4, 6, 8, and 10 wk of age ranged from 0.90 to 0.99 and indicated that rabbits heavier at a given age also tended to be heavier at any later age. Iraqi (2008), with Gabali rabbits, found that genetic correlation between body weights at 4, 8, and 12 wk of age ranged from 0.08 to 0.89. Due to the highest genetic correlation (0.89) obtained between body weights at 8 and 12 wk of age, it can be concluded that selection for body weight is more effective at 8 wk of age to improve post-weaning growth in Gabali rabbits. Hekil *et al.* (2011), Abdel-Kafy *et al.* (2012), and Rabie *et al.* (2020) arrived at the same results in different strains of rabbits. Generally, several factors such as the animal breed, genetic variation within the population, environmental and management situations and the parameter estimation method would have influenced the differences between genetic parameter estimates (Ghavi Hossein-Zadeh, 2017).

Phenotypic and genetic trends

Phenotypic trends for LSB, LWB, BW4, BW6, BW8 and BW10 were positive and equal to 0.06, 15.96, 18.70, 23.15, 27.72 and 50.69 g, respectively (Table 3). Genetic trend estimates for different traits studied, are presented in Table 3. The values of genetic trends were low, positive and equal to 0.20, 12.50 g, 14.20 g, 16.25 g, 20.09 g and 40.10 g, for LSB, LWB, BW4, BW6, BW8 and BW10, respectively. These results are in agreement with El-Deghadi (2019), who reported that genetic trends for LSB and LWB significantly increased with the advantage of generation number. They may reflect the improvement in performance of NZW rabbits through increasing their mothering abilities to take more care of their kits during the suckling period, year by year. Besides, Hassan *et al.* (2015) concluded that epigenetic trends (EP) for litter weight traits under study suggested that it is possible to achieve slow but simultaneous improvement of litter traits with a selection programme in rabbits. LW traits generally recorded a negative EP with parities, and the high LW response was postponed to the later parities.

Table 3: Genetic and phenotypic trends for litter size at birth (LSB), litter weight at birth (LWB), kit weight at one month (BW4), body weight at 6 wk (BW6), body weight at 8 wk (BW8), and body weight at 10 wk or marketing age (BW10) in New Zealand White rabbits.

Trait	Phenotypic trend	Genetic trend
LSB	0.06 ±0.021	0.20±0.01
LWB	15.96±1.35	12.50±0.02
BW4	18.70±1.45	14.20±0.09
BW6	23.15±2.10	16.25±0.10
BW8	27.72±2.90	20.09±0.20
BW10	50.69±3.09	40.10±0.10

Consistently with positive genetic trends for body weight traits in this study, Abou Khadiga *et al.* (2010) analysed the data on the V line and the crosses between the V line and Baladi red rabbits and estimated the genetic trend by regressing the mean of the predicted additive values on generation number. They found that genetic trends for litter birth weight were 6.1 g and 5.7 g for two breeds, respectively, and the corresponding estimates for litter weaning weight were 32.5 g and 34.2 g, respectively. Differences in genetic trends throughout the experiments could be attributed to different populations and surrounding conditions. Mefti Korteby *et al.* (2014), with two lines of rabbits, reported that the genetic progress in body weight was equal to 72.24, 133.44 and 179.27 g *vs.* 37.09, 68.73, and 13.23 g, in line C (selected for growth rate) and line P (selected for litter size), respectively. Moreover, Hekil *et al.* (2011) found that the expected genetic gain per generation for body weight traits in the NZW breed would be 21.69 g in body weight at 4 wk of age, 40.55 g in body weight at 8 wk of age and 50.68 g in body weight at 12 wk of age. The expected genetic progress in the Cal breed would be 16.20 g in body weight at 4 wk of age, 21.43 g in body weight at 8 wk of age, and 24.59 g in body weight at 12 wk of age. On the other hand, negative genetic trends could be due to improvements in environmental conditions, such as the nutrient composition of diet and management (El- Deghadi, 2019). Significant genetic trends for litter size traits in rabbits have been reported in several experiments. Garcia and Baselga (2002a) obtained a genetic trend of 0.161 for total litter size in a maternal line of rabbits. Garcia and Baselga (2002b) reported the genetic trend of 0.11 for total litter size at birth in a line of rabbits selected on litter size at weaning for 21 generations.

CONCLUSION

Current genetic parameter estimates for growth and reproduction traits of New Zealand White rabbits could be used in designing selection programmes and constructing selection indices in this population. The moderate estimates of heritability for litter birth weight, body weight at 4, 6, 8 and 10 wk of age confirmed that improvement of body weight traits can be achieved by selection programmes. Positive and significant phenotypic and genetic trends for the studied traits implied that current breeding programmes are efficient in this population of rabbits. Likewise, positive genetic trends along with positive genetic correlations among traits indicated that improvement of production and reproduction traits of New Zealand White rabbits seems feasible in selection programmes. This will help rabbit production systems to increase their production and profits.

REFERENCES

Abdel-Kafy E.M., Hassan N.S., Morsy W.A., Ali Kh.A.A., El-Sawy M.A., Hassanein M.N.F., Sabra Z.A.M. 2012. Genetic parameters of litter traits in a local Baladi Black rabbit in Egypt. *10th World Rabbit Congress, September 3 - 6, 2012, Sharm El-Sheikh, Egypt, 37-41.*

Abou Khadiga G., Youssef Y.M.K., Saleh K., Nofal R.Y., Baselga M. 2010. Genetic trend in selection for litter weight in two maternal lines of rabbits in Egypt. *World Rabbit Sci., 18: 27-32. https://doi.org/10.4995/WRS.2010.18.04*

Anous R.M. 2001. Selection indexes for improved weaning and marketing body weights of the Burundi local rabbits. *Arch. Tierz., 44: 561-567. https://doi.org/10.5194/aab-44-561-2001*

Bianospino E., Wechsler F.S., Fernandes S., Roça R.O., Moura A.S.A.M.T. 2006. Growth, carcass, and meat quality traits of straightbred and crossbred Botucatu rabbits. *World Rabbit Sci., 14: 237-246. https://doi.org/10.4995/wrs.2006.563*

Boldman, K.G., Kriese L.A., Van Vleck L.D., Van Tassell C.P., Kachman S.D. 1995. A Manual for Use of MTDFREML. A Set of Programs To Obtain Estimates of Variances and Covariances [DRAFT]. *U.S. Department of Agriculture, Agricultural Research Service.*

Egena S.S.A., Akpa G.N., Alemede I.C., Aremu A. 2012. Genetic and non-genetic factors affecting litter size and birth weight of rabbit in Minna Niger state, Nigeria. *Anim. Prod., 14: 160-166.*

El-Deghadi A.S. 2019. Genetic evaluation of some doe, litter and lactation traits of New Zealand White rabbits. *Egypt. J. Rabbit Sci., 29: 23- 43. https://doi.org/10.21608/ejrs.2019.45672*

Ezzeroug R., Belabbas R., Argente M.J., Berbar A., Diss S., Boudjella Z., Talaziza D., Boudahdir N., de la Luz García M. 2020. Genetic correlations for reproductive and growth traits in rabbits. *Can. J. Anim. Sci. 100: 317-322. https://doi.org/10.1139/cjas-2019-0049*

FAO. 2013. Statistical Yearbook. *World Food and Agriculture Organization, Rome.*

Garcia M.L., Baselga, M. 2002a. Genetic response to selection for reproductive performance in a maternal line of rabbit. *World Rabbit Sci., 10: 71-76. https://doi.org/10.4995/wrs.2002.478*

Garcia M.L., Baselga M. 2002b. Estimation of genetic response in litter size of rabbits using a cryopreserved control population. *Livest. Prod. Sci., 74: 45-53.*

Garcia M.L., Baselga M. 2002c. Estimation of correlated response on growth traits to selection in litter size of rabbits using a cryopreserved control population and genetic trends. *Livest. Prod. Sci., 78: 91-98.*

Garreau H., Szendrő Zs., Larzul C., de Rochambeau H. 2000. Genetic parameters and genetic trends of growth and litter size in the White Pannon Breed. *In Proc.: 7th WRC, 4-7 July 2000, Valencia Spain, J. World Rabbit Sci. Assoc, 8 supp 1: 403-408.*

Ghavi Hossein-Zadeh N. 2017. Estimates of genetic parameters and genetic trends for production and reproduction traits in Iranian buffaloes (*Bubalus bubalis*). *Anim. Prod. Sci., 57: 216-222. https://doi.org/10.1071/AN15370*

Gomez E.A., Rafel O., Ramon J. 1998. Genetic relationships between growth and litter size traits at first parity in a specialized dam line, In Proc. 6th W.C.G.A.L.P., XXV:552-555.

Hassan N.S., Abdel-Ghany A.M, Sabri H.M. 2015. Genetic parameters of the newly-developed Egyptian APRI rabbit line raised under north-delta environment using DF–REML animal model 1 litter weight traits. *EC Vet. Sci., 1: 30-46.*

Hekil A.M., Gebriel G.M., Enas A.A., Hamdda I.A., Abdou F.H. 2011. Genetic studies on some economic traits in rabbits 2-post–weaning body weight and growth rate. *Egypt. J. Agric. Res., 89: 345-360. https://doi.org/10.21608/ejar.2011.174306*

Iraqi M.M. 2008. Estimation of Genetic parameters for post-weaning growth traits of Gabali rabbits in Egypt. *Livest. Res. Rural. Dev., 20: 655-664.*

Iraqi M.M., Afifi E.A., Nayera Z.B., Gad S.M.A. 2007. Estimation of genetic parameters for litter traits in Gabali rabbits raised in the north-western coast of Egypt using multi-trait animal model. *In Proc.: 5th International Conference on Rabbit Production in Hot Climate, Hurghada, Egypt, 103-112.*

Khattab A.S., Ghany A., Abou Zeid A.M.E., Kassab R.M. 2006. Non genetic and genetic analysis of some traits in rabbits. II- Genetic analysis. *In Proc.: 57th Annual meeting of the European Association for Animal Production, Antalya, Turkey, P 273.*

Mefti Korteby H., Sid S., Saidj D., Chaou T., Kaidi R. 2014. Effect of different selection to improve the performance of local growth of the Rabbit. *Int. J. Curr. Microbiol. Appl. Sci., 3: 1048-1056.*

Moura A.S.A.M.T., Costa A.R.C., Polastre R. 2001. Variance components and response to selection for reproductive, litter and growth traits through a multi–purpose index. *World Rabbit Sci., 9: 77-86. https://doi.org/10.4995/wrs.2001.449*

Rabie T., Nower A., Abou Zeid A., Khattab A.S. 2020. Assessment of genetic capability for post-weaning growth traits of reciprocal cross between Gabali and V- Line rabbits by animal model. *World Vet. J., 10: 405-413. https://doi.org/10.36380/scil.2020.wvj50*

Rastogi R.K., Lukefahrb S.D., Laucknerc F.B. 2000. Maternal heritability and repeatability for litter traits in rabbits in a humid tropical environment. *Livest. Prod. Sci., 67: 123-128. https://doi.org/10.1016/S0301-6226(00)00180-9*

Rojan P.M., Bindu K.A., Raghunandanan K.V., Raghavan K.C. 2009. Genetic analysis of body weights in rabbits. *J. Vet. Anim. Sci., 40: 26-28.*

Youssef Y.M. Omara M.E., Farid A. 2008. Genetic evaluation for some litter and lactation traits in New Zealand White and Baladi Black rabbits. *Egypt. Poult. Sci., 28: 1203-1216.*