GENETIC PAREMETERS FOR SOME QUANTITATIVE CHARACTERS IN BOUSCAT RABBITS

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Abstract

An analysis of doe litter traits was carried out on 236 does progenitored by 139 dams and produced 1110 litters of Bouscat rabbits. Traits examined were litter size and weight at birth, 21 days and at weaning at 30 days from their birth (LSB, LS21, LSW, LWB, LW21, LWW); litter weight gain up to 21 days and up to weaning (LWG21, LWGW); number dead up to 21 day and up to weaning (ND21, NDW) and gestation length (GL). Dam effects were significant ($p<0.05$, $P<0.01$ or $P<0.001$) on all litter traits of the study except LWG21. Fixed effects (year of kindling, season of kindling and parity) contributed non-significantly to the variance of most litter traits. Performance of the studied traits increased with advance of year of kindling except GL. Season of kindling showed different trends of effect, while parity failed to exert a consistent pattern of effect on litter traits. Estimates of dam variance components in general, were low. Estimates of heritabilities calculated from dam variance components were generally moderate and tended to increase with advance of litter age. Estimates of genetic and phenotypic correlations coefficients were significant ($p<0.05$ or $P<0.001$) and positive for all combinations except those between GL and the other traits which were negative. These estimates were moderate or high in magnitude.

Key words: rabbit, dam of the doe, litter size, litter weight, variance component, dam heritability.

Introduction

Doe productivity is a key factor affecting the efficiency and economics of rabbit production enterprises. Litter size and weigh at weaning (composite traits) are usually regarded as the best estimates of doe productivity since they are a function of all pre-weaning effects.

It has been agreed that the genetic evaluation of the rabbit doe productivity can be improved by the adjustment of productivity for managerial and environmental influences (Khalil *et al.*, 1987). The reproductive performance of exotic rabbit breeds when introduced into a new environment will be deteriorated by lowering fertility and depressing growth (Damodar and Jatkar,1985; Opoku and Lukefahr,1990). So, to improve the reproductive performance of rabbit, we must study all possible factors affecting doe rabbit traits. In this respect, Afifi *et al.*,(1976a) indicated that year of kindling, parity and month of kindling were the most important environmental factors affecting litter traits in rabbits. Most investigators tend to calculate heritability estimates and other genetic parameters through sire of the doe (e.g., Kadry and Afifi, 1984 and Khalil and Afifi, 1986, others). But till now, no available information about genetic parameters obtained through the dam of the doe especially on exotic breeds reared in new regions under commercial production conditions.

The main objective of this study was to throw some light on of some factors affecting commercial production of rabbit under Egyptian conditions. These effects included year and season of kindling as well as parity (as fixed effects), dam of the doe (as random effect) and to quantify some genetic parameters (component of variance and heritability estimates for doe litter traits). In addition, to calculate the genetic and phenotypic correlation coefficients among these traits.

Materials and Methods

The present study was carried out in San. El-Hager agricultural company farm, Sharkeya Governorate, Egypt. The data used were recorded on 1110 Bouscat litters produced by 236 does during two successive years of production started in September 1994. These does were born to 139 dams. Breeding females were grouped randomly into groups of about 3 to 5 does in each. Restricted randomization was practiced at mating to avoid parent-offspring, full and half-sib mating. Natural mating was carried out where each doe was transferred to the cage of the its assigned buck to be bred and returned over again to its cage. Detecting of pregnancy was confirmed out by palpation about 10 days after mating. Does that failed to conceive were returned to the same buck to be re-mated until a successive service was detected.

Rabbits were housed individually in galvanized wire cages, in double-tier batteries in a closed rabbitry. The rabbitry was air-conditioned to keep its inside temperature between 20 and 24° C all over the year.

Newborn rabbits was examined and recorded within 12 hours of birth and were examined repeatedly each morning during the suckling period to remove the dead ones. Weaning takes place 30 days after birth.

The rabbits were fed ad libitum on a commercial pelleted ration. The ration comprised 18% crude protein, 3% ether extract, 14% crude fiber, 2% mineral mixture (1% Ca, 0.7% P, 0.2% Na) and 63% soluble carbohydrates. Fresh clean water was available to rabbits all time through nipples. Doe litter traits data collected were litter size and weight at birth, 21 days and weaning (LSB, LS21, LSW, LWB, LW21, LWW, respectively), litter weight gain up to 21 days and up to weaning (LWG21, LWGW, respectively), number dead up to 21 day and up to weaning (ND21, NDW) along with gestation length (GL). Data were analyzed using the least-squares procedure (Harvey, 1990), for the effect of dam of the doe (as random effect), season of kindling, year of kindling, parity and the possible interactions (as fixed effects), genetic and phenotypic correlation between different litter traits were also calculated. Maternal half-sib heritabilities for litter traits were estimated according to the following formula:

Model of analysis:

$$Y_{ijklm}=\mu + D_i + N_j + S_k + P_l + NS_{jk} + NP_{jl} + e_{ijklm}$$

Where:-

Y_{ijklm} = Y_{ijklm}th observation;

μ = overall mean;

D_i = random effect of the i^{th} dam;

N_j = fixed effect due to year of kindling (j = 1&2);

S_k = fixed effect due to season of kindling (k=1..4);

P_l = fixed effect due to parity (l = 1....9);

NS_{jk} = interaction of j^{th} year of kindling and k^{th} season of kindling;

NP_{jl} = interaction of j^{th} year of kindling and l^{th} parity and

e_{ijklm} = residual random effect.

Results and Discussion

Litter traits:

Number of records (n), actual means and standard deviations (SD) for pre-weaning litter traits are presented in Table 1. These means are generally within the ranges reported for Bouscat rabbits which were from 5.9 to 7.4 young (Hilmy, 1991; Farghaly, 1996) for LSB; from 5.9 to 6.2 young (Yamani, 1994; Farid *et al.*, 2000) for LS21; from 3.8 to 5.9 young (Hilmy, 1991; Farghaly, 1996) for LSW; from 275 to 413 gm (Afifi *et al.*, 1976a; Yamani, 1994) for LWB; from 1678 to 1827 gm (Tawfeek, 1995; Farid *et al.*, 2000) for LW21; from 1197 to 3720 gm (Afifi *et al.*, 1976b; Tawfeek, 1995) for LWW; from 1355 to 1427 gm (Yamani *et al.*, 1994; Tawfeek, 1995) for LWG21 and from 31.07 to 32.0 days (Yamani, 1994; Afifi *et al.*, 2001) for GL. At the same time, LWGW was less than the range from 2995 to 3320 g. (Yamani *et al.*, 1994; Tawfeek, 1995). However, ND21 in this work was higher than 1.0 young (El-Gaafary *et al.*, 1992) and NDW was over the range of 1.9 to 3.0 young (Abdel-Raouf, 1993; Ahmed, 1997) with different breed groups of rabbits. In this respect, NDW was higher than 2.81 young obtained by Afifi *et al.*,(2001).

Differences among means obtained by different authors for litter traits in this breed may be due to differences in management, season, origin and/or size of the sample used in the analysis as illustrated by (Afifi *et al.*, 1976a &b). Also, location and genetic changes with advance of production year in the same herd of the same breed could exert some effects. Differences in the average of litter size at weaning may be due to differences in litter losses during the suckling period which would occur in litters born during the year (Hilmy, 1991; Afifi *et al.*, 1992).

Estimates of coefficient of variation (CV%) for doe litter traits (Table 1) are generally within the ranges reported by different authors being 29.6 to 40.51% (Hilmy, 1991; Farid *et al.*, 2000) for litter size traits, from 17.6 to 34.8% (Hilmy 1991; Yamani *et al.*, 1994) for litter weight traits, from 24.87 to 36.8% (Yamani, 1994; Yamani *et al.*, 1994; Farid *et al.*, 2000) for litter weight gain; from 2.47 to 4.67% (Hilmy, 1991; Afifi *et al.*, 2001) for gestation length. While, the estimate of CV% for NDW was less than 72.67% for Bouscat rabbits (Afifi *et al.*,(2001).

Results in Table 1 also revealed that the percentage of variation in litter size at weaning were lower than that at birth. This trend could be attributed to the great maternal effects on the bunnies along with differences in litter losses that occurred during the suckling period (Afifi *et al.*, 1992). In case of litter weight, it may be attributed to the increase in the differences in growth of the litter up to weaning caused by differences in their genotypes and the variation in milk production of their dams which is the main supply of nutrients up to weaning (Afifi *et al.*, 1992). On the contrary, Hilmy (1991), Youssef (1992) and Abdel-Raouf (1993) observed that the phenotypic variation in litter traits at weaning were higher than that at birth. The low phenotypic variabilities of GL in rabbits were obtained by Hilmy (1991), Youssef (1992) and Abdel-Raouf (1993) working on different breed groups of rabbits which might indicate that GL is a species characteristic (Hilmy, 1991).

Year of Kindling

Means estimates in Tables 2 and 3 indicated, in general, that litter traits tended to be higher in the second year of kindling for most litter traits.

Effect of year of kindling was found to be non-significant for most litter traits as shown in

Tables 4 and 5. Year of kindling did not contribute significantly to variation of LWB (Yamani *et al.*, 1994); litter weight traits (Nayera Bedier *et al.*, 1999) and LWB and LW21 (Abdel-Aziz *et al.*, 2002). The significant effect (P<0.05 or P<0.001) of the same factor was noticed on LW21, LWW, LWG21 and LWGW (Yamani *et al.*, 1994) and on LWW (Abd El-Aziz *et al.* 2002); All working with different breed groups of rabbits. Changes in litter traits according to year of kindling may be due to variation in management, feed quality, health conditions, age of the doe, changes in genetic composition of the herd from year to another and climatic condition (Khalil *et al.*, 1987; Afifi *et al.*, 1982; Youssef, 1992; Abdel-Raouf, 1993; others). However, differences in litter traits at weaning from one year of production to another might be due to year differences in pre-weaning mortality (Afifi *et al.*, 1976a &b).

Season of kindling

Tables 2 and 3 indicated that there were different trends for the effect of season of kindling on doe litter traits. The best estimates were recorded, in general, during winter followed by spring. The highest litter size and weight in the same breed and at the same age, were detected in spring (Farghaly and El-Drawany, 1994) and in winter (Farghaly, 1996). However, Ahmed (1997), with a comparable litter traits to that in the present study, but in New Zealand White and Californian rabbits, found that the best estimates were detected, in general, during winter in the first year of production. However in the present study the higher estimates were detected during autumn in the second year of production.

Results in Tables 4 and 5 showed that season had a significant effect on LWB, GL, LWW, LWGW, ND21 and NDW only (P<0.05 P<0.01 or P<0.001). In agreement with these results, Sedki (1991) and Abd El-Aziz *et al.*,(2002) for LWB and LWW. However, Farghaly and El-Drawany (1994) reported significant effect (P<0.001) for season of kindling on litter size and weight at birth, 21 days and at weaning. Afifi *et al.*,(2001) reported no significant effect of season of kindling for NDW and GL.

Seasonal variation on litter traits is deamed to be a reflection of differences in seasonal climatic conditions in geographical location of the rabbitry, especially for ambient temperature and relative humidity (Abdel-Raouf, 1993; Farghaly, 1996).

Parity:

Means of litter traits, presented in Tables 2 and 3 showed, in general, that there were no clear trend for the effect of parity on litter traits of the study except LSW, LWG21 and GL which their means increased with advance of parity till reaching its peak and decreased thereafter showing positive curvilinear trend of effect. In this respect (Sedki, 1991; Afifi *et al.*, 1992; Nasr, 1994; Farghaly, 1996) reported no definite trend for the effect of parity on litter size and weight traits. While Afifi *et al.*,(1976a), Hilmy (1991) with LSW and Marai *et al.*,(1994) with LSW and LWG21 in different breed groups found that means of the traits increased with advance of parity till reaching its peak and decrease again (positive curvilinear trend of effect).

Parity effects on litter traits were found to be non-significant (Tables 4&5) in traits of the study except GL. These results were confirmed by those of other Egyptian studies (Afifi *et al.*, 1992; Hilmy, 1991; Abd El-Aziz *et al.*, 2002). On the other hand, sedki (1991), Farghaly and El-Darawany (1994) and Yamani *et al.*,(1994) noted that parity had a significant (P<0.05, P<0.01, P<0.001) effects on litter size and weight traits and/or litter weight gain up to 21 days. The pattern of change observed on litter traits may be due to changes in the weather conditions and physiological efficiency of the doe, especially those associated with mean age of doe and the differences in the intra-uterine environment provided during gestation length which occurs with advance of parity and milk production which is related to the udder capacity and ability of the doe to suckle her young. Also, may be related to effects on ovulation rates, implantation sites, embryonic mortality rates and viability of fetus (Afifi *et al.*, 1976a&b, 1982 and/or Khalil *et al.*, 1987). However, variability in litter traits according to season of kindling might be due to differences in feed quality (Youssef, 1992), but Abdel-Raouf (1993) noted that feed availability was not of considerable importance for differences in litter traits since does and their litters were fed on pelleted ration all the year round. The same author added that differences due to season of kindling might be due to changes in ambient temperature and relative humidity.

Interactions:

Among all the interactions at this study (Tables 4&5), the interaction between season of kindling and year of kindling were non-significant for all litter traits except on ND21 and NDW. The interaction between year of kindling and parity were not significant for LS21, LSW, GL, LWGW, ND21 and NDW. While, this interaction was significant (P<0.05, P<0.01, P<0.001) for LSB, LWB, LW21, LWW, LWG21.

Results of the present work indicated that year of kindling and season of kindling, as well as, all possible interactions must be considered in the model of analyzing litter traits to avoid masking the genetic differences among random effects included in the model.

Dam (dam of the doe):

Significant (P<0.05, P<0.01 or P<0.001) dam effects were noticed on litter traits studied except LWG21 (Tables 4&5). Results in Table 6 indicate that dam component of variance increased, in general, with advance of age of the litter. However, a significant dam effect on litter traits, in general,

Table 1. Actual means, standard deviations (SD) and percentages of variation (**CV%**) for litter size and weight, litter weight gain traits, number dead up to different ages till weaning and gestation length in Bouscat rabbits.

Trait	No.	Mean	S.D	CV%
LSB	1110	6.64	2.32	34.18
LS21	701	5.58	1.88	33.00
LSW	665	5.27	1.79	33.54
ND21	673	3.92	2.83	69.00
NDW	742	4.08	2.79	65.24
GL	1110	31.75	1.05	3.22
LWB	1031	368.54	119.38	31.21
LW21	701	1750.51	555.65	29.54
LWW	665	2949.29	982.90	31.64
LWG21	701	1393.36	498.79	33.25
LWGW	665	2591.98	923.35	33.89

LSB = litter size at birth, LS21 = litter size at 21 days, LSW = litter size at weaning, ND21 = number dead up to 21 days, NDW = number dead up to weaning, GL = gestation length, LWB = litter weight at birth, LW21 = litter weight at 21 days, LWW = litter weight at weaning, LWG21 = litter weight gain up to 21 days, LWGW = litter weight gain up to weaning.
CV% = percentages of variation are computed as the square root of the residual mean square divided by the actual mean of a given trait according to Harvey (1990).

Table 2. Least-squares means (**M**)±**S.E** for litter size traits and number dead at different ages and gestation length in Bouscat rabbits.

Independent Variable	LSB		LS21		LSW		ND21		NDW		GL	
	No	**M ± S.E**	No	**M ± S.E**	No	**M ± S.E**	No	**M ± S.E**	No	**M ± S.E**	No	**M ± S.E**
Overall mean	1110	6.7 ± 0.17	701	5.6 ± 0.19	665	5.2 ± 0.19	673	4.0 ± 0.25	742	4.1 ± 0.22	1110	31.9 ± 0.08
Year of Kindling												
1994	700	6.4 ± 0.22	469	5.2 ± 0.23	436	5.0 ± 0.23	412	3.7 ± 0.33	461	3.8 ± 0.31	700	31.9 ± 0.10
1995	410	7.0 ± 0.25	232	6.0 ± 0.30	229	5.5 ± 0.29	261	4.4 ± 0.37	281	4.3 ± 0.33	410	31.8 ± 0.11
Season of kindling												
Winter	250	6.8 ± 0.21	194	5.6 ± 0.22	188	5.2 ± 0.22	137	2.9 ± 0.33	153	3.0 ± 0.31	250	31.7 ± 0.09
Spring	417	6.8 ± 0.19	243	5.7 ± 0.21	232	5.3 ± 0.20	244	4.3 ± 0.30	268	4.5 ± 0.27	417	31.6 ± 0.08
Summer	217	6.6 ± 0.25	146	5.6 ± 0.35	134	5.0 ± 0.37	132	4.2 ± 0.35	150	4.4 ± 0.32	217	32.2 ± 0.11
Autmun	226	6.6 ± 0.39	118	5.6 ± 0.44	111	5.3 ± 0.43	160	4.8 ± 0.56	171	4.4 ± 0.49	226	32.0 ± 0.17
Parity												
1	247	6.9 ± 0.26	186	5.6 ± 0.27	179	5.2 ± 0.26	143	3.6 ± 0.41	160	3.8 ± 0.37	247	31.6 + 0.11
2	239	6.3 ± 0.24	143	5.4 ± 0.26	130	5.2 ± 0.26	137	3.8 ± 0.38	153	3.9 ± 0.35	239	31.8 ± 0.11
3	205	6.9 ± 0.23	127	6.0 ± 0.26	116	5.5 ± 0.26	117	4.1 ± 0.37	133	4.3 ± 0.34	205	31.7 ± 0.10
4	139	7.0 ± 0.25	73	6.1 ± 0.29	70	5.7 ± 0.28	88	4.6 ± 0.38	97	4.6 ± 0.34	139	31.9 ± 0.11
5	89	6.5 ± 0.29	57	5.8 ± 0.32	56	5.5 ± 0.31	55	3.7 ± 0.45	61	3.6 ± 0.40	89	32.0 ± 0.13
6	66	7.2 ± 0.32	47	5.9 ± 0.33	46	5.4 ± 0.32	44	3.9 ± 0.49	47	4.0 ± 0.45	66	32.0 ± 0.14
7	48	6.5 ± 0.39	26	5.3 ± 0.42	26	5.0 ± 0.41	31	4.8 ± 0.72	31	4.6 ± 0.70	48	32.0 ± 0.18
8	33	6.5 ± 0.45	18	5.1 ± 0.54	18	4.5 ± 0.52	25	3.7 ± 0.62	26	3.7 ± 0.59	33	31.8 ± 0.20
9	44	6.6 ± 0.52	24	5.3 ± 0.53	24	4.9 ± 0.51	33	4.2 ± 0.76	34	4.0 ± 0.73	44	32.1 ± 0.23

LSB = litter size at birth, LS21 = litter size at 21 days, LSW = litter size at weaning, ND21 = number dead up to 21 days, NDW = number dead up to weaning, GL = gestation length.

Table 3. Least-squares means (M)±S.E for litter weight and litter weight gain traits at different ages in Bouscat rabbits.

Independent Variable	LWB		LW21		LWW		LWG21		LWGW	
	No	M ± S.E	No	M±S.E	No	M ± S.E	No	M ± S.E	No	M ± S.E
Overall mean	1031	355.6 ± 8.77	701	1797.6 ± 49.89	665	2903.4 ± 97.78	701	1448.7 ± 43.80	665	2550.4 ± 91.80
Year of Kindling										
1994	655	354.3 ± 11.37	469	1600.6 ± 62.35	436	2765.4 ± 119.02	469	1261.2 ± 55.15	436	2422.4 ± 111.84
1995	376	356.9 ± 12.97	232	1994.7 ± 80.96	229	3041.4 ± 153.76	232	1636.1 ± 71.99	229	2678.3 ± 144.60
Season of kindling										
Winter	236	383.2 ± 11.03	194	1874.7 ± 58.84	188	3078.4 ± 112.83	194	1507.3 ± 51.96	188	2713.9 ± 106.01
Spring	377	374.2 ± 9.81	243	1849.9 ± 54.89	232	3183.0 ± 106.99	243	1492.9 ± 48.37	232	2821.8 ± 100.50
Summer	206	337.6 ± 12.80	146	1728.8 ± 97.32	134	2704.8 ± 192.09	146	1373.9 ± 86.75	134	2335.2 ± 180.73
Autmun	212	327.3 ± 19.76	118	1737.2 ± 122.75	111	2647.3 ± 224.94	118	1420.7 ± 109.64	111	2330.5 ± 211.67
Parity										
1	240	359.9 ± 13.38	186	1722.8 ± 73.30	179	2818.0 ± 138.92	186	1376.8 ± 65.07	179	2469.5 ± 130.61
2	213	352.3 ± 12.51	143	1780.4 ± 71.23	130	2834.0 ± 135.92	143	1443.5 ± 63.20	130	2493.6 ± 127.78
3	188	373.5 ± 12.23	127	1988.6 ± 71.19	116	3120.6 ± 138.25	127	1613.6 ± 63.16	116	2748.1 ± 129.98
4	127	379.2 ± 12.90	73	1898.0 ± 78.17	70	3083.4 ± 148.69	73	1530.8 ± 69.47	70	2708.3 ± 139.82
5	82	349.0 ± 14.97	57	1808.5 ± 86.32	56	2924.6 ± 160.45	57	1456.1 ± 76.83	56	2562.7 ± 150.91
6	64	371.7 ± 16.68	47	1770.1 ± 90.15	46	2919.9 ± 168.62	47	1418.6 ± 80.28	46	2567.2 ± 158.61
7	43	351.3 ± 21.40	26	1710.6 ± 117.21	26	2575.2 ± 215.55	26	1350.8 ± 104.65	26	2211.3 ± 202.82
8	33	333.5 ± 22.97	18	1823.6 ± 149.56	18	2964.4 ± 273.16	18	1499.5 ± 133.72	18	2636.4 ± 257.09
9	41	329.8 ± 28.05	24	1676.4 ± 147.50	24	2890.4 ± 269.97	24	1348.5 ± 131.87	24	2556.2 ± 254.09

LWB = litter weight at birth, LW21 = litter weight at 21 days, LWW = litter weight at weaning, LWG21 = litter weight gain up to 21 days, LWGW = litter weight gain up to weaning.

Table 4. F. values of the least-squares analyses of variance for litter size traits and number dead up to different ages and gestation length in Bouscat rabbits.

Source of variation	LSB		LS21		LSW		ND21		NDW		GL	
	d.f	F	d.f	F	d.f	F	d.f	F	d.f	F	d.f	F
Dam	138	1.442^{***}	132	1.387^{**}	131	1.382^{**}	132	1.412^{**}	137	1.342^{*}	138	1.384^{**}
Year of Kindling (yk)	1	3.932^{*}	1	4.743^{*}	1	1.853^{ns}	1	1.823^{ns}	1	1.465^{ns}	1	0.379^{ns}
Season(Sea)	3	0.211^{ns}	3	0.133^{ns}	3	0.325^{ns}	3	7.265^{***}	3	7.276^{***}	3	8.221^{***}
Parity (P)	8	1.871^{ns}	8	1.374^{ns}	8	0.998^{ns}	8	1.072^{ns}	8	0.959^{ns}	8	2.258^{*}
Sea $_x$ yk	3	1.288^{ns}	3	1.408^{ns}	3	1.182^{ns}	3	5.489^{**}	3	6.936^{***}	3	0.088^{ns}
P $_x$ Yk	8	2.851^{**}	8	1.749^{ns}	8	1.544^{ns}	8	0.949^{ns}	8	1.420^{ns}	8	0.278^{ns}
Remainder d.f.	948		545		510		517		581		948	
Remainder M.S.	5.156676		3.390475		3.127450		7.309710		7.097775		1.044555	

*=P<0.05, ** = P<0.01, *** = P<0.001 and ^{ns} = non-significant.
LSB = litter size at birth, LS21 = litter size at 21 days, LSW = litter size at weaning, ND21 = number dead up to 21 days, NDW = number dead up to weaning, GL = gestation length.

indicate that improvement in litter traits can be done by selection for dam of the doe dependent on its own performance of its litter traits. Also, the increase of dam variance components with advance of litter age (i.e., higher variance components at weaning than at birth) indicate that selection for litter size and weight at weaning will improve litter traits greater in magnitude than when selection for litter size at birth.

Heritability:

Heritability estimates obtained in this study (Table 6) were, in general, moderate and indicate that the value of h^2 increased with advance of age of the litter. These results are in agreement with Lahiri and Mahajan (1982) in New Zealand White rabbits (0.11, 0.13, 0.12 and 0.14 for LSB, LSW, LWB and LWW, respectively) and Khalil *et al.*, (1987) in Bouscat rabbits (0.05, 0.24, 0.12, 0.49) for LSB, LSW, LWB, LWW; respectively); while in disagreement with estimates (0.48, 0.32 for LSB, LSW; respectively) obtain by Kadry and Afifi (1984), (0.10 for GL) obtain by Farghaly (1996) and (0.37, 0.14, 0.13, 0.21, 0.22, 0.23, 0.31, 0.06, 0.01, 0.01, 0.01 for LSB, LS21, LSW, ND21, NDW, GL, LWB, LW21, LWW, LWG21, LWGW; respectively) obtain by Ahmed (1997), all working with different breed groups. Values of h^2

Table 5. F. values of the least-squares analyses of variance for litter weight and litter weight gain traits up to different ages till weaning in Bouscat rabbits.

Source of variation	LWB		LW21		LWW		LWG21		LWGW	
	d.f	F	d.f	F	d.f	F	d.f	F	d.f	F
Dam	138	1.402^{**}	132	1.254^{*}	131	1.358^{*}	132	1.220^{ns}	131	1.353^{*}
Year of Kindling (yk)	1	0.024^{ns}	1	14.216^{***}	1	2.038^{ns}	1	16.019^{***}	1	1.976^{ns}
Season(Sea)	3	4.692^{**}	3	0.852^{ns}	3	3.168^{*}	3	0.758^{ns}	3	3.381^{*}
Parity (P)	8	1.183^{ns}	8	1.876^{ns}	8	1.231^{ns}	8	1.828^{ns}	8	1.239^{ns}
Sea x yk	3	0.570^{ns}	3	1.524^{ns}	3	0.366^{ns}	3	1.280^{ns}	3	0.188^{ns}
P x Yk	8	3.781^{***}	8	2.449^{*}	8	2.098^{*}	8	2.112^{*}	8	1.810^{ns}
Remainder d.f.	869		545		510		545		510	
Remainder M.S.	13228.820		267356.586		870538.068		214686.766		771691.287	

*=P<0.05, ** = P<0.01, *** = P<0.001 and ^{ns} = non-significant.
LWB = litter weight at birth, LW21 = litter weight at 21 days, LWW = litter weight at weaning, LWG21 = litter weight gain up to 21 days, LWGW = litter weight gain up to weaning.

Table 6. Dam variance components (σ_d^2), their percentage (V%), dam heritabilities ($h_d^2 \pm$ S.E.)for Litter size and weight, litter weight gain traits, number dead up to different ages and gestation length in Bouscat.

Traits	Dam df	σ_d^2	V%	$h_d^2 \pm$ S.E
LSB	138	0.293	5.38	0.22±0.09
LS21	132	0.258	7.07	0.28±0.13
LSW	131	0.247	7.32	0.29±0.14
ND21	132	0.620	7.82	0.31±0.14
NDW	137	0.468	6.19	0.25±0.12
GL	138	0.051	4.65	0.19±0.08
LWB	138	737.284	5.28	0.21±0.09
LW21	132	13365.932	4.76	0.19±0.12
LWW	131	64359.438	6.88	0.28±0.13
LWG21	132	9302.263	4.15	0.17±0.12
LWGW	131	56203.515	6.79	0.27±0.13

LSB = litter size at birth, LS21 = litter size at 21 days, LSW = litter size at weaning, ND21 = number dead up to 21 days, NDW = number dead up to weaning, GL = gestation length, LWB = litter weight at birth, LW21 = litter weight at 21 days, LWW = litter weight at weaning, LWG21 = litter weight gain up to 21 days, LWGW = litter weight gain up to weaning.

in the present study was lower at birth than at weaning, this may be due to the low number of observations at weaning relatively compared to that at birth. Also, the higher values of h^2 in this study (in most cases) than other studies may be attributed to that estimates in the study calculated for dam of the doe which included all of the maternal variance. The moderate estimates of h^2 for weaning traits in the present study, give evidence that selection in these traits especially LWW and LWGW which are the end results of all other previous traits, will improve doe traits. khalil *et al.*,(1987) reported that higher estimates of heritability for litter size and weight at weaning rather than at birth suggest that selection for litter size and weight at weaning will give greater improvement in these traits than selection at birth. The differences between estimates for the same traits were probably due to methods of analysis and estimations, genetics make up of the breed in the population, number of

Table 7. Estimates of phenotypic correlations (r_P) above diagonal and genetic correlations (r_G) below diagonal in Bouscat rabbits

	LSB	LS21	LSW	LWB	LW21	LWW	LWG21	LWGW	GL
LSB		0.645***	0.534***	0.887***	0.466***	0.435***	0.333***	0.367***	-0.250***
LS21	0.507***		0.934***	0.633***	0.780***	0.721***	0.698***	0.678***	-0.216***
LSW	0.414***	0.950***		0.547***	0.737***	0.788***	0.669***	0.758***	-0.151***
LWB	0.782***	0.524***	0.469***		0.491***	0.468***	0.335***	0.389***	-0.246***
LW21	0.901***	0.792***	0.583***	0.544***		0.712***	0.981***	0.688***	-0.154***
LWW	0.336***	0.699***	0.774***	0.379***	0.713***		0.663***	0.995***	-0.102***
LWG21	0.745***	0.720***	0.540***	0.321***	0.970***	0.729***		0.657***	-0.110***
LWGW	0.235***	0.653***	0.749***	0.279***	0.653***	0.995***	0.682***		-0.078*
GL	-0.259***	-0.132***	-0.072***	-0.327***	-0.534***	-0.235***	-0.540***	-0.208***	

* P<0.05, *** = P<0.001;

LSB = litter size at birth, LS21 = litter size at 21 days, LSW = litter size at weaning, ND21 = number dead up to 21 days, NDW = number dead up to weaning, GL = gestation length, LWB = litter weight at birth, LW21 = litter weight at 21 days, LWW = litter weight at weaning, LWG21 = litter weight gain up to 21 days, LWGW = litter weight gain up to weaning.

observations and for non genetic factors included in the model of analysis (Khalil *et al.*, 1986).

Genetic and phenotypic correlation (r_g & r_p):

Estimates in Table 7 indicate that both genetic and phenotypic correlations between litter traits were mostly high and few of them were moderate. Positive and Significant correlation (P<0.05 and P<0.01) among different traits, except those between GL and all other traits which were found to be negative. These results are in agreement with phenotypic correlation shown by El-Khishin et at (1951) between LSB and LWB and by Afifi *et al.*, (1976a) between LSB, LWB and LWW. However, Afifi *et al.*,(1992) and Farghaly and El-Darawany (1994), with different breed groups, reported positive genetic and phenotypic correlation among litter size and weight at birth, 21 days and at weaning. Negative correlation between litter traits and GL in this study may be due to that the increase in litter size permits earlier kindling and decreases gestation length. Estimates of genetic correlation in the present study together with the corresponding phenotypic ones may indicate that selection for litter traits at birth may lead to improve traits at weaning. The same previous conclusion was reported also by Afifi *et al.*,(1992) and Farghaly and El-Darawany (1994).

References

1. ABD EL-AZIZ, M.M.; AFIFI, E.A.; NAYERA Z. BEDIER; ASAMEL, A.A. and KHALIL, M.H. (2002). Genetic evaluation of milk production and litter weight traits in Gabali, New Zealand White rabbits and their crosses on newly reclaimed area of Egypt. 3rd con. On rabbit production in hot climates 8-11 Oct. :103-116.
2. ABDEL- RAOUF, H.M. (1993). Genetic studies for some economic traits in rabbits. M. Sc. Thesis, Faculty of Agric., Moshtohor, Zagazig Univ., Benha Branch, Egypt.
3. AFIFI , E.A., GALAL, E.S.E. and KADRY A.E. (1982). The effect of breed and some environmental factors on litter traits in rabbit. 7th international congress for statistics, computer science, social Demographic research, Ain shams Univ., Cairo, Egypt.
4. AFIFI, E.A.; FARID, A.; MAHDY, M.R.E. and TOSON, M.A. (2001) Doe traits as affected by respiration rate, internal body temperature, rabbitry air temperature and some other non genetic factors in two breeds of rabbit. Egyptian Journal of Rabbit Science, 11 (1) 57-71.
5. AFIFI, E.A.; GALAL, E.S.E.; EL-TAWIL, E.A. and EL-KHISHIN, S.S (1976a). Litter size at birth and at weaning in three breeds of rabbits and their crosses. Egyptian J. Anim. Prod. 16 (2): 109-119.
6. AFIFI, E.A.; GALAL, E.S.E.; EL-TAWIL, E.A. and EL-KHISHIN, S.S. (1976b). Litter weight in three breeds of rabbits and their crosses Egyptian J. Anim. Prod, 16 (2) : 99-108.
7. AFIFI, E.A.; YAMANI, K.M.; MARAI, I.F.M. and EL-MAGHAWRY, A.M. (1992). Environmental and genetic aspects of litter traits in New Zealand White and California rabbits under the Egyptian conditions. J. Appl. Rab. Res. 15, 335-351, USA.
8. AHMED, E.G. (1997). Productive performance of different exotic strains of rabbits. Ph.D. Thesis, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.
9. DAMODAR, N. and JATKAR, V.D. (1985). Adaptability of Broiler rabbits under subtropical climatic. Indian Journal of Animal Science, 55: 610-611.
10. EL-GAAFARY, M.N., RASHWAN, A.A., EL-KERDAWY, D.M.A. and YAMANI, K.A. (1992). Effects of feeding pelleted diet supplemented with probiotic (Lacto-Sacc) on digestibility, growth performance, blood constituents, semen characteristics and reproductive traits of rabbits. Egyptian Journal of Rabbit Science, 2 (2): 95-105.
11. EL-KHISHIN, A.F.; BADRELDIN, A.L.; OLOUFA, M.M. and KHERELDIN, M.A. (1951). Growth development and litter size in two breeds of rabbits. Bulletin Number2, Faculty of Agric., Cairo Univ. Egypt.
12. FARGHALY, H.M. (1996). Performance of imported and locally born commercial rabbits

population in Egypt. Indian J. of Anim. Sc., 66 (6): 634-640.

13. FARGHALY, H.M. and EL-DARAWANY, A.A. (1994). Genetic and non-genetic factors affecting reproductive performance in exotic rabbit breeds under Egyptian condition. The first International conf. on Rabbits Prod, in Hot climates, Cairo, Egypt, 6-8 Sept 253-256.

14. FARID, A.; AFIFI, E.A.; KHALIL, M.H. and GAD, H.A, (2000). Estimation of doe breeding values for litter traits of three standard breeds of rabbits raised under commercial intensive system of production in Egypt. Egyptian Journal of Rabbit Science, 10 (2): 307-325.

15. HARVEY, W.R. (1990). Userís Guide for LSMLMW. Mixed model least squares and maximum likelihood computer program PC. Version 2, Ohio state University, Columbus, USA, (Mimeograph).

16. HILMY, A.F. (1991). Some productive aspects in rabbits. M. Sc. Thesis , Faculty Agric. Moshtohor Zagazig Univ. Benha Branch Egypt.

17. KADRY, A.E.H. and AFIFI, E.A. (1984). Heritability estimates of litter traits in Bouscat rabbits. Al. Azhar J. of Agric. Res., 1:24-30,Egypt.

18. KHALIL, M.H. and AFIFI, E.A. (1986). Doe litter performance of Bouscat and Giza White rabbits. Second Egyptian-British conference, Banngor, U.K., August, 1986.

19. KHALIL, M.H., OWEN, J. B. and AFIFI, E.A. (1986). A Review of Phenotypic and Genetic parameters associated with meat production traits in rabbits, Animal breeding Abstracts, 1986, Vo.54, Number 1,725-449.

20. KHALIL, M.H., OWEN, J.B. and AFIFI, E.A. (1987). A genetic analysis of litter traits in Bouscat and Giza White rabbits. Anim. Prod. , 45,123-134.

21. LAHIRI, S.S. and MAHAJAN, J.M. (1982). Note on the inheritance of age at first breeding litter size and weight in rabbits. Indian J. Anim. Sc. 52 (11), 1148-1150.

22. MARAI, I.F.M.; YAMANI, K.A.; EL-GAAFARY, M.N. and EL-KELAWY. H.M.E. (1994). Effect of human chorionic gonadotrophin on reproductive and productive performance in female New Zealand White rabbits. Proceeding of the 1st International Conference on Rabbit Production in. Hot climatic, 6-8 September, Cairo, Egypt. 335-365.

23. NASR, A.S. (1994). Milk yield and some associated traits as affected by season of kindling intervals in New Zealand White doe rabbits under Egyptian conditions. Egyptian J. of Rabbit Sc., 4 (2) 149-159.

24. NAYERA Z. BEDIR; AFIFI. E.A. and GAD, S.M. (1999). Genetic study of litter and doe reproductive traits in Gabali, Californian rabbits and their crosses under semi-arid Conditions of Egypt. Minufiya J. Agric. Res., 24 (5), 1651-1666.

25. OPOKU, E.M. and LUKEFAHR, S.D. (1990). Rabbit production and development in Ghana: the National Rabbit Project experience. Journal Applied Rabbit Research, 13: 189-192.

26. SEDKI, A.E. (1991). Some behavior studies on rabbits. M. Sc. Thesis. Faculty Agric., Zagazig Univ., Egypt.

27. TAWFEEK, M.T. (1995). Performance of doe rabbit and their young as affected by re-mating interval, litter size at birth and month of kindling in New Zealand White and Bouscat pure breed under Egyptian conditions. Egyptian J. of Rabbit Sc., 5 (2), 101-115.

28. YAMANI, K.A. (1994). Rabbit meat production situation in Egypt. Proceeding of the 1st International Conference on Rabbit Production in Hot climatic, 6-8 September. Cairo. Egypt, 57-64.

29. YAMANI, K.A.; EL-MAGHAWRY, A.M.; TAWFEEK, M.I.; SOLIMAN, A.M. and FARGHALY, H.M. (1994). Evaluation of the performance of three meat rabbit breeds recently introduced to Egypt. 1 litter weight and related traits. Option Mediterraneennes (1994), 8,285-296. Spain.

30. YOUSSEF, M.K. (1992). The production performance of purebred and crossbred rabbits. M. Sc., Thesis, Faculty of Agriculture, Moshtohor, Zagazig university, Benha Branch, Egypt.

قياسات وراثية لبعض الصفات الكمية في أرانب البوسكات

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أجريت هذه الدراسة على أرانب البوسكات على عدد ١٣٩ أم لعدد ٢٣٦ أنثى أنتجت ١١٠٠ خلفة وكانت الصفات المدروسة: عدد ولدة البطن ووزنها عند الميلاد وعند ٢١ يوم وعند الفطام (عمر ٣٠ يوم) وأيضا الزيادة في الوزن حتي عمر ٢١ يوم و حتى عمر الفطام وأيضا طول فترة الحمل وعدد النافق في ولده البطن حتى عمر ٢١ يوم وعمر الفطام. كما تم دراسة تأثير كل من الأم وسنة الولادة وموسم الولادة وترتيب الولادة على جميع الصفات السابقة كما تم تقدير العمق الوراثى ومعاملات الارتباط الوراثى والمظهري لتلك الصفات.

يمكن تلخيص نتائج هذه الدراسة فيما يلي:

١- كان تأثير الأم (أم الأنثى) معنويا على جميع الصفات المدروسة فيما عدا صفة الزيادة في وزن ولدة البطن حتى عمر ٢١ يوم.

٢- كان تأثير سنة وموسم الولادة وترتيبها غير معنوي في معظم الصفات.

٣- كانت هناك زيادة بتقدم سنة الإنتاج في جميع الصفات فيما عدا صفة طول فترة الحمل.

٤- كانت هناك اتجاهات مختلفة تبعا لتأثير موسم الولادة في جميع الصفات المدروسة. بينما لم يكن لتأثير ترتيب الولادة اتجاها ثابتا.

٥- وجد أن مكونات التباين الأمي منخفضة على وجه العموم.

٦- وجد أن العمق الوراثى المقدر عن طريق الام متوسط على وجه العموم وتزداد قيمته بتقدم عمر الخلفة.

٧- وجد أن الارتباطات الوراثية والمظهرية موجبة ومعنوية وذات قيم متوسطة أو عالية في معظم الارتباطات فيما عدا الارتباطات الوراثية والمظهرية بين طول فترة الحمل وباقي الصفات حيث كانت سالبة الارتباط.