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EVALUATION OF SOME GENETIC PARAMETERS AND PERMANENT ENVIRONMRNTAL EFFECTS FOR SOME MATERNAL TRAITS IN TWO BREEDS OF RABBITS

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This study was carried out at the experimental rabbit farm, over two consecutive years of production starting in September 2005. Records of 430 litters [231 and 199 litters from Californian (CAL) and Baladi Red (BR); respectively] were used to estimate heritabilities (h^2_a), proportion of permanent environmental variance (Pe^2), and repeatabilities (t), for each breed separately, on some litter traits [litter size at birth and at weaning (LSB & LSW), number born alive (NBA), litter weight at birth at weaning (LWB & LWW), pre-weaning litter weight gain (LWG) and daily litter weight gain (DLWG)] and reproductive traits [number of services per conception (NSC), gestation period (GP), kindling interval (KI), days open (DO) and insemination period (IP)]. The results are showed the best performance for CAL rabbits compared to BR in all litter traits. Estimates of CV% for NSC, KI, DO and IP were relatively high. Estimates of h^2_a, Pe^2 and t were between low and moderate and tend to increase at weaning than at birth in both breeds. In BR rabbits, estimates of h^2_a were higher than those of CAL ones for most traits studied.

Key words: Litter size, litter weight, heritability, permanent environmental, repeatability.

Rabbits could contribute significantly to the problem of meat shortage. This is due to that rabbits have a number of characteristics that would make them suitable as meat-producing animals especially when compared with other herbivorous animals. (Taylor, 1980 and Lebas, 1983).

Particularly, rabbit's meat has a low cholesterol content, high protein/energy ratio and is relatively rich in essential fatty acids.

Khalil *et al.* (1986) and Rochambeau *et al.* (1998) verified that heritabitability and/or repeatability estimates for pre-weaning maternal traits have shown broad ranges among different reports. Reasons may include real genetic differences among populations, random variation, environmental dissimilarities and methods of estimation...etc. However, litter size and litter weight traits are greatly affected by the additive genetic effect as well as by maternal effects (Youssef *et al.*, 2003). Maternal effects (genetic and environmental) for pre-weaning traits in rabbits may account for as much as 14% of the total phenotypic variance (Krogmeier *et al.,* 1994). Furthermore, Lukefakr and Hamilton (1997) reported that variance of non additive genetic and permanent environment were important for litter weaning weight. They added also, that the weaning litter weight trait is an economically important composed trait of the doe.

The main objective of this study was carried out to evaluate some genetic parameters (heritability, repeatability) and permanent environmental effects on some pre-weaning maternal traits in Californian and Baladi Red rabbits.

MATERIALS AND METHODS

The experimental work of this study was carried out in the experimental rabbit flock maintained by the Department of Animal Production, Faculty of Agriculture, Al-Azhar University in Nasr City, Cairo, Egypt over two consecutive years of production from 2005 to 2007, to evaluate one local Egyptian breed (Baladi Red, BR) and one exotic breed (Californian, CAL) raised under Egyptian conditions for a long time. According to the breeding plan, bucks were assigned at random to bred the does with a restriction to avoid full-sib, half-sib and parent offspring mating. Each buck was allowed to sire all litters given by 3-4 does throughout the two years of the study. Culled or dead does and bucks during the experimental period were replaced by their substitutes from the same breed from the original stock. Numbers of bucks, does, litters born used in the analyses are presented in Table 1.

Rabbits were raised in a semi-closed rabbitry. Breeding does and bucks were housed separately in individual wire-cages with standard dimensions arranged in double- tier batteries of type. According to the

Table 1. Numbers of bucks, does, litters born used in the analyses.

Breeds	No. bucks	No. of does	No. of litters
Californian	27	49	231
Baladi Red	20	41	199
Total	**47**	**90**	**430**

breeding plan, each doe was transferred to the cage of the assigned buck to be mated and returned back to her own cage after being mated. Each doe was palpated 10 days thereafter to determine pregnancy. Does that failed to conceive were returned to the same mating buck to be re-mated until a service was observed. Weaning occurred at 28 days after birth, and young rabbits were sexed and tagded and transferred to other batteries to be housed in groups of 3 to 4 individuals in standard progeny wire cages equipped by feeding hoppers and drinking nipples. The rabbits were fed *ad-libitum* on commercial pelleted ration, which could provide 16.3% crude protein, 13.2% crude fibers and 2.5% fat. Rabbits were kept under the same managerial, hygienic and environmental conditions.

Data and models of analysis:

Data were collected on litter traits included litter size and weight at birth and at weaning at four weeks of age, number born alive, pre-weaning litter weight gain and daily litter weight gain (LSB, LWB, LSW, NBA, LWG and DLWG; respectively) and reproductive traits (number of service per conception, gestation period, kindling interval, days open and insemination period (NSC, GP, KI, DO and IP; respectively).

Data of each breed were analyzed separately using single-trait animal model (STAM). Multi trait derivatives restricted maximum likelihood (MTDFREML) program of Boldman *et al.*, (1995) was used. Variances obtained by Restricted maximum likelihood (REML) method of variance component (VARCOMP) procedure (SAS, 1996) were used as guessed values for the estimation of variance components. Analysis was done according to the following animal model:

$$y = Xb + Z_a u_a + Z_{pe} u_{pe} + e,$$

Where: y = Vector of observations, b = Vector of fixed effects including year, season and parity for the i^{th} trait; u_a = Vector of random animal effects for the i^{th} trait, u_{pe} = Vector of random permanent environmental effects for the ith trait, e = Vector of random residual effects for ith trait; X, Z_a and Z_{pe} are incidence matrices relating records to fixed, animal and permanent environmental effects, respectively.

The STAM was used to estimate direct additive genetic variance (σ^2_a), heritability (h^2_a), variance of permanent environmental-effects amd its proportion (σ^2_{pe} & Pe^2), variance of error (σ^2_e) and repeatability (t), where: $\mathbf{h^2_a} = \sigma^2_a / (\sigma^2_a + \sigma^2_{pe} + \sigma^2_e)$, $\mathbf{Pe^2} = \sigma^2_{pe} / (\sigma^2_a + \sigma^2_{pe} + \sigma^2_e)$ and $\mathbf{t} = (\sigma^2_a + \sigma^2_{pe}) / (\sigma^2_a + \sigma^2_{pe} + \sigma^2_e)$.

RESULTS AND DISCUSSION

Means, standard deviations and coefficient variations (CV%) for litter and reproductive traits of the two breeds of rabbits are presented in Table 2. These means of litter traits are within the ranges reported in other studies (Ahmed, 1997; Hiam, 2003; Farid, 2004 and Gharib, 2004). These results revealed that litter traits in Californian (CAL) rabbits were better in magnitude than in Baladi Red (BR) and this reflects superiority in their prenatal and postnatal maternal abilities and also higher milk production in CAL rabbits. For doe reproductive traits, the means revealed a long period of NSC, KI and IP in CAL rabbits than in BR rabbits (Table 2). These long reproductive intervals are one of the limiting factors for the effective use of these species on large scale of commercial production (Ahmed, 1997; Afifi *et al.*, 2000 and Haiam, 2003).

Wide range of coefficient of variation (CV%) in all litter traits of both breeds was shown (Table 2). Estimates of CV% for litter traits increased, in general, at weaning than at birth, which indicate their lower phenotypic variation at birth than at weaning. Similar results were observed by Ahmed (1997); Haiam (2003); Youssef *et al.* (2003) and Farid (2004). The higher estimates of CV% for litter traits at weaning than at birth may be attributed to doe differences in litter losses during the suckling period (Afifi *et al.,* 1992). In case of litter weight, it may be attributed to the increase in post-natal differences between litter members in growth caused by differences in milk production of does during the suckling period (Afifi *et al.*, 1992 and Khalil, 1994). Also, it may be because that litters between kindling and weaning become more sensitive to the non-genetic maternal effects (e.g. parity, age of doe, litter size at birth..... etc), which decrease thereafter with advance of litter's age (Khalil, 1994 and others).

Table 2. Actual means, standard deviations (SD) and coefficients of variation (CV%) for doe litter and reproductive traits in Californain and Baladi Red rabbits.

Traits	Californain				Baladi Red			
	NO	Mean	SD	CV%	NO	Mean	SD	CV%
Litter traits								
LSB	231	7.2	1.5	21.1	199	6.6	1.9	28.8
NBA	231	6.4	1.4	21.6	199	5.9	1.8	30.6
LSW	220	5.2	1.5	28.7	183	4.3	1.6	37.3
LWB	231	341	81.7	24.0	199	321	106.1	33.0
LWW	220	1958	561.7	28.7	183	1735	717.6	41.4
LWG	220	1615	534.2	33.1	183	1401	673.3	48.1
DLWG	220	58	19.2	33.3	183	50	24.0	48.0
Reproductive traits								
NSC	231	2.0	0.8	37.9	199	1.7	0.7	38.3
GP (Days)	231	31.1	0.8	2.5	١٩٩	31.2	0.9	2.8
KI (Days)	231	47.9	11.5	24.1	١٩٩	47.3	12.0	25.4
DO	231	16.9	11.3	67.1	١٩٩	16.2	12.0	73.9
IP	231	13.3	8.6	64.6	١٩٩	11.6	8.6	74.2

LSB=litter size at birth, **NBA** =number born alive, **LSW** =litter size at weaning, litter weight at birth (**LWB**), litter weight at weaning (**LWW**), litter weight gain (**LWG**) and daily litter weight gain (**DLWG**)] and reproductive traits [number of services per conception (**NSC**), gestation period (**GP**), kindling interval (**KI**), days open (**DO**) and insemination period (**IP**),

High variation in all reproductive interval traits except gestation period (GP) were observed in Table 2. Similar high estimates of CV% were observed by many investigators (e.g. Afifi *et al.,* 1992; Abdel-Raouf, 1993 and Ahmed, 1997). These estimates of CV% showed that improving these traits through phenotypic selection is quite possible. Khalil (1993) and Afifi *et al.* (2000) showed that the high variation in reproductive traits is due to variation in management procedures, in terms of post-partum mating schedule (e.g. variation in time of mating after kindling, palpation time, fertility of doe and buck, feeding, etc.), and may contribute to the magnitude of the CV% estimates. These lower estimates of CV% for GP in both breeds of rabbits might indicate that GP is considered a species characteristic (Hilmy, 1991).

Heritability (h^2_a):

Heritability estimates were low for litter traits and reproductive traits in both breeds (Table 3). These estimates were within the ranges of (El-Raffa, 2000; Sorensen *et al.,* 2001; Youssef *et al.*, 2003; Farid, 2004; Iraqi *et al.*, 2006 and Gad, 2007) for litter traits, and were lower than reviewed estimates

Table 3. Variance components of direct additive genetic (σ^2_a), heritability (h^2_a), variance of permanent environmental effect (σ^2_{Pe}), proportion of permanent environmental (P^2e), variance of error (σ^2_e) and repeatability (t) for litter and reproductive traits in Californian and Baladi Red rabbits.

	Californian						Baladi Red					
Items	σ^2_a	h^2_a	σ^2_{Pe}	Pe^2	σ^2_e	t	$\sigma^2 a$	h^2_a	σ^2_{Pe}	Pe^2	σ^2_e	t
litter traits												
LSB	0.10	0.04	0.06	0.02	2.40	0.06	0.33	0.06	0.29	0.05	4.95	0.11
NBA	0.06	0.03	0.05	0.02	2.07	0.05	0.37	0.10	0.32	0.09	3.06	0.19
LSW	0.14	0.06	0.07	0.03	2.19	0.09	0.49	0.12	0.34	0.08	3.19	0.20
LWB	467	0.06	1021	0.13	6322	0.19	1640	0.12	1551	0.11	10477	0.23
LWW	60025	0.14	85750	0.20	282976	0.34	139286	0.18	201191	0.26	433334	0.44
LWG	37104	0.10	22262	0.06	311763	0.16	46843	0.10	32790	0.07	388793	0.17
DLWG	8.5	0.02	12.92	0.04	320.74	0.06	69.10	0.11	67.99	0.10	520.37	0.21
Reproductive traits												
NSC	0.03	0.04	0.01	0.01	0.63	0.05	0.01	0.02	0.003	0.01	0.5	0.03
GP	0.01	0.02	0.02	0.03	0.61	0.05	0.03	0.04	0.06	0.07	0.75	0.11
KI	2.55	0.02	12.38	0.09	129.71	0.11	3.26	0.02	9.25	0.06	144.01	0.08
DO	1.52	0.02	4.32	0.05	84.63	0.07	4.51	0.03	0.26	0.002	146.53	0.032
IP	1.01	0.01	5.08	0.06	73.02	0.07	6.52	0.08	0.55	0.01	79.42	0.09

LSB= Litter size at birth, NBA= Number born alive, LSW= Litter size at weaning, LWB=Litter weight at birth, LWW= Litter weight at weaning, LWG= Pre-weaning litter weight gain, DLWG= Daily litter weight gain, NSC =Number of services per conception, GP = Gestation period, KI= Kindling interval, DO= Days open and IP= Insemination period.

for reproductive traits (Farghaly, 1996; Ahmed, 1997 and Gharib, 2004) with different breeds of rabbits.

Heritability estimates in BR rabbits, in most traits studied, were higher than in CAL rabbits. In this respect, Khalil *et al.* (1987) attributed this trend to the low variation occured through previous intensive selection done in exotic breed (CAL in the present study), while don't exposed to the same subjected of selection in local breed (BR in the present study). However, Iraqi *et al.* (2006) reported that the small estimates of heritability for some litter traits may be due to the large maternal effects and/or variation due to permanent environmental effect, i.e. increasing non-additive genetic effects. Also, sampling effects and non-randomness in the distribution of does within sire groups could be added as another cause in this respect (Garcia *et al.,* 1982 a & b). Khalil *et al.* (1986) and El-Zanfaly (1996) indicated that the difference between the magnitute of h^2 in different studies, even in the same breed and traits may attributed to differences in methods of analysis and estimation, number of observations, non-genetic factors included in the model of analysis and genetic make-up of the breed groups used. Farghaly (1996) showed that bunnies of the litters during the suckling period are most sensitive to environmental and managerial conditions, so improvement in those conditions are important to improve litter traits. Farid (2004) suggested low heritability of litter traits (especially litter size) will give low improvement in these traits if selection is directly done on these traits, and this may lead to improve doe traits by selection for weaning traits, especially for LWW (composed traits and it is the end results of all other previous traits).

Permanent environmental Variance (σ^2_{Pe}) and its proportion (P^2e):

The proportion of permanent environmental variance (Pe^2) for litter traits and reproductive traits (Table 3) were between low and moderate in both breeds. These results agreed with Lukefahr and Hamilton (1997); Sorensen *et al.* (2001); Iraqi *et al.* (2006) and Gad (2007). In general, the small amount of σ^2_{pe} may be partially attributed to large temporary environmental variation (including climatic, sanitary, managerial condition ...etc.), which could not be considered in the mathematical model of analysis (Moura *et al.,* 1991). The proportions of σ^2_{pe} for litter traits were generally lower at birth than at weaning age. This may be due to variation in milk production since the pattern of change in pre-weaning litter traits has also the same curvilinear pattern in milk production tilll reaching its peak (Khalil, 1996 and Iraqi *et al.,* 2006). In the present study proportion of permanent environmental was higher for LWW (composed trait) compared to additive genetic variance, so, it considered as the best trait for selection to acheive more gain of improvement. The same trend was noticed for most reproductive traits, especially for KI. This indicates that the permanent environmental effect is more important than the direct additive genetic effect (Table 3). This conclusion was in agreement with findings of Ferraz and Eler (1996).

Repeatability (t):

Repeatability estimates for litter and reproductive traits in CAl and BR rabbits were between low and moderate (Table 3). Estimates of repeatability were within the ranges of reviewed estimates for litter traits (El-Raffa, 2000; Sorensen *et al.,* 2001; Youssef *et al.*, 2003; Farid, 2004; Iraqi *et al.,* 2006 and Gad, 2007), and for reproductive traits were within the ranges obtained by Abd El-Raouf (1993), Khalil (1993) and Ahmed (1997) with different breeds of rabbits.

Repeatability estimates in BR rabbits were some to extent higher than in CAL rabbits for all traits studied. Repeatability estimates for litter weight at various ages were relatively higher than that for litter size at the corresponding ages (Table 3). Afifi *et al.* (1992) reported the same trend at the corresponding various age

However, Szendro *et al.* (1998) reported that higher estimates of repeatability could be obtained by increasing the number of parturitions. Also, Ferraz *et al.* (1991) and Khalil and Afifi (1991) reported that the low repeatability estimates of the doe reproductive traits indicate that values of the first record (single record) are not good indicators for future performance and early records should not be used as criteria for culling or selecting does.

Conclusively, from these results, it can improve litter traits by selection on litter weight at weaning especially on native breeds rabbits, while improving in the reproductive traits can be aceived by improving in the invironmental conditions.

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تقييم بعض المقاييس الوراثيه والتأثير البيئي الدائم لصفات الأم في سلالتين من الأرانب

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أجريت هذه الدراسة في مزرعة الأرانب البحثية بكلية الزراعة- جامعة الأزهر بمدينة نصر- مصر علي مدار سنتين إنتاجيتين متتاليتين بدأت في سيتمبر ٢٠٠٥م. استخدم في هذه الدراسة نوعين من الأرانب الكاليفورنيا (سلالة أجنبية) و البلدي الاحمر (سلالة محلية). اجريت التجربة علي عدد ٤٣٠ بطن (٢٣١ بطن من أرانب الكاليفورنيا و ١٩٩ بطن من أرانب البلدي الاحمر).

تم تحليل البيانات لكل سلالة على حدي باستخدام نموذج الحيوان وحيد الصفة لتقدير متوسط هذه الصفات وقيم المكافئ الوراثى والمعامل التكرارى و التاثير البيئى الدائم لصفات خلفة البطن عند الميلاد و الفطام (عدد ووزن الخلفه – عدد المولود حي – الزيادة في وزن الخلفة من الميلاد حتي الفطام – الزيادة اليومية في وزن الخلفة من الميلاد حتي الفطام) وكذالك صفات الام التناسلية (عدد التلقيحات اللازمة للإخصاب Number of service per conception – طول فترة الحمل Gestation period – الفترة بين ولادتين Kindling interval – الفترة المفتوحة Days open – فترة التلقيح Insemination period). وقد اوضحت الدراسه النتائج الأتية:-

- أظهرت سلالة الكاليفورنيا أداء افضل من سلالة البلدي الاحمر في كل صفات خلفة البطن.
- كانت تقديرات متوسطات عدد التلقيحات اللازمة للإخصاب و الفترة بين ولادتين و فترة التلقيح اطول في سلالة الكاليفورنيا عن سلالة البلدى الاحمر.
- كان تقدير نسبة التباين المضيف إلي التباين الكلي منخفضا نوعا ما أو متوسط القيم في كلا النوعين, وكانت النسبة في سلالة البلدى الاحمر أعلى منها في سلالة الكاليفورنيا في معظم الصفات المدروسة.
- تراوحت تقديرات نسبة التباين البيىء الدائم في سلالة البلدي الاحمر و سلالة الكاليفورنيا ما بين المتوسطة والمنخفضة.
- تراوحت قيم المكافئ الوراثي ما بين القيم المنخفضة والمتوسطة ولوحظ ازدياد تقديرات قيم المكافئ الوراثي عند الفطام عن الميلاد.
- تراوحت قيم المعامل التكراري في كلا النوعين بين المنخفضة والمتوسطة لمعظم الصفات.