

**GENETIC EVALUATION FOR SOME LITTER AND
LACTATION TRAITS IN NEW ZEALAND WHITE AND
BALADI BLACK RABBITS**

By

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Received: **20/10/2008**

Accepted: **10/11/2008**

ABSTRACT: *In an experiment involving 234 records produced from 42 does of New Zealand White rabbits and 47 does from the local Baladi Black rabbits were used to estimate heritability and permanent environmental effects for litter size and weight at birth (LSB and LWB), 21 day (LS21 and LW21) and weaning at 28 day (LSW and LWW) and litter gain in weight during the periods of 1-21 day (LG21) and 1-28 day (PLG), milk conversion ratio (litter gain / milk intake) during the period of 1-21 day (MCR) and milk yield (g) during the periods of 1-21 day (MY21) and 1-28 day (TMY). A repeatability single trait animal model was used to analyze the data.*

Estimates of heritability for litter traits and milk traits tended to be low to moderate in both breeds in general, but the estimates were slightly higher in Baladi Black rabbits than those in New Zealand White rabbits. Heritability estimates for litter traits ranged from 0.02 to 0.20 for New Zealand White and 0.01 to 0.23 in Baladi Black rabbits, while the estimates for milk traits ranged from 0.01 to 0.09 and 0.08 to 0.12, respectively. Estimates of permanent environmental effect for litter traits were mostly moderate and ranged from 0.01 to 0.27 for New Zealand White and from 0.03 to 0.20 for Baladi Black rabbits, while the estimates for milk traits ranged from 0.14 to 0.21 and ranged from 0.10 to 0.18, for New Zealand White and Baladi Black rabbits respectively.

INTRODUCTION

The principal components in litter growth and survival rate during the suckling period are greatly dependent on the amount of milk produced by the doe from kindling up to 21 days, where milk of the doe is the sole source of nutrient supply for young rabbits. In this respect, Lukefahr *et al.*, (1983) detected a strong positive association between milk production of the doe and both litter size and weight traits at 21 days of age. Consequently, recognizing does' milk efficiency is indispensable in most breeding programs specially those associated with prolific breeds and/or accelerated and intensive kindling systems (Abdel-Ghany, 2005). Producers and researchers have used 21-litter weight as a phenotypic reflection of the doe's milking ability and also as a selection criterion for improving this character (Lukefahr *et al.*, 1996; Khalil and Al-Saef, 2008).

New Zealand White rabbits are well known in Egypt as a meat-purpose breed that intensively spread all over the country, while Baladi Black rabbits as a local meat-type breed are endangered of extinction since the total number of these rabbits are very limited now (Khalil, 1999; Youssef, 2004; Galal, 2007). Unfortunately and regarding to the situation of danger of extinction in particular, genetic studies concerning litter and lactation traits in Baladi Black rabbits are very scarce. For these reasons, this study was conducted to estimate heritability and permanent environmental effects for litter and lactation traits in New Zealand White and Baladi Black rabbits using repeatability single trait animal model. This work was done to analyze our local Baladi Black breed of rabbits to compare its genetic capacity and performance with that adapted exotic and traditionally exploited New Zealand White.

MATERIALS AND METHODS

Animals and management

This experiment was carried out in Sakha Experimental Rabbitry, which belongs to Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture during the period from September 2003 to August 2004. Locally born 42 does from New Zealand White rabbits and 47 does from the local Baladi Black rabbits were used in this experiment. Distribution of sires, dams, does, and litters in the two breeds are presented in Table 1.

Table 1. Structure of the data analyzed for New Zealand White and Baladi Black rabbits

Item	New Zealand White	Baladi Black
Number of sires	6	8
Number of dams	11	15
Number of does	42	47
Number of litters	120	114
Total number of bunnies born	840	738
Total number of bunnies weaned	562	429

Rabbits of this study were raised in a semi-closed rabbitry. Breeding does and bucks were housed separately in individual wired-cages with dimensions of 60 × 50 × 35 cm, allocated in two rows along the rabbitry. Cage of each doe was provided with a metal nest box for kindling. Each buck mated 1-4 does of the same breed and each doe palpated 10 days thereafter to detect pregnancy. Those which failed to conceive were returned to the same mating buck. Sire-daughter, full and half sib matings were avoided. At weaning age (28 days), the young rabbits were separated from their mothers' cages, sexed, weighted, ear-tagged and lodged in collective cages in groups having automatic drinkers. All animals were fed *ad libitum* a pelleted ration containing 16.3% crude protein, 13.2% crude fiber and 2.5% fat. Berssem (*Trifolium alexandrium*) was supplied at midday during winter only. Cages of all animals were cleaned and disinfected before each kindling regularly. Manure was collected daily and removed outside the rabbitry.

Data and models of analysis:

Litter traits measured at birth were litter size (LSB) and litter weight (LWB). At 21 day, litter size (LS21), litter weight (LW21), and gain in litter weight from birth to 21 day (LG21), while the traits at weaning including litter size (LSW), litter weight (LWW) and gain in litter weight from birth to weaning (PLG). Milk yield of does was recorded twice weekly in grams using weight-suckle-weight method described by Lukefahr *et al.*, (1983). Accordingly, the bunnies were separated from their mothers at 16.00 PM, thereafter the bunnies were allowed to suckle at 8.00 AM in the next day. The averages of the two records of each week multiplied by 7 to get the weekly milk yield then total milk yield during 21 days (MY21) was calculated by summing milk yield at first, second and third week of lactation period. Total milk yield from birth to weaning (TMY) was calculated by summing milk yield during four weeks of lactation. Milk

conversion ratio (MCR) was calculated as litter gain in grams from birth to 21 day (LG21) divided by MY21.

Data of each breed were analyzed separately using single-trait animal model. **MTDFREML** program of Boldman *et al.* (1995) was used. Variances obtained by **REML** method of **VARCOMP** procedure (SAS, 1996) were used as starting (guessed) values for the estimation of variance components. Analyses were performed using this model (in matrix notation):

$$Y = Xb + Z_a U_a + Z_p U_p + e$$

Where: Y = vector of observation;

X = incidence matrix of fixed effects;

b = vector of fixed effect of parity (4 levels) and season of kindling (4 levels) for analyzing litter traits; parity, season and litter size at birth (11 levels) for analyzing lactation traits;

Z_a and Z_p = incidence matrices respective to random direct additive effects and permanent environmental effects;

U_a and U_p = vectors of animal random effects and permanent environmental effects random, respectively;

e = vector of random errors.

The relationship coefficient matrix (A^{-1}) among animals was considered in such single-trait animal model. **MTDFREML** program of Boldman *et al.* (1995) was adapted to use the sparse matrix package, **SPARSPAK** (George and Ng, 1984). Convergence was assumed when the variance of the log-likelihood values in the simplex reached $<10^{-12}$. Occurrence of local maxima was checked by repeatedly restarting the analyses until the log-likelihood did not change beyond the first decimal. The single-trait animal model was used to estimate proportions of direct additive genetic effects (representing heritability h^2_a), permanent environmental effects (p^2), and error (e^2). Direct heritabilities (h^2_a) were computed as:

$$h^2_a = \sigma^2_a / (\sigma^2_a + \sigma^2_p + \sigma^2_e)$$

Where: σ^2_a = direct additive genetic variance, σ^2_p = permanent environmental effects variance, and σ^2_e = error variance.

RESULTS AND DISCUSSION

Means, standard deviations and minimum and maximum values for litter and milk traits in New Zealand White and Baladi Black rabbits are presented in Table 2. Means of litter traits in this study are within the ranges reviewed in different Egyptian studies (Afifi *et al.*, 1992; Khalil *et al.*, 1995; Afifi *et al.*, 1998; El-Maghawry, 1999; Khalil and Afifi, 2000; Youssef *et al.*, 2003; Youssef *et al.*, 2008; Iraqi, 2008). Results in this table revealed a general superiority for New Zealand White over Baladi Black does for all traits studied except MCR trait which tended to have an opposite trend; this may be due to differences in milk composition between the two breeds in terms of fat, protein and lactose (Safaa *et al.*, 2008). The superiority of New Zealand White does may be due to their superior genetic background and their advanced selection stages (Afifi *et al.*, 1998). Blasco *et al.* (1993) and Khalil (1993) ascribed the superiority of New Zealand White does to their excellence in their pre-natal ability (ovulation rate, fetal survival, uterine capacity, intra-uterine environment, etc.) and post natal abilities (milk production maternal behavior, caring ability, etc.). In hot countries, lower values for milk yield were reported by Ayyat *et al.* (1995) and Khalil and Afifi (2000) and much lower values by Khalil (1994), Abd El-Aziz *et al.* (2002), Al-Sobayil *et al.* (2005) and Al-Saef *et al.* (2008).

Table 2: Actual means, standard deviations (SD) and ranges in variation for litter and lactation traits in New Zealand White and Baladi Black rabbits.

Trait ⁺	Mean	SD	Minimum	Maximum
<i>New Zealand White</i>				
Litter traits:				
LSB, young	7.0	1.7	2	11
LS21, young	5.3	1.3	2	9
LSW, young	4.7	1.2	2	8
LWB, g	351	59	170	470
LW21, g	1751	312	840	2360
LWW, g	2221	385	1210	3220
LG21, g	1401	280	570	1990
PLG, g	1865	352	940	2855
Milk traits:				
MY21, g	2904	451	1410	4045
TMY, g	3780	526	1950	5235
MCR	0.48	0.51	0.37	0.62
<i>Baladi Black</i>				
Litter traits:				
LSB, young	6.5	1.8	1	10
LS21, young	4.3	1.3	1	7
LSW, young	3.8	1.1	1	6
LWB, g	322	71	70	480
LW21, g	1438	292	510	2020
LWW, g	1717	349	630	2300
LG21, g	1116	244	440	1610
PLG	1396	3070	480	1920
Milk traits:				
MY21, g	2149	413	1050	3000
TMY, g	2734	515	13600	3790
MCR	0.52	0.42	0.42	0.75

⁺LSB= Litter size at birth; LSW= Litter size at weaning; LWB= litter weight at birth; LW21= Litter weight at 21 days; LWW= Litter weight at weaning; LG21= Litter gain from birth to 21 day; PLG= pre-weaning litter gain; MY21 = milk yield from birth to 21day, TMY = total milk yield and MCR = milk conversion ratio (g litter gain per g of milk suckled during 21 days of lactation).

Heritability

Estimates of heritability for litter and milk traits in New Zealand White and Baladi Black rabbits are shown in Table 3. Heritability estimates for most traits in Baladi Black were to some extent higher than in New Zealand White. Khalil *et al.* (1987) attributed this trend to the reduction in variability within exotic breeds through previous intensive selection, while local breeds were not subjected to such selection.

In general, heritabilities for the most traits investigated were low and/or moderate (Table 3). For litter size at various ages, heritabilities estimates varied between 0.05 for litter size at birth to 0.20 for litter size at weaning in New Zealand White, while they ranged from 0.12 to 0.23 in Baladi Black rabbits. Consensus exists that heritability of litter size in prolific species is generally around 0.1 (Afifi *et al.*, 1992; Blasco *et al.*, 1993; Ayyat *et al.*, 1995; Lukefahr *et al.*, 1996; Lukefahr and Hamilton, 1997; Rochambeau, 1997; Rastogi *et al.*, 2000; Al-Sobayil *et al.*, 2005; Al-Saef *et al.*, 2008).

Heritability values for litter weight traits tended to be low or moderate and ranged between 0.05 and 0.20 in New Zealand White and between 0.01 and 0.23 in Baladi Black rabbits (Table 3). Low heritabilities estimated for litter weight traits were also reported by Lukefahr *et al.* (1996), Lukefahr and Hamilton (1997), Rastogi *et al.* (2000), Youssef *et al.* (2003), Iraqi (2008) and Al-Saef *et al.* (2008). Heritabilities for litter gain in weight were somewhat moderate in both breeds studied (Table 3). El-Maghawry (1999) reported heritabilities of 0.14, 0.12 and 0.13 for daily weight gain (g) per litter during the periods of 1-21 day, 1-28 day and 21-28 day, respectively.

In both breeds, heritability estimates for milk production traits were low and ranged from 0.01 to 0.12 (Table 3). The estimates in Baladi Black rabbits were higher to some extent than those of New Zealand White for all milk traits studied. The same trend was observed by Hassan (2005) in New Zealand White and Baladi Black breeds. Lukefahr *et al.* (1996) found heritability of 0.11 for total milk yield in pooled data of Californian and New Zealand White and their two reciprocals. Ayyat *et al.* (1995) reported heritability of 0.04 for 1-4 week milk yield (adjusted for litter size at birth). Al-Sobayil *et al.* (2005) found heritabilities for milk yield traits were moderate, ranging from 0.18 to 0.22 for pooled data collected on V-line and Saudi rabbits and all their crosses. Ahmed (1997) reported that heritability estimates of milk production traits from kindling up to 21 days were low

and ranging from 0.064 to 0.121 in New Zealand White and from 0.014 to 0.261 in California rabbits.

Permanent environmental effects:

The proportions of permanent environmental effect (p^2) for litter and milk traits are presented in Table 3. In both breeds, these proportions were low or moderate and ranged from 0.01 to 0.27 in New Zealand White rabbits and from 0.03 to 0.20 in Baladi Black rabbits. This means that the effect of non-genetic maternal effects of the dam is not the main cause of variation. Ferraz *et al.* (1992) noted small values of permanent environmental effects for most reproductive traits studied.

The estimates of p^2 in New Zealand White were mostly higher than those in Baladi Black rabbits (Table 3). However, proportions of p^2 were within the ranges of 0.10 to 0.22 as reported by Rastogi *et al.* (2000) and Al-Saef *et al.* (2008) and greater than the ranges of 0.0 to 0.10 as reported by Lukefahr and Hamilton (1997) and Youssef *et al.* (2003). In general, the small values of p^2 may be attributed partially to the large temporary environmental variation (included sanitary and managerial conditions etc..) which could not be considered in the statistical models (Moura *et al.*, 1991).

In both breeds in the present study, the proportion of p^2 were low at the early ages and increased thereafter with advancing of age till 21 days and decreasing thereafter till weaning. This trend exhibited for most traits studied which might be due to milk production; indicating that a curvilinear pattern and reaching its peak at 21 days. The same conclusion was observed by Ahmed (1997) and Youssef *et al.* (2003).

Table 3: Ratios of additive effect (or heritabilities $h^2 \pm SE$), permanent environment ($p^2 \pm SE$) and random error ($e^2 \pm SE$) relative to the total phenotypic variance for litter and lactation traits in New Zealand White and Baladi Black rabbits.

Trait ⁺	$h^2 \pm SE$	$p^2 \pm SE$	$e^2 \pm SE$
<i>New Zealand White</i>			
<i>Litter traits:</i>			
LSB	0.02±0.01	0.01±0.10	0.97±0.09
LS21, young	0.14±0.13	0.25±0.14	0.61±0.06
LSW, young	0.20±0.18	0.27±0.21	0.53±0.08
LWB	0.05±0.06	0.04±0.21	0.91±0.09
LW21, g	0.18±0.12	0.20±0.11	0.62±0.08
LWW, g	0.20±0.15	0.16±0.14	0.64±0.10
LG21, g	0.18±0.10	0.15±0.08	0.77±0.09
PLG, g	0.17±0.14	0.19±0.11	0.64±0.10
<i>Milk traits:</i>			
MY21, g	0.01±0.02	0.14±0.21	0.85±0.10
TMY, g	0.09±0.06	0.15±0.13	0.67±0.17
MCR	0.09±0.09	0.21±0.23	0.70±0.11
<i>Baladi Black</i>			
<i>Litter traits:</i>			
LSB, young	0.12±0.10	0.07±0.009	0.81±0.10
LS21, young	0.17±0.12	0.12±0.10	0.71±0.14
LSW, young	0.23±0.18	0.10±0.09	0.76±0.15
LWB, g	0.01±0.03	0.03±0.02	0.96±0.10
LW21, g	0.20±0.18	0.14±0.13	0.66±0.14
LWW, g	0.23±0.20	0.10±0.12	0.67±0.16
LG21, g	0.13±0.10	0.20±0.18	0.67±0.12
PLG, g	0.20±0.18	0.09±0.11	0.71±0.16
<i>Milk traits:</i>			
MY21, g	0.08±0.06	0.10±0.11	0.82±0.13
TMY, g	0.12±0.10	0.10±0.11	0.78±0.12
MCR	0.10±0.10	0.18±0.20	0.72±0.13

+ Traits as defined in Table 2.

Lukefahr and Hamilton (1997) reported that variances of non additive genetic and permanent environment were important for doe body weight and also for litter weaning weight; stating that litter weight at weaning is an economically important composite trait to be used in selection of does. This is because litter weaning weight affecting litter size and kit viability, mothering and milking ability and growth response of the litter.

The estimates of stander errors for heritabilities and permanent environmental effects in this experiment were somewhat high and this may be a result of the small number of records used.

CONCLUSIONS

- Since the estimates of heritability for traits of litter weight at weaning, milk conversion and total milk yield were moderate compared with the lowest estimates for other traits studied. Therefore, selection in New Zealand White and Baladi Black does could be effective to improve doe productivity under the Egyptian conditions.
- Further studies involving large data sets particularly in Baladi Black rabbits are needed to get more precise heritabilities and permanent environmental effects.

Acknowledgment

The authors are grateful to Professor Maher Khalil for his useful comments and for revising the manuscript.

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الملخص العربي

التقييم الوراثي لبعض صفات خلفه البطن وإدرار اللبن في أرانب النيوزيلندي الأبيض والبلدي الأسود

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أجريت تجربة شملت 234 سجل إنتاج لـ 42 أم من أرانب النيوزيلندي الأبيض و 47 أم من البلدي الأسود وذلك لتقدير قيمة المكافئ الوراثي والتأثير البيئي الدائم لصفات عدد ووزن خلفه البطن عند الميلاد وعند عمر 21 يوم وعند الفطام، وكذلك الزيادة في وزن خلفه البطن في الفترة من الميلاد وحتى عمر 21 يوم ومن الميلاد وحتى الفطام بالإضافة إلى بعض صفات إدرار اللبن وهي محصول اللبن من الولادة وحتى عمر 21 يوم وكذلك من الولادة وحتى الفطام ومعامل تحويل اللبن (الزيادة في وزن الخلفة من الميلاد وحتى عمر 21 يوم/ محصول اللبن في الفترة من الميلاد وحتى عمر 21 يوم).

أستخدم في تحليل هذه البيانات برنامج نموذج الحيوان (Animal Model)، حيث أظهرت نتائج الدراسة أن تقديرات المكافئ الوراثي لصفات خلفه البطن وإدرار اللبن كانت ما بين المنخفضة والمتوسطة بصفة عامة في كلتا السلالتين، إلا أن تلك التقديرات كانت أعلى قليلا في أرانب البلدي الأسود عنها في أرانب النيوزيلندي الأبيض، وقد تراوحت هذه التقديرات من 0.02 إلى 0.2 لأرانب النيوزيلندي الأبيض، وتراوحت بين 0.01 إلى 0.23 في أرانب البلدي الأسود، بينما كانت تقديرات المكافئ الوراثي لصفات إدرار اللبن تتراوح من 0.01 إلى 0.09 ومن 0.08 إلى 0.12 في كل من أرانب النيوزيلندي الأبيض والبلدي الأسود على الترتيب.

هذا وقد كانت تقديرات التباين البيئي الدائم لصفات خلفه البطن متوسطة بصفة عامة حيث تراوحت ما بين 0.01 و 0.27 لأرانب النيوزيلندي الأبيض وبين 0.03 و 0.2 لأرانب البلدي الأسود، بينما تراوحت التقديرات لصفات إدرار اللبن بين 0.14 و 0.21 لأرانب النيوزيلندي الأبيض وبين 0.1 و 0.18 لأرانب البلدي الأسود.

تشير نتائج هذه الدراسة إلى إنه بالرغم من أن تقديرات المكافئ الوراثي لكل من صفات الوزن عند الفطام و صفات إنتاج اللبن كانت متوسطة القيمة إلا إن هذه القيم كانت أعلى من تلك المقدرة للصفات الأخرى المدروسة، وبالتالي فإن الانتخاب لهذه الصفات قد يؤدي إلى تحسين إنتاجية أمهات كل من سلاتي أرانب النيوزيلندي الأبيض والبلدي الأسود تحت الظروف المصرية.