*Anim. Prod.* 1994, **59**: 141-145
© 1994 British Society of Animal Science
0003-3561/94/21760141$02·00

# Lactational performance of Giza White rabbits and its relation with pre-weaning litter traits

M. H. Khalil

*Department of Animal Production, Faculty of Agriculture at Moshtohor, Zagazig University, Moshtohor, Qalyoubia Governorate, Egypt*

## Abstract

*An experiment was carried out in Egypt using Giza White rabbits to investigate their lactational performance and to estimate the repeatabilities of milk yield and other litter traits. Data on 325 litters from 115 does fathered by 40 sires were used. Lactation traits involved milk yields during the first 7 days, 21 days and 35 days. Litter traits included litter size and weight at birth, number born alive, litter weight and gain at 21 days, litter size and weight at weaning and pre-weaning litter gain. Linear mixed models were used for analysing such data.*

*Phenotypic variation in milk yield was relatively high during the first 7 days, and decreased thereafter with advance of lactation stage. Year-season effects were significant for most litter traits, while month of kindling affected litter weight and gain at 21 days and milk yield during the first 7 days ($P < 0·05$ or $P < 0·001$). Litters kindled during winter had the highest milk yield compared with litters kindled in the other seasons. Milk production, litter size and weight and litter gain had curvilinear relationship with parity ($P < 0·05$ or $P < 0·001$). Sire of doe had no significant effects on litter traits studied. Repeatabilities of all traits were low and ranged from 0·001 to 0·134. Litter size and weight at birth were residually correlated with milk yield. Litter weight and gain at 21 days were significantly correlated with the lactational performance of the doe ($P < 0·001$).*

**Keywords:** *litter traits, milk yield, rabbits, repeatability.*

## Introduction

Intensive rabbit production necessitates a knowledge of the lactational performance of the doe. Growth of litter in rabbits is directly related to the amount of milk received (McNitt and Moody, 1988). While pregnancy could adversely affect milk production, a compromise should be reached between kindling frequency and amount of milk to optimize weight of rabbits produced per unit of time (McNitt and Lukefahr, 1990). A close association between litter traits of the doe and her lactational performance was observed by Lukefahr, Hohenboken, Cheeke and Patton (1983) and Ballay, Szombathy, Szabo and Fulop (1988).

The objectives of this investigation were: (1) to estimate repeatabilities for both litter traits and lactation performance of the doe, and (2) to detect residual correlations among milk yield and other doe litter traits.

## Material and methods

The experimental work of this study was carried out in a single experimental rabbitry at Moshtohor, Zagazig University, Egypt. A native breed called Giza White was used in the study. Records of 325 litters from 115 does by 40 sires were collected throughout 4 years consecutively (from 1985/1986 to 1988/1989).

*Breeding plan and management*

At the beginning of the breeding season (September), females within each breed were grouped at random into groups ranging from four to six does depending upon the available numbers. Animals were reproduced within a nested mating structure, avoiding mating animals with common grandparents. Each buck was allowed to produce all his litters from the same females. Therefore, the mating design produced several progeny for each successful sire-dam combination.

Breeding females and males were housed separately in individual wire cages of Californian type. Cages were arranged in a windowed and insulated rabbitry. According to the breeding plan proposed, each doe was transferred to the buck's cage to be bred. Hand mating was exercised and each doe was weighed at each mating. Young bucks and does were first mated at around 8 months of age. Does were mated from the same assigned bucks 10 days after each kindling. Each doe was palpated 10 days thereafter to determine pregnancy. Does which failed to conceive were returned to the same mating-buck to be remated, and were returned to the same buck every other day thereafter until a service was observed. On the 25th day of pregnancy, the nest boxes were supplied with rice straw. After kindling, new litters were examined and recorded and remained in the dams' cage until weaning at 5 weeks of age. Cross-fostering was not practised. The daily milk production of does was recorded using weigh-suckle-weigh method as described by Lukefahr *et al.* (1983) and McNitt and Lukefahr (1990). Except for the nursing period, once in each day, young rabbits were separated from their dams. The kittens were removed each morning from the nestbox, weighed and then placed in the nestbox of the doe's cage. Normally, the doe immediately entered the box, nursed the litter and left within 3 to 5 min. The litter was removed promptly, reweighed and returned to its own nestbox. The difference between the pre- and post-suckling litter weight estimated the daily milk production of the doe. Young doe replacements were added to the herd as needed.

All animals were always offered food twice daily *ad libitum*. A commercial pelleted diet was provided in the morning and in the afternoon. The ingredients of this diet were 580 g barley, 200 g wheat bran, 150 g horse bean, 56 g crushed maize, 14 g vitamin and mineral mixture per kg. In winter and early months of spring, berseem (*Trifolium alexandrinum*) was supplied at midday. Fresh clean water was available to rabbits at all times.

*Data*

Litter traits included litter size at birth (LSB), number born alive (NBA), litter weight at birth (LWB), litter weight at 21 days (LW21), gain in litter at 21 days (LG21), litter size at weaning (LSW), litter weight at weaning (LWW) and absolute pre-weaning litter gain (PLG). Milk yields during the first 7 days (MY7), 21 days (MY21) and 35 days (total lactation, TMY) were also recorded. Measurements of lactation traits and litter traits at 21 days of age were collected for 2 years only (1986/87 and 1987/88), while measurements of other traits were collected for the 4 years.

*Statistical analysis*

Data were analysed using mixed model least squares and maximum likelihood mean weighed (LSMLMW) program of Harvey (1990). Data of litter traits were analysed using the following mixed model:

$$Y_{ijklm} = \mu + S_i + D_{ij} + YS_k + P_l + e_{ijklm} \quad \text{(model 1)}$$

where $Y_{ijklm}$ = $m$th observation of the $l$th parity of the $j$th doe (within $i$th sire) made in the $k$th year-season subclass, $\mu$ = overall mean, $S_i$ = the random effect of $i$th sire of doe, $D_{ij}$ = the random effect of $j$th doe nested within a random effect of $i$th sire, $YS_k$ = the fixed effect of $k$th year-season in which litter was made, $P_l$ = the fixed effect of $l$th parity, and $e_{ijklm}$ = a random deviation of $m$th litter of $ij$th doe and assumed to be independently randomly distributed $(0, \sigma^2 e)$.

Lactation traits of 2 years (1986/87 and 1987/88) and litter traits at 21 days (LW21 and LG21), as indicators of peak of lactation, were analysed using a mixed model which included doe as random effect along with year of kindling, month of kindling, parity, year × month and year × parity as fixed effects (defined as model 2).

Estimation of variance components depends mainly on Henderson's method 3 (Henderson, 1984). Accordingly, estimates of sire ($\sigma^2_S$), doe ($\sigma^2_D$), and remainder ($\sigma^2 e$), components of variance were obtained. Repeatability estimates ($t$) for litter traits were computed as $t = (\sigma^2_S + \sigma^2_D)/(\sigma^2_S + \sigma^2_D + \sigma^2 e)$. Repeatabilities for lactation traits and litter traits at 21 days of age were estimated as $t = \sigma^2_D/(\sigma^2_D + \sigma^2 e)$ where $\sigma^2_D$ = the sum of genetic and permanent environmental variance among does and $\sigma^2 e$ = the temporary environmental effects associated with each lactation. Approximate standard errors for repeatability estimates were computed by the LSMLMW program of Harvey (1990). Residual correlations among lactation traits and litter traits (adjusted for all effects included in the model) were obtained from least-squares analysis of variance (Harvey, 1990).

## Results and discussion

*Means and variations*

The means, standard errors and deviations and coefficients of variation of different traits in Giza White rabbits are given in Table 1. The milking ability of Giza White does was low (642, 2291 and 3493 g for MY7, MY21 and TMY, respectively). Although Giza White breed is more adapted to the Egyptian conditions, the low post-natal maternal ability in such a breed (due to lower milking and

**Table 1** *Means, standard errors (s.e.) and deviations (s.d.) and coefficients of variation (CV) of different traits studied of Giza White rabbits*

| Trait | Symbol | Mean† | s.e. | s.d. | CV |
|---|---|---|---|---|---|
| Litter traits | | | | | |
| Litter size at birth | LSB | 6·1 | 0·11 | 1·9 | 0·300 |
| Number born alive | NBA | 6·0 | 0·12 | 2·1 | 0·339 |
| Litter weight at birth (g) | LWB | 328 | 5·8 | 104 | 0·287 |
| Litter weight at 21 days (g) | LW21 | 1376 | 38 | 568 | 0·294 |
| Litter gain at 21 days (g) | LG21 | 1036 | 37 | 551 | 0·367 |
| Litter size at weaning | LSW | 4·7 | 0·11 | 1·7 | 0·366 |
| Litter weight at weaning (g) | LWW | 1940 | 51 | 759 | 0·378 |
| Pre-weaning litter gain (g) | PLG | 1613 | 49 | 730 | 0·434 |
| Lactation traits | | | | | |
| Milk yield during 7 days (g) | MY7 | 642 | 20 | 292 | 0·419 |
| Milk yield during 21 days (g) | MY21 | 2291 | 68 | 1012 | 0·359 |
| Milk yield during 35 days (g) | TMY | 3493 | 97 | 1440 | 0·329 |

† Number of records used were 325 and 222 at birth and weaning, respectively.

suckling abilities) may be the main limiting factor for the full use of such genetic potentiality on a large scale of commercial production.

Moderate or high phenotypic variation in litter traits were observed (Table 1). The coefficients of variation (CV) ranged from 0·287 to 0·434. These estimates showed a general trend indicating that litter traits measured at kindling had lower phenotypic variation than those traits measured at weaning (e.g. 0·30 for LSB *v.* 0·366 for LSW; 0·287 for LWB *v.* 0·378 for LWW). PLG recorded also higher phenotypic variation (Table 1). Khalil, Owen and Afifi (1987) attributed this trend to high maternal effect on the kittens (in terms of milk production) along with litter losses that occurred during the suckling period. In contrast to litter traits, coefficients of variation for MY7 was high (0·42), and decreased thereafter with the advance of lactation stage.

*Year-season or month of kindling*

Estimates of individual year-season effects are too numerous to be reported here. Significant effect of year-season of kindling on most litter traits indicated that the contribution of year-season in the variance of these traits was of considerable importance. Consequently, litter performance of doe rabbits in Egypt may be season-specific and less well characterized across seasons. Month of kindling affected LW21, LG21 and MY7 ($P < 0·05$ or $P < 0·001$). Litters born in December had heavier LW21 (2269 g) and LG21 (1877 g) than those litters born in other months of the year. January-kindlers recorded the highest milk yield compared with kindlers of the other months.

*Parity*

Parity had a curvilinear relationship ($P < 0·05$ or $P < 0·01$) with milk production, litter size and weight and litter gain. However, parity effect on litter traits at birth were significant while litter traits measured during the suckling period (litter size, weight and gain and lactation) were not significantly affected. Khalil, Afifi, Emara and Owen (1988) explained these significant differences in litter traits at birth to the differences related to ovulation rate, ova wastage, implantation sites, embryonic mortality, embryo survival, foetal survival, uterine capacity and intra-uterine environment.

*Random effects*

The estimates of the sire, doe and remainder components of variance for the different traits are given in Table 2. Insignificant sire effects on all traits were observed. Similarly, differences in most litter traits due to doe effects were not significant. This might suggest the existence of a negative covariance between adjacent litters which was confirmed previously for the same breed by Khalil and Mansour (1987) and for other breeds by Garcia, Baselga, Blasco and Deltoro (1982a and b) and Baselga, Gomez, Cifre and Camacho (1992). The small coefficients of variation in this study due to doe reflect a larger environmental component of variance associated with the doe during kindling and raising a litter to weaning (Khalil *et al.*, 1987). Genetic and environmental differences in pre- and post-natal maternal influences can be an added factor.

*Repeatability*

Estimates of repeatability for different traits are given in Table 2. These results indicate that all doe litter traits and lactation traits in rabbits were of low repeatability. The estimates ranged from 0·001 to 0·134. However, repeatability estimates in the present study agree generally with the corresponding estimates reported in the literature (Garcia *et al.*, 1982a and b; Lukefahr *et al.*, 1983; Khalil

**Table 2** *Variance components and coefficients of variation (CV) and repeatability estimates (t) for different traits*

| | Sire | | Doe | | Remainder | | | |
|---|---|---|---|---|---|---|---|---|
| Trait† | $\sigma^2_S$ | CV | $\sigma^2_D$ | CV | $\sigma^2_e$ | CV | $t$ | s.e. |
| Model 1: | | | | | | | | |
| LSB | 0·059 | 0·017 | 0·115 | 0·033 | 3·35 | 0·950 | 0·050 | 0·054 |
| NBA | 0·114 | 0·027 | ‡ | 0·000 | 4·11 | 0·973 | 0·027 | 0·052 |
| LWB | 137 | 0·015 | 10·0 | 0·001 | 8864 | 0·984 | 0·017 | 0·051 |
| LSW | ‡ | 0·000 | 0·003 | 0·001 | 2·82 | 0·999 | 0·001 | 0·064 |
| LWW | 12704 | 0·023 | ‡ | 0·000 | 539187 | 0·972 | 0·023 | 0·060 |
| PLG | 9999 | 0·020 | ‡ | 0·000 | 490762 | 0·980 | 0·020 | 0·060 |
| Model 2: | | | | | | | | |
| LW21 | | | 12888 | 0·073 | 163964 | 0·927 | 0·073 | 0·072 |
| LG21 | | | 19804 | 0·121* | 144413 | 0·879 | 0·120 | 0·078 |
| MY7 | | | 3324 | 0·044 | 72536 | 0·956 | 0·044 | 0·074 |
| MY21 | | | 104966 | 0·134* | 677673 | 0·866 | 0·134 | 0·079 |
| TMY | | | 143794 | 0·098* | 1318544 | 0·902 | 0·098 | 0·077 |

† Traits defined in Table 1.
‡ Negative estimate of variance component set to zero.

and Mansour, 1987; Khalil *et al.*, 1988; Baselga *et al.*, 1992). Because of low repeatability it is very advantageous to consider more litters before selecting a doe for these traits. Therefore, culling of does for these traits based on a single production record would not be efficient from a genetic standpoint and consequently assessment of several parities are required before selecting does for these traits (Khalil and Mansour, 1987; Khalil *et al.*, 1988).

*Residual correlations*

Residual correlations among milk production and other associative traits are presented in Table 3. The neonatal traits (LSB and LWB) were associated significantly with MY21 and TMY (estimates around 0·3) ($P < 0·001$). Since litters were not standardized at kindling to a common litter size, such significant correlations may reflect both pre-natal (e.g. uterine and placental capacity, number of foetus, foetal placental lactogen levels) and post-natal litter effects on lactational performance of the doe. Yamani, Daader and Asker (1991) found that milk yield in all stages of lactation was affected considerably ($P < 0·05$ or $P < 0·01$) by litter size at birth. However, the association involving foetal number and placental lactogen on increasing lactational output by the doe is not firmly established in rabbits. In addition, the post-natal effects of a larger litter size may evoke greater tactile stimulation of the teats and indirectly enhance milk secretion through increased prolactin release (Lukefahr *et al.*, 1983). Also, increased sucking intensity in larger litters may allow more complete evacuation of remainder milk, through greater oxytocin release due to increased afferent nerve stimulation of the teats (Cowie, 1969; Linzell, Peaker and Taylor, 1972).

**Table 3** *Residual correlations among lactation traits and litter traits studied*

| Litter trait | Lactation trait† | |
|---|---|---|
| | MY21 | TMY |
| LSB | 0·312** | 0·308** |
| LWB | 0·331*** | 0·319*** |
| LW21 | 0·528*** | 0·487*** |
| LG21 | 0·486*** | 0·455*** |
| LSW | 0·333*** | 0·336*** |
| LWW | 0·386*** | 0·399*** |
| PLG | 0·360*** | 0·367*** |

† Traits defined in Table 1.

The correlation coefficients of lactation traits and litter traits at 21-day (LW21 and LG21) or at weaning were positive and moderate or high ($P < 0·001$); estimates ranged from 0·455 to 0·528. Consistent with these estimates, a correlation of 0·99 (Lukefahr *et al.*, 1983) has been documented. The same authors reported also an estimate of 0·72 between litter size at 21 days and LW21 and consequently milk production level of the doe was the chief determinant of LW21 and LG21 rather than litter size at 21 days. It should, however, be reported that the milk production level and/or nursing behaviour of the doe could well influence the sucking behaviour of the litter.

## Acknowledgements

The author is very grateful to Professor E. S. E. Galal, Faculty of Agricutlure, Ain Shams University, Cairo, Egypt, for his helpful discussion and for reading the manuscript.

## References

**Ballay, A., Szombathy, E., Szabo, E. and Fulop, M.** 1988. Relationships between the milk production and fertility of Angora does. *Proceedings of the fourth world rabbit congress, Budapest, Hungary.*

**Baselga, M., Gomez, E., Cifre, P. and Camacho, J.** 1992. Genetic diversity of litter size traits between parities in rabbits. *Proceedings of the fifth world rabbit congress, Oregon, Corvallis, USA.*

**Cowie, A. T.** 1969. Variations in the yield and composition of the milk during lactation in the rabbit and the galactopoietic effect of prolactin. *Endocrinology* **44:** 28.

**Garcia, F., Baselga, M., Blasco, A. and Deltoro, J.** 1982a. Genetic analysis of some productive traits in meat rabbits. I. Numeric traits. *Proceedings of the second congress on genetics applied to livestock production, Madrid, Spain,* vol. 7, pp. 557-562.

**Garcia, F., Baselga, M., Blasco, A. and Deltoro, J.** 1982b. Genetic analysis of some productive traits in meat rabbits. II. Ponderal traits. *Proceedings of the second congress on genetics applied to livestock production, Madrid, Spain,* vol. 7, pp. 575-579.

**Harvey, W. R.** 1990. *User's guide for LSMLMW. Mixed model least squares and maximum likelihood computer program. PC-version* 2. Ohio State University, Columbus, USA (Mimeograph).

**Henderson, C. R.** 1984. *Applications of linear models in animal breeding.* University of Guelph, Guelph, Ontario, Canada.

**Khalil, M. H., Afifi, E. A., Emara, M. E. and Owen, J. B.** 1988. Genetic and phenotypic aspects of doe productivity in four breeds of rabbits. *Journal of Agricultural Science, Cambridge* **110:** 191-197.

**Khalil, M. H. and Mansour, H.** 1987. Factors affecting reproductive performance of female rabbits. *Journal of Applied Rabbit Research* **10:** 140-145.

**Khalil, M. H., Owen, J. B. and Afifi, E. A.** 1987. A genetic analysis of litter traits in Bauscat and Giza White rabbits. *Animal Production* **45:** 123-134.

**Linzell, J. L., Peaker, M. and Taylor, J. C.** 1972. The effects of prolactin and oxytocin on milk secretion and on the permeability of the mammary epithelium, in the rabbit. *Journal of Physiology* **253:** 547.

**Lukefahr, S., Hohenboken, W. D., Cheeke, P. R. and Patton, N. M.** 1983. Characterization of straightbred and crossbred rabbits for milk production and associative traits. *Journal of Animal Science* **57:** 1100-1107.

**McNitt, J. I. and Lukefahr, S. D.** 1990. Effects of breed, parity, day of lactation and number of kits on milk production of rabbits. *Journal of Animal Science* **68:** 1505-1512.

**McNitt, J. I. and Moody, J. L.** 1988.

**McNitt, J. I. and Moody, J. L.** 1988. Milk intake and growth rates of suckling rabbits. *Journal of Applied Rabbit Research* **11:** 117-119.

**Yamani, K. A. O., Daader, A. H. and Asker, A. A.** 1991. Non-genetic factors affecting rabbit production in Egypt. *Option Mediterraneennes-Serie Seminaires vol. 17,* pp. 159-172.

*(Received 30 December 1992—Accepted 11 March 1994)*