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# GENETIC EVALUATION OF THE LACTATIONAL PERFORMANCE IN GIZA WHITE RABBITS AND ITS RELATION WITH PREWEANING LITTER TRAITS

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*An experiment was carried out in Egypt using Giza White rabbits to investigate its lactational performance and to estimate the repeatabilities of milkyield and some reproductive intervals along with other litter traits. Data on 325 litters from 115 does fathered by 40 sires were used. Lactation traits involved milk yields during the first seven days (MY7), 21 days (MY21) and 35 days (TMY). Litter traits included litter size (LSB) and weight (LWB) at birth, number born alive (NBA), litter weight (LW21) and gain (LG21) at 21 days, litter size (LSW) and weight (LWW) at weaning, preweaning litter gain (PLG) and daily gain in litter (PDG) and preweaning mortality (PM), while reproductive intervals included days open (DO) and kindling interval (KI).*

*Phenotypic variations in DO and KI were relatively high compared with other litter and lactation traits. Year-season effects were significant for most litter and interval traits, while month of kindling affected ($p<0.05$ or $p<0.001$) LW21, LG21 and MY7. Milk production, litter size and weight and litter gain had curvilinear relationship ($p<0.05$ or $P<0.001$) with parity. Most litter and lactation traits were significantly affected by days open. An antagonistic curvilinear relationship was observed between litter traits or lactation traits and days open. LW21 and LG21 increased linearly ($P<0.05$ or $P<0.01$) with the increase of days open. Sire of doe and doe within sire had no significant effects on all doe traits studied. Repeatabilities of all traits were low and ranged from 0.001 to 0.127. LSB and LWB were residually correlated with milk yield. LW21 and LG21 were significantly correlated ($p<0.001$) with the lactational performance of the doe. Interval reproductive traits (DO or KI) had lowly positively residual relationship with milk yield.*

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). However, milk production of the doe could be affected by many factors. While pregnancy could adversely affect milk production, a compromise should be reached between kindling frequency and amount of milk to optimize Kg of rabbits produced per unit of time (Harris, 1988; McNitt and Lukefahr, 1990).

A close association between litter traits of doe and her lactational performance was observed by Lukefahr *et al.* (1983) and Ballay *et al.* (1988). In spite of the possible influence of milk production on the growth and survival of young rabbits per litter, the effect of days open (i.e. interval from kindling to conception) on these variables is not entirely established.

The objectives of this investigation were: (1) to determine the polynomial regression relationship between days open and both litter traits and lactation performance of the doe, (2) to estimate repeatabilities for these associated traits, and (3) 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 the Experimental Rabbitry at Moshtohor, Zagazig University, Banha Branch Egypt. A native breed, GizaWhite, was used in this study. Records of 325 litters from 115 does sired by 40 sires were collected through four consecutive years (from 1985/1986 to 1988/1989).

### Breeding plan and management

At the beginning of the breeding season (September), females were grouped at random into mating groups ranging from 4 to 6 does depending upon the available numbers, avoiding to mate animals with common grand-parents. 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-wired Californian type cages. Cages were arranged in a windowed-insulated rabbitry. According to the breeding plan, 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, while later matings were made weekly 10 days after parturition. Females failing to conceive after four services were excluded. 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's cage until weaning at 5 weeks of age. Cross-fostering was not practiced. The daily milk production of does was recorded using weight-suckle-weight method as described by Lukefahr *et al.* (1983) and McNitt and Lukefahr (1990). Except for the nursing period, once per day, young rabbits were separated from their dams. The bunnies were removed each morning from the nestbox, weighted and then placed in the nestbox of doe's cage. Normally, the doe immediately entered the box, nursed the litter and left within 3 to 5 minutes. The litter was removed promptly, rewieghed and returned to its ownnestbox. 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 fed ad libitum and food was offered two times daily. A commercial pelleted ration was provided in the morning and in the afternoon. The ingredients of this ration were 58% barley, 20.0% wheat bran, 15% horse bean, 5.6% crushed maize, 1.4% vitamin and mineral mixture. In winter and early months of spring, berseem (Trifolium alexandrinum) was supplied at midday. Freshclean water was available to rabbits at all times.

### Data

Interval reproductive traits included days open (interval from kindling to conception, DO) and kindling interval (period between two consecutive parturitions, KI), while 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), absolute preweaning litter gain (PLG), preweaning daily gain in litter (PDG) and preweaning litter mortality percentage (PM). Milk yields during the first seven days (MY7), 21 days (MY21) and 35 days (total lactation, TMY) were also recorded. Data of lactation traits and litter traits at 21 days of age were collected for two years only (1986/87 and 1987/88) while data of other traits were collected for the four years.

### Statistical analysis

Data were analysed using Mixed Model Least Squares and Maximum Likelihood Mean Weighed (LSMLMW) program of Harvey (1990). Data of reproductive traits (DO and KI) were analysed using the following mixed model:

$$Y_{ijklm}=\mu+S_i+D_{ij}+Y_{Sk}+P_l+e_{ijklm} \quad \text{....... (Model 1)}$$

where $Y_{ijklm}$= $m^{th}$ observation of the $l^{th}$ parity of the doe (within $i^{th}$ sire) made in the 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, $Y_{SK}$= The fixed effect of $k^h$ year-season in which litter was produced, $P_l$= 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 $(\sigma, \sigma^2 e)$.

To detect the effect of days open on LSW, LWW, PLG, PDG and PM, the previous model was used in addition to include days open as a covariate (defined as Model 2).

Lactation traits of two 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 included doe as random effect and year of kindling, month of kindling, parity, year x month, year x parity as fixed effects along with days open as a covariate (defined as Model 3).

Estimation of variance components depends mainly on Henderson's Method 3. 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 and interval traits were computed from the ratio of sire and doe variance components to the sum of sire, doe within sire and the remainder variance components, i.e. $t= (\sigma^2S+\sigma^2D) / (\sigma^2S+\sigma^2+\sigma^2 e)$.

Repeatabilities for lactation traits, LW21 and LG21 were estimated from the ratio of doe variance component to the sum of doe and the remainder variance components, i.e. $t= \sigma^2D/(\sigma^2D+\sigma^2 e)$ 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 both litter and interval traits (after adjustment for all effects included in the model) were obtained from least squares analysis of variance (LSMLMW, 1990).

## RESULTS AND DISCUSSION

### Mean and variation

The means, standard deviations and coefficients of variation of different traits in Giza White rabbits are given in Table 1.

Periods of DO and KI obtained here (17.9 days for DO and 48.8 days for KI) indicated that reproductive intervals are moderate and they are one of the encouraging factors for the effective use of this breed on a large scale of commercial production. In Egypt, El-Desoki (1991) found that KI and DO in Baladi rabbits are relatively shorter than in New Zealand White and Californian rabbits. Lactation stress is responsible for such long periods of reproductive intervals in these foreign breeds. The low milking ability for Giza White does obtained in the present study (642, 2291 and 3493 grams for MY7, MY21 and TMY, respectively) could be the main cause of such moderate periods of KI and DO in this native breed. Although Giza White breed is more adapted to the Egyptian conditions, low postnatal maternal ability in such breed (due to lower milking and suckling abilities) may be the main limiting factor for the full use of such genetic potentiality on a large

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

| Trait | Mean* | s.d. | CV% |
|---|---|---|---|
| **Interval traits** | | | |
| DO (days) | 17.9 | 22.1 | 96.4 |
| KI (days) | 48.8 | 25.9 | 46.9 |
| **Litter traits** | | | |
| LSB | 6.1 | 1.9 | 30.0 |
| NBA | 6.0 | 2.1 | 33.9 |
| LWB (g) | 328 | 104 | 28.7 |
| LW21 (g) | 1376 | 568 | 28.8 |
| LG21 (g) | 1036 | 551 | 37.0 |
| LSW | 4.7 | 1.7 | 36.0 |
| LWW (g) | 1940 | 759 | 37.0 |
| PLG (g) | 1613 | 730 | 42.6 |
| PDG (g) | 50.7 | 22.5 | 41.2 |
| PM (%) | 38.7 | | |
| **Lactation traits** | | | |
| MY7 (g) | 642 | 292 | 42.0 |
| MY21 (g) | 2291 | 1012 | 35.9 |
| TMY (g) | 3493 | 1440 | 31.0 |

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

scale of commercial production.

High phenotypic variation in all traits were observed (Table 1). The coefficients of variation (CV) ranged from 28.7 to 96.4%. Blasco *et al.* (1992) attributed the high variation in litter traits at birth (e.g. LSB, NBA and LWB) to the high variation in ovulation rate, embryo survival and prenatal fetal survival. They added that variations in both embryo and fetal survival in determining variation in litter size at birth were also apparent.

Estimates of CV presented in Table 1 indicated that variations in DO and KI were relatively high compared with other litter and lactation traits. Smaller variation in KI (46.9%) than in DO (96.4%) could be attributed to that most of the variation is brought about by variation in DO while the variation in gestation length is small (5.6%). However, high variation in reproductive performance of doe rabbits in Egypt could be attributed to the variation in management decision (in terms of postpartum mating, remating schedule, ...... etc).

The estimates of CV showed a general trend indicating that litter traits measured at kindling had lower phenotypic variation than those traits measured at weaning (e.g. 30.0% for LSB vs 36.0% for LSW; 28.7% for LWB vs 37.0% for LWW). PLG and PDG recorded also higher phenotypic variation (Table 1). Khalil *et al.* (1987) attributed this trend to high maternal effect (in terms of milk production) on the bunnies during the suckling period along with litter losses that occurred during this period. However, the high estimates of CV given here and those reported in literature (e.g. Khalil *et al.*, 1987; EL-Desoki, 1990) gave an evidence to that improvement of litter traits in rabbits through phenotypic selection is quit possible. Opposite to litter traits, estimate of CV for MY7 was high (42.0%), decreased thereafter with advance of lactation stage.

**Year-season**

Degrees of freedom, F-ratios and tests of significance of factors contributing in the variation of different traits are shown in Tables 2 & 3. Estimates of individual year-season effects are too numerous to be reported here. Significant values of F-ratios for the effect of year-season of kindling on most litter and interval traits (Table 2) indicating that the contribution of year-season in the variance of these traits was of considerable importance. Consequently, litter and reproductive performance of doe rabbits in Egypt are highly season-specific and less well-characterized across seasons.

**Month of kindling**

Month of kindling affected ($P<0.05$ or $P<0.001$) LW21, LG21 and MY7 (Table 3). Litters born in December had heavier LW21 (2269 grams) and LG21 (1877 grams) than those litters born in other months of the year. January-kindlers recorded the highest milk yield compared to 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 interval traits and litter traits at birth were significant while litter traits measured during the suckling period (litter size, weight and gain and

Table 2. F-ratios of least squares analysis of variance for reproductive intervals and litter traits.

| | Model 1 | | | | | | Model 2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source | df | DO | KI | LSB | NBA | LWB | df | LSW | LWW | PLG | PDG | PM |
| Sire | 39 | 1.3 | 1.0 | 1.1 | 1.3 | 1.1 | 27 | 0.7 | 1.4 | 1.4 | 1.2 | 1.7* |
| Doe : sire | 75 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 7 | 1.0 | 0.9 | 0.9 | 1.0 | 0.8 |
| Year-season | 10 | 7.0*** | 3.2*** | 2.5** | 1.7 | 3.4*** | 6 | 0.5 | 1.9 | 2.3* | 2.6* | 1.4 |
| Parity | 3 | 10.0*** | 3.7** | 3.1** | 2.0 | 2.7* | 2 | 1.9 | 1.6 | 1.5 | 1.3 | 0.2 |
| **Regression on:** | | | | | | | | | | | | |
| days open, linear | | | | | | | 1 | 8.5** | 8.7** | 7.6** | 7.3** | 1.9 |
| days open, quadratic | | | | | | | 1 | 4.5* | 7.8** | 7.1** | 6.5** | 4.7* |
| Remainder mean squares+ | | 297 | 524 | 3.4 | 4.1 | 8864 | | 2.8 | 504678 | 463309 | 429 | 322 |

+Remainder degrees of freedom were 197 and 127 at birth and weaning, respectively.

Table 3. F-ratios of least squares analysis of variance for milk yield and litter weight and gain at 21 days of age (Model 3).

| Source of variation | df | LW21 | LG21 | MY7 | MY21 | TMY |
|---|---|---|---|---|---|---|
| Doe | 58 | 1.4* | 1.4* | 1.3 | 1.7** | 1.6** |
| Year of kindling (Y) | 1 | 13.2*** | 19.7*** | 0.3 | 2.7 | 11.0*** |
| Month of kindling (M) | 5 | 5.2*** | 4.9*** | 2.4* | 1.2 | 0.6 |
| Parity (P) | 3 | 1.3 | 0.5 | 1.4 | 3.2 | 2.1 |
| Y x M | 5 | 2.7* | 3.3** | 1.1 | 5.3*** | 3.6** |
| Y x P | 3 | 5.1** | 5.3** | 4.2** | 5.2** | 4.8** |
| Regression on: | | | | | | |
| days open, linear | 1 | 8.6** | 4.8** | 0.9 | 3.0* | 7.6** |
| days open, quadratic | 1 | 3.0 | 2.8 | 16.4*** | 4.4*** | 14.5*** |
| Remainder mean squares+ | | 157676 | 147353 | 65202 | 614916 | 1172461 |

+ Remainder degrees of freedom were 126.

lactation) were not significantly affected. Khalil *et al.* (1988), Blasco *et al.* (1992) and Santacreu *et al.* (1992) 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-utrine environment.

## Days open

Research work concerning the effects of days open on litter and lactation traits was very scanty in the literature. In most cases, effects of days open on litter and lactation traits were significant (Tables 2 & 3). Accordingly, correcting records of litter and lactation traits for days open is recommended. It is necessary, therefore, to construct a set of correction factors for days open for every trait. Equations of polynomial regression analysis given in Table 4 could be used for deriving such set of correction factors. However, Perry (1983) and Lammers *et al.* (1988) reported significant effect for days open on some litter and lactation traits, while Partridge *et al.* (1984), Szendro (1988) and Yamani *et al.* (1991) reported insignificant differences due to length of post-partum interval.

The magnitude of days-open effects, as judged by the size of the F-ratios (Tables 2 & 3) were somewhat smaller for lactation and litter traits at 21 days (MY7, MY21, LW21 and LG21) than in corresponding traits at weaning

(LSW, LWW, PLG, TMY). In this respect, Fraga *et al.* (1989) found that milk yield decreased ($P<0.05$) with the decrease of remating interval. They concluded that this decrease in milk yield was related to the decrease in milk production obtained from 21 days to weaning in the pregnant does. This decline has no practical importance because at the end of the lactation period, the milk of pregnant does has higher concentrations of protein and fat than those of non-pregnant does (Partridge *et al.*, 1986; Fraga *et al.* 1989) and furthermore the young rabbits have begun to eat solid food.

The estimates of partial linear regression coefficients of different traits on days open are presented in Table 4. These results show that each one day increase in days open has resulted in an increase of 1.5, 8.1, 17.9, 12.0, 10.7 and 0.32 grams in MY7, MY21, TMY, LWW, PLG and PDG, respectively along with a reduction of 0.14% in PM. A negative quadratic relationship was also detected between litter or lactation traits and days open (Table 4). From the economic point of view, however, it would not desirable to prolong days open. Delaying of days open may caused by several factors, e.g. management decision (in terms of post-kindling mating, remating schedule, ....etc) and culling policy. Accordingly, the rabbit breeders were likely to mate their does of large-sized litters later than does of moderate- or small-sized litters. This could automatically produce an antagonistic relationship between milk yield and days open.

**Table 4. Estimates of polynomial regression analysis of 2$^{nd}$ degree (b±s.e.) for lactation and litter traits on days open.**

| Trait | Linear (g/day) | | Quadratic (g/day2) | |
|---|---|---|---|---|
| | b | s.e. | b | s.e. |
| MY7 | 1.5 | 1.53 | -0.24*** | 0.06 |
| MY21 | 8.1 | 4.7 | -0.70*** | 0.18 |
| TMY | 17.9** | 6.5 | -0.96*** | 0.25 |
| LW21 | 7.0** | 2.4 | -0.16 | 0.09 |
| LG21 | 5.1* | 2.3 | -0.15 | 0.09 |
| LSW | 0.027** | 0.01 | -0.0007* | 0.0003 |
| LWW | 12.0** | 4.1 | -0.38** | 0.13 |
| PLG | 10.7** | 3.9 | -0.35** | 0.13 |
| PDG | 0.32** | 0.118 | -0.0101** | 0.0039 |
| PDG | 0.32** | 0.118 | -0.0101** | 0.0039 |
| PM | -0.14 | 0.102 | 0.0074* | 0.0034 |

The partial linear and quadratic regression coefficients of MY21, TMY, LSW, LWW, PLG and PDG on days open were significant and consequently these traits increased curvilinearly with the increase of days open, i.e. a curvilinear curves could be fitted on the data of these traits. It was observed that the curves for lactation traits were similar to the curve of litter size, weight and gain traits (Table 4). However, this curvilinear trend could be attributed to the competition between milk production of the doe and the nutrition of her foetus especially with the beginning of the 2nd half of the pregnancy period. It could be also explained on the basis that milk-secretion hormones decrease with the advance of stage of pregnancy.

The partial linear regressions of LW21 and LG21 reflect increased ($P<0.05$ or $P<0.01$) litter performance with the increase of days open, while quadratic relationship between MY7 and PM were observed. This non-linear relationship between days open and PM indicates that when days open increases PM will decrease. For each additional day open, LW21 and LG21 increased by 7.0 and 5.1 grams, respectively.

**Random effects**

The estimates of the sire, doe-within-sire and remainder components of variance for the different traits are given in Table 5. Insignificant sire effects on all traits were observed, except PM ($P<0.001$). Similarly, differences in most litter and interval reproductive traits due to doe effects were non-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 *et al.* (1982) and Baselga *et al.* (1992). The smaller proportions 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. With other breeds of rabbits, some investigators (e.g. Lukefahr *et al.*, 1983) reported significant effects for doe on litter traits and consequently the negative environmental component, if real is breed specific.

**Repeatability**

Estimates of repeatability for different traits are given in Table 5. These results indicate that all doe litter traits, reproductive intervals and lactation traits in rabbits were of low repeatability. The estimates ranged from 0.001 to 0.127. However, repeatability estimates in the present study agree generally with the corresponding estimates reported in the literature (Garcia *et al.*, 1982; Lukefahr *et al.*, 1983; Lukefahr *et al.*, 1984; Khalil and Mansour, 1987; Khalil *et al.*, 1988; Baselga *et al.*, 1992). Because of low repeatability more litters are to be considered 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

Table 5. Variance components and percentages of variation (V%) and repeatability estimates (t) for different traits studied.

| Trait | Sire | | Doe | | Remainder | | t | s.e. |
|---|---|---|---|---|---|---|---|---|
| | $\sigma^2 s$ | V% | $\sigma^2 D$ | V% | $\sigma^2 e$ | V% | | |
| **Model 1& 2:** | | | | | | | | |
| DO | 13.3 | 4.1 | 12.9 | 4.0 | 298 | 91.9 | 0.081 | 0.057 |
| KI | + | 0.0 | 12.1 | 2.3 | 524 | 97.7 | 0.023 | 0.051 |
| LSB | 0.059 | 1.7 | 0.115 | 3.3 | 3.35 | 95.0 | 0.050 | 0.054 |
| NBA | 0.114 | 2.7 | + | 0.0 | 4.11 | 97.3 | 0.027 | 0.052 |
| LWB | 137 | 1.5 | 10.0 | 0.1 | 8864 | 98.4 | 0.017 | 0.051 |
| LSW | + | 0.0 | 0.003 | 0.1 | 2.82 | 99.9 | 0.001 | 0.064 |
| LWW | 17376 | 3.3 | + | 0.0 | 504678 | 96.7 | 0.034 | 0.068 |
| PLG | 14144 | 3.0 | + | 0.0 | 463309 | 97.0 | 0.030 | 0.067 |
| PDG | 12 | 2.7 | + | 0.0 | 429 | 97.3 | 0.027 | 0.067 |
| PM | 114 | 12.8*** | + | 0.0 | 780 | 87.2 | 0.127 | 0.060 |
| **Model 3:** | | | | | | | | |
| LW21 | | | 17732 | 10.1* | 157676 | 89.9 | 0.101 | 0.078 |
| LG21 | | | 18216 | 11.0* | 147353 | 89.0 | 0.110 | 0.078 |
| MY7 | | | 5871 | 8.3 | 65202 | 91.7 | 0.083 | 0.077 |
| MY21 | | | 142917 | 18.9** | 614916 | 81.1 | 0.189 | 0.081 |
| TMY | | | 241923 | 17.1** | 1172461 | 82.9 | 0.171 | 0.081 |

+Negative estimate of variance component set to zero.

parities are required before selecting does for these traits (Khalil and Mansour, 1987; Khalil *et al.*, 1988).

Estimates of repeatability for litter traits at 21 days (peak of lactation) and for lactation traits were higher than those for other litter and interval traits (Table 5). These results indicate that lactation traits are slightly more repeatable than litter and interval traits.

**Residual correlations**

Residual correlations among milk production and other associative traits are presented in Table 6.

The neonatal traits (LSB and LWB) were associated (P<0.001) with MY21 and TMY (estimates around 0.3). Since litters were not standardized at kindling to a common litter size, such significant correlations may reflect both prenatal (e.g. uterine and placental capacity, number of foetus, fetal placental lactogen levels) and postnatal litter effects on lactational performance of the doe. Yamani *et al.* (1991) found that milk yield in all stages of lactation was considerably (P<0.05 or P<0.01) affected by the effect of litter size at birth. However, the association involving fetal number and placental lactogen on increasing lactational output by the doe is not firmly established in rabbits. In addition, the postnatal 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 suckling 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 *et al.*, 1972).

LW21 and LG21 were shown to be an excellent criteria of the lactational performance of the doe, based on the correlation coefficients (P<0.001) of about 0.5 (estimates ranged from 0.455 to 0.528). Consistent with these estimates, correlation of 0.99 (Lukefahr *et al.*, 1983) have 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 suckling behaviour of the litter.

Despite the clear relationship (P<0.001) between milk yield and litter traits at weaning (LSW, LWW, PLG), the relationship is less marked relative to the relationship with LW21 and LG21 (Table 6). Similar trend was observed by Ballay *et al.* (1988) who reported a close correlation of 0.69 between milk production at 21 days and litter weight at the same age, while an estimate of 0.63 between milk yield and litter weight at 42 days of age was obtained.

Table 6. Residual correlations among lactation and litter traits studied.

| Interval or litter trait | Lactation trait | |
|---|---|---|
| | MY21 | TMY |
| DO | 0.049 | 0.106 |
| KI | 0.064 | 0.128 |
| 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*** |
| PM | -0.104 | -0.154 |

Milk yield and interval reproductive traits (DO and KI) were lowly positively related (correlations ranged from 0.049 to 0.128). Such positive and unfavourable correlations between milk yield and interval traits can be explained on the basis of the effect of delayed pregnancy on milk production. Such unfavourable correlations may have causes other than purely genetic ones. These results must be also interpreted with caution, for example, it was shown that days open was influenced to a greater extent by factors at herd level (Yamani *et al.*, 1991). Thus, if the rabbit breeders were to mate large-littering does later than moderate - or small - littering does this would automatically produce an antagonistic relationship between milk yield and days open. It is also possible that large-littering does will be afforded more chances of conceiving than small-littering does, a management practice which could also create a "false antagonism". A higher incidence of retained placenta in large-littering does might have the same effect. Accordingly, correlations between production and/or lactation traits and the interval traits (e.g. DO or KI) are subject to these influences. From this point of view, interval reproductive measures which included days open can be questioned when investigating the relationship between productive and reproductive performance, at least on field data, where it is difficult to assess management practices. For example, when correlating DO with milk yield, one would expect to find an antagonistic relationship due to the depressing effect of pregnancy after the 2nd half of the pregnancy period.

## General consideration and conclusion

When evaluating breeding does for milk yield, adjustments should be made for the effect of days open. If such adjustments are not performed, does with poor fertility and long reproductive intervals will be favoured in the evaluation for milk yield. The question as to whether there is real antagonism between milk production and fertility (i.e. DO or KI) in does might be difficult to answer without deeper knowledge of physiological background, such as the hormonal interplay between hormones of reproduction and lactation. Looking to the future, further research in such aspects is needed to plan selection programme for overall improvement of rabbits stocks.

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