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Evaluation of the Performance of Three Meat Rabbit Breeds Recently Introduced to Egypt. 1. Litter weight and related traits

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SUMMARY *Data on 3571 parturitions produced by 94 Californian (Cal), 311 New Zealand White (NZW) and 384 Bauscat (Bos) purebred doe rabbits (paternal half-sisters) during two successive years of production (1991 / 92 and 1992 / 93), were used in the present study. The present work aimed to evaluate litter traits of the three breeds recently introduced (1991) to Egypt and the adaptation of three strains in the new environment in San El-Hagar, Sharkiya Governorate, Egypt. The results obtained can be summarized as:*

1. *Sire of the doe effect was not significant on the does litter traits. Differences among does within sires were significant (P< 0.05 and P< 0.01) in all litter traits studied, except litter weight weaning and bunny weight gain at 21 days and viability (%) at 30 days in Cal rabbits, bunny weight at birth in NZW and bunny weight at weaning and viability at 21 days in Bos breed.*
2. *Year of kindling and parity affected most of the pre-weaning litter traits in three breeds studied.*
3. *Month of kindling and litter size at birth were the most important non-genetic factors influencing all litter traits significantly (P< 0.05 and P< 0.01) in the three breeds studied.*
4. *Repeatability estimates of most pre-weaning litter traits were of moderate values.*
5. *Phenotypic correlation coefficients between each of litter traits were positive and of low to mderate magnitudes.*

Key words: *pre-weaning litter traits, repeatability, correlation, rabbits.*

Introduction

Californian, New Zealand White and Bauscat rabbit strains were introduced to Egypt at 1991. Under intensive production and housing system, it was worthy to evaluate the size and weight of the litter, as determinant traits of the doe productivity under the conditions of Sharkiya Governorate during two successive years (1991/92 and1992/93).

Materials and Methods

The data sets in this study came from the San-El-Hagar Agricultural Company Farm, San El-Hagar, Sharkiya Governorate, Egypt during two successive years (1991/ 92 and 1992/ 93). The animals were confined in metal cages, flat deck system, in a closed air conditioned building where the internal temperatures varied from 18 to 31°C.

The data set used to study the effects of sire, doe within sire, parity, litter size at birth, year and month of kindling and year x month of kindling interaction. After sorting of the data 3571 parturitions (94 Cal, 311 NZW and 384 Bos purebred does) were used. Females were mated, at the buck's cage and logged individually (6: 1 does : buck ratio). Sire-daughter, full and half sib and parent-offspring matings were avoided to reduce inbreeding. Bucks were allocated to the does at random. The animals were reared under similar environmental conditions. They were fed *ad libitum* on a commercial ration composed of 18% CP, 3% EE, 14% CF, 2% mineral mixture (1% Ca, 0.7% P and 0.3 Na) and 63% soluble carbohydrates. The DE was 2600 K.cal / kg ration. Constant fresh water was provided from automatic drinkers with nipples. Number and weights of rabbits of each litter were recorded, at parturition (within 12 h after kindling), at 21 and 30 days of age (weaning age). All weights were recorded to the nearest gram.

The data were analysed separately for each of Cal, NZW and Bos breed rabbits by using the least-squares and maximum likelihood computer program (Harvey, 1990). The data were sorted according to sire-daughter (paternal half-sister) group and only data on litters produced by does with sires having at least two daughters (does) were included in the statistical analysis.

Litter traits studied were litter weight at birth (LWB), Litter weight at 21 days (LW21D), litter weight at weaning (LWW), litter weight gain from birth to 21 days (LWG 21 D), litter weight gain from birth to 30 days (LWG 30 D), milk yield from birth to 21 days (MY 21D), bunny weight at birth (BWB), bunny weight at 21 days (BW21), bunny weight at weaning (BWW), daily weight gain from birth to 21 days (DWG 21 D), daily weight gain from birth to 30 days (DWG 30) and viability from birth to 21 days (V 21 D) and from birth to 30 days (V 30 D).

Doe milk consumed by the pups from birth up to 21 days of age was estimated by the following equation:

Y= Litter weight gain (g) during the period 0-21 days / 0.56.

where: Y was the doe milk consumed by pups during the period 0-21 days of age, 0.56 was standard figure given by Cowie (1969) for the NZW strain and Partridge and Allan (1982) for crossbred does depending on the linear relationship between the litter weight gain (kg) and doe milk consumed (kg).

A mixed model (Model type - 4 of

Harvey, 1990) including sire of the doe and the doe within sire as random effects, as well as, year (YK) and month of kindling (MK), YK x MK interaction, parity (PR) and litter size at birth (LSB) as fixed effects were adapted.

Repeatability estimates were computed as the following formula:

$$t = s^2_S + s^2_{D:S} / s^2_S + s^2_{D:S} + s^2_W$$

where $s^2_S + s^2_{D:S}$ estimates the sum of genetic and permanent environmental variance among does and s^2_W estimates temporary environmental effects associated with each litter. Estimates of phenotypic correlation coefficients were obtained by LSML - 76 program of Harvey (1990). Records of pre-weaning viability percentage were subjected to arc - sin transformation before being analysed to approximate normal distribution.

Results and discussion

MEANS AND VARIANCE OF UNCORRECTED DATA:

The coefficients of variation for litter weight traits in the present study were found to increase by the advancement of age in NZW and BOS rabbits. However, in Cal breed rabbits it was higher at birth than at 21 days but highest at weaning (Table 1). Similar results were reported by Lukefahr (1982), Khalil *et al.* (1987), El- Maghawry *et al.* (1988) and Afifi *et al.* (1992) who observed higher coefficients of variation at weaning than at birth. This was attributed to differences in litter losses during the suckling period and to differences in postnatal growth of the litter-mates up to weaning caused by differences in their genotypes and in milk production of their dams during the suckling period (Afifi *et al.,* 1992). Selection may be suggested as an effective tool to a greater imorovement in case of higher variability values in litter weight beside the good management. Data presented in Table 1 show that the means of doe litter traits of NZW and BOS rabbits were similar and of better values than the corresponding values in Cal ones. However, the BOS rabbits surpassed the other two breeds in daily weight gain, while the Cal does were of higher variability at 21 and 30 days of age.

NON-GENETIC EFFECTS:

The effect of year kindling was significant ($P< 0.05$, 0.01 or 0.001) on most traits studied in NZW and BOS does, but less affected in Cal ones (Table 2). The restricted sample size and the number of records used in Cal rabbits may be a determined effect beside the environmental and genetic effects mentioned by Virllon *et al.* (1979).

Table 1. Means, standard deviations (SD) and coefficients of variation (CV) of preweaning litter traits studied in Cal, NZW and Bos rabbits (uncorrctedrecords).

Traits	Breeds					
	Cal		NZW		BOS	
	$\bar{x}$ ± S.D.	C.V. (%)	$\bar{x}$ ± S.D.	C.V. (%)	$\bar{x}$ ± S.D.	C.V. (%)
:LWB	397.65 ± 128.84	20.78	403.78 ± 111.04	16.27	409.37 ± 126.11	17.60
LWZID	1682.70 ± 470.72	18.37	1740.45 ± 501.08	20.71	1764.86 ± 497.63	20.19
LWW	3217.34 ± 1098.45	24.35	3352.21 ± 1219.64	26.15	3404.01 ± 1185.72	25.75
LWG2ID	1285.05 ± 414.14	24.00	1336.66 ± 446.06	25.66	1355.49 ± 434.49	24.87
LWG30D	2819.68 ± 1038.80	27.49	2948.42 ± 1165.52	29.14	2994.64 ± 1123.27	28.56
MY21D	2294.71 ± 739.55	23.99	2386.89 ± 796.53	25.66	2420.52 ± 775.85	24.87
BWB	54.55 ± 13.26	21.33	57.83 ± 13.02	21.12	57.97 ± 12.47	19.38
BW21D	287.67 ± 75.37	20.05	302.16 ± 85.71	21.55	308.71 ± 90.12	21.50
BWW	546.56 ± 134.42	21.88	569.87 ± 156.99	24.55	581.69 ± 157.71	25.21
DWG21D	11.06 ± 4.61	39.08	11.53 ± 3.83	26.66	11.85 ± 4.06	26.64
DWG30D	16.53 ± 4.77	24.92	17.91 ± 5.35	23.01	18.22 ± 5.13	23.19
V21D	86.47		84.53		83.43	
V30D	84.20		80.94		79.97	

Table 2. Statistical significance at P < 0.05 (*), 0.01 (**) and 0.001 (***) for different preweaning litter traits of Cal, NZW and Bos rabbits.

Traits	Cal							NZW							BOS						
	Sire	Doe:Sire	PR	LSB	YK	MK	YK.MK	Sire	Doe:sire	PR	LSB	YK	MK	YK.MK	Sire	Doe:sire	PR	LSB	YK	MK	YK.MK
LWB	ns	xxx	ns	xxx	ns	xxx	ns	ns	xxx	xx	xxx	ns	xxx	xx	ns	xxx	xx	xxx	ns	xxx	xx
LW21D	ns	xxx	xxx	xxx	ns	xxx	x	ns	xxx	xxx	xxx	xxx	xxx	xxx	ns	xxx	xxx	xxx	xxx	xxx	xxx
LWW	ns	ns	xx	xxx	ns	xx	xxx	ns	xxx	ns	xxx	xxx	xxx	xxx	ns	xxx	ns	xxx	xxx	xxx	xxx
LWG21D	ns	xx	xx	xxx	ns	xx	ns	ns	xxx	xxx	xxx	xxx	xxx	xxx	ns	xxx	xxx	xxx	xxx	xxx	xxx
LWG30D	ns	ns	xx	xxx	x	xx	xxx	ns	xxx	ns	xxx	xxx	xxx	xxx	ns	xxx	ns	xxx	xxx	xxx	xxx
MY21D	ns	xx	xxx	xxx	ns	xx	ns	ns	xxx	xxx	xxx	xxx	xxx	xxx	ns	xxx	xxx	xxx	xxx	xxx	xxx
BWB	ns	xx	ns	xxx	ns	ns	ns	ns	ns	ns	xxx	ns	xxx	ns	ns	xx	ns	xxx	ns	xxx	ns
BW21D	ns	xx	ns	xxx	ns	x	ns	ns	xxx	x	xxx	x	xxx	x	ns	xxx	ns	xxx	ns	xxx	x
BWW	ns	x	ns	xxx	ns	ns	x	ns	xx	ns	xxx	ns	xxx	xx	ns	ns	ns	xxx	xx	xxx	xxx
DWG21D	ns	ns	ns	xxx	ns	ns	ns	ns	xxx	ns	xxx	x	xxx	xx	ns	xxx	ns	xxx	ns	xxx	ns
DWG30D	ns	xx	ns	xxx	ns	ns	x	ns	xxx	ns	xxx	ns	xxx	xxx	ns	xxx	ns	xxx	xx	xxx	xxx
V21D	ns	xx	x	xxx	ns	ns	ns	ns	xxx	ns	xxx	ns	xxx	xxx	ns	ns	ns	xxx	ns	xxx	xxx
V30D	ns	ns	ns	ns	ns	ns	ns	ns	xxx	ns	xxx	xx	xxx	xxx	ns	xxx	ns	xxx	xx	xxx	xxx
DF	13	80	9	7	1	11	11	38	272	9	7	1	11	11	46	337	9	7	1	11	11

ns = not significant

Month of kindling and month x year interaction effects were found to be significant (P< 0.01 or 0.001) on most litter traits studied in the three breeds (Table 2). Luckefahr *et al.* (1983), El-Maghawry *et al.* (1988), Moura *et al.* (1991), Afifi *et al.* (1992) and Khalil (1993) reported significant effects (P< 0.05, 0.01 or 0.001) for month of kindling on preweaning litter traits at different breeds of rabbits. However, month of kindling effects were found to be non- significant on litter weight at birth, 21 days and at weaning age by Afifi and Khalil (1986), Lukefahr *et al.* (1983) and El-Maghawry *et al.*(1988) respectively. Khalil (1993) claimed that litter of doe rabbits in Egypt are highly season - spesific and less well-characterized across seasons.

The results presented in Table 2 showed that the differences among paroties were significant (P< 0.05, 0.01 or 0.001) in some of the traits studied in Cal, NZW and BOS doe rabbits. Castellini and Panella (1988) with NZW rabbits found that parity showed highly significant effects at 16 days (average of litter weight and 28 day (individual weight at weaning). Khalil and Afifi (1986) and Moura *et al.* (1991) showed a significant effect (P< 0.01 or 0.001) for parity on mean bunny weight at weaning in Bauscat and Giza White rabbits. However, the differences due to parity in litter traits were not significant were reported by Afifi *et al.* (1982) in Giza White, El-Maghawry *et al.* (1988), Zucchi and Desalvo (1988) in NZW and Cal rabbits and Khalil (1993) in Giza White rabbits.

Data in Table 2 showed that litter size at birth is an important non-genetic factor affecting (P< 0.001) all pre - weanig litter traits in doe rabbits. Similar results were obtained by Kawinska and Niedzwiadek (1967), Rao *et al.* (1977), Khalil and Afifi (1986) and El- Maghawry (1990) at different pre - weaning ages in various rabbit breeds.

RANDOM EFFECTS:

The results from a combined least- squares analysis of variance showed that the effects of sire of the doe on litter traits studied were not significant (Table 2). This may be due to that sires did not prove to be important because no selection was carried out among sires and improvement in litter traits could be achieved through selection of the sires based on their daughters performance. Similar to the present study, El- Maghawry (1990) showed that the effects of sire of the doe on litter traits were not significant in NZW and Cal breed rabbits.

Differences among does within sires constituted significant (P< 0.05, 0.01 or 0.001) source of variation in most traits of this work, except LWW, LWG 30 D, DWG 21 D and V 30 D in Cal breed, BWB in NZW breed and BWW and V 21 D in BOS ones (Table 2). Randi and Scassiroli (1980) reported the significant doe effects on litter traits might be due to doe differences in ovulation rate and maternal effects determined by the number of mature, fertilized, established Ova and the environment that the doe provides her litter and the genes she transmitts to her offspring in addition to milk production during the suckling period. Afifi *et al.* (1992) suggested that the non- significant doe effects on litter traits may possibly be due to masking of the full genetic expression of doe by systems of feeding and management practices and maternal effects from one year to another concerning kindling of rearing of does in litters different in size and weight. The results of this study showed that the doe within sire variance component contributes to a great extent in the phenotypic value of her litter traits by its genetic potential and her maternal environment she supported as well, Rouvier, *et al.* (1973), Garcia *et al.* (1982) and Afifi *et al.* (1992). However, the contribution of LSB was strongly effective on pre-weaning traits. The contribution was very pronouced at birth and decreased gradually up to weaning concerning litter weight, but showed the highest effect on bunny weight and gain at 21 days in both NZW and BOS, and less effect in Cal breed concerning the same latter traits, the present results may support the dependence on the does (dams of the litter) for the improvement of litter traits up to weaning and their selection according to their own performance or their own selection of sires of the does on their daughters performance.

REPEATABILITY:

The repeatability estimates of different traits for Cal, NZW and BOS breeds are given in Table 3. These results indicate that all doe litter traits were of modernate or low repeatability. Low and moderate repeatability values were reported on rabbits by Suh *et al.* (1978), Lukefahr *et al.* (1984), Khalil *et al.* (1988), Afifi *et al.* (1992) and Khalil *et al.* (1993). Culling of does for litter weight of moderate values, based on single record at 21 days of age concerning litter weight, litter weight gain and milk yield may be reconmended in the three breeds of the present study.

PHENOTYPIC CORRELATION

Phenotypic correlation coefficients between different litter traits in Cal, NZW and BOS rabbits were mostly positive and of high to moderate magnitude, but tended to decrease as the time intervals between

Table 3. Repeatability ± S.E. and phenotypic correlation coefficients values among preweaning litter traits based on paternal half-sibs.

Items	Breeds	LWB	LW21	LWW	LWG21	LWG30	MY21	BWB	BW21	BW30	DWG21	DWG30	V21	V30
"t" values	C	0.21±0.05	0.19±0.05	a	0.15±0.05	a	0.15±0.05	0.14±0.05	0.18±0.05	0.08±0.04	0.06±0.04	0.11±0.04	0.11±0.05	a
	N	0.13±0.02	0.17±0.03	0.13±0.02	0.16±0.03	0.13±0.03	0.16±0.02	0.01±0.02	0.11±0.03	0.07±0.02	0.09±0.02	0.16±0.03	0.08±0.02	0.10±0.03
	B	0.09±0.02	0.16±0.02	0.16±0.02	0.16±0.02	0.08±0.02	0.16±0.02	0.04±0.02	0.08±0.02	0.02±0.01	0.06±0.02	0.06±0.02	0.02±0.02	0.08±0.03
"r_p" values	C		0.20	0.20	-0.06	0.10	-0.06	0.15	0.02	0.11	-0.18	0.02	0.13	-0.02
LWB	N		0.36	0.30	0.20	0.23	0.20	0.45	-0.07	-0.04	-0.16	-0.09	0.31	0.29
	B		0.39	0.32	0.21	0.25	0.21	0.44	-0.08	-0.05	-0.17	0.11	0.24	0.24
	C			0.56	0.97	0.54	0.97	0.13	0.25	0.0	0.30	0.02	0.54	0.18
LW21	N			0.57	0.98	0.56	0.98	0.19	0.23	-0.01	0.23	-0.04	0.62	0.57
	B			0.57	0.98	0.57	0.98	0.23	0.23	-0.05	0.22	-0.02	0.46	0.60
	C				0.51	0.99	0.52	0.08	0.17	0.30	-0.06	0.32	0.58	0.27
LWW	N				0.55	0.99	0.55	0.15	-0.14	0.18	-0.14	0.32	0.57	0.66
	B				0.56	0.98	0.56	0.15	-0.13	0.18	-0.14	0.34	0.41	0.64
	C					0.53	1.00	0.09	0.25	-0.03	0.35	0.01	0.52	0.19
LWG21	N					0.54	1.00	0.11	0.25	0.01	0.28	-0.03	0.60	0.55
	B					0.55	1.00	0.15	0.26	-0.04	0.26	0.00	0.44	0.56
	C						0.53	0.06	-0.18	0.29	-0.04	0.32	0.57	0.28
LWG30	N						0.54	0.12	-0.13	0.19	-0.13	0.34	0.56	0.66
	B						0.55	0.12	-0.13	0.19	-0.13	0.36	0.40	0.63
	C							0.09	0.25	-0.03	0.35	0.01	0.52	0.19
MY21	N							0.11	0.25	0.01	0.28	-0.03	0.60	0.55
	B							0.15	0.26	-0.04	0.26	0.00	0.44	0.56

Cont.

Items	Breeds	LWB	LW21	LWW	LWG21	LWG30	MY21	BWB	BW21	BW30	DWG21	DWG30	V21	V30
	C								0.04	0.07	-0.01	0.10	0.13	0.02
BWB	N								0.02	0.02	0.02	0.03	0.13	0.13
	B								0.10	0.04	0.05	0.05	0.05	0.10
	C									0.21	0.60	0.28	-0.48	-0.13
BW 21	N									0.20	0.97	0.38	-0.49	-0.41
	B									0.20	0.98	0.43	-0.43	-0.42
	C										0.07	0.67	-0.15	-0.34
BW30	N										0.19	0.38	-0.16	-0.19
	B										0.19	0.43	-0.17	-0.21
	C											0.18	-0.42	-0.06
DWG21	N											0.38	-0.46	-0.40
	B											0.43	-0.43	-0.43
	C												-0.18	-0.34
DWG30	N												-0.31	-0.36
	B												-0.27	-0.36
	C													0.26
V21	N													0.88
	B													0.67
	C													--
V30	N													--
	B													--

C= Cal, B= Bos, N= NZW

the correlated traits increased (Table 3). The estimates between litter weight at 21 days were positively and highly significant correlated and ranged from moderate to high magnitude with most of the doe traits, but were not significantly correlated with bunny weight and daily weight gain at weaning in the three breeds studied. This may indicate that selection based on litter weight at 21 days may be improved by milk yield and better viability in Cal, NZW and BOS rabbits. Nearly similar phenotypic correlation coefficients were obtained by Rouvier *et al.* (1973), Lahiri and Mahajan (1982), Khalil *et al.* (1988) and Afifi *et al.* (1992). The phenotypic correlation coefficients in the present study revealed that daily weight gain may not be recommended as a selection criterion because of its significant negative correlation or non-significant phentoypic correlation values with the other litter weight traits.

Conclusion

It may be concluded that, the litter weight at 21 days of age could be a good criterion for selection to improve the litter weight and viability up to weaning in rabbits. The high correlation between litter weight and milk yield would support this conclusion.

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