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Litter Weight in Three Breeds of Rabbits and their Crosses

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Litter weight at birth and at weaning at four weeks of age were investigated with three breeds of rabbits (Bauscat, Chinchilla, and Giza White) and their crosses located at the Experimental Farm of the Faculty of Agriculture, Ain Shams University at Shoubra Al-Kaima. Data were available on 499 litters kindled during three consecutive production seasons from 1965/66 to 1967/68, inclusive.

The overall means of litter weight in 1965/66, 1966/67 and 1967/68 seasons, respectively, were 352.3, 274.6, and 281.6 g at birth; 1891.3, 1105.6,and 1262.8 g at weaning at four weeks of age.

Breed group effecs were not significant on litter weight at birth, while they were significant on litter weight at weaning in 1966/67 and 1967/68 seasons only.

In general, hybrid vigour was associated with both crossbred litters and crossbred mothers.

Differences in litter weight due to maternal and sex-linked effects as well as those due to age of doe effects were not significan either at birth or at weaning age.

Litter weight both at birth and at weaning dificient with parity but not similarly in the three seasons of the study. Parity effects on the two traits attained significance only in 1965/66 season.

Litter weight both at birth and at weaning were found to increase significantly with the increase of the doe's weight in both 1965/66 and 1967/68 seasons.

The data of litter weight at birth and at weaning were analysed once more after neglecting the effect doe's weight and the general findings seemed to be similar to those summarized above. The same data were also analysed as a function of litter size in addition to those factors included in the first analysis. The results, in this case, revealed that litter size at birth was the most important factor affecting litter weight at birth and that litter size at weaning was a major source of variation in litter weight at weaning. Differences in the results between this analysis and the other two analyses were discussed in the text.

The economic efficiency of a doe is greatly determined by the weight of the litters she produces. The objective of this study was to compare the performance of three breeds of rabbits and their crosses and to study the effects of some environmental factors on litter weight at birth and weaning.

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Material and Methods

This study involved data on three purebred groups of rabbits, *viz*, Bauscat (BB) Chinchilla (CC), and Giza White (GG); and all the six possible single crosses among these breeding groups, *viz*., Bauscat-Chincilla (BC), Bauscat-Giza White (BG), Chinchilla-Giza White (CG), and their reciprocals (CB, GB and GC). Also two duoble crossbred groups resulting from the mating of CB bucks to GB does and its reciprocal were included in the study. A total of 499 litters produced at the Experimental Farm of the Faculty of Agriculture, Ain Shams University at Shoubra Al-Khaima during three consecutive seasons 1965-1968 inclusive. In the *1st* (1965/66) season only litters of the three pure breeds were obtained. While in both the *2nd* (1966/67) and *3rd* (1967/1968) seasons, litters of the three pure breeds as well as those of the single crosses were produced. The double crossbred litters were obtained only in the *3rd* season.

Details of the mating plan and management were given by Afifi *et al*. (1973).

Least squares estimates of factors were obtained on a within season basis as outlined by Harvy (1960), for)litter weight both at birth and at weaning. Constants were fitted for a model including the effects of breeding group, age of doe, parity (litter sequence) and regression of litter weight on doe's weight.

Results and Discussion

Litter weight at birth

The general means for litter weight at birth was computed as 352.3, 274.6, and 281.6 gm for the *1st*, *2nd*, and *3rd* seasons of study, respectively (Table 1).

Within pure breeding groups, the heaviest litter weight at birth was exhibited by GG rabbits in both the *1st* and *3rd* seasons (264.7 and 313.0 g, respectively), but by BB rabbits in the *2nd* season (307.4 g). The ranking of the pure breeding groups with respect of this trait was similar to that shown in litter size birth of the same date (Afifi *et al*., 1976) and this suggests the importance of the variation in litter size at birth on that of litter weight at birth.

Table 1 shows that all crossbred groups except BC, GB and GC of the *3rd* season exhibited hetrosis. In general, these findings denote the presence of heterotic effects on litter weight at birth which were reported by terentjeva (1966).

Crossbred litters produced by crossbred does (300.9 g) weighed more than crossbred litter produced contemporaily by purebred does (276.8 g). This might indicate the effect of crossbreeding on improving maternal environment on litter weight at birth and that a major part of heterosis was obtained when does were crossbred rather than when litters themselves were crossbred.

TABLE 1. Least squares estimates of factors affecting litter weight at birth.

Classification	Season 1965/66			Season 1966/67				Season 1967/68			
	N	Const. (g)—S.B	DMRT[a,b]	N	Const. (g)±S.E.	DMRT	R%	N	Const. (g)±S.E.	DMRT	R%
General moan	90	352.3 ± 11.6		161	274.6±9.0			248	281.6±6.4		
parity											
1*st*	34	−60.8 ± 18.6	a	35	2.3±20.8	abc		53	−7.1±14.8	a	
2*nd*	33	38.6 ± 18.2	b	31	23.6±20.7	ac		50	1.0±14.7	a	
3*rd*	23	22.3 ± 20.5	b	27	−32.1±17.9	bd		50	−2.1±13.3	a	
4*th*				25	−28.7±18.9	ab		40	−1.4±13.3	a	
5*th*				19	33.5±13.6	cd		25	−8.3±19.3	a	
6*th*				24	1.3±21.7	abc		30	17.8±18.0	a	
age of doe											
1*st* age				90	18.6±15.0	a		157	14.1±11.5	a	
2*nd* age				71	−18.6±15.0	a		91	−14.1±11.5	a	
Bread groupe											
BB	18	2.3 ± 22.0	a	19	32.8±19.8	a		24	−6.7±17.7	abc	
CC	43	−14.7 ± 18.3	a	16	−40.6±20.8	b		19	−34.2±19.7	b	
GG	29	12.4 ± 20.3	a	15	−26.9±21.6	ab		13	31.4±23.7	abc	
BC				18	2.2±19.7	ab	2.25	17	−34.8±20.6	ab	−5.49
CB				21	12.8±18.4	ab	6.17	22	−18.4±18.4	abc	0.78
BG				17	11.5±20.4	ab	3.08	16	27.4±21.8	abc	5.12
GB				17	13.8±20.2	ab	3.91	24	−20.9±17.6	abc	−1.31
CC				20	−10.5±18.8	ab	9.65	15	37.7±22.7	abc	14.00
GC				18	4.9±19.4	ab	16.05	17	−20.0±20.6	abc	−6.64
CB—GB								39	29.6±15.6	c	12.10
GB—CB								42	9.0±15.3	abc	4.68
Reg. on doe's weight		0.99±0.034		—	0.016±0.024			—	0.094±0.20		

a : Duncan new multiple range test (1955).

b : Within the same classification, the apperance of the same letters with 2 constants signifies that they do not differ significantly (5% level), otherwise they do.

c : The breeds were symbolized as : Bauscat = B, Chinchilla = C and Giza white = G The symbol of breed of buck is listed before that of the doe.

Estimates of crossbred groups demonstrated that the difference between each cross and its reciprocal was statistically non-significant in both the 2*nd* and 3*rd* seasons (Table 1). These observations might indicate that maternal and sex-linked effects expressed in the differences between reciprocal crosses are of minor impartance on litter weight at birth.

Results summarized in Table 1 illustrate that does in their 1*st* production season (of the first age group) gave their litters with heavier weights than litters kindled by does in their 2*nd* production season (of the 2*nd* age group), but the differences were not statistically significant (Tables 1 and 2). This is in accordance with the findings of Casady *et al.* (1962). With respect to the effect of age of dam on birth litter weight different conclusions were reported by other workers. Rollins *et al.* (1963) suggested an age-of-dam effect on litter weight.

The mean of litter weight at birth was found to vary with parity (Table 1). Data of both the 1*st* and 2*nd* seaons indicated that litter weight at birth was low at the beginning of the season (1*st* parity in the 1*st* season, and 1*st* and 4*th* parities in the 2*nd* season), increased for litters produced during the middle of the season (2*nd* parity in the 1*st* season, and 2*nd* and 5*th* parities in the 2*nd* season), then slightly decreased at the end of the season (3*rd* parity in the 1*st* sason, and 3*rd* and 6*th* parities on the 2*nd* season). In the 3*rd* season, litter weight at birth did not show similar trends except for those of the 1*st* three parities. These observations showed a general tendency for litter weight at birth to increase as the production season advanced and to decrease slighthy at the end of the season. It seems that the factors which played a role in expressing this trend were more or less of nutritional and climatic origins. At the beginning of the production season, the green fodder (Egyptian clover) for the pregnant does is not available in enough quantities and of lesser nutritive value, while as the season advances it becomes more abundant and of higher nutritive value. Also, the weather conditions become milder. At the end of the season, there is a lack in the green fodder and the weather becomes warmer.

The analysis of variance showed that differences in birth litter weight due to the effect of parity were statistically highly significant in the 1*st* season but they proved non-significant in either the 2*nd* or the 3*rd* season (Table 2). These findings are similar to those observed on the same data for the effect of parity on litter size at birth (Afifi *et al.* 1976). This may probably be due to that in the 1*st* season pregnancies in each parity occurred nearly during a distinct time of the season, while in the other two seasons, the time of the pregnancy of each parity overlaped with that of the other parities.

The regression coefficient of litter weight at birth on doe's weight was 0.099, 0.016, and 0.94 g for the 1*st*, 2*nd* and 3*rd* seasons, respectively, only the 1*st* and the 3*rd* coefficients being significant (Table 1 and 2). Wanis (1958) showed that litter weight at birth was affected significantly by the dam's weight.

TABLE 2. Least squares analysis of variance for litter weight at birth

Source of variation	Season 1965/66			Season 1966/67			Season 1967/68		
	D.F.	Mean square	% of variation	D.F.	Mean square	% of variation	D.F.	Mean square	% of variation
Parity . .	2	89356.67**	14.4	5	16709.66	5.1	5	2382.68	0.0
Age of doe	—			1	11626.31	2.9	1	11787.12	1.6
Breed group	2	5864.45	0.0	8	8107.14	0.4	10	12094.71	2.6
Reg.on doe's weight	1	127343.54**		1	3550.98		1	180595.52**	
Residual .	84	15378.15	85.6	145	7572.03	91.6	230	7829.08	95.8

** Significant at 1 % level.

Data of litter weight at birth was reanalysed using another model including the effects of breeding group, age of doe, and parity, *i.e.* after ommiting the regression on the doe's wetght. The aim being to study the merits of the breeding groups as such without excluding the effect of doe's weight which was taken as a breed characteristic. Findings showed that the means of breeding groups differed but had the same general trends. As a result, the mean litter weight at birth obtained from BB and CC females become higher, while those produced by GG females were decreased. Also, a wider difference was observed between the GB-CB group and its reciprocal. These changes may probably be a reflection of the effects of doe's weight being positively correlated with litter weight at birth.

In order to examine to what extent litter weight at birth was affected by the number of youngs born per litter, the data were submitted to a 3*rd* model of analysis including the effects of litter size at birth in addition to those factors included in the 1*st* model. Pertinent observations, showed that factors which are related to litter size, *e.g.* doe's weight, doe's age, and parity exhibited less pronounced effects. Also, they demonstrated that litter weight at birth increased significantly with the increase of birth was the most important factor contributing to the variation of litter weight at birth. In this concern El-Khisin *et al.* (1951) stated that litter weight at birth increased significantly with the increase of litter size at birth in both Giza White and Bauscat rabbits. These results coupled with those of this analysis confirm the importance of litter size at birth on the variation of litter weight at birth.

Litter weight at weaning

The mean weight of litter at weaning at four weeks of age was 1891.3, 1105.6, and 1262.8 g for the 1*st*, 2*nd* and 3*rd* seasons, respectively (Table 3). However, litter weight at weaning in the 1*st* season was markedly the heaviest relative to the other two seasons.

TABLE 3. ast squares estimates of factors affecting litter weight at weaning at weeks of age.

Classification	Season 1965/66			Season 1966/67				Season 1967/68			
	N	Const. (g)±S.E.	DMRT[a,b]	N	Const.(g) ±S.E.	DMRT	N%	N	Cost. (g)±S.E.	DMRT	N%
General mean	78	1891.3±54.5		104	1105.6± 30.8			198	1262.8± 11.5		
Parity											
1*st*	28	60.5±85.7	ab	18	48.8±153.9	a		42	145.9± 78.4	a	
2*nd*	28	160.2±83.4	a	25	—74.5±135.8	a		43	91.3± 76.1	ab	
3*rd*	22	—220.7±89.8	b	18	—43.0±123.5	a		36	—60.7± 71.1	ab	
4*th*				12	—98.4±141.0	a		30	—158.6± 71.6	b	
5*th*				14	187.0±164.2	a		21	6.2± 99.4	ab	
6*th*				17	—19.8±153.7	a		26	—24.1± 92.3	ab	
Age of doe											
1*st* age				59	82.5±103.1	a		122	—109.9± 61.5	a	
2*nd* age				45	—82.5±103.1	a		76	109.9± 61.5	a	
Breed group[c]											
BB	14	21.5±106.0	a	18	172.0±119.8	ac		22	—65.9±87.4	a	
CC	37	—111.1±83.9	a	9	—145.2±163.5	ab		12	—62.0±114.5	ac	
GG	27	89.6±94.2	a	9	—360.2±159.1	b		10	—33.2±126.6	abc	
BC				8	—8.4±165.9	ab	—1.95	11	57.5±118.5	ac	10.13
CB				16	245.6±122.8	ac	20.75	15	98.0±104.6	ac	13.51
BG				11	—15.6±149.1	ab	7.76	12	132.8±122.1	ac	15.03
GB				12	333.3±138.2	a	42.25	19	46.9± 92.5	ac	7.95
CG				8	—49.3±166.5	ab	23.85	14	—77.2±111.4	ac	—2.44
GC				13	—172.1±132.4	bc	9.45	14	—411.7±105.6	b	-29.96
CB-GB								37	215.6± 78.7	cd	22.59
GB-CB								32	99.2± 84.2	ad	12.94
Reg. on does weight	—	0.697±0.179		—	—0.104± 0.163			—	0.208±0.105		

a : Duncan new multiple range test (1955).

b : Within the same classification, the appearance of the same letter with X constant signifies that they do not differ significantly (5% level), otherwise they do.

c : The breeds were symbolised as : Bauscat=B, Chinchilla=C and Giza, G. the svmbol of breed of buck is listed before that of the doe.

Results obtained on the same data, showed that there were no considerable differences in litter size at birth among the three seasons (6.37, 5.89, and 5.89 youngs, respectively), but indicated marked differences in mortality percent per litter from birth to weaning between the 1*st* (12.3%) and the other two seasons (60.0 and 35.5%, respectively). Also, the average individual weight per litter at birth in the 1*st* season (58.89) was the heaviest relative to the other two seasons (49.0 and 49.6 g, respectively). These results together with those of the overall mean of litter weight at weaning show that the average individual weight per litter at birth and mortality percent per litter during the suckling period were important factors in determinging litter weight at weaning.

Figures illustrated in Table 3 reveal that each of the pure breeding groups and most of the crossbred groups exhibited different weights for the litters at weaning in the three seasons. This may mainly be due to differences in litter losses which will be discussed in details in another paper. Means of weaning litter weight of the purebred groups showed a tendency to be lower in the 2*nd* season than in either the 1*st* or 3*rd* season, and that the GG group was the most affected. Meanwhile, these obserbations could indicate some sort of breed by season interaction.

Among the pure breeds, the highest ranking litters, were those of GG rabbits in the 1*st* and 3*rd* seasons and those of BB rabbits in the 2*nd* season. Constants representing the effects of breeding groups of this study, indicated that the ranking of these groups for litter weight at weaning differed from one season to another, more so than did litter weight at birth (Tables 1 and 3). This may probably be due to differences in total litter weight gain attained during suckling period.

The analysis of variance demonstrated that breeding group effects on litter weight at weaning were significant in the 2*nd* season, highly significant in the 3*rd* season, but lacked significance in the 1*st* season (Table 4).

Data presented in Table 3 revealed that of the six single crosses produced four or more crosses showed evidence of heterotic effects in litter weight at weaning in both the 2*nd* and 3*rd* seasons. There was also heterotic effects exhibited by the double cross litters obtained in the 3*rd* season. These results suggest the presence of heterosis in weaning weight of the cross bred litters.

The weaning weight of the double crossbred litters, produced only in the 3*rd* season, exceeded that of the single crossbred litters obtained in the same season. The average of the means of the litter weight at weaning was estimated to be 1420.2 g for the double cross litters and 1237.2 g for the single crossbreds. The superiority of the weaning weight exhibited the crossbred litters produced by the crossbred does relative to that of the crossbred litters produced by purebred does may have resulted from superiority in their weight at birth as shown before, and probably to the more milk produced and the better care provided by the crossbred does.

TABLE 4.Least squares analysis of variance for litter weight at weaning at 4 weeks of age

	Season 1965/66			Season 1966/67			Season 1967/68		
	D.F.	Mean square	%of variation	D.F.	Mean square	% of variation	D.F.	Mean square	% of variation
Parity . . .	2	907433.10*	8.6	5	133391.60	0.0	5	318409.19	2.6
Age of doe	—			1	155787.99	0.0	1	539119.18	8.0
Breed group	2	287078.08	0.2	8	529663.43*	9.9	10	436373.74**	8.1
Reg. on doe's weight	1	4138278.22**		1	98946.27		1	671279.34*	
Residual .	72	273687.34	91.2	88	243065.41	90.1	180	169070.36	81.3

* Significant at 5 % level.
** Significant at 1 % level.

Results listed in Table 3 indicated that in both the 2*nd* and 3*rd* seasons, the difference between any two reciprocal crosses in the weaning weight of litter was statistically non-significant, except between GG and GG crossbred* litters of the 3*rd* season. Therefore, maternal and sexlinked effects on litter weight at weaning seemed to be negligable.

Findings obtained illustrated that litter weights at weaning age for litters produced by does of the first age group (does in their 1*st* production season) were heavier than those produced by does of the second age group (does in their 2*nd* production season) in 1966/67 season, but the reverse was found in 1967/1968 season (Table 3). Differences in both seasons had not reached significance (Table 4). Therefore, age of dam seemed to be of minor importance in affecting the variation of the litter weight at weaning. This conclusion is in accordance with that of Casady *et al.* (1962) who found that litter weight was not affected by age of the doe.

Results on the effect of parity on litter weight at weaning age did not show any consistent trend (Table 3). The analysis of variance presented in Table 4, showed that parity effects on litter weight at weaning were significant ($P < 0.5$) in the 1*st* season, but did not prove signficant in both the 2*nd* and 3*rd* seasons.

Estimates of the regression of litter weight at weaning age on doe's weight showed that for each 100 g increase in the doe's weight the mean of litter weight at weaning increased by 69.7 and 20.8 g in the 1*st* and 3*rd* seasons, respectively, while decreased by 10.5 g in the 2*nd* season (Table 3). The conflicting results obtained in the 2*nd* season, probably be due to the great losses in litters that occurred shortly before weaning in that season as a result of a case diagnosed as vitamin and mineral deficiency. The analysis of variance offered and indication that litter weight at weaning was affected significantly by dam's weight in the 1*st* season ($P < .01$) and 3*rd* season ($P < .05$), but not significantly in the 2*nd* season (Table 4). Wanis (1958) reported a positive but not signifiant correlation between litter weight at weaning and the weight of the doe ($r = 0.0549$) with Giza White rabbits.

Data of litter weight at weaning were analysed once more for the effect of the same factors included in the analysis discussed above except for those of the doe's weight which was considered as a breed characteristic. For reasons similar to those of the analysis of litter weight at birth, a model excluding the regression on doe's weight was used. Pertinent results showed that different constants changed in value but more or less had the same trends as the 1*st* analysis. The only distinct difference was that the age of dam proved highly signifcant effects in the 3*rd* season.

A 3*rd* analysis for the data was undertaken to study the effects of litter size at birth and at weaning in addition to the effects of all the factors included in the 1*st* model. Estimats of the effects of breeding groups, age of doe, parity, and regression on doe's weight of this analysis, showed some changes in their values when compared with their correspondings in the 1*st* analysis. Differences between breeding groups lacked significance as compared with the 1*st* analysis. This could indicate that the breeding groups manifested their effects on litter weight at weaning *via* their effects on litter size. The same was also observed for the effect of age of doe in the 3*rd* season. Results with respect to the effect of parity and the weight of the doe, were generally the same in both the two analyses. The effect of litter size at birth on litter weigh at weaning was found to be insignificant in the 1*st* and 2*nd* seasons, but highly significant in the 3*rd* season. Litter weight at weaning was evidenced to increase with the increase of litter size at weaning. It appeared that this factor was the most important single factor affecting litter weight at weaning since its effect was highly significant in the three seasons, accounting for 85.9, 70.4, and 62.5% of the total variation respectively. From these results, it could correctly be assumed that litter weight at weaning is more or less a monotonic function of litter size at weaning.

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وزن ولدة البطن الواحدة فى ثلاث سلالات من الأرانب وخلطاتها

عزت عطا عفيفى ، السيد صلاح الدين جلال ، عصام عبد السلام الطويل
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أجريت دراسة لوزن ولدة البطن الواحدة عند الولادة وعند الفطام لسلالات البوسكات والشنشلا والجيزة الأبيض وخلطاتها المرباه فى مزرعة الأبحاث بكلية الزراعة جامعة عين شمس بشبرا الخيمة . استخدم فى هذه الدراسة ٤٩٦ بطنا ولدت خلال ثلاثة مواسم انتاجية متتالية بدأت فى نهاية عام ١٩٦٥ ويمكن تلخيص نتائج هذه الدراسة فيما يلى :

بلغ متوسط وزن ولدة البطن الواحدة ٣ر٣٥٢ ، ٦ر٢٧٤ ، ٦ر٢٨١ جراما عند الولادة و ٣ر١٨٩١ ، ٦ر١١٠٥ ، ٨ر١٢٦٢ جراما عند الفطام فى عمر أربعة أسابيع .

لم يكن للاختلافات بين المجموعة التربوية Breediny groups تأثيرا معنويا على وزن ولدة البطن الواحدة عند الولادة ولكن تأكد عكس ذلك بالنسبة لوزن ولدة البطن الواحدة عند الفطام فى الموسمين ١٩٦٧/٦٦ ، ١٩٦٨/٦٧ فقط .

كان الخلط بين السلالات بالنسبة للولدة وللأمهات مصحوبا بظهور قوة الهجين فى وزن ولدة البطن الواحدة سواء عند الولادة أو عند الفطام .

لم يكن للتأثيرات الأمية والارتباط بالجنس Maternal and sex-linked effects أو لعمر الأم تأثيرا معنويا فى تباين وزن ولدة البطن الواحدة عند الولادة أو عند الفطام .

كان لترتيب الولادة تأثيرا معنويا على وزن ولدة البطن الواحدة عند الولادة وعند الفطام أيضا فى الموسم الانتاجى ١٩٦٦/٦٥ فقط حيث لم يتأكد ذلك فى الموسمين الآخرين (١٩٦٧/٦٦ و ١٩٦٨/٦٧) .

تلاحظ وجود علاقة موجبة معنوية بين وزن الأم عند التلقيح ووزن ولدة البطن الواحدة عند الولادة وعند الفطام أيضا فى الموسمين ١٩٦٦/٦٥ ، ١٩٦٧ / ١٩٦٨ .

كان عدد ولدة البطن الواحدة أهم مسببات التباين التى درست فى وزن ولدة البطن الواحدة سواء عند الميلاد أو عند الفطام .