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CROSSBREEDING COMPONENTS FOR GROWTH PERFORMANCE OF THE EGYPTIAN BALADI RED RABBITS CROSSED WITH THE ACCLIMATISED NEW ZEALAND WHITE

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SUMMARY

Data of the present study were obtained on a total of 621 F_1 straight-bred (337) and cross-bred (284) weaned rabbits, produced from two breeds, one exotic, New-Zealand White (NZW) and the other is an Egyptian, Baladi-Red (BR) as well as their two reciprocal crosses. The experiment was carried out at Kafr-El-Sheikh, Sakha Research Station, Ministry of Agriculture, Egypt. The study aimed to estimate the heterotic components of biweekly body weight (BW) and daily gain (DG) traits from weaning (at the 6th wk of age) up to marketing (at the 16th wk of age).

Mating group effect succeeded to prove significance on BW and DG traits, except at 14 wk of age for BW and 12-14 wk of age for DG. Significant heterosis was found for DG from 6 till 12 weeks of age intervals but not for BW, where insignificant negative values are found except at weaning. Direct additive effect for BW and DG traits were not significant in favor of BR bucks except BW at 10 weeks of age and DG at 6-8, 8-10 and 14-16 weeks of age. Maternal additive effects for BW and DG were in favor of NZW breed, positive values and significant at 8, 10 and 12 weeks of age for BW and 6-8, 8-10 and 10-12 weeks of age for DG traits.

Keywords: Rabbit crossing, body weights and daily gains, direct and maternal additive effects, direct heterosis

INTRODUCTION

Crossbreeding is one of the rapid tools available to the breeder for improving productive efficiency in farm animals through the utilization of the resultant heterosis. Crossing between different breeds of rabbits under the Egyptian conditions was associated with the presence of heterotic effects on productive and reproductive performance. The New Zealand White bucks generally produce litters with larger size and heavier weight along with heavier mean bunny weight at birth and at 21 days of age than do the Baladi Red bucks (Youssef, 1992). In terms of reproductive intervals, the same author found that litters produced by Baladi Red bucks were associated with shorter lengths of insemination period, days open and kindling interval compared to litters produced by New Zealand White bucks. Baladi Red sired progeny are poorer in body weights and gains up to 12 weeks than those sired by New Zealand White rabbits (El-Desoki, 1991). Growth performance at early ages (5 and 6 weeks) of Baladi Red sired rabbits are not significantly different from rabbits sired by New Zealand White, while significant differences are evidenced during the later ages of growth at 10 and 12 weeks (Afifi *et al.*, 1993). This study was conducted to evaluate genetically body weight, BW and daily gain, DG traits from weaning (at 6 wk.) up to marketing (at 16 wk.) age. Diallel mating scheme between Baladi Red, BR (as a local breed) and New Zealand White, NZW (as an exotic one) was conducted, to estimate the importance of some genetic factors (breed group, direct and maternal additive effects) and direct heterotic effect on the aforementioned traits. Those, besides the recognition of the optimal mating group combination associated with crossbreeding between the two considered breeds.

MATERIALS AND METHODS

The experimental work of this study was conducted at Kafr-El-Sheikh, Sakha Research Station, which belongs to Animal Production Research Institute, Ministry of Agriculture, Egypt. Data were obtained from a total of 621 straight-bred (337) and cross-bred (284) weaned rabbits produced from a diallel mating between two breeds. One of the two breeds was the acclimatized exotic breed, whose sires and dams were descendents of the New Zealand White (NZW) rabbits raised under the Egyptian conditions and the other one is a native breed named Baladi Red (BR). This gave rise to a total of four mating groups (i. e. NZW x NZW; BR x BR; NZW x BR and BR x NZW). In the straight-bred groups, bucks were assigned at random to breed the dams, as in case in the crossbred ones, but with a restriction of avoiding half-sib, full-sib and parent-offspring matings. Throughout the whole period of this study, each sire was allowed to sire all his bunnies from the same dam.

Body weights (BW) were recorded biweekly from weaning (at 6 week of age) up to marketing (at 16 week of age), while daily gain in weight (DG) were computed in intervals of 6-8, 8-10, 10-12, 12-14 and 14-16 week of age. All mating groups were divided randomly into two feeding groups each was fed on one of two types. The first feed type was a commercial crumpled (harshly regrinded after pelleting) and the second one is a pelleted diet, each containing approximately 16.1% crude protein, 2.39% crude fat and 12.8% crude fiber and 2500 kcal/kg diet of digestible energy. Feed and water were provided *ad libitum.*

Mixed Model Least Squares and Maximum Likelihood Computer Program (Harvey, 1990) was used for analyzing the data. The linear fixed model adopted for the analysis comprised the effects of mating group (BG with 4 classes), sex, feed type (crumpled or pelleted with 1 cm long and 4 mm diameter), month of birth (from November till May), parity (1st, 2nd and 3rd) and litter size at birth, as well as the interactions between BG x sex and BG x feed type. The basic form of the general linear mathematical model is:

$$Y = X\beta + e$$

Where

Y = an (n x 1) observational column vector.

X = Incidence matrix of zeros and ones which relating records to the appropriate fixed effects.

ß = The vector of unknown fixed effects.

e = The vector of random error.

Crossbreeding effects of Additive maternal (G^m), direct additive (G^I) and direct heterotic (H^I) for BW or DG traits were derived applying a selected set of linear contrasts on mating groups' least squares means (Dickerson, 1992). Each single degree of freedom contrast was tested for significance with Student's t-test.

RESULTS AND DISCUSSION

Means and coefficients of variation of uncorrected records

Means, standard deviations (SD), number of observations (N), and coefficients of variation (CV%) for all straight-bred and cross-bred mating groups peculiar to individual BW and DG traits from weaning at 6 week of age till marketing at 16 week of age are given in Tables 1 & 2.

Coefficient of variability (CV%) of BW and DG traits (Tables 1 & 2) ranged from 15.3 to 31.4 in NZW and 24.1 to 46.0 % in BR rabbits, while they extended from 16.0 to 33.7 % in NZW x BR and 25.1 to 62.1 % in BR x NZW rabbits. Estimates of CV% given in Table 1 showed a general trend indicating that phenotypic variations of BW or DG traits decreased with advance of rabbit's age. Similarly, Youssef (1992), Abdel-Raouf (1993), Ahmed (1997), Ali (1998), Abdel-Aziz (1998) and Abdel-Ghany *et al.* (2000) observed the same tendency of change of CV% for body weights and daily gains of rabbits.

However, the higher CV% for BW or DG traits at weaning than at marketing could probably be attributed to that rabbits would become less sensitive to non-genetic maternal effects (e.g. lactation; mothering ability...etc.), which in general, diminishes with advance of progeny age (Khalil *et al.*, 1987).

Breed group

Breed group differences were generally significant for weaning and post-weaning BW or DG traits at various age stages (Tables 3 & 4) except at 14 wk. of age for BW and 12-14 wk. of age for DG. In agreement with the present results, Afifi *et al.* (1990), Hanna (1992), Youssef (1992), Ali (1998) and Abdel-Aziz (1998) indicated that breed group effects on weaning and post-weaning BW and DG were generally significant. Least squares means presented in Table 3 revealed that the cross that sired by BR bucks (i. e. BR x NZW) consistently for all considered traits excelled its reciprocal cross which genitored by NZW males. These results may verify that using males from Baladi-Red rabbits and females from New Zealand White would be the strategy for developing locally produced broiler rabbits.

Table 1. Number of observation (N), actual means (grams), standard deviations (SD) and coefficient of variability (CV%) for body weights of various mating groups (BG) from 6 (weaning) up to 16 (marketing) weeks of age

Mating group	Statistic	Body weight (age per weeks)					
		6	8	10	12	14	16
Straight-breds							
New Zealand (NZW)	N	253	219	195	188	119	59
	Mean	544.3	742.6	937.8	1143.4	1264.5	1342.0
	SD	171.2	205.9	225.9	276.7	266.2	265.2
	CV%	31.4	27.7	24.1	24.2	21.1	19.8
Baladi-Red (BR)	N	84	72	67	62	43	36
	Mean	503.0	704.9	875.2	1040.2	1176.2	1434.9
	SD	137.1	148.1	201.8	244.7	201.8	216.2
	CV%	27.3	21.0	23.1	23.5	17.2	15.3
Total of Straight -breds	N	337	291	262	250	162	95
	Mean	534.0	733.3	921.8	1117.8	1241.0	1377.2
	SD	164.1	193.7	221.3	272.4	253.1	250.7
	CV%	30.7	26.4	24.0	24.4	20.4	18.2
Cross-breds							
NZW x BR	N	74	60	58	53	33	17
	Mean	472.1	686.3	862.9	1090.9	1245.5	1428.2
	SD	151.1	182.7	215.9	232.4	209.1	228.3
	CV%	32.0	26.6	25.0	21.3	16.8	16.0
BR x NZW	N	210	174	153	135	47	31
	Mean	487.0	702.8	891.0	1099.0	1319.0	1458.7
	SD	164.1	197.2	234.5	267.6	276.0	320.2
	CV%	33.7	28.0	26.3	24.4	20.9	22.0
Total of Cross-breds	N	284	234	211	188	80	48
	Mean	483.1	6985	883.4	1096.8	1288.7	1447.9
	SD	160.6	193.3	229.4	257.6	251.8	288.8
	CV%	33.3	27.7	26.0	23.5	19.5	19.9
Overall (Straight-breds + Crossbreds)	N	621	525	473	438	242	143
	Mean	510.7	717.8	904.6	1108.8	1256.8	13.1
	SD	164.4	194.1	225.5	266.0	253.2	3.8
	CV%	32.2	27.0	24.9	24.0	20.1	28.8

NZW = New Zealand White; BR = Baladi Red.

Straight-bred differences

Results of linear contrasts given in Tables 3 & 4 revealed that there wasn't a general trend of superiority ranking could be detected. However, NZW rabbits surpassed (not significantly at most ages) BR ones for BW at most ages considered (except at 16 week of age). On the other hand, BR recorded the superiority concerning DG at all ages (not significantly at most age spans) except at 10-12 and 12-14 weeks. DG data were not in agreement with most of the Egyptian studies dealing with crossing of native breeds of rabbits with exotic ones, which indicate a general superiority of exotic breeds against local ones (i.e. Afifi *et al.*, 1990; Hanna, 1992; Youssef, 1992; Afifi *et al.*, 1994; Ali, 1998 and Abdel-Aziz, 1998). However, the later differences were not significant except at 14-16 week of age for DG ($P \leq 0.001$). In this respect, Afifi *et al.* (1990), Hanna (1992), Youssef (1992), Afifi *et al.* (1994), Ali (1998), Abdel-Aziz (1998) and Abdel-Ghany *et al.* (2000) found that rabbits of pure breeds were not significantly different for most growth traits at miscellaneous age spans.

Table 2. Number of observation (N), actual means (grams), standard deviations (SD) and coefficient of variability (CV%) for daily gains in weight of various mating groups (BG) from 6 (weaning) up to 16 (marketing) weeks of age

Mating group	Statistic	Daily gain (age periods per weeks)				
		6-8	8-10	10-12	12-14	14-16
Straight-breds:						
New Zealand (NZW)	N	219	195	188	119	59
	Mean	13.2	13.4	13.8	13.3	12.3
	SD	6.1	4.6	4.5	4.2	4.0
	CV%	46.0	34.2	32.9	31.5	32.5
Baladi-Red (BR)	N	72	67	62	43	36
	Mean	13.4	12.6	12.0	12.0	13.0
	SD	5.6	5.0	4.6	3.3	3.1
	CV%	41.7	39.6	38.2	27.5	24.1
Total of Straight breds	N	291	262	250	162	95
	Mean	13.3	13.2	13.4	13.0	12.6
	SD	6.0	4.7	4.6	4.0	3.7
	CV%	44.9	35.7	34.5	30.9	29.4
Cross-breds:						
NZW x BR	N	60	58	53	33	17
	Mean	14.2	13.4	14.2	14.2	13.7
	SD	8.8	5.8	4.7	4.0	3.5
	CV%	62.1	43.5	32.8	28.1	25.1
BR x NZW	N	174	153	135	47	31
	Mean	14.7	14.1	14.2	15.3	14.6
	SD	7.7	5.7	4.5	3.9	3.9
	CV%	52.1	40.1	31.8	25.7	26.7
Total of Cross-breds	N	234	211	188	80	48
	Mean	14.6	13.9	14.2	14.9	14.3
	SD	8.0	5.7	4.6	4.0	3.7
	CV%	54.6	41.0	32.0	26.7	26.2
Overall (Straight-breds + Crossbreds)	N	525	473	438	242	143
	Mean	13.9	13.5	13.7	13.4	13.1
	SD	6.9	5.2	4.6	4.1	3.8
	CV%	50.1	38.3	33.5	30.0	28.8

NZW = New Zealand White; BR = Baladi Red.

Heterotic effect

Estimates of direct heterosis (H^I), calculated in units (g.) and as percentages (%) for post weaning BW and DG traits are shown in Tables 3 & 4. However, estimates of H^I for BW were generally obscure. Fortunately, these negative estimates of direct heterosis were not significant at all ages except at 6 weeks of age ($P \leq 0.01$). These findings may convince us to determine that crossbreeding exploiting Baldi-Black rabbits and NZW ones was of trivial consequence for promoting BW traits during the age period under consideration (from weaning up to 16 wk. of age). Howbeit, negative direct heterosis, if any might be attributable to directional dominance of heterozygous loci affecting these traits. In this respect, estimates of DG direct heterosis were significantly positive ($P \leq 0.05$; $P \leq 0.001$) in early age spans (from 6 till 12 wk. of age). This may notify us to focus on using BR as the sire breed with NZW does to secure appreciable heterotic effect. These data also might lead us to conclude that at least a considerable part of genes affecting these traits lies on the sex chromosomes. In this respect, Falconer (1989) showed that a cross between two base populations would show heterosis if they differ in the frequency of genes affecting a given trait. The same author also added that the negative sign of heterosis could be attributed in some cases to the nature of the measurement (i. e. if the trait is expressed in another way such as the reciprocal of the present the heterosis would be

Table 3. Least squares means, gm (± standard error, SE) and linear contrasts of factors affecting body weights from 6 (weaning) up to 16 (marketing) weeks of age

Independent variable	Age per weeks											
	N	6 weeks	N	8 weeks	N	10 weeks	N	12 weeks	N	14 weeks	N	16 weeks
Breed group†:		****		*		**		*		ns		*
New Zealand White (NZW)	253	629.4 ± 17.0	219	783.0 ± 23.7	195	962.7 ± 29.7	188	1200.1± 36.8	119	1405.9 ± 53.1	59	1485.5 ± 72.9
Baladi Red (BR)	84	593.4 ± 22.5	72	760.9 ± 30.1	67	943.9 ± 37.5	62	1135.0± 46.9	43	1366.8 ± 65.2	36	1667.1 ± 85.1
NZW × BR	74	544.3 ± 20.3	60	719.3 ± 28.4	58	867.5 ± 35.3	53	1094.4± 44.1	33	1310.1 ± 66.4	17	1483.9 ± 95.9
BR × NZW	210	581.3 ± 17.1	174	796.3 ± 23.8	153	983.7 ± 30.1	135	1212.7± 37.7	47	1333.1 ± 52.5	31	1527.8 ± 72.4
Straight-bred differences:												
NZW vs. BR		36.0 ± 18.1*		22.2 ± 23.6		18.8 ± 29.8		65.1 ± 38.3		39.0 ± 44.5		-181.6±57.9**
Direct heterosis:												
H^I (F_1)	Units	- 48.6± 13.0***		-14.2 ± 17.2		-27.7 ± 21.8		-14.0 ± 27.3		-64.7 ± 45.8		- 70.5 ± 6.0
	%	- 20.97		-9.51		-7.32		-6.05		- 7.0		-8.17
Direct additive:	Units	-0.5 ± 13.4		-4.6 ± 3.0		-48.7 ± 22.7*		-26.6 ± 28.6		8.0 ± 4504		-112.8 ± 60.3
Maternal Additive:	Units	37.0 ± 19.8		77.0 ± 26.6**		116.2±33.9***		118.3 ±42.0**		23.0 ± 77.8		43.9 ± 102.3

* = Significant at (P ≤0.05); ** = significant at (P ≤0.01); *** = significant at (P ≤0.001); **** = significant at (P ≤0.0001); ns = not significant.

† Sire-breed listed before dam-breed.

NZW = New Zealand White; BR = Baladi Red.

Table 4. Least squares means, gm (± standard error, SE) and linear contrasts of factors affecting daily gains during different periods from 6 (weaning) up to 16 (marketing) wk. of age

Independent variable		Periods (weeks)									
		N	6-8 weeks	N	8-10 weeks	N	10-12 weeks	N	12-14 weeks	N	14-16 weeks
Breed group:			****		***		**		ns		*
New Zealand White (NZW)		219	9.48 ± 0.93	195	11.29 ± 0.72	188	13.15 ± 0.66	119	14.90 ± 0.85	59	13.78 ± 1.00
Baladi Red (BR)		72	10.10 ± 1.18	67	11.36 ± 0.92	62	11.89 ± 0.84	43	14.20 ± 1.04	36	16.25 ± 1.17
NZW × BR		60	11.42 ± 1.12	58	11.05 ± 0.86	53	12.62 ± 0.79	33	14.48 ± 1.06	17	14.32 ± 1.32
BR × NZW		174	13.78 ± 0.93	153	13.75 ± 0.73	135	14.53 ± 0.67	47	14.72 ± 0.84	31	15.39 ± 0.99
Straight-bred differences:											
NZW Vs. BR			-0.6 ± 0.9		-0.1 ± 0.7		1.3 ± 0.7		0.7 ± 0.7		-2.5 ± 0.8**
Direct heterosis[††]**:**	Units		2.8 ± 0.7***		1.1 ± 0.5*		1.1 ± 0.5*		0.05 ± 0.8		-0.2 ± 0.9
	%		45.72		23.48		14.67		2.01		-4.45
Direct additive:			-4.6 ± 3.0		-48.7 ± 22.7*		-26.6 ± 28.6		8.0 ± 45.4		-112.8 ± 60.3
Maternal Additive:			77.0 ± 26.6**		116.2±33.9***		118.3 ±42.0**		23.0 ± 77.8		43.9 ± 102.3

* = Significant at (P ≤0.05); ** = significant at (P ≤0.01); *** = significant at (P ≤0.001); **** = significant at (P ≤0.0001). ns = not significant.

† Sire-breed listed before dam-breed.

NZW = New Zealand White; BR = Baladi Red.

positive in sign). The present results were in disagreement with those reported by Youssef (1992), Afifi *et al.* (1994), Ali (1998), Abdel-Aziz (1998) and Abdel-Ghany *et al.* (2000) who indicated the presence of direct heterotic effect on weaning and post weaning BW and DG for the investigated mating groups at miscellaneous ages.

Direct additive effect

Contrasts of direct additive effect ($G^I = G^I_{NZW} - G^I_{BR}$) for BW and DG traits were generally insignificant in of favor BR bucks (Tables 3 & 4) excluding that for BW at 10 weeks of age and DG at 6-8, 8-10 and 14-16 weeks of age. Afifi *et al.* (1994) with NZW and BR, retrieved that sire-breed effect was not significant on BW at 5, 6 & 8 weeks of age and DG at 5-6 & 10-12 weeks of age, while the same effect exhibited significance on BW at 10 & 12 weeks of age and on DG during the periods of 6-8 and 8-10 weeks of age. El-Desoki (1991) with NZW and Baladi Red, detected significance of sire-breed effect on BW and DG up to 12 weeks of age. However, Ali (1998) with Californian and Gabali, found that direct additive effect was significant on BW at 4, 12, 14 & 16 weeks of age, while significance was detected on DG at 8-12, 12-16 & 4-16 weeks of age. These results indicate that paternity of BR rabbits is better compared with NZW ones. The superiority of BR as sires suggests that the use of this breed as a terminal sire breed in any crossbreeding program to produce crossbred broilers for meat production. These results were in discrepancy with those of El-Desoki (1991) with NZW and BR, and Abdel-Aziz (1998) with NZW and Gabali, who reported that rabbits sired by exotic breed were superior to Baladi sired ones for BW and DG traits. Nevertheless, results shown by Ali (1998) with Californian and Al-Gabali and Abdel-Ghany *et al.* (2000) with NZW and Baladi Black were in correspondence with those reported here concerning the superiority of crosses sired by local Egyptian breeds.

Maternal effect

Results proved that estimates of maternal additive effect ($G^M = G^M_{NZW} - G^M_{BR}$) for BW and DG were frequently positive and significant in preference of NZW at all considered age periods (Tables 3 & 4). Linear contrasts show that NZW-dammed cross excelled that mothered by Baladi rabbits for most traits under study. These results may lead us to assume that dams of NZW rabbits were better in their mothering abilities on post weaning growth traits considered compared with BR. Therefore, it may be recommended to use NZW does as a terminal dam-breed in crossing programs that comprise these two breeds. Similar conclusion has been reaches out by Abdel-Ghany *et al.* (2000) with NZW and Baladi Black. In this respect, Ali (1998) using Californian and Al-Gabali rabbits, proved that maternal additive effects on BW at 4, 8, 12 and 16 as well as DG during 4-8, 8-12 and 4-16 weeks of age of Egyptian Al-Gabali rabbits, were negative and significant ($P \leq 0.01$ or $P \leq 0.001$). However, Abdel-Aziz (1998) with NZW crossed with Al-Gabali rabbits declared that maternal additive effects for growth traits were positive and significant ($P \leq 0.05$ or $P \leq 0.01$) and mostly in favor of Al-Gabali.

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