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GENETIC COMPONENTS OF CROSSBREEDING FOR GROWTH AND LIVABILITY TRAITS IN GABALI, CALIFORNIAN RABBITS AND THEIR CROSSES UNDER SEMI ARID CONDITIONS

E.A. Afifi[1], Nayera Z. Bedier[2] and S.M.Gad[2]

1- Faculty of Agriculture, Moshtohor, Zagazeg University, Banha Branch, Egypt, 2- Desert Research Center, Matareya, Cairo, Egypt

SUMMARY

A crossbreeding experiment was carried out in Maryout station to study genetic and non-genetic effects on growth and livability traits in Gabali, Californian rabbits and their crosses. Genetic components of crossbreeding were also investigated. Traits involved were growth (individual body weight at 4,6,8,10,12,14 and 16 weeks of age and post-weaning daily gain during the age intervals of 4-8, 8-12,12-16 and 4-16 weeks of age and post-weaning livability up to 8,12 and 16 weeks of age.

Linear mixed model used including the effects of breed group, year of birth, month of birth, sex and parity (as fixed effects), and sire and dam (as random effects). Heterotic components of direct and maternal additive and direct heterosis were estimated for growth and livability traits. Year of birth had significant effect on livability from weaning up to 16 weeks of age. Most traits studied were significant influenced by month of birth. Breed group effect was generally significant for body weight and daily gain in weight traits at different ages. Purebred differences were not significant for all traits studied. Gabali rabbits were superior to Californian ones for most body weight traits along with all body weight gain and livability traits. Estimates of direct heterosis for growth traits were positive and significant Heterosis for livability was significant only up to eight weeks of age. Heterotic percent for body weight decreased from 3.2 to 1.1% with advance of age till 12 weeks and increased thereafter up to 1.85 and 1.9% at 14 and 16 weeks of age, respectively for daily gain. Heterosis percentage increased, with advance of age from 1.4 to 1.9% for daily gain and it ranged from 2.38 to 6.25% for post-weaning livability. Maternal additive effect was significant for most growth traits and non-significant for livability traits. Rabbits damed by Gabali does excelled those damed by Californians for most growth and livability traits studied. Direct additive effect was significant for body weight at 16 weeks of age, daily gain during the intervals of 8-12 and 12-16 weeks of age and non-significant for livability traits.

Keywords: Rabbits, heterotic components, Gabali, growth, livability

INTRODUCTION

The Egyptian studies (e.g. Afifi, 1971; Afifi *et al.*, 1994; Abd El-Aziz 1998; others) evidenced, in general, that crossing local breeds of rabbits with exotic standard breeds was associated with improvement in growth traits. All crossbreeding experiments, in which local breeds of rabbits were crossed, with exotic ones did not include Gabali rabbits. The present study was carried out to investigate growth performance and livability traits of the Egyptian local Gabali (**Gab**) and (**Cal**) rabbits as well as their crosses. Genetic aspects of crossing between **Gab** and **Cal** rabbits were also studied.

MATERIALS AND METHODS

A crossbreeding experiment was conduced for three consecutive years of production in Maryout experimental station, Desert Research Center (35 km to south west of Alexandria in a newly reclaimed area, i.e. under semi-arid conditions), Ministry of Agriculture and Land Reclamation. Rabbits used in this study belong to **Gab** and **Cal** rabbits. **Gab** does and bucks were bought from the Bedouins of north Sinai. **Cal** does and bucks descended from **Cal** rabbits raised under the Egyptian conditions.

At the beginning of the experiment (September 1993), breeding does of each of the two breeds were divided at random into two groups. Those of the first group of each breed were mated with bucks from their own breed while those of the second group were mated with bucks from the other breed. Bucks were assigned at random to mate the does with a restriction of avoiding full sib. half-sib and parent-offspring matings. The breeding plan permitted the simultaneous production of purebred Gab and Cal rabbits in addition to their two reciprocal crosses. Rabbits were raised in a semi-closed rabbitary. Breeding females and males were housed individually in wire cages with standard dimensions. Composition and ingredients of the ration supplied and details of management were described by Gad (1998). Growth traits involved in the study were individual body weight at 4 (weaning), 6,8,10,12,14 and 16 weeks of age and daily gain during the age intervals of 4-8,8-12,12-16 and 4-16 weeks as well as post-weaning livability up to 8,12 and 16 weeks of age.

Data of growth performance and livability traits were analyzed by adopting mixed model including the fixed effects of breed group, (four classes), year of birth, (three classes), month of birth, (12 classes), parity, (six classes), sex and interaction between parity and each of breed group and year of birth. Random effects of sire nested within breed group and dam nested within sire within breed group were also included in the model of analysis. Harvey's least squares and maximum likelihood computer program (Harvey, 1987) was used. Crossbreeding genetic effects (maternal additive, direct additive and direct heterosis) were estimated for different traits according to the genetic model of Dickerson (1992). The genetic model permit to drive a selected set of linear contrasts to estimate heterotic component of direct additive effect, maternal additive effect and direct heterotic effect in addition to purebred differences.

RESULTS AND DISCUSSIONS

Non-genetic aspects

Year of birth had little effect on body weight and daily gain in weight but exerted a significant ($P<0.01$) influence on livability from weaning at 4 weeks up to 16 weeks of age (Table1). Similar results were observed by different investigators (Afifi and Emara, 1988; Hanna, 1992; Ahmed, 1997 and Abd-El-Aziz, 1998). Results, in Table 1 show that month of birth had a significant ($P<0.05$ or $P<0.01$) effect on body weight at different ages (4,6,8,12 and 16 weeks), on daily gain during the interval of 8-12 weeks and on all post-weaning livability traits studied. These results are in agreement with those of Afifi and Emara (1988 & 1990) and Hanna (1992). Parity was found to have significant ($P<0.05$ or $P<0.01$or $P<0.001$) effect on body weight at 12 weeks of age, daily gain in weight during the intervals of 8-12 and 4-16 weeks of age only and on post-weaning livability up to 12 and 16 weeks of age. However, no consistent trend for the effect of parity on body weight, post-weaning daily gain and livability up to different ages was detected. Similar to the present result, Hanna (1992), Ahmed (1997), and Abd-El-Aziz, (1998) found that parity exerted significant ($P<0.05$ or $P<0.01$or $P<0.001$) effect on body weight and daily gain in weight at different stages of age. Also, Ahmed (1997) showed significant ($P<0.05$ or $P<0.01$or $P<0.001$) effect for parity on post-weaning livability up to 12 weeks of age. Effects of the interaction between breed group and parity was significant ($P<0.05$ or $P<0.01$or $P<0.001$) on body weight at 4,6 and 8 weeks of age and interaction between year of birth and parity was significant ($P<0.05$ or $P<0.01$) on body weight at 4,6 and 12 weeks of age as well as on daily gain in weight during the interval of 8-12 weeks of age and on post-weaning livability up to 12 and 16 weeks of age (Table 1).

Breed group differences

Breed group differences were generally significant ($P<0.05$ or $P<0.01$or $P<0.001$) for body weight and daily gain in weight traits, but non-significant for post-weaning livability traits (Table 1). Similar results were observed by Afifi *et al.* (1994). The heaviest body weight at different ages was recorded by the two crossbreeds (Table 2).

Purebred differences

Linear contrasts show the superiority of **Gab** rabbits over **Cal** ones for most body weights, all post-weaning daily gains in weight and livability from weaning at 4 weeks up to 8,12 and 16 weeks of age but the differences were always not significant (Table2). These results might indicate the superiority of **Gab** rabbits over **Cal** ones for these traits. Results of Khalil and Afifi (2000) stated that Gabali rabbits are genetically characterized by heavy body weight especially after weaning, i.e. genetic potentiality of post-weaning growth was in favour of Gabali rabbits. Similar to the present results, Afifi *et al.*, (1994) found that rabbits of the two purebreds were not significantly different for most body weights and post-weaning daily gains in weight. However, Abd-El-Aziz, (1998) showed that **Gab** rabbits excelled New Zealand White ones for body weight at all ages and for post-weaning daily gain during most age intervals studied. He noticed that the differences were mostly significant for body weight traits but non-significant for all daily gain traits.

Direct heterotic effect

Estimates of direct heterosis were positive and significant ($P<0.05$ or $P<0.01$or $P<0.001$) for all post-weaning weights and daily gains and for only post-weaning livability up to eight weeks of age (Table 2). Heterotic effect decreased from 3.2 to 1.1% with advance of age till 12 weeks and increased thereafter up to 1.85 to 1.90% at 14 and 16 weeks of age, respectively,. For daily gain, heterosis percentage increased with advance of intervals of growth from 1.05 to 1.90%. Also, it increased from 6.25% (for livability up to 8 weeks of age) to 6.80% (for livability up to 12 weeks of age). All these

Table1. F-ratios of least squares analysis of variance of factors affecting body weight, daily gain and livability traits

Traits	Breed group	Sire/breed group	Dam/sire/ breed group	Year of birth	Month of birth	Parity	Sex	Breed group X Parity	Year of birth X Parity	Remainder df	Remainder mean squares
Body weight at:											
4 wks	4.4*	1.0	1.7**	1.4	4.4**	1.0	42.4	2.6**	1.8*	1145	2783.3
6 wks	4.5*	0.8	1.8**	2.2	2.8**	1.1	22.3**	1.8*	2.2*	1040	3490.8
8 wks	2.1	1.6*	1.9**	1.3	2.7**	1.4	18.7**	2.7***	1.7	984	4517.6
10 wks	4.9*	1.4	2.0***	1.7	2.3	0.6	10.4*	1.2	1.3	858	5598.2
12 wks	8.9**	1.9**	2.2**	1.9	3.2**	2.5*	4.2*	1.4	2.8**	793	5559.8
14 wks	16.4***	1.1	1.9***	0.9	2.4	1.0	2.8	0.9	0.9	517	5448.7
16 wks	20.2***	1.0	2.3***	1.6	2.4*	1.8	3.7	1.2	1.1	478	4747.0
Daily gain during:											
4-8 wks	6.6***	1.50	1.7***	1.80	1.00	1.9	1.7***	1.50	1.60	948	3.3
8-12 wks	5.5**	3.3**	1.4	2.30	2.30*	3.2*	4.5*	1.00	4.1**	793	4.8
12-16 wks	27.4***	0.58	1.55**	0.38	1.15	0.79	0.12	1.47	0.82	487	1.31
4-16 wks	32.7***	0.90	2.2**	1.00	1.20	3.4**	3.8	1.50	1.20	905	0.53
Livability up to:											
8 wks	1.2	1.3	1.4*	2.1	2.6**	2.4*	2.9	1.0	1.5	1145	0.117
12 wks	0.2	1.1	1.6**	7.9**	2.4*	6.8*	5.3*	1.0	2.0*	1145	0.166
16 wks	0.5	1.3	1.5**	6.5**	2.8**	5.4***	7.5**	0.9	2.4**	905	0.200

*=P<0.05, **=P<0.01,***= P<0.001.

Table 2. Estimates of breed groups means ± SE, purebred difference, direct heterosis (H^I), maternal additive effect (G^m) and direct additive effect (G^I) for body weight, daily gain and Livability traits

Item	N	Breed group Cal x Cal	N	Gab x Gab	N	Cal x Gab	N	Gab x Cal	Purebred differences $[(G^I_{cal} + G^m_{cal}) - (G^I_{Gab} + G^m_{Gab})]$	Heterosis contrast $H^I_{cal\ x\ Gab}$ unit	%	Maternal additive effect $(G^m_{cal} - G^m_{Gab})$	Direct additive effect $(G^I_{cal} - G^I_{Gab})$
Body weight at:													
4 wks	567	440.5±4.5	275	432.5±6.4	232	444.6±6.7	253	456.3±6.0	7.9±5.1	13.96±3.7*	3.2	11.65±5.2*	-1.85±3.7
6 wks	522	742.1±5.5	248	752.1±7.7	214	761.4±8.1	237	765.9±7.3	- 10.1±6.0	16.6±8.6**	2.2	4.5±6.1	-7.3±4.35
8 wks	477	1063.4±10.6	229	1082.8±13.1	194	1091.8±14.2	225	1090.5±11.3	- 19.5±7.3	17.7±10.3**	1.65	- 0.6±7.2	9.05±4.35
10 wks	433	1375.8±10.6	217	1419.6±14.1	178	1423.4±15.0	207	1413.1±12.7	- 34.8±0.4	20.6±6.2**	1.45	- 10.3±8.4	-16.75±6.0
12 wks	395	1690.6±15.6	205	1765.3±19.2	174	1774.8±20.9	195	1744.7±16.7	- 74.6±8.5	31.8±6.4***	1.1	-30.0±8.5***	-22.3±6.1
14 wks	285	1913.2±10.5	150	1997.8±14.0	123	2007.6±17.1	125	1975.6±13.9	- 84.6±9.9	36.1±7.8***	1.9	-31.9±10.5***	-26.3±7.8
16 wks	267	2138.9±11.4	146	2235.7±15.2	119	2246.9±16.1	119	2211.4±15.0	- 96.8±9.4	41.8±14.9***	1.9	-35.4±10.0***	-30.65±7.0***
Daily gain at:													
4-8 wks	477	22.12±0.25	229	23.31±0.31	194	23.35±0.33	225	22.73±0.27	-1.19±0.19	0.32±0.14*	1.40	-0.62±0.19**	-0.29±0.14
8-12 wks	395	22.4±0.50	205	24.3±0.6	174	24.3±0.7	195	23.3±0.5	-1.8±0.24	0.4±0.2*	1.70	-0.9±0.2***	-0.4±0.2***
12-16 wks	267	20.1±0.0	146	21.4±0.2	119	21.5±0.2	119	20.9±0.2	-1.27±0.16	0.22±0.2**	1.05	-0.04±0.2	-0.7±0.2**
4-16 wks	267	16.0±0.14	146	17.4±0.19	119	17.2±0.21	119	16.6±0.2	-1.20±0.09	0.4±0.2***	1.90	-0.6±0.1***	-0.8±0.1
Livability up to:													
8 wks	567	0.80±0.03	275	0.81±0.04	232	0.83±0.04	253	0.88±0.04	-0.003±0.03	0.05±0.02*	6.25	0.1±0.03	-0.03±0.025
12 wks	567	0.69±0.04	275	0.69±0.05	232	0.72±0.05	253	0.73±0.05	-0.002±0.04	0.047±0.03	6.80	0.004±0.04	0.005±0.025
16 wks	489	0.54±0.05	226	0.61±0.06	182	0.61±0.07	186	0.58±0.06	-0.07±0.05	0.014±0.35	2.36	-0.29±0.50	-0.02±±0.035

Cal= Californian, Gab= Gabali, *= $P<0.05$, **= $P<0.01$, ***= $P<0.001$.

finding lead to state that crossbreeding between **Cal** and **Gab** rabbits was associated with improvement in growth traits and post-weaning livability. This might refer to the presence of considerable non-additive genetic breed effect. The present results were supported by those of Afifi *et al.* (1994) who found that heterosis percentages ranged from 2.5 to 10.4% for body weight and from 0.7 to 18.9% for post-weaning daily gain in weight and from 12.5 to 47.4% for post-weaning livability. Abd-El-Aziz (1998) with Gabali, New Zealand White rabbits and their crosses, found positive direct heterosis for most body weights and daily gains in addition to livability traits but insignificant. He found that heterotic effect was significant ($P<0.05$ or $P<0.01$) for most body weights and insignificant for post-weaning daily gain and livability traits.

Maternal additive effect

Maternal additive effect was significant ($P<0.05$ or $P<0.01$ or $P<0.001$) for body weight at four, 12, 14 and 16 weeks of age and most post-weaning daily gain traits but insignificant for livability traits (Table 2). However, Afifi *et al.* (1994) indicated that maternal additive effect on most body weight and daily gain traits were not significant. Linear contrasts show that **Gab**-damed rabbits excelled **Cal**-damed ones for body weight at eight, 10, 12,14 and 16 weeks of age and for daily gain in weight traits. Superiority of **Gab**-damed rabbits over **Cal**-damed ones may suggest the use of this breed as a dam breed in crossbreeding program including both breeds. This result is in agreement with that of Abd-El-Aziz (1998) working on **Gab**, New Zealand White rabbits and their crosses.

Direct additive effect

Contrasts in Table 2 show that direct additive effect was significant ($P<0.01$ or $P<0.001$) for body weight at 16 weeks of age only and post-weaning daily gain in weight during the age intervals of 8-12 and 12-16 weeks of age, while it was insignificant for livability up to 8,12 and 16 weeks of age. For most post-weaning growth and livability traits (Table 2), direct additive effects were in favour of Gabali rabbits. Such superiority of **Gab**-sired rabbits in direct additive effect may be an encouraging factor for the rabbit breeders in hot-climate countries to use their **Gab** rabbits in any crossbreeding stratification system. Afifi *et al.* (1994) with New Zealand White and Baladi Red rabbits and their crosses found that direct additive effect was significant ($P<0.05$ or $P<0.01$ or $P<0.001$) for body weight at 10 and 12 weeks of age and daily gain during the intervals of 6-8 and 8-10 weeks of age. They observed that the direct additive effect for post-weaning livability up to 8 and 16 weeks was non-significant.

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