Egypt. Poult. Sci. Vol (29) (III): (711-734)

TEROSIS AND COMBINING ABILITY OF SOME PRODUCTIVE TRAITS IN FOUR BREEDS OF RABBITS

By

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Received: **04/06/2009** Accepted: **30/09/2009**

Abstract: *This study was conducted to evaluate the effect of crossing rabbit breeds in a complete 4x4 diallel crossbreeding experiment [New Zealand White (N), Californian (C), V-Line (V) and El-Gabali (G)] on some productive traits including relative growth rate (RGR), average daily gain (ADG), and carcass traits, as well as heterosis and combining abilities of such traits.*

Results showed that V-Line rabbits had significant ($p < 0.05$) higher relative growth rate at 4-6 (75.49 %), 10-12 (18.48 %) and 4-12 (129.34 %) weeks of age than other purebreds. GC crossbreds showed the highest RGR % at 4-6 weeks of age (50.24 %), while its reciprocal CG was superior at 6-8 weeks of age (71.77 %). NV crossbreds had the highest values of ADG at 4-6 and 4-12 weeks of age (45.88 and 28.19 g). At 8-10 week of age VN crossbred had high positive H % for RGR and ADG (20.48, 15.38 %).

V-Line rabbits had the highest values for hind and intermediate part % (21.38 and 13.38). NV crossbreds recorded the superior estimate for intermediate part % (12.83). Also, GV and GN crossbreds showed higher significant values for giblet % (4.74, 4.74). GV crossbreds recorded high positive heterosis (H%) for giblet % (14.80), while NV recorded the highest negative one. The effect of general combining ability on all studied traits was non-significant ($p > 0.05$). On the contrary, the effect of specific combining ability was highly significant ($p < 0.01$). Gabali rabbit showed high positive general combining ability for most of carcass traits, while GV crossbreds recorded high positive estimate of specific combining ability for the same traits

INTRODUCTION

In comparison to common livestock species virtues of rabbits are small body size, limited cost of the animals and of the housing structures, efficient reproductive ability, early age of sexual maturity (4-5 months), short fattening period (less than two months from weaning) and meat quality of rabbits is similar to that of fowl and meat yield are high. They have a good meat to bone ratio compared with other livestock. The rabbit meat shown to be very high in protein, low in fat, triglyceride and cholesterol, low in energy value and have a mineral percentage higher than other meats **(Schlolaut, 1992)**. Crossbreeding has an advantage over the synthesis of the breed in utilizing the breed differences due to the expected segregation along with the recombination **(Dickerson, 1969)**. Moreover, crossing between exotic and local breeds can be also done to take advantage of the existence of heterosis or hybrid vigor in most of economic traits **(Yossef, 1992)**.

The objective of this work is to investigate the effect of purebred rabbit versus crossbreds and their reciprocal crosses on some productive traits including relative growth rate (RGR), average daily gain (ADG), and carcass traits (slaughter weight, dressing percentage, hot carcass weight, giblet percentage, carcass cuts including forepart, intermediate part and hind part), as well as heterosis and combining abilities of such traits.

MATERIALS AND METHODS

This study was conducted at the rabbit farm belongs to Department of Animal Wealth Development, Faculty of Veterinary Medicine, Zagazig University.

I. Experimental flock:

The flock composed of four rabbit breeds New Zealand White, Californian, V-Line and El-Gabali . Two bucks and five does from each breed were used in the experiment. Mature bucks and does were mated in a full 4 x 4 diallel design

Bucks and does were apparently healthy and vaccinated against pasteurllosis and rabbit viral hemorrhagic disease (RVHD).

II. Flock management:

Rabbits were housed in an open sided house. Breeding animals were kept individually in triangular galvanized wire Cages (40 x 60 x 50 cm) provided with nipple system for watering and manual feeder. Metal nest box (40 x 40 x 40 cm) was attached to the doe's cage.

Litters were weaned, ear tagged and separated in cages at 4 weeks of age. They were raised identically under the same managerial and nutritional conditions. Individual records were established for each breeding animal for recording all the data needed for the investigation.

a. Feeding and watering:

Rabbits of all ages were fed commercial pelleted ration obtained from ATEMEDA Company. The ration contains Crude protein (not less than) 18.5 %.

Clean fresh water was available all times to rabbits. Prophylactic antibiotics and anticoccidial drugs were supplied to water just after weaning for 3 to 5 days. Also vitamin E, Selenium, AD3E to cover any deficiencies. Pregnant, lactating does and young rabbits fed ad-libitum, while empty does and bucks fed 130-150 g daily to avoid over fattening and consequently poor productive and reproductive performance.

b. Doe management:

Each doe was introduced to the buck's cage. Doe, buck number and date of mating were recorded, then each doe palpated for pregnancy 14 days after service. For positively palpated does, the expected date of kindling is recorded, while, negatively palpated does were remated. At 26th or 27th day of gestation, clean disinfected with some rice straw kindling box is provided for each doe's cage. Moreover, fourteen hours light per day were provided.

c. Litter management:

Examination of litter, just after kindling was carried out and dead kits were removed. Moreover, Litter size, born alive and born dead were also recorded. Each litter is weighed. The litter was inspected daily and dead ones were removed and recorded till weaning at 4 weeks of age.

III. Studied traits:

1. Average daily gain:

Individual body weights were recorded at different ages, first at weaning (4 weeks of age). Then the weights were recorded biweekly till market age (12 weeks of age). Average daily gain is the weight gain related to the number of days calculated.

2. Relative growth rate: It was calculated according to **Broody (1945)**.

3. Carcass traits:

At three months of ages (Marketing age), (**Amal., 2000**), five males and five females were randomly assigned from each genetic group, fastened for 6 hours and weighed to the nearest gram before slaughtering. Slaughtered rabbits were allowed to bleed freely.

a. Organ weights:

Liver, heart and kidney (giblets), perirenal fat and periscapular fat were weighed as a percentage of live body weight.

b. Hot carcass weight:

Hot carcass weight: carcass is weighed with head, without any organs, 15-30 minute after slaughter.

c. Dressing out percentage:

$$\text{Dressing out percentage} = \frac{\text{Hot carcass weight}}{\text{Live weight}} X100$$

d. Carcass cuts:

Chilled carcass was weighed and then cut in to the anatomical cuts (Forepart, Intermediate part and Hind part). Percentage of each cut was calculated in relation to slaughter weight.

IV. Data handling and statistical analysis:

Data were analyzed by the General Linear Model (GLM) procedure of the SAS statistical analysis system package (**SAS, 2002**).

Least Squares Means (LSM) ± standard errors were calculated and tested for significance using "T'"test (**Steel and Torrie, 1960**).

The data were analyzed using different statistical models as following:

$$Y_{ijk} = \mu + B_i + C_j + e_{ijk}$$

Y_{ijk} = any observed value.

μ = overall mean.

B_i = effect of breed (i = 1, 2, 3, and 4, i.e. New Zealand White, Californian, V-Line and El-Gabali).

C_j = effect of crossing (j = 1, 2, 3… 12).

e_{ijk} = random deviation due to unexplained source.

Heterosis (Hybrid Vigor)

Heterosis or hybrid vigor will be estimated for the different crossbreds and reciprocal crossbreds based on the following formula **(Legates and Warwick, 1990)**

Where:

$$H\% = \frac{\bar{X}F_1 - 1/2\,(\bar{X}P_1 + \bar{X}P_2)}{1/2\,(\bar{X}P_1 + \bar{X}P_2)} \times 100$$

$\bar{X}F_1$ = actual heterozygote mean of the first generation

$\bar{X}P_1$, $\bar{X}P_2$ = mean of the parents breed.

General and specific combining abilities:

The following model was used for analysis of general and specific combining abilities **(Martínez-Garza, 1983, 1991)**.

$$Y_{ijk} = \mu + g_i + g_j + s_{ij} + m_i - m_j + r_{ij} + e_{ijk}$$

Where:

Y_{ijk}: variable analyzed.

μ : overall mean.

g_i: effect of the general combining ability of the **i**th breed.

g_j: effect of the general combining ability of the **j**th breed.

S_{ij}: effect of the specific combining ability of the cross (**i**, **j**).

mi: maternal effect of the **i**th breed.

mj: maternal effect of the **j**th breed.

rij: reciprocal (sex-linked) effect of the cross (**i**, **j**).

eijk: random error.

RESULT AND DISCUSSION

I. Relative Growth Rate (RGR %):

Least squares means ± standard errors of relative growth rate percentages as well as the heterosis % at different age intervals due to crossing of New Zealand white, Californian, V-Line and Gabali rabbit are shown in Tables (1 and 2).

I. A Purebreds:

V-Line rabbit had significant ($p < 0.05$) higher relative growth rate at 4-6 weeks (75.49 %) compared to other purebreds. V-Line rabbit followed by Gabali rabbit (60.54 %), while Californian rabbits recorded the lowest estimate (47.85 %).on the other hand, Californian rabbit showed significant ($p < 0.05$) higher relative growth rate at 6-8 weeks (55.26 %) compared to other purebreds. V-Line rabbit had significant ($p < 0.05$) higher relative growth rate at 10-12 weeks (24.5 %) than other purebreds, while Californian rabbit showed the lowest estimate (10.61 %).

The obtained results of RGR agreed those obtained by **Heba (2004)**. She found that, V-Line had higher RGR at 4-6 and 6-8 weeks of age (50.60 and 42.00 %) than New Zealand white and Californian. The New Zealand white RGR at 8-10 weeks of age was significantly higher than Californian (17.20 %). On the contrary, **Youssef (1992)** and **Afifi et al. (1994)** found that New Zealand white rabbit surpassed non-significantly Baladi Red rabbit in body weight and daily gain traits.

The overall mean of crossbreds and reciprocal crossbreds (64.88 %) significantly ($p < 0.05$) exceed that of purebreds (59.23 %) at 4-6 weeks of age, the reverse results observed at 6-8 weeks of age (38.29 vs. 34.98 %) where purebreds significantly ($p < 0.05$) exceed crossbreds and reciprocal crossbreds (Table 1).

I. B Crossbreds and reciprocal crossbreds:

The reciprocal crossbreds (CG, CV, NC, NG, and NV) showed high significant ($p < 0.05$) RGR at 4-6 weeks of age (71.77, 71.24, 70.97, 70.49 and 69.19 %: respectively) over the crossbreds GC, VC, CN, GN and VN (56.76, 61.74, 54.22, 56.76 and 61.77 %: respectively). On the contrary, crossbred GV rabbits (69.62 %) was significantly ($p < 0.05$) higher over reciprocal crossbreds VG (60.79 %). At 6-8 weeks of age GC crossbred rabbits were significantly higher ($p < 0.05$) than all crossbreds and reciprocal crossbreds (50.24 %).

These obtained results agreed with those reported by **Heba (2004)**. She found that, VN crossbred had the highest RGR at 8-10 weeks of age. **Skrivanova et al. (2000)** indicated that significantly higher ($p < 0.05$) daily weight gains were observed in the New Zealand white x Californian (34.5 g) at the age between 30-80 days.

I. C. Heterosis %:

NC, CG and NG crossbreds showed high positive Heterosis % at 4-6 weeks of age (42.08, 32.44 and 25.22 %; respectively), while VG crossbreds showed the highest negative estimate (-10.61 %). At 8-10 week of age VN crossbred had high positive H % (20.48 %) and its reciprocal NV had high negative H % at 8-10, 10-12 weeks of age (-16.87, -27.66 %). The estimated values of heterosis percentage for NC, CN, VN, NV is close to those estimated by **Heba (2004)** with exception that she estimate high negative H % for CN crossbred at 10-12 weeks of age (-38.18 %). Also, the results agreed with those obtained by **(Gad, 1998)**. Who reported that Crossing between Gabali and Californian rabbits evidenced the presence of Positive significant direct heterosis for body weight, daily gain till 16 weeks of age.

II. Average Daily Gain (ADG):

Least squares means ± standard errors of average daily gain as well as heterosis % at different age intervals due to crossing of New Zealand white, Californian, V-Line and Gabali rabbit are shown in Tables (1 and 2).

II. A Purebreds:

Gabali rabbit had significantly higher ($p < 0.05$) ADG at 4-6 weeks of age (40.89 g) than New Zealand White and Californian, but it was non significantly ($p > 0.05$) higher compared with V-Line (38.32 g/d). New Zealand White (34.46 g/d) is significantly higher ($p < 0.05$) than Californian (26.66 g/d). Californian rabbits were significantly higher than other pure lines (52.53 g/d) at 6-8 weeks of age. Also, there is a non significant difference among Gabali, New Zealand White and V-Line at the same age interval. The superiority of Gabali rabbit over other exotic breeds is also reported by **Abdel-Aziz (1998)**. Who found that, Gabali rabbit excelled NZW for daily gain during most age-intervals but non-significantly. On the contrary, **Youssef (1992)** and **Afifi et al. (1994)** found that New Zealand white rabbit surpassed Baladi Red rabbit for body weight and daily gain traits.

II. B. Crossbreds and reciprocal crossbreds:

NV, NC and GV crossbreds had the highest values of ADG at 4-6 weeks of age (45.88, 43.18 and 42.73 g/d: respectively). On the other hand GC crossbred being the lowest (30.75 g/d), but significantly ($p < 0.05$) higher at 6-8 weeks of age (44.43 g/d). VN crossbreds showed the highest significant value at 8-10 weeks of age (27.75 g/d) and GN crossbred had the lowest value (18.54 g/d). CN crossbred was inferior at most of age interval studied (Table 1). The superiority of NV, NC and VN crossbreds at 4- 6, 8-

10 weeks of age was also reported by **Heba (2004)**. Superiority of CG crossbred over the reciprocal GC was also agreed with **Gad (1998)**.

II. C. Heterosis %:

NC, NV, CG and VC crossbreds showed high positive H % at 4-6 weeks of age (41.29, 26.07, 21.05 and 23.80 %; respectively), While VN had the highest negative H % (-10.19 %). At 6-8 weeks of age GN and VG crossbreds had high positive H % (24.98 and 22.35 %), while the reciprocal CV showed the highest negative H % (-44.45 %).

The estimated values of heterosis % agreed with that recorded by **Heba (2004)**. She found that, NC crossbreds showed high positive % for average daily gain at 4-6 weeks of age; also she found that, VN crossbred showed high positive % for average daily gain at 10-12 weeks of age. Also, the results agreed with (**Gad, 1998**). Who reported that Crossing between Gabali and Californian rabbits evidenced the presence of Positive significant direct heterosis in body weight daily gain till 16 weeks of age.

Combining ability of Relative Growth Rate (RGR %) and Average Daily Gain (ADG):

The effect of general combining ability on the RGR % and ADG of rabbits was non-significant ($p > 0.05$) at most age intervals. On the contrary, the effect of specific combining ability was highly significant ($p < 0.01$) at all age intervals (Table 3 and 4). Similar results were recorded by **Hemeda et al. (1992)**.

GC crossbreds showed the highest positive value of specific combining ability for RGR % at 4-6 (5.01) and 4-12 (5.02) weeks age intervals. GN crossbreds had the highest positive value at 6-8 (3.22) and 10-12 (1.90) age intervals. CN crossbreds showed high positive value at 4-6 weeks age intervals (4.29) for RGR %, also CN crossbreds showed high positive value of SCA for ADG at 4-6 (3.23) and 10-12 (2.15) weeks age intervals. VN, GN and GV crossbreds showed high positive value for ADG at 6-8 weeks of age (2.77, 2.69 and 2.51; respectively. These results confirmed those obtained by **Hemeda et al. (1992)**. They found that, crossing of Californian to New Zealand white showed high positive SCA value for body gain (3.48) at 1-4 weeks and 8-10 weeks (3.83) after weaning and crossing of Baladi with New Zealand white had positive values at 1-4 weeks (0.59) and 4-8 weeks after weaning.

III. Carcass traits:

1. Slaughter weight:

Least squares means ± standard errors of slaughter weight, hot carcass weight, dressing percentage, Carcass cuts and giblet weight percentages as well as heterosis % due to crossing of New Zealand white , Californian , V-Line and Gabali rabbit are shown in Tables (5 and 6).

1. a. Purebreds:

There was no significant difference ($p < 0.05$) among the pure lines studied. Gabali rabbit surpassed other purebreds (2242 g), V-Line purebred rabbit showed the lowest LBW (2045 g), Californian rabbits showed higher slaughter weight than that of New Zealand White (2165.5 & 2121 g). These results agreed with those obtained by **Heba (2004)**. She recorded non-significant difference among purebreds studied; also found that, Californian rabbits showed higher slaughter weight than the New Zealand White (1450 & 1380 g). **Gómez et al. (1998) and Plá et al. (1996)** found that, the means of Line V for slaughter weight (2040 g) at 9 weeks of age.

1. b. Crossbreds and reciprocal crossbreds:

VG, GN and NV crossbreds showed higher significant ($p < 0.05$) slaughter weight (2425, 2366 and 2346 g; respectively) than other purebreds and crossbreds except GV crossbreds the differences were non-significant (2313 g). The results agreed with **Toson et al. (1999)**. They found that, crossbred rabbits had higher average for slaughter weight. Baladi x New Zealand White crossbred rabbits had higher slaughter weight. Also, **Ozimba and Lukefahr (1991)** found that, Purebreds were lighter for preslaughter than were C x N crossbreds.

1. c. Heterosis %:

VG, NV and GN showed the same trend of their superiority recording positive heterosis % (13.13, 12.62 and 8.45 %), while CV showed the highest negative H % (-17.34 %) (Table 6). This agreed with **Abdel-Aziz (1998).** He reported that crossing between Gabali and New Zealand White rabbits showed positive direct heterosis in most carcass traits (weight of fasted rabbits).

2. Hot Carcass weight:

2. a. Purebreds:

Hot carcass weight followed the same trend of slaughter weight where Gabali rabbit had the highest value of the hot carcass weight (1368 g) which is significantly higher than V-Line (1236.5 g) but recorded non-significant higher values compared those of Californian (1301.5 g) and New Zealand White (1285 g). Californian is higher non-significantly over New Zealand White. This agreed with **Abdel-Aziz (1998) and Gad (1998).** They reported that, Gabali rabbits approximate or slightly excel New Zealand White and Californian in all carcass traits. **Gómez et al. (1998) and Plá et al. (1996)** founded that the means of V-Line for hot carcass weight (1214 g).

2. b. Crossbreds and reciprocal crossbreds:

VG, GN and NV crossbreds followed the same trend as LBW, recording higher hot carcass weight (1544.5, 1425 and 1420.5 g; respectively) than other purebreds and crossbreds, GV crossbred rabbits showed the lowest significant value (1350 g) compared with its reciprocal, on the other hand the reciprocal CV showed the lowest value of hot carcass weight (1068 g).

The results agreed with **Toson et al. (1999)**. They found that, crossbred rabbits had higher average for carcass weight. Baladi x New Zealand White crossbred rabbits had higher carcass weight. **Zaky et al. (2001)** found that Californian x New Zealand white crossbreds showed higher value for carcass traits than other crosses and purebred. Superiority of GN crossbred rabbits over the reciprocal NG in favour of New Zealand White maternity over Gabali; this agreed with **Khalil (1996)**, but disagreed with **Abdel-Aziz (1998)** who found the opposite.

2. c. Heterosis %:

VG, NV and GN showed the same trend of their superiority, recording high positive heterosis % (18.60, 12.75 and 7.42 %), while CV showed the highest negative value (-15.83 %) (Table 6). These results agreed with those obtained by **Abdel-Aziz (1998)**. He reported that crossing between Gabali and New Zealand White rabbits showed Positive direct heterosis in most carcass traits. Also, **Gad (1998)** reported that crossing between Gabali and Californian rabbits evidenced the presence of Positive direct heterosis in most carcass traits at 12 and 16 weeks of age. Also, **Toson et al. (1999)** reported high positive heterosis % due to crossing between Baladi and New Zealand White.

3. Dressing Percentage:

3. a. Purebreds:

Table (5) showed that, the differences among purebreds were non-significant ($p > 0.05$). Gabali rabbits had the highest dressing % (61.05 %) followed by New Zealand white (60.57 %), while Californian showed the lowest percentage (60.13 %). This agreed with **Abdel-Aziz (1998) and Gad (1998)**. They reported that, Gabali rabbits approximate or slightly excel New Zealand White and Californian in all carcass traits. **Abd El-Galil and Khidr (2000)** found that dressing percentage as proportion of live body weight for New Zealand white rabbits were (55.61). **Amber et al. (2002)** reported that dressing percentage of the carcass without head was 56.7% in New Zealand white rabbits.

3. b. Crossbreds and reciprocal crossbreds:

There were non-significant differences in dressing percentage. VG crossbred rabbits followed their superiority over other purebreds and crossbreds (63.16 %) followed by VN crossbreds (62.25 %). Also CN crossbreds (61.90 %) and reciprocal NC (61.55 %) being superior over their parental purebreds. GV crossbred rabbits show the lowest percentage (58.37) (Table 5). This agreed with **Heba (2004)**. She found that, CN and NC showed high dressing % over other crossbreds and parental lines (50.08 & 50.21 %).

3. c. Heterosis %:

VG showed the highest positive H % (3.91) followed by VN (2.82) and GV had the highest negative estimate (-3.96) (Table 6). This agreed with **Abdel-Aziz (1998)**. He reported that crossing between Gabali and New Zealand White rabbits showed Positive direct heterosis for dressing %. Also, **Gad (1998)** reported that crossing between Gabali and Californian rabbits evidenced the presence of positive direct heterosis for dressing % at 12 and 16 weeks of age. Also, **Toson et al. (1999)** reported high positive heterosis % due to crossing between Baladi and New Zealand White for dressing %.

4. Carcass cuts (Forepart, Intermediate part and Hind part Percentages):

4. a. Purebreds:

Table (5) showed that, the difference among purebreds for intermediate part and hind part % were non significant ($p > 0.05$). V-Line rabbits had the highest values for hind part % (21.38) and intermediate part % (13.38). Gabali rabbits (20.69) exceed New Zealand white (20.58) and Californian (20.64 %) for hind part %, but New Zealand white exceed (11.57) Gabali rabbits (11.05) and Californian (10.75) for intermediate part %. This agreed with **Rania (2005)**. She reported non significant differences among purebreds for carcass cuts.

4. b. Crossbreds and reciprocal crossbreds:

Table (5) showed that, there were significant differences among different crossbreds and reciprocal crossbreds for intermediate part %, with NV crossbreds showed the highest value (12.83) and were higher significantly over its reciprocal VN (11.02) and GC crossbred had the lowest value (9.94).

There were no significant differences among different crossbreds and reciprocal crossbreds for forepart and hind part %, while CN crossbreds showed the highest value for forepart (22.36) over other purebreds and crossbreds, and GC crossbreds showed the highest value for hind part % (22.37). This agreed with **Heba (2004)**. She founded that, there was a significant difference among crossbreds for carcass cuts. CV crossbred rabbits showed the highest hind part % (19.03) followed by NV crossbreds (18.99)..

4. c. Heterosis %:

The estimated values of forepart % were positive for all crossbreds except VG. CG crossbreds showed the highest positive heterosis % (13.22) followed by VN (13.14). The estimated H % for hind part % showed that VG crossbreds showed high positive value (22.35) and CG crossbreds showed high negative value (-22.63). CG crossbreds showed high positive value (23.80) for intermediate part % and CV crossbreds showed high negative value (-12.68) (Table 6). This agreed with **Abdel-Aziz (1998)** and **Gad (1998)**. They reported that, crossing between Gabali and Californian rabbits evidenced the presence of Positive direct heterosis in most carcass traits at 12 and 16 weeks of age.

5. Giblet weights %:

5. a. Purebreds:

There were non significant differences ($p > 0.05$) among purebreds for giblet %. Californian and Gabali rabbits showed the highest values (4.18, 4.17), while New Zealand White showed the lowest one (3.97) (Table 5). **Akinici et al. (1998)** showed that genotype has a significant effect on slaughter traits and carcass characters ($p < 0.01$) except liver, kidney, and stomach weight percentage. **Rania (2005)** found significant difference ($P < 0.05$) among purebreds for organ weight % except for heart and edible part %.

5. b. Crossbreds and reciprocal crossbreds:

GV and GN crossbreds showed higher significant values for giblet % (4.74, 4.74), while NV crossbreds had the lowest giblet % (3.57).). **Rania (2005)** found that, Flander x New Zealand white showed high periscapular fat % and the reciprocal showed the highest liver %.

5. c. Heterosis %:

GN and GV crossbreds showed higher positive H % for giblet % (16.21, 14.80) (Table 6). These results agreed with those obtained by **Abdel-Aziz (1998)**. He reported that crossing between Gabali and New Zealand White rabbits showed Positive direct heterosis in most carcass traits. The existence of negative heterotic effect for CV crossbreds for and periscapular fat % and perirenal fat % was also reported by **Heba (2004)**, and this could be utilized in breeding program to avoid obesity as pointed by **Zaky et al. (2001)**. From the estimated heterosis %, it is cleared that Gabali breed could be used as sire breed for increasing organs weight %.

Combining ability for Carcass traits:

1. Slaughter weight, Hot carcass weight, Dressing %:

Table (8) showed that, the effect of general combining ability on these traits was non-significant ($p > 0.05$) with exception of hot carcass weight was highly significant ($p < 0.01$). On the contrary the effect of specific combining ability, it was highly significant ($p < 0.01$) for all these traits. Gabali breed showed high positive GCA for live body weight (90.55) and hot carcass weight (50.91). New Zealand white had positive value for the both traits (9.74, 9.81). **El-Sheikh et al. (1992)** recorded that, New Zealand white had positive value for GCA for body weight (0.16) and hot carcass weight (0.05), while Baladi showed high positive value for dressing % (2.74), but showed negative value to live body weight and carcass weight.

GV crossbred rabbits had the highest positive value of specific combining ability for live body weight (152.63) and hot carcass weight (97.58). GN crossbreds showed high positive estimate for live body weight (18.46). CN crossbreds had high positive estimate to hot carcass weight (15.39) (Table 7). **El-Sheikh et al. (1992)** found that, Californian x New Zealand white showed high positive SCA value for live body weight. Also, Baladi x Californian were being superior in SCA effect for dressing % (0.44).

2. Carcass cuts:

The effect of general combining ability on carcass cuts was highly significant ($p < 0.01$) for forepart % and significant ($p < 0.05$) for intermediate part %. For hind part %, it was non-significant ($p > 0.05$). On the contrary, the effect of specific combining ability was highly significant ($p < 0.01$) for all carcass cuts (Table 8). Similar results were recorded by **El-Sheikh et al. (1992)** and **Jakubec et al. (1988)**. They observed that, general combining ability was significant for carcass, giblet weight, breast and leg muscles weights.

Californian showed the highest positive GCA for forepart % (0.55) and hind part % (0.22), while V-Line showed the highest positive value for intermediate part % (0.57) followed by New Zealand white (0.29). For specific combining ability, GC crossbred rabbits showed the highest positive (SCA) for hind part % (0.75), while GN crossbred rabbits had the highest positive (SCA) for intermediate part % (0.44), for forepart % VN crossbred rabbits had the highest positive value (0.89).

El-Sheikh et al. (1992) found that, New Zealand white showed high positive (GCA) for middle part % (0.56). They reported that Baladi x Californian being superior in SCA effect for rear part % (0.63).

3. Giblet weight %:

The effect of general combining ability on giblet weight % was non-significant ($p > 0.05$). On the contrary, the effect of specific combining ability. was highly significant ($p < 0.01$) (Table 8). Gabali rabbits showed the highest positive GCA for giblet % (0.19). GV crossbred rabbits showed the highest positive SCA for giblet % (0.27). Also GN crossbred rabbits had high positive value for giblet % (0.11). Similar results were recorded by **El-Sheikh et al. (1992)**. They found that, New Zealand white showed high positive (GCA) for liver % (0.29),

Table (1): Least square means ± standard errors (LSM ± SE) of average daily gain and relative growth rate at different age intervals due to crossing of New Zealand white (N), Californian (C), V- Line (V) and Gabali (G) breeds.

Trait		Relative growth rate				Average daily gain			
Age period		4 - 6 weeks	6 - 8 weeks	8 – 10 weeks	10- 12 weeks	4 - 6 weeks	6 - 8 weeks	8 – 10 weeks	10- 12 weeks
Genotype	N	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
NN	20	52.05 ± 2.03^{c}	35.27 ± 3.65^{b}	18.53 ± 1.50^{ab}	15.07 ± 1.17^{b}	34.46 ± 2.37^{b}	33.96 ± 3.04^{b}	23.60 ± 1.95^{a}	10.23 ± 0.81^{b}
CC	18	47.85 ± 3.54^{c}	55.26 ± 2.18^{a}	15.94 ± 1.63^{b}	10.61 ± 1.04^{c}	26.66 ± 1.92^{c}	52.53 ± 1.88^{a}	20.85 ± 1.98^{a}	7.19 ± 0.72^{c}
VV	20	75.49 ± 3.20^{a}	33.51 ± 2.20^{b}	22.38 ± 1.38^{a}	24.50 ± 1.23^{a}	38.32 ± 1.90^{ab}	28.60 ± 2.24^{b}	24.50 ± 1.47^{a}	18.48 ± 1.11^{a}
GG	17	60.54 ± 1.52^{b}	29.51 ± 2.33^{b}	19.78 ± 1.65^{ab}	16.74 ± 1.95^{b}	40.89 ± 1.57^{a}	30.00 ± 2.58^{b}	25.31 ± 2.38^{a}	10.51 ± 1.40^{b}
Mean	75	59.23 ± 1.83^{B}	38.29 ± 1.74^{A}	19.22 ± 0.80^{A}	16.89 ± 0.89^{A}	35.00 ± 1.16^{B}	36.17 ± 1.65^{A}	23.54 ± 0.96^{A}	11.76 ± 0.70^{A}
CN	15	54.22 ± 2.45^{c}	28.12 ± 1.81^{c}	18.58 ± 1.51^{bc}	18.14 ± 1.35^{ab}	32.47 ± 1.15^{de}	26.61 ± 2.98^{de}	20.19 ± 1.02^{de}	14.32 ± 1.62^{a}
VN	21	61.77 ± 2.27^{b}	$34.89 \pm 2.94b^{c}$	24.64 ± 1.18^{a}	13.38 ± 1.43^{b}	32.68 ± 0.96^{de}	29.59 ± 2.40^{cd}	27.75 ± 1.16^{a}	9.98 ± 1.17^{cd}
GN	16	56.76 ± 2.16^{bc}	39.06 ± 3.58^{b}	14.82 ± 1.52^{c}	17.67 ± 1.04^{ab}	35.49 ± 2.26^{cd}	39.97 ± 2.40^{ab}	18.54 ± 1.96^{e}	12.51 ± 0.99^{c}
VC	16	61.74 ± 1.36^{b}	31.30 ± 1.31^{bc}	21.34 ± 1.70^{ab}	17.18 ± 1.89^{ab}	39.33 ± 1.30^{bc}	31.42 ± 1.94^{cd}	26.02 ± 1.30^{ab}	11.62 ± 1.23^{abcd}
GC	19	60.82 ± 1.28^{bc}	50.24 ± 3.37^{a}	21.34 ± 1.70^{ab}	14.47 ± 0.97^{b}	30.75 ± 0.66^{e}	44.43 ± 2.99^{a}	24.84 ± 1.24^{abcd}	10.25 ± 0.76^{cd}
GV	17	69.62 ± 3.25^{bc}	32.65 ± 2.01^{bc}	20.02 ± 0.77^{bc}	18.86 ± 0.90^{ab}	42.73 ± 1.81^{ab}	32.12 ± 1.70^{cd}	26.38 ± 2.23^{ab}	12.57 ± 0.73^{abcd}
NC	15	70.97 ± 2.66^{a}	32.78 ± 2.07^{bc}	17.58 ± 2.13^{bc}	13.07 ± 1.66^{b}	43.18 ± 2.42^{ab}	31.97 ± 1.94^{cd}	21.86 ± 2.62^{bcde}	9.21 ± 1.19^{d}
NV	21	69.19 ± 1.23^{a}	33.11 ± 1.00^{bc}	17.00 ± 1.07^{bc}	16.19 ± 1.37^{ab}	45.88 ± 0.92^{a}	35.37 ± 0.97^{bc}	23.40 ± 1.65^{abcde}	10.38 ± 0.88^{abcd}
NG	16	70.49 ± 3.25^{a}	35.70 ± 1.85^{bc}	20.80 ± 1.37^{ab}	14.47 ± 4.95^{b}	39.64 ± 1.18^{bc}	33.57 ± 2.01^{bcd}	25.30 ± 1.35^{abc}	13.69 ± 1.04^{ab}
CV	16	71.24 ± 1.72^{a}	32.08 ± 2.68^{bc}	21.49 ± 2.35^{ab}	17.26 ± 1.16^{ab}	34.73 ± 1.15^{de}	22.53 ± 1.98^{e}	24.78 ± 1.27^{abcd}	14.33 ± 1.04^{a}
CG	19	71.77 ± 3.66^{a}	33.52 ± 1.91^{bc}	17.52 ± 1.18^{bc}	14.12 ± 1.28^{b}	41.81 ± 2.61^{ab}	31.92 ± 2.05^{cd}	20.98 ± 1.22^{cde}	10.02 ± 0.82^{cd}
VG	17	60.79 ± 2.11^{a}	34.60 ± 0.86^{bc}	19.27 ± 0.68^{ab}	20.53 ± 1.08^{a}	40.25 ± 1.65^{b}	35.85 ± 0.73^{bc}	26.14 ± 1.15^{ab}	13.01 ± 0.68^{bcd}
Mean	208	64.88 ± 0.75^{A}	34.98 ± 0.76^{B}	19.66 ± 0.47^{A}	16.41 ± 0.50^{A}	38.02 ± 0.53^{A}	32.84 ± 0.76^{B}	24.11 ± 0.47^{A}	11.87 ± 0.31^{A}

Table (2): Heterosis % of average daily gain and relative growth rate % for crossbreds and reciprocal crossbreds due to crossing of New Zealand, Californian, V- Line and Gabali rabbits.

Trait	Relative growth rate				Average daily gain			
Genotype \ age	4-6weeks	6-8 weeks	8-10 weeks	10-12 weeks	4-6weeks	6-8 weeks	8-10 weeks	10-12 weeks
CN	8.54	-37.87	7.83	64.40	6.25	-38.45	-9.13	41.27
VN	-3.13	1.45	20.48	-30.45	-10.19	-5.40	15.38	-32.35
GN	0.83	20.59	-22.61	20.63	-5.78	24.98	-24.17	11.13
VC	0.11	-29.47	11.37	-9.43	21.05	-22.53	14.77	-2.10
GC	12.23	18.54	12.09	15.81	-8.94	7.68	7.62	5.85
GV	2.36	3.61	-2.03	-13.25	7.90	9.62	5.94	-8.53
NC	42.08	-27.57	2.03	5.74	41.29	-26.06	-1.62	1.79
NV	8.49	-2.55	-16.87	-27.66	26.07	13.07	-2.70	-18.14
NG	25.22	10.21	8.61	32.01	5.22	7.32	3.47	-7.29
CV	15.51	-27.71	12.16	11.69	5.78	-44.45	9.30	-1.65
CG	32.44	-20.90	-1.90	13.22	23.80	-22.63	-9.09	3.29
VG	-10.61	9.80	-8.58	-10.21	1.64	22.35	4.97	-0.43

Table (3): General and specific combining ability for relative growth rate and average daily gain at different age intervals due to crossing of New Zealand white (N), Californian (C), V-Line (V) and Gabali (G) breeds.

Trait	Relative growth rate				Average daily gain			
Age period	4 - 6 weeks	6 - 8 weeks	8 -10 weeks	10 -12 weeks	4 - 6 weeks	6 - 8 weeks	8 -10 weeks	10 -12 weeks
General combining ability								
NN	-2.51	-1.44	-0.58	-0.44	-0.47	-0.65	-0.74	-0.98
CC	-2.64	4.1	-0.83	1.24	-0.68	2.96	-1.22	-1.96
VV	4.71	-2.51	1.75	1.84	1.89	-3.26	1.66	2.65
GG	0.46	-0.12	-0.30	-0.126	1.29	0.95	0.33	0.33
Specific combining ability								
CN	4.29	-7.92	0.1	1.68	3.23	-6.8	-0.78	2.15
VN	-0.17	2.23	0.25	-2.98	0.11	2.77	0.87	-3.28
GN	2.21	3.22	-0.69	1.90	-1.01	2.69	-1.44	0.45
VC	0.96	-5.61	1.10	0.60	2.57	-6.49	1.19	0.137
GC	5.01	2.18	0.52	-0.26	-0.09	0.47	0.03	-0.47
GV	-3.43	0.53	-0.87	-0.69	0.54	2.51	0.5	0.3

Table (4): The analysis of variance for general and specific combining ability for relative growth rate and average daily gain at different age intervals due to crossing of New Zealand white (N), Californian (C), V-Line (V) and Gabali (G.) breeds.

Trait		Relative growth rate				Average daily gain			
S. O. V	D.F	4 - 6 weeks	6 - 8 weeks	8 -10 weeks	10 -12 weeks	4 - 6 weeks	6 - 8 weeks	8 -10 weeks	10 -12 weeks
G. Combining ability	3	0.94	62.93**	39.72**	3.12	0.62	2.72	73.5**	5.67
S. Combining ability	4	74.41**	59.1**	38.66**	69.31**	45.65**	2.0	62.78**	111.5**
Error	4	101.53	40.01	12.91	4.41	54.34	24.41	10.48	5.62

** Highly significant at level (0.01)

Table (5): Least square means ± standard errors (LSM ± SE) of carcass traits due to crossing of New Zealand white (N), Californian (C), V- Line (V) and Gabali (G) breeds.

Trait		Slaughter weight	Hot carcass weight	Dressing %	Forepart %	Intermediate part %	Hind part %	Giblet %
Genotype	N	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
NN	10	2121.00 ± 70.84a	1285.00 ± 47.96ab	60.57 ± 0.78a	19.97 ± 0.35ab	11.57 ± 0.44a	20.58 ± 0.30a	3.97 ± 0.13a
CC	10	2165.50 ± 30.79a	1301.50 ± 15.64ab	60.13 ± 0.40a	21.71 ± 0.25a	10.75 ± 0.22a	20.64 ± 0.21a	4.18 ± 0.17a
VV	10	2045.00 ± 72.25a	1236.50 ± 41.85b	60.52 ± 0.71a	18.52 ± 1.11b	13.38 ± 1.43a	21.38 ± 0.44a	4.08 ± 0.17a
GG	10	2242.00 ± 36.48a	1368.00 ± 20.86a	61.05 ± 0.65a	21.73 ± 0.21a	11.05 ± 0.20a	20.69 ± 0.19a	4.17 ± 0.13a
Mean	40	2143.37 ± 53.04A	1297.75 ± 18.15A	60.57 ± 0.31A	20.48 ± 0.36B	11.69 ± 0.40A	20.82 ± 0.15B	4.10 ± 0.074A
CN	10	2014.00 ± 102.95c	1250.00 ± 71.66bc	61.91 ± 0.77a	22.37 ± 1.22a	11.37 ± 0.44bcd	21.96 ± 0.83a	4.11 ± 0.12bc
VN	10	1977.50 ± 67.62c	1229.00 ± 38.69cd	62.25 ± 0.74a	21.78 ± 0.50a	11.02 ± 0.40bcde	22.04 ± 0.29a	3.69 ± 0.11de
GN	10	2366.00 ± 114.42a	1425.00 ± 57.55ab	60.54 ± 0.89a	21.64 ± 0.52a	11.81 ± 0.13ab	21.83 ± 0.51a	4.74 ± 0.19a
VC	10	2115.00 ± 57.33bc	1304.00 ± 32.30bc	61.70 ± 0.50a	21.76 ± 0.39a	11.53 ± 0.49bc	21.42 ± 0.42a	4.21 ± 0.16b
GC	10	2070.00 ± 37.42c	1269.50 ± 12.79bc	61.45± 0.83a	22.09 ± 0.55a	9.94 ± 0.33e	22.38 ± 0.24a	4.39 ± 0.13ab
GV	9	2313.33 ± 80.86ab	1350.00 ± 47.78bc	58.37 ± 0.61a	20.50 ± 0.46a	11.22 ± 0.29bcd	20.12 ± 0.27a	4.74 ± 0.12a
NC	10	2063.00 ± 53.04c	1271.50 ± 40.91bc	61.55 ± 0.66a	21.99 ± 0.32a	11.00 ± 0.34bcde	20.70 ± 1.35a	3.82 ± 0.12cde
NV	10	2346.00 ± 49.04a	1421.50 ± 38.05ab	60.54 ± 0.54a	21.42 ± 0.54a	12.83 ± 0.39a	21.12 ± 0.41a	3.57 ± 0.03e
NG	9	2138.89 ± 32.64bc	1317.78 ± 18.54bc	61.64 ± 0.57a	21.61 ± 0.41a	11.78 ± 0.28ab	20.51 ± 0.18a	3.79 ± 0.16cde
CV	10	1740.00 ± 61.81d	1068.00 ± 42.76d	61.33 ± 0.80a	22.20 ± 0.58a	10.54 ± 0.37cde	22.21 ± 0.57a	3.75 ± 0.12cde
CG	10	1997.00 ± 67.26c	1197.00 ± 28.80cd	60.17 ± 0.92a	21.95 ± 0.42a	10.25 ± 0.28de	21.66 ± 0.37a	4.01 ± 0.11bcd
VG	10	2425.00 ± 57.66a	1544.50 ± 125.14a	63.16± 3.54a	21.50 ± 0.14a	11.29 ± 0.31bcd	20.39 ± 0.26a	4.30 ± 0.15b
Mean	118	2128.85 ± 26.06A	1303.47 ± 18.61A	61.23 ± 0.35A	21.74 ± 0.16A	11.20 ± 0.11A	21.37 ± 0.17A	4.09 ± 0.050A

* Means of purebreds, and crossbreds & its reciprocal within the same category having different superscripts (small letters) are significantly different al level ($p < 0.05$).
* Means of purebreds versus crossbreds & its reciprocal within the same column having different superscripts (capital litters) are significantly different al level ($p < 0.05$).

Table (6): Heterosis % of carcass traits for crossbreds and reciprocal crossbreds due to crossing of New Zealand, Californian, V- Line and Gabali rabbits.

Trait / Genotype	Slaughter weight	Hot carcass weight	Dressing %	Forepart %	Intermediate part %	Hind part %	Giblet %
CN	-6.03	-3.34	2.56	7.29	1.79	6.55	0.85
VN	-5.06	-2.51	2.82	13.14	-11.62	5.00	-8.45
GN	8.45	7.42	-0.46	4.52	4.33	5.81	16.21
VC	0.46	2.75	2.28	8.15	-4.47	1.99	2.18
GC	-6.06	-4.88	1.40	1.65	-8.80	8.27	5.27
GV	-0.68	3.66	-3.96	1.83	-8.19	-4.69	14.80
NC	-3.74	-1.68	1.98	5.51	-1.43	0.38	-6.25
NV	12.62	12.75	00.00	11.27	2.88	0.61	-11.19
NG	-1.95	-3.28	1.36	3.33	4.06	-0.58	-7.12
CV	-17.34	-15.83	1.67	10.34	-12.68	5.66	-1.47
CG	-9.38	-10.32	-0.69	13.22	23.80	-22.63	-3.83
VG	13.13	18.60	3.91	-10.21	1.64	22.35	4.12

Table (7): General and specific combining ability for carcass traits due to crossing of New Zealand white (N), Californian (C), V-Line (V) and Gabali (G) breeds.

trait	Slaughter weight	Hot carcass weight	Dressing %	Forepart %	Intermediate part %	Hind part %	Giblet %
General combining ability							
NN	9.74	9.81	0.14	-0.[illegible]	0.29	-0.05	-0.136
CC	-92.43	-55.40	-6.25 x 10-3	0.55	-0.55	0.22	-8.7 x 10-3
VV	-7.86	-5.31	-2.5 x 10-3	-0.64	0.57	0.03	-0.043
GG	90.55	50.91	-0.12	0.17	-0.27	-0.19	0.19
Specific combining ability							
CN	-12.49	15.39	0.53	0.27	0.12	-0.06	0.02
VN	26.19	16.68	0.19	0.89	-0.27	0.37	-0.029
GN	18.46	6.59	0.01	0.09	0.44	-0.02	0.11
VC	-105.88	-57.34	0.46	0.08	-0.31	0.32	0.057
GC	-98.30	-66.31	0.12	-0.13	-0.39	0.75	-0.07
GV	152.63	97.58	0.16	-0.36	-0.36	-0.81	0.27

Table (8): The analysis of variance for general and specific combining ability for carcass traits due to crossing of New Zealand white (N), Californian (C), V-Line (V) and Gabali (G) breeds.

S. O. V	D.F	Slaughter weight	Hot carcass weight	Dressing %	Forepart %	Intermediate	Hind part part %%	Giblet %
G. Combining ability	3	1.035	237**	0.025	128.54**	7.66*	0.35	0.8
S. Combining ability	4	210.87**	19859.7**	2037.26**	5049.65**	910.64**	2717.6**	202.05**
Error	4	43534.34	18722.85	3.62	0.187	0.28	0.67	0.19

* Significant at level (0.05)
** Highly significant at level (0.01)

REFERENCES

Abd El-Galil, k. and Khidr, R.E. (2000): *Utilization of Acacia saligana in feeding growing rabbits under desert and newly reclaimed areas. Egyptian Poultry Science Journal. 20 (III): 497-515.*

Abdel-Aziz, M.M. (1998): *Crossbreeding between El-Gabali and New Zealand White rabbits in the north coast belt of the Egyptian western desert. PhD Thesis, Faculty of Agriculture at Moshtohor, Zagazig University, Banha Branch, Egypt.*

Afifi, E. A., M. H. Khalil., Amina, F. Jhadr and Y. M. K.Youssef. (1994): *Heterosis, maternal and direct effects of post-weaning growth traits and carcass performance in rabbit crosses. J. Anim. Breed Genet. 111: 138-147.*

Akinici, Z., Poyraz, O., Akcapinar, H. and Evogliyan, N. (1998): *The effect of genotype, sex, and age on some slaughter traits and carcass characteristics of New Zealand White and Californian rabbits. Lalahan Hayvancilik Àrastirma Enstitusu Dergisi, 38(2): 48-102.*

Amal, K. El-Asheeri (2000): *Growth performance, carcass characteristics and chemical composition of New Zealand White rabbits as affected by age, sex and carcass cuts. Egyp. J. Anim. Prod. 37: 47-56.*

Amber, Kh., N.S. Isshak, Nimmat and M. El-Abd. (2002): *Effect of dietary fiber sources on performance of growing New Zealand White rabbits. Egyp. Poult. Sci. J. 22 (I): 596-618.*

Broody, S. (1945): *Bioenergetics and growth. Reinhold Pub Crop N.Y., U.S.A.*

Dickerson, G.E. (1969): *Techniques for research in quantitive genetics. Techniques and procedures in animal science research. American society of animal science, campaign, Il.*

El-Sheikh, A.I., El-Bayomi, KH. M. and Hemeda, Sh.A. (1992): *Combining ability and heterosis for slaughter performance and meat quality in three breed diallel crosses of rabbits. Proc. Fth Sci. Conf. Fac. Vet. Med. Assiut Univ. Nov. 8-10, 1992, Egypt. 171- 178.*

Gad, S.M.A. (1998): *Evaluation of growth and production performance of Al-Gabali rabbits and their crosses under semiarid conditions. M.Sc. thesis, Faculty of Agriculture at Moshtohor, Zagazig University, Banha Branch, Egypt.*

Gómez, E.A., Baselga, M., Rafel, O. and Ramón, J. (1998): *Comparison of carcass characteristics in five strains of meat rabbit selected on different traits. Livest. Prod. Sci, 55: 53-64.*

Heba, I. Basha (2004): *Biochemical genetic variations due to crossing of rabbit. M. Sc. Thesis, Fac. Vet. Med., Alex. Univ. Egypt.*

Hemeda, Sh.A., El-Shéikh, A.I and El-Bayomi, KH, I (1992): *Evaluation of combining ability and heterosis for weaning weight and post-weaning growth performance in rabbit crosses. Proc. Fth Sci. Conf. Fac. Vet. Med. Assiut Univ. Nov. 8-10, 1992, Egypt. 171- 178.*

Jakubec, V., Soukupova, and Kinzel, I. (1988): *Genetic effects estimated for a complete cross of four lines of fowls. Zivocisa Vyroba (1988), 33 (11): 961-968. A. B. A., 1990, Vol. 58, No. 5, p. 458.*

Khalil, M.H. (1996): *Technical report on the project entitled "Production of purebred and crossbred parental stock of rabbits to be distributed to small scale breeders in Qalyoubia Governorate". Faculty of Agriculture at Moshtohor and Regional Council for Research and Extension, Ministry of Agriculture, Egypt, p. 9.*

Legates, J.E. and Warwick, E.J. (1990): *Breeding and Improvement of Farm Animals. 8th Ed, Cm (Mc Graw - Hill Publications in the Agricultural Sciences).*

Martínez-Garza A. (1983): *Statistical Designs and Analysis of Experiments of Diallel Crosses (In Spanish). Colegio de Postgraduados. Montecillo, Edo. México. 252 p.*

Martínez-Garza A. (1991): *Analysis of diallel experiments by means of the IML procedure of SAS (In Spanish). Comunicaciones en Estadística y Cómputo. Centro de Estadística y Cálculo. Colegio de Postgraduados. Montecillo, Edo. México. 36 p.*

Ozimba, C. E. and Lukfehar, S. D. (1991): *Comparison of rabbit breed types for post-weaning litter growth, feed efficiency and survival performance traits. J. Anim. Sci. 69: 3494-3500.*

Plá, M., Hernández, P. and Blasco, A. (1996): *Carcass composition and meat characteristics of two rabbit breeds of different degrees of maturity. Meat Sci, 44(1-2): 85-92.*

Rania, A. Hassan (2005): *Effect of crossing on productive performance of rabbits. MSc .Thesis, Faculty of Vet. Med. Suez Canal Univ. Egypt.*

SAS (2002): *SAS/STAT users guide. SAS Institute INC, Cary, NC 27513, USA.*

Schlolaut, W. (1992): *Management in rabbit production – graduator for transfer of knowledge into production level. Fifth Congress of the World Rabbit Science Association. July 25-30, 1992. Oregon, U.S.A. Vol. A, pp 594-614.*

Skrivanova, V., Marounek, M., Tumova, E., Skrivan., M. and Lastova, J. (2000): *Performance, carcass yield and quality of meat in broiler rabbits: a comparison of six genotypes. Czesh Journal of Animal Science, 45 (2) 91-95.*

Steel, R.G.D. and Torrie, J.H. (1960): *Principles and procedures of statistics Mc Graw- Hill Book Comp. Inc., New York.*

Toson, M.A., Sallam, M.T. and Uohana, B.A. (1999): *Evaluation of purebred and crossbred rabbits for growth and carcass traits Egypt. Poult. Sci. Vol. 19 (I): 53-70.*

Youssef, M.K. (1992): *Productive performance of purebred and crossbred rabbits. M.Sc. Thesis, Faculty of Agriculture at Moshtohor, Zagazig University, Banha Branch, Egypt.*

Zaky, H.I., Shehata, M. and Sabra, Z.A.M. (2001): *Effect of crossbreeding, sex, and age on carcass traits in rabbits. J. Egy. Poult. Sci. 22(I): 558-584*

الملخص العربى

قوة الهجين وقدرة التوافق لبعض الصفات الإنتاجية فى أربع سلالات من الأرانب

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قسم تنمية الثروة الحيوانية - كلية الطب البيطري- جامعة الزقازيق

أجريت هذه الدراسة بهدف تقييم أثر الخلط التبادلى الكامل لأربع سلالات من الأرانب (النيوزيلاندى الأبيض والكاليفورنين والفى لاين والجبلى) على مجموعة من الصفات الإنتاجية والتى تشمل (معدلات النمو النسبية ومتوسط الزيادة اليومية)، علاوة على ذلك صفات الذبيحة و التى تشمل (وزن الذبح، وزن الذبيحة الدافىء، نسبة التصافى، قطعيات الذبيحة والتى تشمل، الجزء الامامى و الأوسط والخلفى). إستهدفت الدراسة أيضا تحديد نسبة قوة الهجين وقدرة التوافق العامة والخاصة لهذه الصفات.

سجل الفى لاين قيم عليا معنوية لمعدل النمو النسبى فى الفترة من الاسبوع الرابع إلى السادس (٧٥.٤٩ %)، ومن الاسبوع العاشر إلى الثانى عشر(١٨.٤٨ %)، ومن الرابع إلى الثانى عشر(١٢٩.٣٤ %) مقارنة بالأفراد النقية الاخرى. أظهر الخليط (ذكورالجبلى مع اناث الكاليفورنين) قيم عالية فى الفترة من الاسبوع السادس الى الثامن (٥٠.٢٤ %)، بينما أظهرالخليط العكسي لذكور الكاليفورنين مع اناث الجبلى قيما متميزة لمعدل النموالنسبى فى الفترة من الاسبوع الرابع إلى السادس (٧١.٧٧ %). أظهر خليط ذكور النيوزيلاندى الأبيض مع إناث الفى لاين أعلى قيم لمتوسط الزيادة اليومية فى الفترة من الأسبوع الرابع إلى السادس، و الفترة من الأسبوع الرابع إلى الثانى عشر(٤٥.٨٨ و ٢٨.١٩). أظهر خليط ذكور الفى لاين مع إناث النيوزيلاندى الأبيض أعلى نسبة لقوة الهجين لمعدل النمو النسبى (٢٠.٤٨ %) ولمتوسط الزيادة اليومية فى الوزن (١٥.٣٨ %) فى الفترة من الاسبوع الثامن إلى العاشر.

أظهرالفى لاين أعلى قيم لنسبة الجزء الأوسط (١٣.٣٨%) والخلفى (٢١.٣٨%)، بينما سجل خليط ذكور النيوزيلاندى الابيض مع إناث الفى لاين أعلى قيم لنسبة الجزء الو سطى (١٢.٨٣%). حقق خليط ذكور الجبلى مع إناث الفى لاين، وذكور الجبلى مع إناث النيوزيلاندى الابيض أعلى قيم لنسبة الاحشاء (٤.٧٤ و٤.٧٤ %). كذلك أظهر خليط ذكور الجبلى مع إناث النيوزيلاندى الابيض أعلى قيمة إيجابية لقوة الهجين لنسبة الأحشاء (١٦.٢١ %)، بينما حقق خليط ذكور النيوزيلاندى الابيض مع إناث الفى لاين أعلى القيم السالبة (-١١.١٩ %). تأثيرقدرة التوافق العامة على كل الصفات السابقة كان غير معنوى، على العكس من ذلك تأثيرقدرة التوافق الخاصة كان معنويا جدا. أظهر الجبلى قيم عليا إيجابية لقدرة التوافق العامة لمعظم الصفات. أظهر خليط الجبلى مع إناث الفى لاين قيم عالية وإيجابية لقدرة التوافق الخاصة لنفس الصفات.