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ECONOMIC BENEFITS OF ONE-WAY CROSS BETWEEN TWO LINES OF RABBITS REARED UNDER SELECTION PROGRAMS ON PRODUCTIVE PERFORMANCE OF OFFSPRING

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ABSTRACT: The study aimed to explore the economic benefits of offspring growth performance in three genetic groups of meat rabbits (Alexandria line, V line & crossing between Alexandria line males and V line females). For the three genetic groups, the studied offspring growth traits were: individual weight at weaning (WW), 6 weeks (BW6), 8 weeks (BW8), 9 weeks the end of fattening period (SW), and individual daily weights gain. Analysis of variance results showed that live body of rabbits at marketing age was highly significantly ($P \leq 0.001$) affected by the genetic groups. Also, the results indicated that least square means of body weight at 9 weeks of age increased by 135 & 277 gram in cross rabbits than those recorded for Alexandria line & V line rabbits, respectively. Furthermore, the result showed that economic efficiency and relative economic efficiency in AV genetic group increased by (36 % & 16 %) and (75 % & 33 %) than those found for AA and VV rabbits, respectively.

Key words: Rabbits, Growth, Economic benefits, Crossing, Productive performance

INTRODUCTION

Advantages of rabbits as micro livestock include small body size, short generation intervals, ability to utilize less competitive feeds, rapid growth, possibility for genetic improvement and production of high-quality meat and beneficial by-products (Egbo et al., 2001; Herbert, 2011). These advantages make rabbits seems to be a great way to solve the shortage in animal protein all over the world especially, when we take the right ways to improve its productive and reproductive ability under consideration.

In general, traits related with growth, such as weaning weight, body weight at marketing and daily gain through the fattening period are important in the breeding of rabbits for meat production as these productive traits are strongly correlated with the production efficiency of the young (El-Raffa, 2005). The heavier in the market weight means the higher is the kilograms of rabbit that marketed and the higher in the profit for rabbit producers (Zeferino et al., 2013).

In this respect, improving daily gain from weaning to slaughter age is a main economic trait for improving growth performance for rabbits (Baselga, 2004), but Enhancing feed efficiency is the primary goal, as it has a higher economic value than daily gain. (Armero and Blasco, 1992). As daily gain is a trait that has a negative correlation with feed conversion (Moura et al., 1997). Also, this trait is easier to record than individual feed conversion rate. In addition, improving daily gain through fattening period can modify the complete growth curve of rabbits and changing the age at which commercial slaughter weight is raised.

The conventional procedure to a breeding programs for meat rabbit productions improvement has been the establishment of expert lines through selection. Sire lines or paternal lines are frequently selected for daily weight gain from weaning to market age and dam lines or maternal lines, selected for litter size. These lines are then crossed in a crossbreeding program to produce market fryers that aim to reduce time and food in their fattening period (Baselga, 2004). In other words, the mating between paternal line males and maternal line females may lead to improve growth performance traits of growing rabbits produced through their fattening period, this will save time and cost of offspring to reach to marketing age (Peiró et al., 2019).

In this respect, Abdel-Hamid (2015) reported that, the main goals of crossing is to creat superior crosses (i.e. apply of hybrid vigor), enhance fitness and fertility traits and to combine different characteristics in which the crossed breeds were desirable, especially, in the case of high cost phenotypic recording which is true for many economic traits (Sevane et al., 2010)

The primary goal of this investigation is to determine the benefits of one way crossing between paternal line male (Alexandria line) and mater line female (V line), on productive performance and economic efficiency of growing rabbits, under Egyptian environmental condition.

MATRIALS AND METHODS

Population

The present study was carried out at the nucleus breeding rabbit farm of Poultry Research Center, Faulty of Agriculture, Alexandria University, spreading a period from 2019 up to 2020.

Three genetic groups of rabbits were used in the investigation, Alexandria line, V line & cross between Alexandria line male and V line females. Alexandria line

(A) is a synthetic paternal line of rabbits, established and developed at the nucleus breeding rabbit unit of the Poultry Research Center, Faculty of Agriculture, Alexandria University, Egypt (El-Raffa, 2007). Daily weight gain through fattening period was used as a criterion for genetic improvement in this line. Whereas, Line V (V) is a synthetic maternal line originated in 1982, and was developed at the Department of Animal Science of Universidad Polytechnic de Valencia, Valencia, Spain. Litter size at weaning was considered as the criterion for the selection goal in this line (Estany et al., 1989). A set of V Line rabbits was imported to the Poultry Research Center, Faculty of Agriculture, Alexandria University at the end of year 1998 (El-Raffa, 2000), multiplied for five years and after that the selection was continued under the same criterion. The third genetic group was AV rabbits that are a cross between Alexandria line bucks and V line does.

Housing and management

The rabbits were housed in a windowed rabbitry, with a flat deck design cages having galvanized wire. Each cage was equipped with a feeder, and a water supply carried out by nipple drinkers and a plastic plate on the floor protected against sore hocks. On day 28^{th} of gestation, metal nesting boxes were attached to the cages of pregnant does and were fixed outside the cages and supplied with a thin layer of wood shaving. All the flock was kept under the same managerial, environmental and hygienic condition. Rabbits were fed with a commercial pelleted feed in which a minimum content of crude protein is 18%, while the maximum level of crude fiber was 14%. Bucks, no pregnant does and non-lactating ones were fed restricted amount of food (130-150 gm. / day) to keep them in a good condition but not fat. Pregnant does after 15 days of pregnancy, lactating ones and growing rabbits were fed ad libitum. Clean fresh water was available for rabbits all the time. Manure was dropped from the cages on the floor and were collected and removed daily. The relative humidity was around 60% ± 10 %. A period of 14-16 hours of day light was provided. Health caring: The occurrence of disease could be largely avoided by a high standard of hygiene and careful management, so, the rabbits in our farm have never been treated with any kind of systematic medication or vaccination program.

Reproductive management

The females were first mated at a mean age of 5 months. At the beginning of the breeding season, during September, the breeding rabbits were divided into groups for within group mating. Each group was made up by four does and one buck that were chosen to avoid mating between close relatives (avoiding full-sib, half-sib and parent-offspring mating). Each doe was transferred to the buck's cage to be mated. Does were palpated 15 days post mating to detect pregnancy and those remained not pregnant were returned to the same buck at the next mating date. At the 33^{rd} day of pregnancy, the birth was released by an injection of oxytocine in case of the doe had not littered until then. During the pre-weaning period, the does had free admission to their litters. During this period, unrestricted access for litters to food and water was allowed. The offspring were weaned at the 4^{th} weeks of age. At weaning, young rabbits were removed from doe's cages and raised in collective cages in groups of five rabbits, so that the group size effect

on body weight and daily weight gain was reduced. The kits were individually ear tagged at weaning. Fattening period lasted 5 weeks.

Studied traits

For the three genetic groups, the growth traits studied were:

Individual weight in grams at weaning of 4 weeks (WW), at 6 weeks (BW6), at 8 weeks (BW8) and individual weight at the end of the fatting period at 9 weeks (SW).

Individual daily weight gain during the age intervals from 4 to 6 weeks (DWG4-6), from 6 to 8 weeks (DWG6-8), 8 to 9 weeks (DWG8-9) and during the fattening period between (DWG4-9), in grams per day. Daily weight gain (during the fattening period) measured using the following formula:

Daily weight gain = (SW - WW) / interval (4-9)

Where: Interval (4-9): The number of days between 4 and 9 weeks weighing dates.

-Daily feed intake during the age intervals from 4-6, 6-8, 8-9 and 4-9 weeks of age (DFI4-6, DFI6-8, DFI8-9 & DFI4-9, respectively), in grams.

-Feed conversion ratios during the age intervals from 4-6, 6-8, 8-9 and 4-9 weeks of age (FCR4-6, FCR6-8, FCR8-9 & FCR4-9), respectively.

This trait was calculated as feed consumed divided by weight gain.

Whereas, the traits characterizing economic efficiency, studied for three genetic groups were:

- Saved time (ST), in days: The number of days that needed for each of two pure genetic groups (Alexandria line & V line) to reach to marketing weight for cross genetic group. This trait was calculated as follows:

$$ST = \frac{BW9\ for\ AV\ Rrabbits - BW9 for\ Alexandria\ or\ V\ LINE}{DWG4{-}9\ for\ Alexandria\ or\ V\ LINE}$$

- Saved feed (SF), in grams: The amount of feed that needed for Alexandria or V line rabbits, after 9 weeks, to reach the marketing weight of AV rabbits. This trait was measured as follows:

$$SF = DFI \times ST$$

Whereas: DFI is the daily feed intake for pure line

- Economic efficiency of feeding (EEF):

EEF = (profitability / feed cost) x 100

Where:

The price of one Kg rabbit = 100 EGP and the cost of one Kg diet = 14 EGP.

Profitability = Total revenue – Total feed cost

Where: Total revenue = live body weight * price per Kg

Feed cost = Total feed intake (FI) * Price per kg

- Relative economic efficiency (REF):

REF = (EEF * 100) / EEF for V line

For the three genetic groups, the data set available for the investigation are shown in Table 1.

Statistical procedure:

Best Linear Unbiased Estimates (BLUE) is the method most frequently used in animal breeding for estimation of fixed effects (Weigel et al., 1991). To derive BLUE of the fixed effects, least squares procedures and the type III methods described by statistical analysis system (SAS , 2004) was used. Evaluation of the approximate significance of the effect was performed from the analysis including only fixed effects. Significance of the effects was tested at level $P \leq 0.05$ (*), $P \leq 0.01$ (**) and $P \leq 0.001$ (***) with the appropriate F statistic. Values of

probability higher than 5% were considered to be not significant.

Least squares mean and their standard errors were computed for levels of each class variable and Computations were carried out using the general linear model (GLM) procedure described by SAS program.

Data for body weight at all ages studied (4, 6, 8 & 9 weeks of age) and daily weight gain during all intervals recorded (4-6, 6-8, 8-9 & 4-9 weeks) were analyzed by adopting the following fixed linear model:

$Y_{ijklm}= \mu + G_i + SE_j + S_k + PO_l + b\ (NBA-\bar{x}) + e_{ijklm}$

Where:

Y_{ijklm} is the observed value of the dependent variable.

μ is the overall mean

G_i fixed effect of the i^{th} genetic group.

SE_j fixed effect of the j^{th} season of birth.

S_k fixed effect of the k^{th} sex.

PO_l fixed effect of the l^{th} parity order.

B overall linear regression coefficient for number born alive.

e_{ijklm} the random error.

RESULTS AND DISCUSSION

The number of observations, least square means and standard errors of individual growth traits studied in three genetic groups of rabbits are presented in Table 2. It must be remembered that these results were obtained after adjustment these studied traits for season of birth, sex, parity order and number born alive of which the growing rabbit was born, as described in the statistical model used to analyze the data.

Analysis of variance results showed that live body of rabbits at marketing age was significantly ($P \leq 0.001$) affected by the genetic groups. The results obtained indicated that least square means of body weight at 9 weeks of age increased by 135 & 277 gram in cross rabbits than those recorded for Alexandria line & V line rabbits, respectively. In other words, marketing weight of AV rabbits significantly 7.70 % and 17.13% higher than those of AA & VV rabbits, respectively.

Also, there is a significant difference in daily weight gain of growing rabbits for the three genetic groups under consideration through the period from 4th to 9th week of age. The values of daily weight gain in AV rabbits were higher by 3.06 & 4.46 gram / day than those obtained for AA & VV genetic group, respectively.

Our results agree well with many investigators working with several breeds of rabbits (Peixoto-Gonçalves *et al.*, 2023). They pointed out the relative important for crossing to enhance the rabbits' growth performance during the fattening period. In these respects, Abou Khadiga et al. (2008) showed that crossing between paternal line males and maternal line females resulted in increased marketing weight and daily weight gain of growing rabbits compared with those of pure lines. Moreover, Alexander (2023) and Cedano-Castro, et al., (2023) concluded that, it may use rabbit paternal line as sire and maternal line as dam, in mating system to achieve the best productive performance for growing rabbits.

Results observed significant differences between three genetic groups of growing rabbits in daily feed intake during the fattening stage. Growing rabbits belong to AV genetic group consumed less amount of feed by about 1.8 & 4.72 gm / day during the fattening period than those of AA & VV genetic groups, respectively. Moreover, Data of Table 2 showed that feed conversion ratio also improved in

AV rabbits during the period from 4th to 9th weeks of age. Whereas, VV rabbits achieved the worth feed conversion ratio comparing with other two genetic groups.

IN agreement with our results (Marín-García, et al., 2023) found that the most important economic characteristics in rabbit farming are feed conversion ratios (FCRs), and genetic advancement is concentrated on enhancing these characteristics in maternal and paternal lines, respectively.

From the results provided in Table 3, it is cleared that VV & AA growing rabbits needed about 8.98 & 4.52 days, respectively to receive the same marketing weight for AV genetic group. Moreover, the cross group rabbits save about 918 & 462-gram feed, for each growing rabbit, through their fattening period comparing with those amounts consumed by VV & AA rabbits, respectively to receive the same marketing weight.

Stated differently, suppose we have a rabbit farm with a capacity of 500 does under the commercial intensive production system with (reproductive schedule – remating 10 days' post parturition. Under this production system, each doe have one weaned kit every week, as well as provides 50 kids per year. The total amount of growing rabbits expects to produce in this farm will be 25 000 rabbits per year. The feed amount needed for growing rabbits in this farm will save by 22950 & 10275 kg / year for AV genetic group comparing with those needed for VV & AA genetic groups, respectively to produce the same amount of annual production.

The results represent in Table 4 show that, each of economic efficiency of feeding and relative economic efficiency for growing rabbits belong to AV genetic group were significantly improved. It is clearly apparent that both of economic efficiency and relative efficiency values were significantly higher in AV growing rabbits followed by the values obtained for AA and VV genetic groups, respectively. On other words, economic efficiency and their relative values in AV genetic group increased by (36 % & 16 %) and (75 % & 33 %) than those found for AA and VV rabbits, respectively.

These results agree well with those reported by Saker *et al*. (2020) and Abd El-latif et al. (2021). They found that economic efficiency measurements for growing rabbits were significantly affected by genetic groups. In this respect, Khamis (2014) reported that there were significant differences between growing rabbits of V line and Alexandria line in economic efficiency. On the other hand, Abdel-Hamid and Farahat (2015) noted that no significant differences were obtained among different breeds of growing rabbits for net profit.

The best economic efficiency results recorded for AV growing rabbits may be due to low amount of feed consumption, that reduced total feeding cost, and increase weight gain, that resulted more improvement in live body weight at marketing and increase total revenue. These leads to the beneficial effect on economic efficiency measurements in AV rabbits comparing with values acquired for AA & VV rabbits.

From the results obtained in this study, it might be concluded that in commercial meat rabbit farms, crossing between paternal line males and maternal line female will save time and cost for growing rabbits to reach their marketing weight.

Table (1): Structure of the data set.

Genetic group	
Alexandria Line	
82	Does *mated with*
27	Males
1602	Total tested offspring
V Line	
37	Does *mated with*
17	Males
493	Total tested offspring
AV Rabbits	
87	Does *mated with*
26	Males
1123	Total tested offspring

Table (2): Least square means and standard errors (S.E.) for the effect of genetic group on growth performance of growing rabbits.

Genetic group	Number of rabbits	MW (g)		DWG (g/d)		DFI (g)		FCR	
		LSM	S.E.	LSM	S.E.	LSM	S.E.	LSM	S.E.
AA	1367	1759^{b}	10	32.7^{b}	0.26	99^{b}	1.0	3.0^{b}	0.05
VV	395	1617^{c}	14	31.3^{c}	0.36	102^{c}	1.1	3.3^{c}	0.05
AV	975	1894^{a}	15	35.8^{a}	0.37	97^{a}	0.6	2.7^{a}	0.03
Sig. level		***		***		***		***	

Table (3): Differences in growth performance at marketing age between genetic groups of growing rabbits.

Difference between Genetic groups	Difference in MW (gram)	Saved Time (days)	Saved Feed (gram)
AV - AA	135.45	4.14	411
AV - VV	276.91	8.98	918
AA - VV	141.46	4.52	462

Table (4): Economic efficiency evaluations of AA, VV and AV genetic groups.

Item	Genetic group		
	AA	VV	AV
Live body weight (g)	1759^{b}	1617^{c}	1894^{a}
Total feed intake (g)	3465^{b}	3570^{c}	3400^{a}
Total revenue (L.E)	175.9	161.7	189.4
Total feed cost (L.E)	48.5	50.0	47.6
Profitability *(C)* (L.E)	127.4	111.7	141.8
EEF (%)	262.7^{b}	223.4^{c}	297.9^{a}
REF (%)	117.6^{b}	100.0^{c}	133.3^{a}

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الملخص العربي
الفوائد الاقتصادية للخلط في إتجاه واحد بين خطين من الأرانب المرباة تحت برامج الإنتخاب علي الأداء الإنتاجي للنسل

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تهدف هذه الدراسة إلى التعرف علي الفوائد الاقتصادية لأداء النمو في ثلاث مجموعات وراثية من أرانب اللحم (خط الإسكندرية، خط V، والخليط بين ذكور خط الإسكندرية وإناث خط V) .تم تقديرصفات النمو التي شملت الوزن الفردي عند الفطام (WW)،وعند عمر 6 أسابيع (BW6)، 8 أسابيع (BW8)، 9 أسابيع (BW9)، وفي نهاية فترة النمو (SW)، وأيضا تقديرالزيادة في الوزن اليومي.
أظهرت نتائج تحليل التباين أن الوزن الحي للأرانب عند عمر التسويق تأثر معنوياً ($P\leq0.001$) بإختلاف المجموعة الوراثية. كما أشارت النتائج إلى أن متوسط وزن الجسم عند عمر 9 أسابيع زاد بمقدار 135 و 277 جرام في الأرانب الخليطة عن تلك المسجلة في أرانب خط الإسكندرية وخط V على الترتيب .علاوة على ذلك أظهرت النتائج أن الكفاءة الاقتصادية والكفاءة الاقتصادية النسبية في المجموعة الوراثية الخليطة زادت بنسبة (36% و16%) و(75% و33%) مقارنة بتلك الموجودة في الأرانب خط الاسكندرية وخط V على الترتيب.