GENETIC GROUPS COMPARISONS FOR LITTER AND LACTATIONAL TRAITS AND FEEDING PARAMETERS IN PROGRAM OF SYNTHESIZING NEW LINES OF RABBITS

Khalil, M.H. [1] **, Al-Saef, A M.** [2]
[1] Faculty of Agriculture, Benha University, Moshtohor, 13736, Qalubia, Egypt
[2] *College of Agriculture & Veterinary Medicine, Qassim University, Buriedah 51452 P.O.Box 6622, Saudi Arabia.*
[1] Corresponding author: maherhkhalil@yahoo.com

ABSTRACT

Five-years crossing scheme involving the Spanish V-line (V) and Saudi Gabali (S) rabbits was practiced to produce 14 genetic groups: V, S, ½V½S, ½S½V, ¾V¼S, ¾S¼V, $(½V½S)^2$, $(½S½V)^2$, $(¾V¼S)^2$, $(¾S¼V)^2$, $((¾V¼S)^2)^2$, $((¾S¼V)^2)^2$, **Saudi 2** and **Saudi 3**. A total of 3496 litters of 1022 does mothered by 419 dams and fathered by 151 sires were used to evaluate litter size at birth (LSB) and weaning (LSW), litter weight at birth (LWB) and weaning (LWW), litter survival (PLS), milk yield at lactation intervals of 0-7 days (MY07), 0-21 days (MY021), 0-28 days (total, TMY), milk conversion ratio (MCR), milk components (fat, protein, lactose, ash and total solids), total (TFC) and daily (DFC) feed consumption per doe per litter, feed to litter gain conversion ratios (FCRLG), and feed to milk conversion ratios (FCRM) in different doe genetic groups obtained. The solutions of the mixed model equations for the genetic group effects were used to identify the possibilities of using Saudi 2 and S3 as synthetic lines in hot climate areas.

S2 line was significantly superior to S by 1.12 kit, 1.45 kit, 54 g, 558 g, 72%, 111 g, 170 g, 180 g, and 753 g in LSB, LSW, LWB, LWW, PLS, MY7, MY21, MY28, and TMY, respectively (P<0.05 or p<0.01). For S3 line, the corresponding superiorities were 0.99 kit, 1.54 kit, 40 g, 578 g, 9.1%, 118 g, 195 g, 208 g, and 929 g, respectively (P<0.05 or p<0.01). For S2 and S3 vs V line, the contrasts for litter traits were mostly non-significant. The highest contrasts in fat, lactose and protein and total solids were in favour of S2 relative to S line by 1.7, 0.8, 0.35 and 3.0 % and by 2.0, 0.9, 0.36 and 3.5 % for S3 line (P<0.05 or p<0.01). The best genetic group in conversion ratio of milk to litter-gain was 0.20 kg/kg for S2 doe group and 0.18 kg/kg for S3 doe group relative to S and V lines. Rates of feed consumption per litter in synthetic S2 and S3 does compared to S and V does were moderately favourable by 0.555 and 0.883 kg in TFC and 20 and 32 g in DFC, respectively. Feed conversion ratios increased slightly by 0.32 in does of S2 and 0.16 in does of S3. Does of S2 and S3 recorded relatively higher feed consumption but with favourable conversion ratios of feed to litter gain compared to S and V doe groups.

Keywords: Rabbits, crossbreeding, synthetic lines, litter traits, lactation, feeding parameters.

INTRODUCTION

In the last decades, synthetic lines are being developed in hot climate countries by selection for defined objectives (El-Raffa *et al.*, 2005; Khalil *et al.*, 2004, 2005; Al-Saef *et al.*, 2008; Youssef *et al.*, 2008; Iraqi *et al.*, 2009; Khalil, 2010). These lines, depending on their specialization, perform better than the standard of the original breeds and the current production tends to rely on them. During the process of synthesis of new lines it is common to have several genetic groups of animals, like the founders, F1, F2, backcrosses, other types of crossbreds and the synthetics (Brun and Baselga, 2005). Comparing performances of different genetic groups is useful to explain the differences between the founders and the synthetics. In Saudi Arabia, two synthetic maternal lines Saudi 1 and Saudi 2 (¾ of their genes coming from V) and one synthetic paternal line (Saudi 3 with ¾ of its genes coming from line S) were developed from crossing Saudi Gabali with V-line rabbits, both selected for litter weight at weaning and individual weight at 84 d. The main objective of the present study is to evaluate litter, milk and feeding parameters of these two new lines developed in such crossbreeding program.

MATERIALS AND METHODS

Animals and crossbreeding plan

Five-years crossbreeding project involving Saudi Gabali breed(S) and Spanish V-line (V) was started in September 2000 in the experimental rabbitry, College of Agriculture and Veterinary Medicine, Qassim University to develop new lines of rabbits in Saudi Arabia. Two parallel crossbreeding schemes were carried out. The first scheme began by crossing Saudi Gabali bucks with V line does to get the F_1 (½S½V), then does and bucks of this F_1 were mated to get the F_2 $(½S½V)^2$ and at the same time does of F_1 were backcrossed with bucks of V line to get ¾V¼S, then progeny of the backcross were mated to get $(¾V¼S)^2$, followed by four generations of "inter se" mating of $(¾V¼S)^2$ of the previous progeny to get a new synthetic maternal line named **Saudi 2**. The second scheme began by crossing V-line bucks with Saudi does to get the F_1 cross (½V½S), then does and bucks of this F_1 were mated to get the F_2 $(½V½S)^2$ and at the same time does of F_1 were backcrossed with Saudi bucks to get ¾S¼V, then progeny of this backcross were mated to get $(¾S¼V)^2$, followed by four "inter se" mating generations of $(¾S¼V)^2$ of the previous progeny to form a new synthetic paternal line named **Saudi 3**. The breeding plan in the project permitted to produce 14 genetic groups as shown in Table 1. The bucks were randomly assigned to mate the does naturally with the restriction to avoid the matings of animals with common grandparents. A total of 3496 litters of 1022 does mothered by 419 dams and fathered by 151 sires were used.

Housing and feeding

Rabbits were raised in a semi-closed rabbitry where the environmental conditions were monitored; temperature ranged from 20 to about 32 °C, the relative humidity ranged from 20 to 50 % and photoperiod was 16L: 8D. Breeding does and bucks were housed separately in individual wired-cages. All cages are equipped with feeding hoppers and drinking nipples. Young rabbits were weaned at four weeks of age. All rabbits were fed a commercial pelleted diet during the whole period. On dry matter basis, the diet contained 17.9% crude protein, 15.57% crude fiber, 2.45% ether extract, 58.5 nitrogen free extract, and 6.29% ash. Feed and water were available *ad libitum*.

Data set and model of analysis

Data collected were litter size at birth (LSB) and weaning (LSW), litter weight at birth (LWB) and weaning (LWW), pre-weaning litter survival (PLS), milk yield at lactation intervals of 0-7 days (MY07), 0-21 days (MY021), 0-28 days (total, TMY), and milk conversion ratio as *kg* of litter gain per *kg* of milk suckled during 21 days of lactation (MCR). Milk components (g/100g) in terms of fat, protein, lactose, ash and total solids were also estimated. Total (TFC) and daily (DFC) feed consumption per doe per litter during the lactation period were estimated. Feed to litter gain conversion ratios (FCRLG) were calculated as the amount of feed consumed divided by pre-weaning litter gain per litter. Feed to milk conversion ratios (FCRM) were calculated as kg of feed per kg of milk produced. A single-trait animal model used for analyzing all traits was:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z_a u_a} + \mathbf{Z_p u_p} + \mathbf{e}$$

where **y** was the vector of records of the trait, **b** was the vector of fixed effects of genetic groups of the doe (14 levels; see Table 1), year-season of kindling (one year season every three months), and parity order of the doe (five levels); $\mathbf{u_a}$ was the vector of random additive effects of the does and bucks in the pedigree, $\mathbf{u_p}$ was the vector of random effects of the permanent environment of the doe (permanent non-additive effect); **X**, $\mathbf{Z_a}$ and $\mathbf{Z_p}$ were the incidence matrices relating records to the fixed effects, additive genetic effects, and permanent environment, respectively; and **e** was the vector of random residual effects. Variance components of the random effects were estimated using MTDFREML software of Boldmann *et al*. (1995). The variance components obtained by the Animal Model were used to solve the corresponding mixed model equations, obtaining solutions for the genetic group means and their standard errors, using the PEST program (Groeneveld, 2006). In order to evaluate the performance of the synthesized S2 and S3 lines, a comparison between them and the founders (line V and S) was performed.

Table 1. Genetic group of the does, their parents and grand dams and number of litters born

Ordinal number	Doe genetic group	Sire genetic group	Dam genetic group	Grand-dam group	Number of litters born
1	V-line	V-line	V-line	V-line	753
2	Saudi (S)	S	S	S	571
3	½V½S	V	S	S	264
4	½S½V	S	V	V	280
5	¾V¼S	V	½S½V	V	122
6	¾S¼V	S	½V½S	S	277
7	$(½V½S)^2$	½V½S	½V½S	S	37
8	$(½S½V)^2$	½S½V	½S½V	V	77
9	$(¾V¼S)^2$	¾V¼S	¾V¼S	½S½V	222
10	$(¾S¼V)^2$	¾S¼V	¾S¼V	½V½S	164
11	$((¾V¼S)^2)^2$	$(¾V¼S)^2$	$(¾V¼S)^2$	¾V¼S	89
12	$((¾S¼V)^2)^2$	$(¾S¼V)^2$	$(¾S¼V)^2$	¾S¼V	187
13	Saudi 2	$(¾V¼S)^2$	$(¾V¼S)^2$	$(¾V¼S)^2$	149
14	Saudi 3	$(¾S¼V)^2$	$(¾S¼V)^2$	$(¾S¼V)^2$	404

RESULTS AND DISCUSSION

Comparing synthetic Saudi 2 and/or Saudi 3 lines with the founder breeds:

S2 line was significantly superior to S by 1.12 kit, 1.45 kit, 54 g, 558 g and 11.9% in LSB, LSW, LWB, LWW and PLS, respectively. For S3 line, the corresponding superiorities were 0.99 kit, 1.54 kit, 40 g, 578 g and 9.1%, respectively. For S2 and S3 vs V line, the contrasts for litter traits were mostly non-significant. Results of Medellin and Lukefahr (2001) using New Zealand White (as a popular commercial dam breed, NZW) and crossbred rabbits involving Altex (as a developed sire breed in USA), revealed that litter size and weight at weaning and litter survival rate in Altex-dammed and NZW-dammed litters were similar.

Contrasting milk yields and components and milk conversion ratio of each synthetic doe group relative to the founder S (Table 2) indicate an improvement in the lactation performances of the synthetic S2 and S3 does obtained. These improvements were 111, 170, 180 and 753 g in S2 relative to S rabbits for MY7, MY21, MY28 and TMY, respectively ($P<0.05$ or $p<0.01$). For S3, the corresponding improvements were 118, 195, 208 and 929 g, respectively ($P<0.05$ or $p<0.01$). Lactation performances of S2 and S3 were higher than crossbreds involving V-line or Gabali rabbits in the Arabian areas (Abdel-Aziz, 2002; Ali, 1998; Khalil and Afifi, 2000; Al-Sobayil *et al*, 2005; El-Deghady, 2005; Iraqi *et al*, 2007)**.**

The highest contrasts in fat, lactose, protein and total solids were in favour of S2 relative to S line by 1.7, 0.8, 0.35 and 3.0 % and by 2.0, 0.9, 0.36 and 3.5 % for S3 line ($P<0.05$ or $p<0.01$). In most cases, genetic group of S2 or S3 gave the highest milk yield and components compared to the founder V doe group (Table 2). These estimates were lower than those reported by Iraqi et al (2007) in a crossbreeding experiment involving Gabali and V- line rabbits in Egypt. The best does in conversion ratio of milk to litter-gain was S2 doe group with reduction of 0.20 kg/kg followed by does of S3 doe group with reduction of 0.180 kg/kg relative to does of S and V lines.

Clear differences in feeding parameters among genetic groups of does were notified (Table 2). Rates of feed consumption per litter in synthetic S2 and S3 does compared to S and V does were moderately favourable by 0.555 and 0.883 kg during the suckling period (TFC) and 20 and 32 g daily (DFC). Conversion ratios of feed to litter gain were favourable and in favour of S2 by 2.59:1 and by 2.43:1 in S3 compared to S, while these ratios in S2 and S3 comparable to V line were 3.15:1 and 2.86:1, respectively. Also, conversion ratios of feed to milk were favourable since they were 1.61: 1 kg/kg for S2 and 1.59: 1 kg/kg for S3. Many reviewed studies (e.g. Grobner *et al.,* 1985; Medellin and Lukefahr, 2001) reported a range of feed conversion ratio of 2.4:1 to 5.5:1 for different breeds such as New

Table 2: Contrasts (±SE) for the effects of Saudi 2 (S2) and Saudi 3 (S3) lines relative to the founders (V and S) in terms of litter traits, milk yields (grams) and components (g/100g) and milk conversion ratio (kg of litter gain per kg of milk suckled), and feed consumptions and conversions**.**

Trait	Average of S	Average of V	S2 vs V	S3 vs V	S2 vs S	S3 vs S	S2 vs S3
Litter trait:							
LSB, *kit*	7.44	8.63	0.02±0.12	0.03±0.15	1.12±0.28**	0.99±0.34*	0.69±0.34*
LSW, *kit*	6.0	7.02	0.98±0.46	0.90±0.54	1.45±0.42**	1.54±0.38**	1.4±0.45*
LWB, *g*	393.6	420.5	4.4±12.8	12.9±14.6	53.7±14.6**	39.9±14.8**	29.9±12.4*
LWW, *g*	3431	3461	37±38	260±98*	588±104**	578±132**	192±74*
PLS, *%*	80.15	80.65	6.3±5.4	7.2±3.8	11.9±4.8*	9.1±6.4*	8.4±5.6
Milk yield:							
MY7, g	976	993	12±8	35±28	111±34**	118±26**	91±42*
MY21, g	2438	2607	37±18	65±34	170±56**	195±43**	33±21
MY28, g	934	1065	139±46*	123±56*	180±56**	208±48**	70±34
TMY, g	4331	4873	535±214*	627±124**	753±218**	929±212**	493±126*
MCR	0.74	0.54	-0.10±0.06	-0.10±0.04	-0.20±0.06*	-0.18±0.06*	-0.08±0.05
Milk component %							
Fat	12.9	14	0.8±0.45	0.6±0.43	1.7±0.42**	2.0±0.65**	1.1±0.52
Protein	12.0	12.6	0.3±0.26	0.1±0.28	0.8±0.32*	0.9±0.38*	0.2±0.24
Lactose	2.1	2.19	0.6±0.14**	0.1±0.18	0.35±0.16*	0.36±0.12*	0.11±0.16
Ash	2.2	2.18	0.1±0.14	-0.01±0.18	-0.07±0.11	-0.01±0.12	0.05±0.14
Total solids	29.1	30.9	1.6±0.6	0.9±0.7	3.0±0.8**	3.5±0.6**	1.7±0.8
Feeding parameter							
TFC, kg	6471	5980	1.008±0.06**	1.074±0.1**	0.555±0.16*	0.883±0.18*	0.451±0.92
DFC, g	231	214	36±12*	38±12**	20±11	32±13*	21±14
FCRLG	2.27	2.52	0.88±0.18**	0.59±0.14**	0.32±0.12*	0.16±0.14	0.19±0.12
FCRM	1.73	1.35	-0.04±0.02	-0.13±0.03*	-0.12±0.04*	-0.14±0.06*	-0.05±0.4

*= P<0.05; *= P<0.01.

Zealand White, Altex, Palamino and Chincilla Giant Rabbits. As stated before, Medellin and Lukefahr (2001) in USA found that Altex-sired litters gave an increase in feed efficiency (total litter gain per litter feed intake) by 1.28 kg compared to NZW-sired litters (P<0.01).

Comparing Saudi 2 to Saudi 3

Does of S2 showed better values by 0.69 kit, 1.40 kit, 30 g, 192, 91 g and 493 g in LSB, LSW, LWB, LWW, MY7 and TMY compared with does of S3, respectively. The contrasts for the other traits were similar between the two synthetic lines developed, *i.e.* both lines of S2 and S3 are nearly similar in lactional traits and feeding parameters.

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CONCLUSIONS

Saudi 2 and Saudi 3 lines perform better in litter size and weight at birth and weaning, feed consumption and conversion and milk yields and components than the average of the founder breeds. The Saudi 2 line is significantly superior relative to line V in most traits and consequently, could be a promising maternal line in hot climates.

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