GENETIC GROUPS COMPARISONS FOR GROWTH, CARCASS, MEAT QUALITY AND BLOOD PARAMETERS IN PROGRAM OF SYNTHESIZING NEW LINES OF RABBITS

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ABSTRACT

An evaluation for five-year crossbreeding project was performed for growth, carcass performance, meat quality and blood parameters. This crossing project involving a Spanish maternal line called V-line (V) and a Saudi Gabali (S) rabbits and 14 genetic groups of V, S, ½V½S, ½S½V, ¾V¼S, ¾S¼V, $(½V½S)^2$, $(½S½V)^2$, $(¾V¼S)^2$, $(¾S¼V)^2$, $((¾V¼S)^2)^2$, $((¾S¼V)^2)^2$, **Saudi 2** (S2), and **Saudi 3** (S3) were produced. A total number of 10178 rabbits fathered by 106 sires and mothered by 621 dams were weaned and 2770 rabbits fathered by 91 sires and mothered by 402 dams were slaughtered. The solutions of the mixed model equations for the genetic group effects were used to evaluate genetic groups of this project in terms of body weights, preslaughter weight (PSW), hot carcass weight (HCW),dressing percentages (DP), offal weight (OW), weights of meat, fat and bone in the carcass, dry matter (DM), crude protein (CP), ether extract (EE) and ash in the lean. Blood parameters including total proteins (TP), albumin (ALB), globulin (GLOB), albumin: globulin ratio (AGR), total lipids (TL), cholesterol concentration (CH), and cholesterol index (CI) were also evaluated. S2 was significantly superior in body weights by 36, 165, 193, 222 and 157 g at 4, 6, 8, 10 and 12 weeks of age relative to S rabbits, while the corresponding superiorities were 31, 148, 188, 230 and 129 g for S3 line. S2 and S3 were significantly superior in the majority of carcass and meat quality traits relative to line V or S. Tissues composition in the carcass were mostly in favour of S2 and S3 by 92.9, 12.0 and 13.8 g for weights of meat, bone and fat, respectively, while the respective superiorities were 110, 10.5 and 14.9 g for S3 line relative to the founder breeds. Carcasses were significantly in favour of S2 and S3 relative to V line rabbits for some traits (PSW, HCW and OW). DM, CP, EE and ash contents in the lean were mostly in favour of the synthetic lines relative to the founder breeds where the estimates for S2 relative to S were greatly deviated by values of 5.0, 6.6, -3.3 and 2.6 % in DM, CP, EE and ash and by 5.1, 6.1, -3.9 and 2.1 % in S3 rabbits, respectively ($P<0.05$ or $P<0.01$). Blood concentrations in terms of TP, ALB, GLOB and AGR in S2 and S3 were lower than those in the founder S and V, while CH and TL were decreased and CI was improved in blood of the synthetic lines. Rabbits of S2 showed heavier body weights than S3 rabbits by 27, 68, 54, 53 and 57 g at 4, 6, 8, 10 and 12 weeks of age, while carcass, meat quality and blood parameters were nearly similar in both lines.

Keywords: Rabbits, synthetic lines, growth, carcass, meat quality, blood parameters.

INTRODUCTION

Genetic improvement strategies could considerably increase growth and meatiness in the rabbits (Pla *et al.,* 1998; Piles *et al.,* 2000). In fact, selection programmes in most parts of the world are selecting for fast growth rates and use of terminal sires, with the goals to improve growth and carcass efficiency (Feki *et al.,* 1994; Lobera *et al.,* 2000; Sánchez *et al.,* 2004). In developed countries, using crossbred terminal sires for growth and carcass traits is necessary to synthesize new paternal lines (Pla *et al.,* 1998; Piles *et al,* 2000). At the beginning of this decade (2000), a co-operative rabbit project was established between Saudi Arabia and Spain to synthesize new lines of rabbits adaptable for hot climate (Khalil *et al.,* 2002). The objective of the present study was to evaluate growth, carcass performance, meat quality and blood parameters of the two new lines synthesized.

MATERIALS AND METHODS

Crossbreeding plan and management

Five-year crossbreeding project was started in September 2000 in the Experimental Rabbitry, Qassim University to develop new maternal and paternal lines of rabbits. Rabbits used in this project represent one Saudi Gabali breed (S) and one exotic Spanish breed (V-line). Such crossbreeding plan permitted simultaneous production of 14 genetic groups as shown in Table 1.
The rabbits were managed in a semi-closed rabbitry where the environmental conditions were monitored; temperature ranged from 20 to about 32°C, relative humidity ranged from 20 to 50%, and the photoperiod in hours was 16 h light: 8 h dark. At four weeks of age, young rabbits were weaned, ear tagged, weighed, sexed and reared in progeny wire cages equipped with feeding hoppers and drinking nipples. Rabbits were fed a commercial pelleted diet during the whole period. On a dry matter basis, the commercial pelleted diet contained 17.9% crude protein, 15.57% crude fiber, 2.45% ether extract, 58.5 nitrogen free extract, and 6.29% ash.

Data set

A total number of 14251 rabbits fathered by 106 sires and mothered by 621 dams were weaned at 4 weeks of age and body weights were recorded biweekly thereafter up to 12 weeks of age. At 12 weeks of age, a total of 2770 rabbits fathered by 91 sires and mothered by 402 dams were randomly slaughtered. The numbers of rabbits slaughtered from each genetic group are presented in Table 1. Preslaughter weight (PSW) and hot carcass weight (HCW) were recorded and dressing percentages (DP) were calculated. The offal representing heart + liver + kidneys (OW) was also weighed. For lean composition traits, all carcasses were divided longitudinally into two similar halves. The right half was separated into lean, fat and bone. Lean of each half was separated and prepared for chemical analysis. Dry matter (DM) using an air-evacuated oven for 16 h, crude protein (Nitrogen x 6.25), ether extract (EE) and ash in the lean were determined according to the A.O.A.C. (1990).

Table 1. Genetic groups of the rabbits and their sires, dams, and numbers of rabbits weaned and slaughtered for each genetic group.

Ordinal number	Rabbit genetic group	Sire genetic group	Dam genetic group	Grand-dam group	Rabbits weaned	Rabbits slaughtered	Rabbits chemically analyzed
1	V-line (V)	V-Line	V-Line	V	1302	276	234
2	Saudi (S)	Saudi (S)	Saudi (S)	S	1259	275	232
3	½V½S	V	S	S	1088	223	203
4	½S½V	S	V	V	1355	260	216
5	¾V¼S	V	½S½V	V	828	141	129
6	¾S¼V	S	½V½S	S	1091	204	158
7	(½V½S)^2	½V½S	½V½S	S	316	113	111
8	(½S½V)^2	½S½V	½S½V	V	771	157	145
9	(¾V¼S)^2	¾V¼S	¾V¼S	½S½V	486	173	155
10	(¾S¼V)^2	¾S¼V	¾S¼V	½V½S	1682	202	198
11	((¾V¼S)^2)^2	(¾V¼S)^2	(¾V¼S)^2	¾V¼S	445	197	189
12	((¾S¼V)^2)^2	(¾S¼V)^2	(¾S¼V)^2	¾S¼V	1122	145	137
13	**Saudi 2**	((¾V¼S)^2)^2	((¾V¼S)^2)^2	(¾V¼S)^2	894	123	122
14	**Saudi 3**	((¾S¼V)^2)^2	((¾S¼V)^2)^2	(¾S¼V)^2	1612	281	224
		Total			**14251**	**2770**	**2453**

Blood samples were taken from each animal at slaughter, centrifuged and plasma samples were separated, then stored at –15 Cº. Blood parameters were determined in the plasma samples using commercial kits (Biomerieux, France). These plasma parameters included total proteins (TP), albumin (ALB), globulin (GLOB), albumin: globulin ratio (AGR), total lipids (TL), cholesterol concentration (CH), and cholesterol index (CI, i.e. cholesterol lipid ratio). Concentrations of protein, albumen and globulin were recorded as g per 100 *ml* of blood, while concentrations of CH and TL were recorded as mg per 100 ml.

Model for analysis

The animal model (in matrix notation) used for analysing all traits was:

$$\mathbf{y= Xb + Z_a u_a + Z_c u_c + e}$$

Where y = vector of measurements for the rabbits, b = vector of fixed effects of genetic group of rabbits (14 levels; see Table 1), and year-season of birth (20 levels), sex, parity order of the doe (five levels), and litter size in which the rabbits were born (9 levels); u_a = vector of random additive effect of the individual rabbit, u_c = vector of random effects of the litters in which the animal was born; X, Z_a and Z_c are incidence matrices relating the records to the fixed effects, additive genetic effects, and common litter environmental effects, respectively; and **e** is a vector of random residual effects. Variance components of the random effects were estimated using MTDFREML software of Boldmann *et al.* (1995). The inverse of the numerator relationship matrix (A^{-1}) was used with $Var(u_a)= A\sigma^2_a$, $Var(u_c)= I\sigma^2_c$ and $Var(e) = I\sigma^2_e$ representing variance components for additive genetic, common litter and error effects, respectively. The solutions of the mixed model equations for the genetic group effects were used to identify the possibilities of using S2 and S3 as synthetic lines in hot climate areas; through obtaining solutions for the genetic group means and their standard errors, using the PEST program (Groeneveld, 2006).

RESULTS AND DISCUSSION

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

S2 was significantly superior in body weights by 36, 165, 193, 222 and 157 g at 4, 6, 8, 10 and 12 weeks of age relative to S line, while the corresponding superiorities were 31, 148, 188, 230 and 129 g for S3 line ($p<0.05$ or $p<0.01$). Body weights of S2 and S3 were heavier than those crossbreds involving V-line or local rabbits in the Arabian areas (Abdel-Aziz, 1998; Ali, 1998; Youssef *et al.*, 2009; Khalil and Afifi, 2000)**.**

S2 and S3 were significantly superior in the majority of carcass and meat quality traits relative to V or S line (Table 2). Offal of the synthetic S2 and S3 lines was less in weight than V-line rabbits (Table 2). Liver and heart (offal) are organs of early development and animals with high growth rate have an earlier development (Gomez *et al.*, 1998). Crossbreeding experiments carried out in the Arabian countries (*e.g.* Afifi *et al.*, 1994; El-Deghadi 2005) showed much less estimates in growth, carcass traits than for the two synthetic lines developed here. Metzger *et al.* (2004b) with Pannon White (P), Pannon Ka (PK), Hycole (H), Zika (Z) rabbits and their crossbreds reported that the most important carcass traits in P rabbits had an advantage. Results in the literature comparing breeds of large-size with small-size breeds and straightbreds with crossbreds for carcass traits are not consistent (Lukefahr et al 1983; Ozimba and Lukefahr, 1991; Pla et al 1996; Bianospino et al 2004a,b) because measurements were made at different slaughter weights but differences can be partially due to true genetic differences between breeds.

Tissues composition in the carcass were mostly in favour of S2 by 94, 12.0 and 13.8 g for weights of meat, bone and fat, respectively while the respective superiorities of 110, 10.5 and 14.9 g were in favour of S3 line relative to S line (Table 2). Carcasses were significantly in favour of S2 and S3 relative to V line rabbits for some traits (PSW, HCW and OW). The same trend was recorded for some meat quality traits (BW and FW). Also, favourable contrasts were recorded for meat-to-bone ratios in favour of S2 and S3 rabbits by 1.03 and 0.99, respectively. MBR was greater with earlier maturity and consequently synthetic rabbits had greater MBR than S and V-line rabbits (Pla *et al.*, 1996). Although the fat content of the carcass in rabbits is low relative to other animals, fat deposited in the carcass of the synthetic rabbits was greater than that in V-line rabbits (Table 2). Similar breed differences in fat deposited in the carcass have been found by Gomez *et al*. (1998) and Metzger *et al*. (2004 a ,b).

Table 2: Contrasts (±SE) of the effects of lines Saudi 2 (S2) and Saudi 3 (S3) relative to the founders (V and S) in terms of body weights, carcass, meat quality and blood parameters

Trait	Average of S	Average of V	S2 *ve* V	S3 *vs* V	S2 *vs* S	S3 *vs* S	S2 *vs* S3
Body weight (g):							
Week 4	612	619	56±16*	21±10*	36±16*	31±12**	27±11*
Week 6	1041	1089	109±38**	108±42**	165±41*	148±34**	68±28*
Week 8	1438	1547	117±44**	121±38**	193±52*	188±42**	54±22*
Week 10	1826	1998	124±52**	131±41**	222±54*	230±56**	53±18*
Week 12	2256	2405	88±24*	94±31*	157±36*	129±32**	57±22*
Carcass traits:							
PSW, g	2282	2460	103±29*	127±24*	147±28*	138±26*	34±25
HCW, g	1194	1304	101±26*	81±21*	145±14**	155±26**	-20±16
DP	53.4	51.5	-1.5±0.3	1.0±0.4	-0.5±0.4	-0.4±0.3	2.0±0.2
OW, g	89.6	103.5	-12±1.7*	-8.0±1.1*	9.6±2.4	23.5±6.5**	4.0±0.8
MW, g	838.7	913.7	13±10	31±18	93.9±32*	110±56*	18±12
BW, g	28.4	28.2	7±2.0*	8±5.2	12.0±4.0*	10.5±2.5*	-9.0±4.8
FW, g	241.5	267.4	3.2±1.0*	3.5±0.9*	13.8±4.6*	14.9±4.1*	0.3±1.34
MBR	3.61	3.54	-0.28±0.14	0.34±0.18	1.03±0.28**	0.99±0.19*	0.04±0.07
Meat quality, DM basis (%)							
DM	28.63	72.6	0.64±0.34	1.12±0.84	5.0±0.92**	5.1±0.91**	0.1±0.95
CP	21.8	27.41	-0.4±0.38	0.4±0.46	6.6±1.3*	6.1±1.2*	-0.5±1.9
EE	4.98	21.1	-0.73±0.62	-0.83±0.72	-3.3±0.2**	-3.9±1.1**	-0.6±0.5
Ash	1.97	4.69	1.88±0.84	1.99±0.86	2.6±0.42**	2.1±0.14**	-0.5±0.16
Blood parameters							
TP	8.19	7.71	-0.3±0.26	-0.43±0.18*	-0.18±0.12	-0.35±0.16*	0.17±0.14
ALB	4.4	4.48	-0.99±0.64	-1.13±0.45*	-0.44±0.34	-0.44±0.42	-0.38±0.44
GLOB	3.79	4.19	-0.69±0.52	-0.71±0.54	-0.62±0.38	-0.78±0.56	-0.45±0.62
AGR	2.5	2.52	-0.74±0.65	-1.03±0.82	0.54±0.42	-0.89±0.72	-0.80±0.62
CH	154	160	22.0±14.2	-8.0±7.8	63.0±14.8*	91.0±38.4*	31.0±18.8
TL	447	453	36.0±24.5	42.0±35.4	66.0±28.6*	38.0±28.4	42.0±32.8
CI	42.6	37	-6.7±4.5	-5.6±4.4	-7.8±5.6	-1.5±4.8	-12.7±4.2

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

Contrasts for DM, CP, EE and ash contents in the lean were mostly in favour of the the synthetic lines relative to the founder breeds (Table 2). S2 relative to purebred S rabbits were greatly deviated by values of 5.0, 6.6, -3.3 and 2.6 % in DM, CP, EE and ash and by 5.1, 6.1, -3.9 and 2.1 % in S3 rabbits, respectively (P<0.05 or P<0.01). In comparison with purebred V-line, the corresponding estimates were slightly deviated by 0.64 and 1.88 % in DM and ash of S2 rabbits and 1.12, 0.4 and 1.99 % in DM, CP and ash of S3 rabbits, respectively.

Blood concentrations (g or mg per 100 ml) in terms of TP, ALB, GLOB and AGR in S2 and S3 were lower than those in the founder S and V. But, the levels of CH and TL were decreased and CI was improved in blood of the synthetic lines.

Comparing Saudi 2 with Saudi 3:

Rabbits of S2 showed heavier body weights than S3 rabbits by 27, 68, 54, 53 and 57 g at 4, 6, 8, 10 and 12 weeks of age, respectively (Table 2). But, the contrasts for both lines were nearly similar with no significant differences between them in all traits studied.

CONCLUSION

The two lines successfully synthesized (named **Saudi 2** and **Saudi 3)** could be used in hot climates areas efficiently since they perform better than those of the founder lines in terms of growth, carcass traits, carcass composition and meat quality traits.

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