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Genetic analysis for semen traits in a crossing program of Saudi Aradi with Damascus goats

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ABSTRACT

A crossbreeding program between Aradi Saudi breed (A) of goats with Syrian Damascus breed (D) was practiced for six years in two experiments (dairy experiment in Jouf and meat experiment in Qassim) applying bio-techniques of estrous synchronization and artificial insemination. The breeding plan permitted to produce four genetic groups of AA, DD, ½D½A and ¾D¼A in each experiment separately. A total number of 1800 ejaculates collected from 298 bucks were evaluated for volume of ejaculate (EV), pH, sperm concentration (SC), total motile sperm (TMS), total sperm output (TSO), percentages of motile (MS), live (LS), abnormal (AS) and dead sperms (DS). Animal models were used to estimate the heritabilities and permanent environmental effects, while a generalized least square procedure was used to estimate individual additive genetic effects, individual heterosis, maternal heterosis and individual recombination effects. Heritabilities for most semen characteristics were low or somewhat moderate and ranging from 0.08 to 0.23, while the permanent environmental effects were slightly higher than the respective heritabilities since the estimates ranged from 0.10 to 0.29. Estimates of individual additive effects for SC, TMS and TSO were in favour of Damascus bucks relative to Aradi bucks by 0.2, 0.43 and 0.44×10^9 per ml in the dairy experiment and by 0.08, 0.13 and 0.11×10^9 per ml in the meat experiment, respectively. Significant individual heterotic improvements (with a range of 4.9–26.5%) were recorded in the dairy and meat experiments for EV (0.075 ml *vs.* 0.085 ml), SC (0.25×10^9 per ml *vs.* 0.11×10^9 per ml), TMS (0.275×10^9 per ml *vs.* 0.125×10^9 per ml), and TSO (0.33×10^9 per ml *vs.* 0.155×10^9 per ml), associated with significant reduction in percentage of DS (5.5% *vs.* 1.55%). Crossbred dams showed significant maternal heterotic improvements in semen of their crossbred bucks in both dairy and meat experiments for EV (0.058 ml *vs.* 0.055 ml; $P < 0.05$), SC (0.15×10^9 per ml *vs.* 0.09×10^9 per ml; $P < 0.05$), TMS (0.225×10^9 per ml *vs.* 0.085×10^9 per ml; $P < 0.05$), and TSO (0.58×10^9 per ml *vs.* 0.115×10^9 per ml; $P < 0.01$), associated with favourable significant increases in MS (3.3% *vs.* 4.05%; $P < 0.05$) and LS (3.7% *vs.* 2.25%; $P < 0.05$) along with a reduction in percentage of DS (4.3% *vs.* 2.25%; $P < 0.05$); the estimates ranging from 3.3 to 34.1%. The estimates of individual recombination losses for most semen parameters were favourable and non-significant.

1. Introduction

There are some biotechnologies that have been applied successfully in goats (such as artificial insemination, estrous synchronization and multiple ovulation rates) and these techniques could be used as new powerful and

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successful tools in planning breeding programmes to increase the rates of genetic improvement in goats and to multiply rapidly the populations of elite breeds (Evans, 1991; Baldassarre and Karatzas, 2004; Gama and Bressana, 2011). The application of AI in goats with either fresh or frozen semen has not been extensively investigated and it is still in their infancy stage in the Arabian countries. AI may be also regarded as one technique that has made the greatest contribution to genetic improvement programs, mainly due to well-established methods for identifying males with the highest genetic merit. To maximize the benefits from applying AI in genetic improvement programme, it is necessary to use only the semen of males producing the largest number of high quality doses (Evans, 1991; Baldassarre and Karatzas, 2004; Gama and Bressana, 2011). The number of inseminating doses produced from each ejaculate depends on the volume, sperm concentration, and motile sperm after freezing/thawing. Also, techniques of semen preservation (fresh, refrigerated and frozen) and insemination (vaginal, cervical and intrauterine) are considered as very important techniques in genetic improvement programme in goats (Leboeuf et al., 2000; Baldassarre and Karatzas, 2004).

As well known, it is necessary to have the knowledge of genetic parameters to be used in evaluating the bucks in a genetic improvement program (Barillet, 2007; Shrestha and Fahmy, 2007a,b; Furstoss et al., 2009). In order to improve also the genetic make up of goats, studying some semen characteristics is of most importance, as this will enhance proper selection of proven bucks. Since 2006, a goat project of crossing Aradi Saudi breed (A) with Damascus breed (D) was established in Saudi Arabia to develop new lines of dairy and meat goats suitable for hot climate (Khalil et al., 2010). This program was performed applying some biotechnological techniques to accelerate the rate of genetic gain. The main objective of the present study was to estimate the additive, heterotic and recombination effects for some semen parameters in such crossbreeding program involving a Saudi Aradi (A) and Damascus (D) goats. However, bucks of two-breeds cross could demonstrate considerable potentiality in improving the productivity of goats in developing countries (Valencia et al., 2005; Barillet, 2007; Fahmy and Shrestha, 2000; Shrestha and Fahmy, 2007a,b). Also, reviewed studies concerning genetic and crossbreeding analyses for semen quality traits in goats raised in hot climate countries are scarce.

2. Materials and methods

2.1. Breeding plan

A crossbreeding program between Aradi Saudi goats (A) with Syrian Damascus goats (D) was started in 2006 in Saudi Arabia. Two experiments were practiced, one of them to develop dairy line (named dairy experiment) in Jouf research station and the second experiment to develop meat line (named meat experiment) in Qassim University. In the dairy line, selection was practiced for milk production traits, while in the meat line selection was practiced for body weight and carcass traits. The two lines are being selected by a BLUP methodology under animal model, following the two criteria of selection. The hottest month of the year is August with an average high and low temperature of 41 °C and 25 °C, respectively, whereas January is the coldest month of the year, with an average high and low temperature of 15 °C and 4 °C, respectively. The annual rainfall ranges from 0 to 3 mm. Does of Aradi goats were randomly divided into two groups and each group of Aradi does was subdivided into two subgroups to be inseminated artificially from semen of elite bucks of the same breed and of Damascus breed (Table 1). In both experiments, does of Damascus breed were randomly artificially inseminated from bucks of the same breed to produce purebred kids. Also, crossbred does of ½D½A were backcrossed with Damascus bucks to get the genetic group of ¾D¼A. Accordingly, the breeding plan permitted to produce four genetic groups of AA, DD, ½D½A and ¾D¼A in each experiment separately and a total number of 1400 kids fathered by 115 sires and mothered by 517 dams were obtained as shown in Table 1.

2.2. Housing and feeding

Animals were housed in semi-shaded/open front barn and fed on a commercial concentrate and alfalfa hay. The amount of concentrate and hay were calculated according to the nutritional requirements for goats (kids, does and bucks) depending on the animal ages and production status (National Research Council; NRC, 1981). Water, straw, salt and minerals supplemented in blocks were freely available to all animals. Animals were fed *ad libitum* individually.

2.3. Semen collection and evaluation of semen traits

A total number of 1800 ejaculates collected by artificial vagina from 298 bucks of different genetic groups were evaluated for semen traits. Semen was collected 2–3 times monthly all the year round. Immediately after collection, the semen tubes were placed in a water bath at 37 °C and samples were evaluated for some semen characteristics which including pH, volume (ml), sperm cells concentration ($\times 10^9$/ml), total motile sperm ($\times 10^9$/ml), total sperm output ($\times 10^9$/ml), spermatozoa motility (%), abnormal spermatozoa (%), living spermatozoa (%) and dead spermatozoa (%). All these procedures were performed within 10 min of collection using the standard techniques described by Pirohit et al. (1992) and Al-Ghalban et al. (2004). pH is determined using a litmus paper strip roll between the range of 5.5–8.0 and precise pH matches at every 0.2 intervals. Ejaculate volume was determined using a transparent graduated glass collection tube. Sperm cells concentration determined using a spectrophotometer, previously calibrated with a haemocytometer. Individual motility determined by placing a drop of semen diluted with 0.9% sodium citrate on glass slide and a coverslip was then placed over it and observation performed for the percentage of progressively motile sperm using a bright field microscope at high magnification (400×). Sperm viability (live/dead) and morphological abnormalities were determined using semen smears stained with eosin–nigrosin and examined under oil immersion objective at 1000× magnification. A total of 100 spermatozoa were examined per slide for each ejaculate and the percentage of non-viable and abnormal sperm cells were calculated.

Table 1
Number of does and bucks used in mating and number of kids born.

Experiment	Does			Bucks		Total kids
	A	D	½D½A	A	D	
Dairy experiment (Jouf)	161	30	157	19	56	977
Meat experiment (Qassim)	81	23	65	15	25	423
Total	242	53	222	34	81	1400

A: Ardi and D: Damascus.