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Kid's Growth and Dairy Performances of Pure Breeds and Crossed Caprine Genotypes in the Coastal Oases of Southern Tunisia

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Abstract: A data issued from 16 years performances schedule of local goat, Alpine, Damascus, Murciana and crossed groups was used to study the genotypes productive behaviour under Tunisian oases conditions. The aim is to evaluate the possibilities of local goat productivity improvement by cross breeding in intensive mode and also, to choose the better improving breed and the propice crossing level. So, data of periodic individual weighing was used to estimates kid's weight at some standard ages and dairy performances such as, daily milk average, total production by lactation and milking period of studied genetic goats groups. Statistical analysis of about 1928 kid's weights and 1923 individual goat milking shows that, the cross breeding allows to improve the growth performances since the first generation with respect to local population production. ANOVA test shows an important effect of genotypes and environment upon kid's weights ($p<0.01$). The kid's weight average at birth and at 120 days age was about 3.49 and 15.78 kg, respectively. The cross breeding second generation allows the better improvement of local goat potentialities kid's weight at 120 days reaches 16.19 kg for Damascus x local genotype. The dairy production with this generation is, about 248 kg for the Alpine one, of 181 kg for Damascus and 190 kg for Murciana, is only 137 kg by lactation for the local breed.

Key words: Local goat, cross breeding kid's growth, dairy production, Tunisian oases

INTRODUCTION

The *Capra hircus* is considered being the oldest domesticated animal among livestock species and its husbandry goes up to more than 10000 years B.C. (Fabre-nys, 2000). During this long breeding period, goat has varied its breeds and products to which explain its actual large distribution in the major environments and production systems in the world (Alexandre *et al*., 1997a). Nowadays, goat breeding knows an increasing interest because of the high caprine productivity and the quality of goat products.

In Tunisia, the national caprine herd is estimated at approximately 1 300 000 reproductive females and more than 60% of the national herd is raised on the arid rangelands of the country (DGPA, 2005; Najari *et al*., 2006). Since centuries, local goat population has been valorizing the arid pastures with scarce resources and harsh climatic environment. The lactated kid's meat is the main product for this breeding mode and contributes with about 75% in the regional meat production (Najari *et al*., 2007; Chemineau *et al*., 1991; Alexandre *et al*., 1997b; Delgadillo *et al*., 1997; Arbi, 2004).

Under oasian conditions, the goat husbandry plays a key role by its significant various contributions in the farmer's incomes (D'Aquino *et al*., 1995; Jamali and Villemeot, 1996). Goat benefits from an intensified breeding mode under low climatic risks which characterize the arid area (Morand-Fehr and Doreau, 2001). Contrary to pastoral mode, the main goat oasian production of reduced herds is milk.

The confirmed local goat low productivity in pastoral system can be attributed to natural and technical resources scarcity (Caruolo, 1974; Pasquini *et al*., 1994). The extensive breeding mode can be considered as a factor reducing goat productivity. In some cases, the local goat population genetic capacity represents a serious restriction to improve goat production, especially for milk (Najari *et al*., 2007).

To improve caprine productivity and to optimize oases resources valorisation, a crossing plan of the local goat was adopted as a solution to resolve this genetic problem.

Based on a large data base issued from 16 years (1981 to 1996) animal survey of pure breeds and crossed genotypes performances, the present study focuses on the kid's growth potentialities and dairy performances analysis to evaluate the improvement possibilities by local goat cross breeding and the choice the propice imported breed and the cross level to allow better valorisation regarding the oases intensive resources.

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MATERIALS AND METHODS

Study area: The study was carried out in the Institute of the Arid Areas station of Chenchou (Southern Tunisia, latitude: 33°29' 57.8 north and longitude: 10°38' 37.3). The station is located in the lower arid bioclimatic stage; with an average annual rainfall of 188 mm. January is the coldest month of the year, with an average temperature of 10.7°C, whereas August is the hottest with about 27.3°C average (Ouled Belgacem, 2006). The project was started since 1981.

Animal material

Local goat: The indigenous goat population shows a large variability both in morphology and performances (Najari *et al.*, 2007). The local goat population is characterised by its small size with an average height of 76 cm for the male and 60 cm for the female (Ouni, 2006; Najari *et al.*, 2007). It is distinguished by the ability to walk long distances, water shortage resistance and good kidding ability. The native goat is hairy and basically black coat colored with spots on the head horned and has bread and dewlap on the neck. Fertility rate is about 87% and prolificacy rate varies between 110 and 130% (Najari *et al.*, 2006). Kidding season begins in October and continues till February with a concentration in November and December when 69.2% of kid's are born.

Ameliorative breeds: To cross local goat, three ameliorative breeds were used: Alpine, Damascus and Murciana breeds were imported, respectively from France, Cyprus and Spain since 1980. Table 1 shows the characteristics of the imported breeds (Najari, 2005).

Crossing scheme: To produce the first crossed generation, local goats are mated with bucks of ameliorative breeds. For later crossing stage, at each generation, the crossed females are mated with bucks of imported breeds as indicated in Fig. 1.

So, the crossing scheme allows a progressive increase of the ameliorative percentage genes pool, during successive generations (Gaddour *et al.*, 2006). Theorically, the crossing plan will be considered as achieved with reaching crossed genotypes performances similar to those of the ameliorative breeds.

Table 1: Characteristics and performances for ameliorative breeds in their original countries

		Adult weight (kg)		Dairy production	
Breed	Origin	Male	Female	Total production (kg)	Lactation period (days)
Alpine	France	80	60	570	245
Murciana	Spain	70	50	500	210
Damascus	Cyprus	80	60	200	90

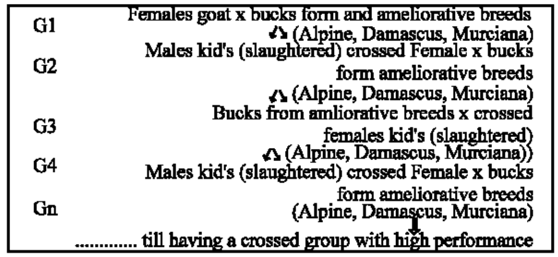

Fig. 1: Local goat cross breeding diagram

Data base: During 16 years, the crossing scheme was applied and an individual periodical weighing control was continuously realized since the birth and till the kid's weaning in summer beginning. So, about 1928 annual kid's data files are registered and used as the data base for this study. For each kid the data include: Kid's and mother identification, birth data, sex, birth mode, genotype and control dates with respective observed weights. The data set was verified and individual kid's weight at standard ages was estimated by extra or intra polation (Gaddour *et al.*, 2006; Ouni, 2006). The considered standard ages are birth, 10, 30, 70, 90 and 120 days.

To study the dairy performances, 1923 lactation data collected during the control period were used. For each goat, dairy file contains: Genetic group, date of kidding, kidding mode and daily milk produced with respective control date.

This considerable quantity of information was elaborated in order to estimate the following performances for each goat: Total milk production, average daily milk production and milking period.

Statistical analysis: The individual quantitative performances were subjected to an Analysis of the Variance (ANOVA) to diagnose the effects of some variation factors.

Regarding the kids' growth, the model used are the following:

$$Y_{ij\,kl\,m} = \mu + RA_i + AN_j + NS_k + MN_l + \varepsilon_{ij\,kl\,m}$$

Where:

$Y_{ij\,kl\,m}$	:	Kid's weight at birth, 10, 30, 70, 90 and days.
μ	:	The general average,
RA_i	:	The genotype effect,
AN_j	:	The year effect,
NS_k	:	The sex of the kid's effect,
MN_l	:	The mode of birth effect, $\varepsilon_{ij\,kl\,m}$: residual error.

For the various dairy performances, the model was:

$$Y_{ijkl} = \mu + RA_{I} + AN_{j} + MN_{k} + \varepsilon_{ijkl}$$

Where:

- Y_{ijkl} : Total milk production (kg), milking period (days) and average daily milk production (kg/days)
- μ : The general average
- RA_{I} : The genotype effect
- AN_{j} : The year effect
- MN_{k} : The mode of birth effect
- ε_{ijkl} : Model residual error.

After the variance analysis, an SNK mean comparison test (α = 5%) was applied to identify homogeneous statistical groups for each variable and variation factors. Statistical analysis was done by SPSS program (SPSS, 1998).

RESULTS AND DISCUSSION

Variance analysis: Table 2 resume the ANOVA results of the test significance relative to the model factors effects upon kid's weights.

The model determination Coefficient (CD) varied from 96 to 97% (Table 2). These values can be retained for a data relative to animal production and collected during 16 years. Whereas, kid's sex and kidding mode affect partially some studied variables, with a significance probability ($p<0.01$ or 0.05) at 30, 70 and 90 days ages.

Several authors assigned an important effect of environmental and genetic factors upon caprine performances as animal quantitative traits (Chemineau *et al*., 1991). The importance effect of the year factor on the studied variable wasn't being expected because of the intensification of the breeding mode. Tradionally, the year climatic conditions affect herd resources by forage variation in pastoral mode especially in arid lands (Ouled Belgacem, 2006). Whereas, under oasian mode, goat alimentation is sufficient and animal are correctly feeded by Alfa Alfa and concentrate. So, such year effect can be only justified by the variation of the climatic effects such as temperature, heat picks and humidity. Also, the herd genetic level, whose vary with

Table 2: Results of variance analysis (ANOVA) of kid's weight (kg) at the standard ages

Factors	YE	GE	NE	MN	CD (%)
ddl	14	11	1	2	-
PN	HS	HS	NS	NS	97
P10	HS	HS	S	NS	96
P30	HS	HS	S	S	96
P70	HS	HS	HS	S	96
P90	HS	HS	HS	S	96

ddl: degree of freedom, HS: highly significant ($p<0.01$); S: significant ($p<0.05$); NS: non significant; YE: Year, GE: Genotype, NE: Sex, MN:Kidding mode; PN, 10, 30, 70, 90 and 120: kids weight at birth, 10, 30, 70, 90 and 120 days

Table 3: Variance of dairy performances of local goat, ameliorative pure breeds and crossed genotypes

Factors variables	Genotype	Year	Birth mode	CD (%)
ddl	9	5	1	-
Milk production (kg)	HS	S	S	89
Average production (kg/days)	HS	NS	S	94
Milking period (days)	S	HS	NS	96

ddl: degree of freedom, (HS: highly significant S: significant NS: no significant Mode B: Birth mode)

cross breeding, can explain partially such year effect. As well as environmental factors, the genotype factor had also significative action upon all growth performances. So, differences between genetic groups have to be considered to evaluate genotypes potentialities (Table 2).

Table 3 presents ANOVA results of dairy performances relatives to studied genotypes in the experimental station.

Table 3 shows that the model Coefficient of Determination (CD) varied from 89 to 96%. These values can be accepted for a data collected upon animal husbandry during 16 years of schedule. The ANOVA test shows that total milk production, average daily milk production and Milking period were essentially affected by year and genotype factors. Whereas, kidding mode affect only partially some variables, with significant probability ($p<0.05$) upon total production and daily mean.

In the bibliography several authors assigned an important affects of environmental and genetic factors upon caprine dairy performances (Chemineau *et al*., 1991; Alexandre *et al*., 1997a). The important year effect of the year factor on the studied variable wasn't being expected because of the intensification of the breeding mode. Tradionally, the year climatic conditions affect herd resources by forage variation in pastoral mode especially in arid land (Ouled Belgacem, 2006). Whereas, under oasian mode, goat alimentation is produced in irrigation and animal are correctly feeded by Alfa Alfa and concentrate. So, such year effect can be only justified by the variation of the climatic effects temperature and heat picks. Also, the herd genetic level, whose vary with cross breeding, can explain this effect.

Thus, the observed variability at the level of dairy performances is partially attributed to genetic differences between studied genotypes, with is verified in other studies (Najari, 2005).

The action of the non genetic factors, like the year or the month of the production, is traditionally explained by a direct or indirect effect on the animal feeding (Gromela *et al*., 1998). In this case of study, animals are raised in intensive system and their food is independent on the climatic factors. The importance of the action of the no heritable factors can be justified only by other components of the environment like moisture or the temperature. Moreover, the factors not included in the model of analysis of the variance, especially the age of mother and the number of lactations can have, partly, their effects represented by the factor year.

Performances variation with respect to genotype

Kid's growth performances means comparison by genotype: After birth and at later standard ages, among the pure breed, the Damascus and the Alpine kid's, had the heaviest weights for all the considered ages. For example, we registered a 5.49 and 5.41 kg as kid's weight at 10 days age, respectively for Damascus and Alpine. At 120 days age, the Damascus kids still the heaviest with a weight of 16.48 kg. The local population and the Murciana breed recorded the weakest weights with 12.85 and 11.98 kg, respectively at 120 days (Fig. 2).

Figure 2 and 3 resume the kid's weights separately for pure breeds and crossed genotypes.

Among the crossed genotypes, the SNK test (α = 5%) shows that the heaviest group is composed by the crosses: A2 (A×Lo), A3 (A×Lo), D1 (D×Lo) and D2 (D×Lo) with respective weights at the birth of 3.37, 3.31, 3.55 and 3.44 kg. The crosses D3 (D×Lo), M1 (M×Lo) and M2 (M×Lo) have 2.54, 2.61 and 2.72 kg as weights at the some age, respectively Fig. 3.

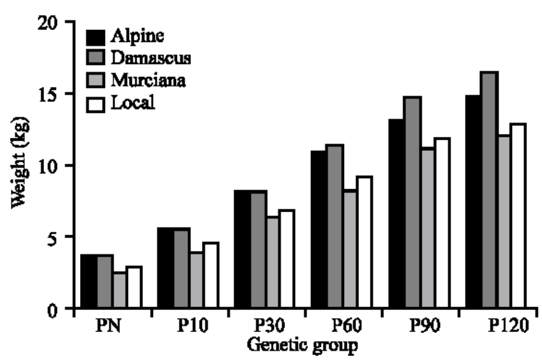

Fig. 2: Kid's weights at standard age for local population and ameliorative breeds

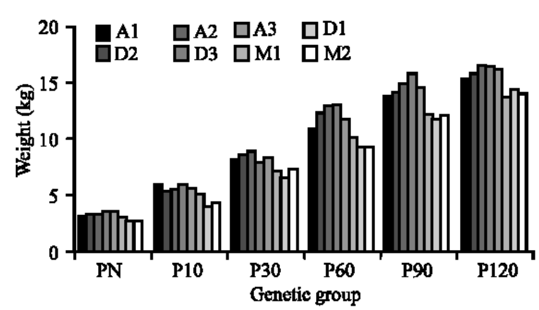

Fig. 3: Kid's weights at standard age for crossed breeds

Kid's weight at birth remain an important productive index due to it relation with meat production and also, with the kid's survival probability (Hussain *et al.*, 1995; Awemu *et al.*, 1999; Anastazios and Ezzat, 2002).

Among the crossed genotypes, with respect to the kid's weights after birth, the SNK test (α = 5%) differenciated two groups relatively homogenous, the first group corresponding to the highest weights contains A2 (A×Lo), A3 (A×Lo), D1 (D×Lo) and D2 (D×Lo) genotypes. For example, the kid's of D1 (D×Lo) genotype weight about 3.55 kg at birth.

At the third crossing generation, the crossed (A×Lo) kid's had the highest weight at 30 days age (8.96 kg). The weight gain explained by the superiority of their mothers on the level of the dairy performances compared to the others crosses (Gaddour, 2005; Gaddour *et al.*, 2006). The weight of the Damascus crossed kids at 120 days in the first generation is about 16.5 kg Fig. 3).

Dairy performances means comparison by genotype: The performances of dairy production of the various studied genetic groups and the SNK test (α = 5%) are presented in Table 4 and 5.

Among the pure breeds (Table 4 and Fig. 4), the Alpine goat presents the best performances of mean dairy

Table 4: Total milk production, Average daily milk production, Milking period and SNK test for dairy performances of local goat Alpine, Damascus, Murciana

Genetic groups	Alpine (A)	Damascus (D)	Murciana (M)	Local (Lo)
Observations	213	51	46	10
Milk production (kg)	244.44	177.05	187.75	133.53
Average milk (kg/days)	1.85	1.22	1.20	0.76
Milking period (days)	132.12	145.12	156.45	175.69

Table 5: Total milk production, Average daily milk production, Milking period and SNK test for dairy performances of crossed genotypes

Genetic groups	A1	A2	D1	D2	M1	M2
Observations	25	14	14	19	7	13
Milk production (kg)	164.53	226.21	183.41	180.18	179.37	160.82
Average milk (kg/days)	1.17	1.53	1.17	1.17	1.12	1.28
Milking period (days)	140.62	147.84	156.76	154	160.15	125.64

A1, A2: crossed Alpine ×local; D1, D2: crossed Damascus × local and M1, M2: crossed Murciana ×Local

with a total production of 244.44 kg during a period of more than 132 days and with a daily mean production of 1.85 kg days^{-1}, followed by Damascus with a total production of 177.05 kg during 145.12 days. The Alpine breed is known with its high dairy performances (Najari, 2005).

The Murciana breed registered the weaker performances since its total production is about 187.75 kg. Also, Murciana breed is characterized by its long period of lactation with 156.45 days. The local goat has the

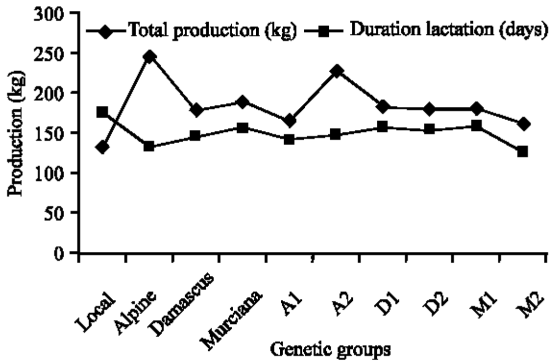

Fig. 4: Dairy performances of local goat, pure breeds and crossed genotypes. (A1, A2: crossed Alpine x local; D1, D2: crossed Damascus x local; M1, M2: crossed Murciana x local)

weakest performances, with a total production of 133.53 kg during approximately 175.69 days.

Compared with their dairy performances in their relative original cradles, all ameliorative breeds register low than the half of their milk production under Tunisian oasian conditions and adaptative capacities remains necessary to realize high milk production (Najari, 2005).

Concerning the crossing genotypes, the crossed Alpine confirm the superiority of their performances as compared to the other groups. Also, their dairy productions increase with the degree of substitution through crossbreeding. Indeed, the production by lactation of A1 (A×Lo) and A2 (A×Lo) were 164.53 and 226.21 kg, respectively with reference to the some results (Table 5 and Fig. 4). So, an heterosis effect not appears in this study for dairy characters, the performances of the crossed genotypes are all lower than those of the paternal pure breeds.

CONCLUSIONS

The individual performances' comparison of the pure breeds and the crossed genetic groups shows that, the local goat production remains low even though under intensive breeding mode. The ameliorative races knew a decrease of their production compared to that known in their origin country. The applied crossing plan permitted to improve the local goat productivity especially for dairy performances. The Alpine breed was distinguished both as pure and as crossed by the best performances in dairy production and kids' growth. For the meat traits, the Damasquine crosses with local goat registered heavy weight at standard ages. The best production improvement was led at the second crossing generation. Despite of the individual production study importance, it remains necessary to include some bio economic indexes to allow a correct choice of the ameliorative breed. Also, rather than genotype effects, other environmental factors vary largely the goat production especially in the arid zone. Indeed, other parameters of production like the reproduction and kids' mortality need to be included as important components affecting final herd productivity in the oasian mode.

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