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Dairy Performances of the Goat Genetic Groups in the Southern Tunisian

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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 cross level. About 1923 individual goat milking data was used to evaluate the dairy potentialities of local goat, imported breeds and crossed genotypes. A statistical analysis was applied on estimated dairy performances such as, daily milk average, total production by lactation and milking period. The cross breeding with imported breeds improves the dairy performances since the first generation. The crossing between these goats races appreciably improves the dairy performance of the local goat and this, as of the first generation. 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, dairy production, oases, Tunisia

INTRODUCTION

The *Capra hircus* is considered being the oldest domesticated animal among livestock species. Its husbandry goes up to more than 10000 years before J.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*., 1997). 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, 2002; 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).

The Tunisian local goat population shows a large morphological and productive variability with a particular adaptation capacity to difficult natural conditions (Najari *et al*., 2006). In the Tunisian arid regions, local goat is essentially raised in pastoral and agropastoral modes and is often considered able to reproduce during all the years, as well as for other caprine rustic populations (Chemineau *et al*., 1991; Alexandre *et al*., 1997; 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.

Regardless of the production objective, goat productivity success remains largely assessed by reproductive performances and kids survival. It is well known that the heat peaks and climatic stress affect reproduction, both of the male and the female, for caprine as well as for all the mammalies species (Williams and Helliwell, 1993; Arbi, 2004). In addition, the environmental stress decreases the oestrus duration the fecundation rates and increase foetal mortality (Le Gal and Planchenault, 1993).

The confirmed local goat low productivity in pastoral system can be attributed to natural and technical resources scarcity (Caruolo, 1974) The extensive breeding mode can be considered as a factor reducing goat productivity. In some cases, the local goat population genetic capacities represents a serious restriction to improve goat production, especially for milk, knowing that local goat is traditionally raised to produce kid's meat (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. Thus, a crossing program to substitute local

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goat by more productive caprine crossed genotypes was carried out by the Institute of the Arid Areas (Médenine Tunisia). To meet this goal, some performant breeds (Alpine, Damascus and Murciana) were imported and the crossing program was conducted in the experimental station in Chenchou (Gabès).

Based on a large data base issued from 16 years (1981 to 1996) animal survey of pure breeds and crossed genotypes performances, several studies was realised to evaluate genotypes productivities (Najari *et al*., 1996; Najari, 2003; Hatmi *et al*., 1998; Gaddour, 2005). Despite of dairy production importance in oases, the kid's meat production contributes in the family incomes each flow.

MATERIALS AND METHODS

Study area: The crossing program was conducted in the Institute of the Arid Areas of Medenine at the station of Chenchou (Gabès, southern Tunisia). 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 month with about 27.3°C average (Ouled Belgacem, 2006).

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.

Table 1: Characteristics and performances of the ameliorative breeds

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

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.

Data base: The collected data correspond to the years of controls since 1980, a total of: 1923 cards of lactation of the goats gathering for each goat, dairy control data. This considerable quantity of information was elaborated in order to estimate the following performances: Dairy performances are for each goat: Total milk production, average daily milk production and milking period.

Statistical analysis: The analysis of the variance for the various performances was made according to the following statistical model:

$$Y_{ijkl} = \mu + RA_i + AN_j + MN_k + RA_{ij} \times AN_{ij} + RA_{ik} \times MN_{ik} + AN_{jk} \times MN_{jk} + RA_{ijk} \times AN_{ijk} \times MN_{ijk} + e_{ijkl}$$

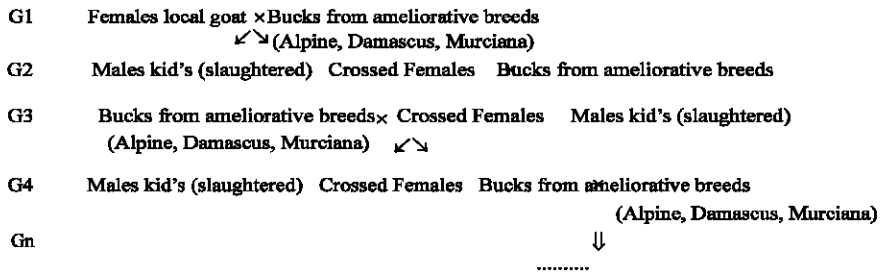

Fig. 1: Local goat cross breeding diagram

Where:

Y_{ijkl}: Total milk production (kg), milking period (days) and average daily milk production (kg days^{-1}), μ: The general average, RA_i: The genotype effect, AN_j: The year effect, MN_k: The mode of birth effect, $RA_{ij}\times YEAR_{ij}$: The genotype x year interaction effect, $RA_{ik}\times MN_{ik}$: The interaction genotype x mode of birth effect , $YEAR_{jk}\times MN_{jk}$: The year x mode of birth effect, $RA_{ijk}\times YEAR_{ijk}\times MN_{ijk}$: The genotype x year interaction x mode of birth effect , e_{ijkl}: 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 dairy: Table 2 presents ANOVA results of dairy performances relatives to studied genotypes in the experimental station.

Table 2 shows that the model coefficient of determination (R^2) varied from 89 to 96%. These values can be accepted for a data collected D'man animal herd during 16 years. The ANOVA test shows that total milk production, Average daily milk production and Milking period were essentially affected by year and genotype factors. Whearas, kidding mode affect only partially some variables, with significant probability ($p<0.05$) upon total production and daily mean. Concerning the interaction effects upon goat dairy performances, Table 3 shows that the interaction genotypes x year have a high is significant effect ($p<0.01$) upon all total milk production, Milking period. Also genotypes×Birth mode affects significatively ($p<0.05$) some variables as such 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; D'Aquino *et al*., 1995; Benlekhal and Tazi, 1996). 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). Whearas, 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. 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 (Morand-Fehr, 2001). 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 MEANS COMPARISON

Genotype effect: The performances of dairy production of the various studied genetic groups and the SNK test (α = 5%) are presented in Table 4.

Table 2: Variance of dairy performances of local goat, ameliorative pure breeds and crossed genotypes

Factors variables	ddL	Total milk production (kg)	Average daily milk production (kg days^{-1})	Milking period (days)
Genotype	9	**	**	*
Year	5	*	NS	**
Birth mode	1	*	*	NS
Genotype×Year	21	**	*	**
Genotype × Birth mode	9	NS	NS	NS
Year×Birth mode	5	*	NS	*
R^2 (%)		89	94	96

ddL: Degree of freedom, **: Highly significant ($p<0.01$); *: Significant ($p<0.05$); NS: Non Significant; R^2: The model coefficient of determination

Table 3: Total milk production, Average daily milk production, Milking period and SNK test for dairy performances of local goat Alpine, Damascus, Murciana and crossed genotypes

Genetic groups	N	Total milk production (kg)	Average daily milk production (kg days^{-1})	Milking period (days)
Alpine (A)	213	244.44^{a}	1.85^{a}	132.12^{b}
Damascus (D)	51	177.05^{ab}	1.22^{a}	145.12^{b}
Murciana (M)	46	187.75^{ab}	1.20^{b}	156.45^{ab}
Local (Lo)	10	133.53^{b}	0.76^{c}	175.69^{a}
A1	25	164.53^{ab}	1.17^{b}	140.62^{b}
A2	14	226.21^{a}	1.53^{b}	147.84^{b}
D1	14	183.41^{ab}	1.17^{b}	156.76^{ab}
D2	19	180.18^{ab}	1.17^{b}	154^{ab}
M1	7	179.37^{ab}	1.12^{b}	160.15^{ab}
M2	13	160.82^{ab}	1.28^{b}	125.64^{b}

N: Observations; A1, A2: crossed Alpine ×Local; D1, D2: Crossed Damascus×Local and M1, M2: Crossed Murciana×Local; ^{a}and^{b}: Homogeneous groups

Table 4: Dairy performances goat in relation to the year

Year	N	Total milk production (kg)	Average daily milk production (kg days^{-1})	Milking period (days)
1989-1990	86	224.44^{ab}	1.61^{a}	147.95^{b}
1990-1991	115	187.17^{b}	1.60^{b}	117.49^{c}
1992-1993	41	220.38^{ab}	1.91^{a}	116.78^{c}
1993-1994	92	235.55^{a}	1.40^{b}	169.06^{a}
1994-1995	59	232.10^{a}	1.43^{b}	162.14^{a}
1995-1996	19	130.19^{c}	1.04^{c}	128.79^{c}

N: Observations; $^{a, b}$ and^{c}: Homogeneous groups

Among the pure breeds (Table 4 and Fig. 2), the Alpine goat presents the best performances of mean dairy 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 weakest performances, with a total production of 133.53 kg during approximately 175.69 days. These results seem to be largely higher than those mentioned in the final report of PNUD Project (1991) and the analyses achieved on a more reduced data base by Ben Hamouda *et al.* (1991).

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 kg and 226.21kg respectively with reference to the some results (Table 4 and Fig. 3). So, a heterosis effect not appears in this study for dairy characters (Griffing, 1971). The performances of the crossed genotypes are all lower than those of the paternal pure breeds.

Effect of the year on the dairy performances: The Table 4 presents the variation of the dairy performances in relation to the years of control. For the local goat, the weak mean performances plug the effect of the environmental factors (Steinback, 1987; Benlekhal and Tazi, 1996). In other words, the potential factors of variation do not find the possibility of illustrating their action on performances with weak margin of variation. (Fig. 4-6).

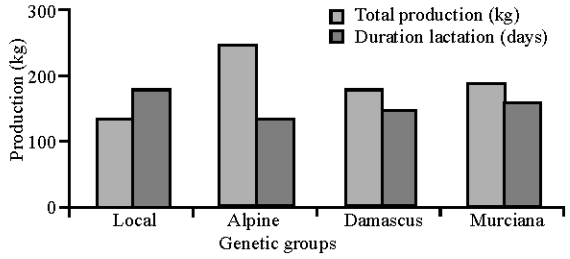

Fig. 2: Dairy performances of local goat and pure breeds

Figure 7 described the evolution of the total dairy production and the lactation of duration according to years; one notices certain proportionality between the

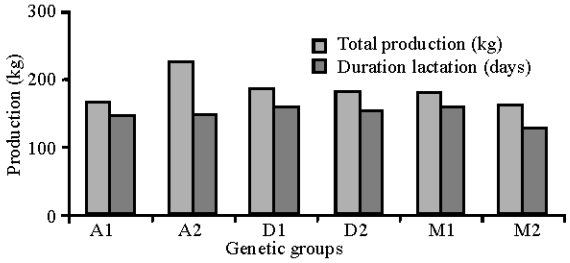

Fig. 3: Total milk production (kg) and Milking period (kg days^{-1}) for crossed genotypes, *(A1, A2: Crossed Alpine×local; D1, D2: crossed Damascus×local; M1, M2: Crossed Murciana×local)*

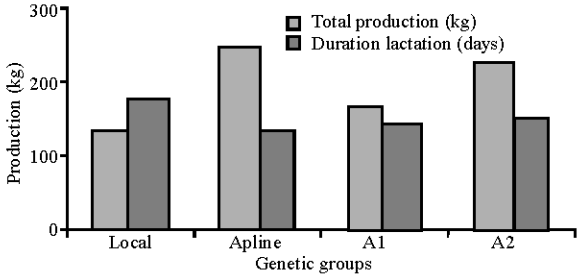

Fig. 4: Dairy performances of local goat, breeds Alpine and its crossed*(A1, A2: Crossed Alpine×local)*

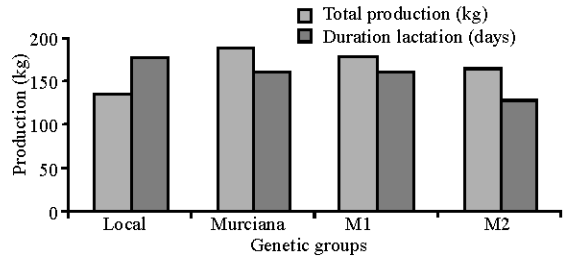

Fig. 5: Dairy performances of local goat, breeds Murciana and its crossed *(M1, M2: Crossed Murciana×local)*

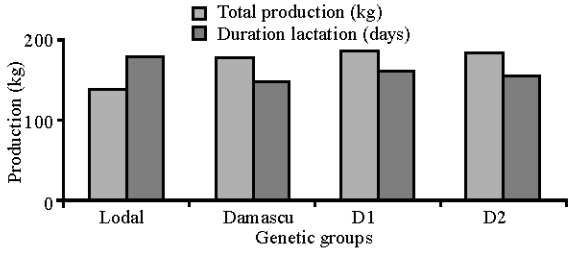

Fig. 6: Dairy performances of local goat, breeds Damascus and its crossed *(D1, D2: Crossed Damascus×local)*

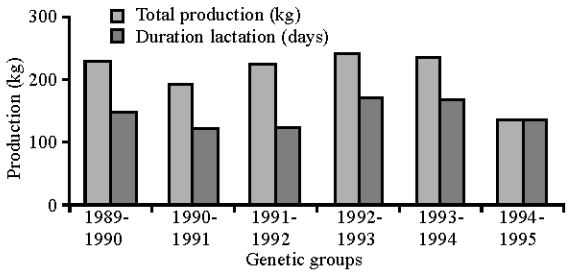

Fig. 7: Dairy performances goat in relation to the year

dairy production and the lactation of duration. Indeed, for a maximum of dairy production a maximum lactation of duration corresponds, moreover, one notices that the lactation of duration is fixed at a maximum level independently of the year.

CONCLUSION

The comparison of the pure races and the genetic groups cross shows that, the performances of the local goat remains weak whereas the ameliorative races knew a decrease of their production compared to that known in their country of origin. The Alpine race was distinguished both as pure and as crossed by the best performances in dairy production and growth of the kid's. However, the comparison of performances of production remains insufficient to conclude about the bio economic interest of the choice from the ameliorative race. Indeed, other parameters of production like the reproduction and mortality need to be included to reach more valid conclusions on the level of the development of the goat breeding in the littoral oases. The important difference between the studied genotypes appears visible by studying the performances of the reproduction and of mortality. This could be explained by the interaction between genotypes and the environment.

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