Evaluation of the productivity of some goat's genotypes for growth and dairy performances under oases breeding mode

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Abstract

The study aimed to develop a set of indicators of an economic and biological nature that can be adopted from a better evaluation of the productivity of different genetic groups resulting from the local breeding program for goats with improved and specialized breeds in the oases of southern Tunisia. The proposed indicators depend on adjusting the average qualifications of milk and meat production for each genetic group, by taking into account the outcome of the breeding season and the cost of breeding for each group separately. The database was collected over a period of 22 years in the caprine herd of the Arid Areas Institute of Médenine. It consisted of direct records of 1,654 weights and 993 records of periodic milk production for members of the domestic goat herd, imported breeds, and hybrid groups. The proposed economic and vital indicators are based on collecting and adjusting all the components of milk production and growth of the goat by calculating the reproductive data, mortality, infertility and abortion. In the second stage, the productivity obtained above is modified by dividing it by the average metabolic weight ($P^{0.75}$), which reduces the cost of breeding, which is correlated with the relative body size and feeding requirements in particular, which differ from one genetic group to another. The application of economic and biological indicators led to a classification and evaluation of productivity completely different from what was obtained based on a comparison of individual performance and production only as usual and which does not reflect the true effectiveness of the heterogeneous herds. It was noted that some strains, with high performance from milk products or heavy weights in weaning, were subject to evaluation influencing their ranking due to infertility rates or high mortality. Moreover, the correction by metabolic weight has profoundly altered the genetic difference arrangement in favor of local goats and *marsiana* with small sizes compared to *latin*, damascene and hybrid goats. Consequently, the incorporation of all productive components and animal behavior into the evaluation criteria provides effective technical means for comparing the productive performance of heterogeneous herds which supports the effectiveness of genetic improvement programs. Improvements can be made to the studied indicators by calculating other elements that interfere in the outcome of education or by adopting individual indicators instead of the medium, which is included in future studies.

Key words: productivity assessment indicators, Local goats, crossbreeding, growth, milk, metabolic weight .

Introduction:

The role of goats in the economies of developing countries and their contribution to the livelihoods of many resource-poor small holder farmers cannot be overemphasized **(Delgadilo *et al.*, 1997).** Goats and also sheep production, provides one of the practical means of using the vast arid and semi-arid areas, where crop production is impractical **(AL Saef, 2013**). In Tunisia, more than 60% of the national caprine herds estimated to 1 500 000 goats were raised in the arid area (**FAO, 2017**). Since centuries, the pastoral breeding mode allows to valorize the rangelands resources by ambulant small ruminant herds under harsh conditions. Goat meat production is a widely extended activity in the more arid areas of Tunisia. Local breeds are normally used because of their adaptation to produce under the harsh conditions of this region. Local goat breeds are famous for their walking ability, resistance to hydric restrictions and high temperatures and good fertility. However, these breeds are also characterized by a very small size and low productivity (**Najari, 2005**). This makes farmers tend to use foreign selected breeds, which lack adaptation to harsh conditions (**Atoui *et al.*, 2019**).

Local goats were traditionally raised in oases under favourable conditions, where goat contributes significantly in the farmer's incomes. The main goat production objective in oases is the milk. Such breeding goal cannot be satisfied by local goat adapted to pastoral harsh conditions and registering reduced dairy performances despite of the resource's abundance in oases. To improve goat productivity and to optimize oases resources valorization, a crossing plan of the local goat was adopted as the solution to resolve this genetic problem. Based on a large data base issued from 16 years' animal survey of pure breeds and crossed genotypes performances, several studies evaluated genotypes productivities.

The present study aims to establish some evaluation indexes of the effectiveness of different genetic groups issued from the local goat crossbreeding program. The proposed indexes adjust, for each genotype, dairy and meat performances by the reproductive parameters and metabolic weight, to consider the principal livestock products and nutritive charges. Breeding efficiency was estimated by the adjustment of individual performances with reared kids' number **(Najari, 2005).** With regard to breeding costs, the main difference between genetic groups can be represented by adult metabolic weight.

Material and Methods

Location

All studied animals belong to the goat experimental herd of the Arid Areas Institute of Médenine Tunisia (33°30' N and 10° 40' E), which is located in southeastern Tunisia, between the mountains of Matmata and the Mediterranean Sea. This region is characterized by an arid continental Mediterranean climate; with irregular precipitations with an average annual rainfall of about 200 mm. The summer is normally the hottest and driest season with a maximum temperature of 47°C (**Ouni, 2006**).

Animals and management

Local goats

The Tunisian local goat population is very polymorphic **(Najari, 2005**), but it is generally characterized by its small body size with average height of 76 cm for the male and 60 cm for the female (**Atoui *et al.*, 2018**). A photograph of the Tunisian goat is provided in Figure (1). Animals were mated following a breeding system of one kidding per year **(Atoui *et al.*, 2018).** The main mating period was from June to August, which corresponded to births in autumn. If a doe was not pregnant during the first mating period, it was transferred to the group that was mated at the next mating period (October-November, which corresponds to births in spring). The female kids were mated for the first time between 12 and 18 months of age, depending on their birth season (**Najari *et al.*, 2010**). In pastoral mode, the birth weight is 2.41 kg and the average milk yield per lactation is 98 kg (**Najari, 2003**). Kidding season begins in October and continues till February with a concentration in November and December when 69.2% of kids are born **(Atoui *et al.*, 2018).**

Fig. 1: Photograph of the Tunisian goat.

Imported breeds

Three imported breeds were used in the crossing scheme: Alpine, Shami and Murciana, imported respectively from France, Cyprus and Spain since 1980. Table (1) shows the characteristics of the imported breeds (**Najari, 2005**).

Table 1: Characteristics and performances of the imported breeds.

Breed	Origin	Adult weight (kg)		Total production (kg)	Lactation period (days)
		♂	♀		
Alpine	France	80	60	570	245
Murciana	Spain	70	50	500	210
Shami gaot	Cyprus	80	60	200	90

Cross breeding diagram

Absorption cross breeding of the local goat population consists in mating, at each generation, between crossed females (in the first step, local goat) with males of the introduced breed. The crossing diagram **(Fig.2)** allows increasing progressively the improved percentage of genes pool, during successive generations and till reaching a satisfactory productive level, the crossed will be mated intra group.

G_0 **Females local goat × Bucks from improved breeds**

G_1 **Males kid's (slaughtered) Crossed Females X Bucks from improved breeds***

G_2 **Bucks from improved breeds* X Crossed Females Males kid's (slaughtered)**

G3 **Males kid's (slaughtered) Crossed Females X Bucks from improved breeds***

⇩

Gn **...**

*G: crossing generation; ×: mating; *Bucks improved: Alpine, Shami, or Murciana*

Fig.2: Local goat cross breeding diagram.

Data recording and statistical analysis

During 16 years, a recording was applied for the different genetics groups: local goat, Alpine, Shami, Murciana, and also for the crossed groups: Local×Alpine, Local×Shami and Local×Murciana, in all crossing generations. The studied traits are:

- Reproductive performances by genetic group: fertility, sterility; prolificacy.
- Mortalities of adults and kids.
- Weights of kids, periodically registered since the birth till 6 months of age.
- Dairy performances of goats; periodically collected from kidding till drying.

Growth records of 1654 kids and dairy performances of 993 goats of different genetic groups were collected. Data on the reproductive performances and mortalities were collected every year for all groups (Table 2).

The data set was verified and individual kid's weight at 120 days was estimated. Weight at 120 days' age (W120) was estimated as follows **(Atoui *et al.* ,2018):**

$$\mathbf{W120} = \frac{\mathbf{Wi} + (\mathbf{120 - Di}) \times ((\mathbf{Wi + 1 - Wi})}{(\mathbf{Di + 1 - Di})}$$

Where W_{120}: weight at 120 days of age; W_i: weight at the age of weighing (i); D_i: the age at weighing (i).

For each genetic group, the goats reproductive and kid's mortality rates were annually estimated for each genotype according to the following expression **(Najari,2005):**

$$\textbf{Fertility rate } (\%) = \frac{\textbf{Total of pregnant does}}{\textbf{Total goats at mating season}} \times \mathbf{100}$$

$$\textbf{Prolificacy rate } (\%) = \frac{\textbf{Total of kids born}}{\textbf{Total of kidding females}} \times \mathbf{100}$$

$$\textbf{Fecundity rate } (\%) = \frac{\textbf{Total of births at kidding}}{\textbf{Total goats at mating season}} \times \mathbf{100}$$

$$\textbf{Mortality rate at kidding } (\%) = \frac{\textbf{kids born died}}{\textbf{Total of kids}} \times \mathbf{100}$$

$$\textbf{Mortality ratio before weaning }(\%) = \frac{\textbf{kids died before weaning}}{\textbf{Total of kids}} \times \textbf{100}$$

Two variables, birth weight (BW) and weight at 120 days of age (W120) were considered as measures of kids' growth since they represent two main components of the growth performance.

Firstly, an ANOVA procedure of the Statistical Package of Social Sciences (SPSS.20) was carried out for determining the effects of genetic group on studied traits. Significant means were separated using the Student Newman Keuls means comparison test (SNK, α= 5%).

The general model for the analysis used was as follows:

$$\mathbf{Y_{ijklm} = Yi + M_j + S_k + G_l + e_{ijklm}}$$

Where Y_{ijklm}: the observation for each trait; Y_i: year of birth; M_j: month of birth; S_k: sex of kid; G_l: genetic group and, e_{ijklm} was the random residual term.

Table2: Number of records of kids' growth, goats' dairy and reproductive performances.

Genetic group	Number of kids at weighning	Number of dairy goats	Years of reproduction records
Local	148	150	12
Alpine	767	521	15
Shami	169	90	11
Murciana	148	111	13
F1A	137	54	12
F1D	49	14	8
F1M	15	7	5
F2A	176	14	8
F2D	28	19	5
F2M	17	13	2
Total	1654	993	91

F1A, F2A: crossed Alpine × local; F1D, F2D: Shami ×local cross; F1M, F2M: cross Murciana × local. F1: first generation of crossing; F2 second generation.

The index of meat production was estimated for two ages: at birth and at 120 days of age. The index estimates the average number of kids at each age reported to the number of present adults per each genotype **(Najari, 2005).**

$\mathbf{N_1}$ = Number of kids produced per female present at mating period, at kidding.

$$\mathbf{N1} = \frac{(\textbf{Fecondity rate} - \textbf{Birth mortality rate})}{\textbf{100}}$$

$\mathbf{N_2}$ = Number of kids produced per female present at mating period, for age 120 days.

$$N2 = \frac{(Fecondity\ rate - weaning\ mortality\ rate\ )}{100}$$

N_1 and N_2 will be used to determine the average weight of the kids by genotype at each considered age, as follow:

V_1 (kg) = Production of meat by female present at mating period

$$\mathbf{V1 = N_1 \times BW}$$

V_2 (kg) = Meat production per female present at mating season, for age 120 days

$$\mathbf{V2 = N_1 \times P_{120}}$$

The meat production was adjusted by metabolic weight, in order to correct the previous V indexes by the metabolic weight ($P^{0.75}$) to include the nutritive charges for each genotype. Thus, we can estimate the genetic group efficiency as the meat produced, at birth and at 120 days, per one kg of weight reared at mating season. The adjustment is as follows:

V'_1 = Average weight of meat produced, per metabolic weight (kg) of a female present at mating season and at kidding.

$$V'1 = \frac{V1}{P0.75}$$

V'_2 = Average weight of meat produced, per metabolic kg of a female present at mating season and at the age of 120 days.

$$V'2 = \frac{V2}{P0.75}$$

The total dairy production per female (L1) was estimated as follow:

$$L1 = \frac{Total\ dairy\ production \times Fertilily\ rate}{100}$$

L_1 = Total milk production per female present at mating season.

The milk performance corrected by metabolic weight (**L'_1**) was estimated as follow (Najari, 2005):

$$L'1 = \frac{L1}{P0.75}$$

L'_1 = Average dairy production (kg) by metabolic weight

Results

Evaluation indexes

Several studies were achieved to identify the best improved breed in this crossbreeding project. This work was based on statistical comparison of the estimated dairy and meat production of each genetic group. Results led to conclude that crossing local goat with Alpine and Shami generate a significant improvement of dairy production and kids 'weights. The best dairy performances correspond to the F2A and the F1D kids **(Hatmi *et al.*, 1998; Boujenane and Hazzab ,2008, Najari, 2003).** However, such results determine the groups' productive efficacy which must integer, and compare, the litter size for each genotype and the nutritive charges of heterogeneous animal groups, as previously discussed.

Estimation of the genetic groups' numeric productivity N_1, N_2

As a result of the combination of fecundity rates, which integer fertility and prolificacy, and the mortalities rates of each genotype, we establish the litter size per goat presents at mating season. Such results were presented in Table (3).

Table 3. Reproductive rates (%), Kids' mortality rates (%) and litter size per goat presents at mating season.

Genetic group	Fertility rate%	Prolificacy rate%	Fecundiy rate %	Mortality (%) at		Litter size at	
				Birth	120 days	BirthN1	120days N2
Alpine	88.59	143.68	127.07	4	21	1.23^{b}	1.06^{d}
Shami	95	136.86	129.71	1.37	17.99	1.28^{b}	1.12^{c}
Murciana	88.04	133.90	118.27	0.48	14.05	1.18^{bc}	1.04^{d}
Local	92.71	153.43	142.50	1.52	13.56	1.41^{ab}	1.29^{ab}
F1A	93.38	132.8	125.07	2.94	14.29	1.22^{b}	1.11^{c}
F2A	84.01	135.16	113.75	6.91	10.68	1.07^{c}	1.04^{d}
F1D	98.44	155.32	153.75	0	17.45	1.54^{a}	1.36^{a}
F2D	100	140.64	140.67	1.82	13.79	1.39^{ab}	1.27^{ab}
F1M	95.14	141.19	136.14	0	14.05	1.36^{ab}	1.22^{b}
F2M	95	111.11	105	0	0	1.05^{c}	1.05^{d}

F1A, F2A: crossed Alpine × local; F1D, F2D: Shami × local cross; F1M, F2M: cross Murciana ×local. F1: first generation of crossing; F2 second generation.
a,b, c,d, e…; homogeneous class with SNK test (α= 5%)

As shown in Table (3), the local goat was distinguished by a higher litter size at all studied ages. The local goat, presents at mating season, gives an average of 1.41 kids at birth and 1.29 kids at the age of 120 days. The mean for litter size at birth obtained in this study, 1.41, for local goat, was lower than that of some world prolific goat breeds including Nubian, Pygmy, American Alpine, French Alpine, Saanen and Toggenburg with the average litter size of 2.0, 1.9, 1.9, 1.7, 1.7 and 1.6, respectively **(Amoah *et al.*, 1996**). A relatively small litter size might be a direct result of the long natural selection process under arid conditions. In fact, the local population must have a productive behavior coherent with the local resources on rangelands and the pastoral extensive breeding system. The likely reduced dairy performance does not allow feeding more than one or two kids per year. Thus, local goats' reduced litter size represents a genetic adaptation to natural environment of pastoral breeding in arid regions (**Najari, 2005; Atoui *et al.*, 2018**).

As illustrated by SNK test (Table 3), the litter size of Alpine breed was seriously reduced between birth and 120 days because of the high mortality rates; these rates reached more than 40% during some years. Such result can be explained by an interaction between the genotype and the environment that is expressed differently on kid's survival of the imported genotypes **(Najari, 2005).**

Among crossed genotypes, a high litter size at birth was observed in F1D goats (Table 3). This superiority expresses a phenomenon of heterosis that was clear when local goat is crossed by Shami males. Moreover, the female F1D, issued from local group, illustrated their maternal instinct and high fertility rates; all kids F1D survived until the age of 120 days, and N2 numerical index remained higher than 1.27 at 120 days.

Estimation of the kids' meat production per goat presents at mating season

Table (4) shows the results of the ANOVA analyses to test the significance fixed effects of studied traits. The regression coefficient was 96 and 97% respectively for weight at 120 days and at birth. It seems that the model represents all the factors affecting the studied traits. The significant effect of the kidding year might be due to fluctuations in availability of feeds from year to year or to instability of management practices related to feeding regimes and changes in climatic factors. Result is substantiated by the findings of **Atoui *et al.*, 2019**, **Alexander *et al.*, (1997**), **Zhang *et al.*, (2009)** and **Najari *et al.*, (2007). Ouni (2006)** reported that the higher variation on weight due to year of birth can be explained by variations in amount of annual rainfall which in turn influenced pasture production and availability of feed for the dam especially in late pregnancy, which affects the milk production and the birth weight of kids.

Table4: ANOVA of variance analysis for weight (kg) at birth and at 120 days of age.

Factors	df	BW	W120
Y	15	**	**
G	11	**	**
S	1	NS	*
R^2 (%)	-	97	96

df: degree of freedom, **: highly significant (p<0.01); *: significant (p<0.05); NS: not significant; R^2: coefficient of determination

Y: Year of birth, G: Genotype, S: Sex of kids

BW and W120: weight at birth and at 120 days.

To establish V_1 and V_2 indexes, the weight of kids was adjusted by the previous values of N_1 and N_2 (Table 3), respectively at birth and at 120 days. Table (5) shows the values of V_1 and V_2 for the studied genetic groups indicating that the best meat production result is obtained with Shami goat.

Table 5: Weight at birth and at 120 days, per goat present at mating season for genetic groups.

Genetic Groupes	N	Weight of kids (kg)		Meat production by goat at mating season (kg)	
		Birth	120 days	Birth = V1	120 days = V2
Alpin	767	3.6^{a}	14.80^{ab}	4.44^{ab}	15.7^{cd}
Damasqus	169	3.66^{a}	16.48^{a}	4.69^{ab}	18.46^{b}
Murciana	148	2.38^{c}	11.98^{c}	2.80^{d}	12.47^{e}
Local	148	2.92^{dc}	12.85^{d}	4.04^{b}	16.58^{cd}
F1A	137	3.08^{bc}	15.03^{ab}	3.72^{bc}	16.63^{cd}
F2A	176	3.37^{ab}	15.78^{a}	3.58^{c}	16.41^{cd}
F1D	49	3.55^{ab}	16.42^{a}	5.37^{a}	19.57^{a}
F2D	28	3.48^{ab}	16.19^{a}	4.67^{ab}	20.05^{a}

F1M	15	2.61^{c}	14.42^{bc}	3.55^{c}	17.59^{c}
F2M	17	2.72^{c}	13.9^{c}	2.86^{d}	14.62^{d}

F1A, F2A: crossed Alpine ×local; F1D, F2D: Shami × local cross; F1M, F2M: cross Murciana × local. F1: first generation of crossing; F2 second generation.

a,b, c,d, e…; homogeneous class with SNK test (α= 5%)

While, the Alpine goat has a lower meat production index than the local population, at the age of 120 days, despite the value of the weight of the Alpine kids estimated with an average of 14.81 kg (Table 5) towards 12.85 kg for local kids. This result reflects the high sensitivity of the Alpine goat to herd management and to climate irregularities of the arid environment, even under oasis conditions **(Boujenane and Hazzab 2008).**

The lowest meat productivity rates correspond to the Murciana breed; even after adjustment with N values, the Murciana kids present the lowest weights at birth and at 120 days of age. The meat produced by Shami crosses, F1D and F2D, was higher than the one of local population. In fact, Shami crosses produced approximately 20kg at 120 days in comparison with the pure breed which present 18.5 kg (Table5). The vigor of the hybrid or heterosis seems significant with the Shami breed in terms of weight and litter size.

Kids' meat production adjusted by metabolic weight

The meat production adjusted by metabolic weight was provided in table 6. As a result of the metabolic weight correction, the local goat presents the highest "yield". While the corrected weight of F1D kids seems the highest among all genetic groups.

Table 6: Adult weight (kg), metabolic weight ($P^{0.75}$, kg), and meat produced per kg of adult metabolic weight of female present at mating season.

Genetic groups	N	Adult weight (kg)	Metabolic weight ($P^{0.75}$, kg)	Kids' meat produced per 1kg of adult metabolic weight	
				At kidding = V'1	At 120 days = V'2
Alpin	767	51.6	19.25	0.23^{bc}	**0.82^{d}**
Shami	169	47.2	18	0.26^{b}	**1.03^{c}**
Murciana	148	33.2	13.83	0.2^{c}	**0.9^{cd}**
Local	148	31.4	13.26	**0.3^{ab}**	**1.25^{a}**
F1A	137	36.2	14.76	0.25^{b}	**1.13^{b}**
F2A	176	43.9	17.05	0.21^{bc}	**0.96^{cd}**
F1D	49	39.3	15.7	**0.34^{a}**	**1.25^{a}**
F2D	28	39.2	15.67	**0.3^{ab}**	**1.28^{a}**
F1M	15	33.3	13.86	0.26^{b}	**1.27^{a}**
F2M	17	**33**	**13.77**	**0.21^{bc}**	**1.06^{c}**

F1A, F2A: crossed Alpine×local; F1D, F2D: Shami × local cross; F1M, F2M: cross Murciana × local. F1: first generation of crossing; F2 second generation.

a,b, c,d, e…; homogeneous class with SNK test (α= 5%)

F1M kids have a higher yield than Alpine pure breed and its crosses; this result is due to the high metabolic weight of Alpine latter breed. Using the bioeconomic indexes changes the classification of the genotype in favor of the genetic groups represented by lightest goats and penalizes seriously the efficiency of heavy breed as for Alpine and Shami (Table 6).

Efficiency of dairy production

Dairy performance corrected by breeding parameters

Improving goat dairy performances in oases remains the first objective of the native goat cross breeding project. The success of this improvement program depends to the choice of the paternal breed to mate local and crossed goats. An evaluation criterion has to be established on the dairy production efficiency of groups and not on individual average performances which elapses the breeding loads and the genotypes fertility parameters (**Mekki *et al.*, 2011a**).

For each genotype, only the goats giving births will have a lactation; therefore, we adopt the fertility rate, as previously defined and which takes into account the costs induced by sterile females, to correct dairy performances.

Table7: Dairy production per lactation (kg), per goat present in herd (kg) and fertility rates (%).

Genetic groups	N	Dairy production(kg)	Fertility rate (%)	Dairy production per present goat (kg) = L1
Alpin	213	248.44 [a]	88.59	220.09[a]
Damasquin	51	180.5[bc]	95	171.48[c]
Murciana	46	189.6[bc]	88.04	166.92[cd]
Local	83	137.53[d]	92.71	127.5[e]
F1A	145	164.53[c]	93.38	153.64[d]
F2A	114	226.21[b]	84.01	190.04 [b]
F1D	125	183.41[bc]	98.44	180.55 [bc]
F2D	89	180.18[bc]	100	180.18 [bc]
F1M	71	179.37[bc]	95.14	170.65[c]
F2M	56	160.82[c]	95	152.78[d]

F1A, F2A: crossed Alpine × local; F1D, F2D: Shami × local cross; F1M, F2M: cross Murciana × local. F1: first generation of crossing; F2 second generation.

a,b, c,d, e…; homogeneous class with SNK test (α= 5%)

The SNK means comparison test shows that for the pure breeds, no changes were recorded in the ranking established according to the average dairy performances. Breeding behavior did not influence the superiority in dairy production of the Alpine breed towards other pure breeds. Along crossed groups, the F2A illustrated the best performances even after correction; and keep a better ranking than the F1A goats.

When Shami and Murciana breeds were used as paternal breed in the crossing scheme, the crossed goats of the first generation seems more efficient than those of the second generation.

Local goat illustrated the worst dairy performances. Similar result was obtained by **Najari (2005)** who indicate that the limited local goat dairy production is due to the natural selection process. Indeed, the adaptation to pastoral arid breeding mode led to decrease the biological animal needs to survive and produce kids under harsh environment with restricted and irregular resources.

Milk performance corrected by metabolic weight

The estimation of dairy production corrected by metabolic weight was shown in table 8.

Table 8: Adult weight (kg), metabolic weight (kg), and dairy production of different genetic groups.

Genetic groups	Adult weight (P, kg)	Metabolic weight ($P^{0.75}$, kg)	Dairy production per 1kg of metabolic weight of goats = L'1
Alpin	51.6	19.25	11.43[b]
Damasqus	47.2	18	9.53[d]

Murciana	33.2	13.83	12.07 [a]
Local	31.4	13.26	9.62[d]
F1A	36.2	14.76	10.41[c]
F2A	43.9	17.05	11.15 [bc]
F1D	39.3	15.7	11.5 [b]
F2D	39.2	15.67	11.5 [b]
F1M	33.3	13.86	12.31[a]
F2M	33	13.77	11.1 [bc]

F1A, F2A: crossed Alpine × local; F1D, F2D: Shami × local cross; F1M, F2M: cross Murciana × local. F1: first generation of crossing; F2 second generation.

a,b, c,d, e…; homogeneous class with SNK test (α= 5%)

As shown in table8, the correction by the metabolic weight affects deeply the ranking of genotypes compared to the classification based on the dairy performances as observed or as adjusted by fertility rates, previously presented in table 7. In fact, the weights vary immensely between genetic groups; in average, the Alpine goat body size is 20 kg heavier than the weight of the local goat. Consequently, the low metabolic weight favored the Murciana breed towards other pure breeds.

Discussion

Concerning the local goat, the application of the corrections by the reproductive performances as well as by the breeding costs confirm its reduced genetic potentialities especially for dairy production. Despite the intensification of herd management in oases, the local goat seems not able to produce sufficient milk considered as the first production objective in the oases breeding system. The natural selection process reduced mainly the dairy production of local goat. The absorption crossbreeding improved the performance of goat in the oases, especially by increasing individual production average of meat and milk. Thus, the crossbreeding scheme allows a clear improvement of dairy production. However, the performances of imported breeds were largely slow to their realizations in their native regions; the effect of the genotype×environment interaction is clear and the intensification of the feeding mode cannot elapse its impacts upon exotic genotypes.

The establishments of bioeconomic indexes allow taking account of capital production components and management factors to assess an evaluation criterion which synthesizes the economic objectives of the local goat's absorption crossbreeding. Results indicated that the comparison of the potentialities of pure goat breeds and crossed genotypes, based on the individual kids' growth and goats' dairy production, remains insufficient to conclude correctly on the genetic and economic efficiency of genotypes and the crossbreeding utility. Thus, the paternal breed choice can be biased and not allows reaching the improvement objectives as established by herders and developers. In fact, the efficiency indexes allow more equitable evaluation through the adjustment of dairy and growth performance. Following the application of the bioeconomic indexes, the data analysis produces a genetic groups' ranking quite different from those established by comparing average groups' performances. Therefore, the integration of the components of efficacy, such as fertility, mortality and metabolic weight, seems essential for the reasonable choice of improved breeding breeds.

The local goat presents a low litter size (an average of 1.41). A relatively small litter size might be a direct result of the long natural selection process under arid conditions. In fact, the local population must have a productive behavior coherent with the local resources on rangelands and the pastoral extensive breeding system. The likely reduced dairy performance does not allow feeding more than one or two kids per year. Thus, local goats' reduced litter size represents a genetic adaptation to natural environment of

pastoral breeding in arid regions **(Najari, 2005).** The local goat presents a high litter size in comparison with the other genetic groups. When, the local goat finds favorable breeding conditions, an increase in reproductive performances was observed (the prolificacy rate reached on average of 153%) (**Najari, 2005).** Thus, the process of natural selection, which has resulted in the acquisition of adaptation traits, has also led to sedimentation of the genes responsible for the continuity of the genetic group under difficult conditions. Moreover, results confirm that efficacy can be acquired through the phenomenon of heterosis, which is expressed some traits such as prolificacy.

Regarding the global efficiency of meat production, the applied indexes illustrated that the heavy breeds, especially the Shami and Alpine, present productivity indicators slightly higher than those of the local goat.

For dairy production, the correction of performance confirms the superiority of Alpine goat in pure and in crosses groups. Among the crossed groups, the best kids' meat improvement remains not spectacular and mostly correspond to first crossbreeding generation which cannot serve as stable genotypes in absorbing crossbreeding schemes. Indeed, going to higher crossing generation leads to a reduction in productivity and raises questions about the effectiveness of prolonged absorption of the local population (**Mekki *et al.,* 2011b**). Other ways of improvement may, perhaps, be an alternative; also, the efficacy would be improved at the same time by non-genetic factors according to the recognized importance of the interaction between the genotype and the environment **(Najari, 2016).**

Conclusion

The comparison of the pure races and the genetic groups cross shows that; the performances of the local goat remained low whereas the improved races showed a decrease in 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 kids. However, the comparison of performances of production remains insufficient to conclude about the bio economic interest of the choice from the improved breed.

The corrected performances indicated that under oases conditions, the breeds having a large body size were seriously penalized at the efficiency level. However, it necessary to improve the indexes ability by synthesizing all production components in one evaluation criteria allowing more complete consideration of the economic margins that breeders can achieve, regardless of performances. It would also be beneficial to evaluate the response of breeders in terms of the choice of goat genotypes according to the resources of the different herds and breeding systems. The breeders' appreciation of one genotype synthesizes more breeding characteristics than those recorded by the animal records.

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تقييم انتاجية اللحوم والألبان لمجموعات وراثية من الماعز في ضل نمط التربية

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الملخص

هدفت الدراسة إلى استحداث مجموعة مؤشرات ذات صبغة اقتصادية وبيولوجية يمكن اعتمادها من التقييم الأفضل لإنتاجية مجموعات الوراثية مختلفة ناتجة عن برنامج تهجين الماعز المحلي بسلالات محسنة ومختصة في واحات الجنوب التونسي. تعتمد المؤشرات المقترحة على تعديل متوسط مؤهلات إنتاج الحليب واللحوم لكل فريق جيني وذلك من خلال الأخذ بالاعتبار حصيلة موسم التكاثر وتكلفة التربية لكل فريق على حده. تم جمع قاعدة البيانات على مدى 22 عاماً في قطيع الماعز المحلي بمعهد المناطق القاحلة في مدنين والسلالات المستوردة والمجموعات المهجنة. تكونت قاعدة المعطيات من تسجيلات مباشرة لـ 1654 أوزان و993 سجلاً لإنتاج دوري للحليب. ترتكز المؤشرات الاقتصادية والحيوية المقترحة على تجميع وتعديل كل عناصر ومكونات إنتاج الحليب ونمو الجديان عبر احتساب معطيات الإنجاب ومعدلات الوفيات والعقم والإجهاض. وفي مرحلة ثانية يتم تعديل الإنتاجية المتحصل عليها آنفاً من خلال قسمتها على متوسط الوزن الأيضي ($P^{0.75}$) الذي يختزل تكلفة التربية المترابطة مع حجم الجسم النسبي ومتطلبات التغذية خاصة والتي تختلف من مجموعة وراثية إلى أخرى. أدى تطبيق المؤشرات الاقتصادية والحيوية إلى تصنيف وتقييم للإنتاجية مختلف تماماً عن المتحصل عليه بناءً على مقارنة الأداء الفردي والإنتاج فقط كما جرت العادة والذي لا يعكس الفعالية الحقيقة للقطعان الغير متجانسة وراثياً. لوحظ ان بعض السلالات، ذات الأداء العالي من إنتاج الحليب أو الأوزان الثقيلة عند الفطام، خضع تقييمها لعقوبات مؤثرة على ترتيبها بسبب معدلات العقم أو الوفيات العلية. علاوة على ذلك فإن التصحيح بالوزن الأيضي غيّر بعمق ترتيب الفرق الوراثية لصالح الماعز المحلي ومرسيانا ذات الأحجام الصغيرة مقارنةً بماعز الالتين والدمشقي وهجائنها. وبالتالي فإن دمج جميع المكونات الإنتاجية والسلوك الحيواني في معايير التقييم يوفر وسائل تقنية ناجحة لمقارنة الأداء الإنتاجي للقطعان الغير متجانسة مما يدعم فعالية برامج التحسين الوراثي. ويمكن إضافة تحسينات على المؤشرات المدروسة باحتساب عناصر أخرى تتدخل في حصيلة التربية أو باعتماد مؤشرات فردية عوض المتوسطة وهو ما تشمله الدراسات المستقبلية.

الكلمات المفتاحية : مؤشرات تقييم الانتاجية، الماعز المحلي، التهجين، النمو، الحليب، الوزن الأيضي ($P^{0.75}$)