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Environmental factors affecting birth weight of Tunisian local goat population kids

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Abstract - Data collected on 964 local kids, recorded between 1998 and 2014 were used to study the impact of genetic and non genetic factors on birth weight. Results indicate that Tunisian local goat population kids were characterised by a reduced weight at birth, it was only 2.34 ± 0.44Kg. Similar performances were observed for rustic goat population. The kidding year affect the birth weight, while the kid's colour pattern had no significant effects (P> 0.05). The kidding season, had a significant (P<0.05) influence on the studied trait. It was inferred that single born kids were significantly heavier than multiple. In average, the birth weight for male and female were 2.46 ± 0.44 and 2.20 ± 0.39Kg respectively. The birth weight was found to be the highest in 5years age group (2.64 ± 0.42Kg). The weight of the dam had significant effect on birth weight of kids of both sexes. The establishment of the kid's weight parameters under arid regions helps to develop accurate selection indices and to optimally a breeding programs and performance recording systems for maximum economic gain or profit from growth traits.

Keywords: Local goats, arid regions, birth weight, non-genetic factors.

1. Introduction

Goats are known to be potential genetic resources for meat, milk, skin and fiber. They also play an important role in the socio-economic life of the people as they feature prominently in socio-cultural functions like ceremonies and religious festivities. Goats are widely distributed in the tropics and subtropics as a result of the ability to adapt to a variety of environments (Mbayahaga et *al.*.1996).
Birth weight is an economically important trait in livestock production. It is measure of prenatal growth and whish affect partially in post natal development (Barlow, 1978). Bailgy et *al., (*1990), reported that birth weight determine the future performance of individual engaged in prevailing environment. Weight at birth is influenced by genetic and non genetic factors. Hence, the performance records of an animal should be corrected for classifiable non-genetic sources of variation, which is essential for obtaining precise estimates of genetic parameters and breeding values so that breeding animals with the potential genetic merit can be identified and selected for further genetic improvement. The present study pretends to identify the impact of known environmental factors and their interaction on birth weight of local goat population kids bred under hard arid conditions.

2. Materiels and methods

The study was being carried out during sixteen years (from1998 to 2014). Data were collected through periodical weighing plan of 946 local kids bred under arid conditions of southern Tunisia with irregular and sporadic rains, average annual rainfall of 200mm (Ferchichi, 1996).
The local goat population shows a large variability regarding both morphology and production (Najari, 2003). Characteristics of this population include the small body size with a mean height of 76 cm for the male and 60 cm for the female (Ouni et *al.*, 2007) and the ability to pasture along extended distances. Fertility rate was about 87% and prolificacy rate was about 110-130% (Najari et *al.*, 2006). Kidding season begins in October and continues till February, with a peak during December.
The birth weight of the animals was measured within half an hour of their birth. Each kid records included goat mother and kid identification, birth date, sex and type of birth.
Analysis of variance ANOVA was applied to determinate the effect of the kidding year, kidding season, sex of kids, type of birth, age /weight of dam at kidding, the kid's colour pattern, and two way

interactions between these factors on birth weight. Means comparison test (SNK, alpha=5%) was performed to classify kids regarding each factor variation. The mathematical model used to analyze the studied traits was as follows:

$$\mathbf{Y_{ijklm} = \mu + yob_i + sob_j + sex_k + tob_l + dalc_m + wob_n + pat_p + (yob \times sob)_{ij} + (yob \times sex)_{ik} + (yob \times tob)_{il} + (sob \times sex)_{jk} + (sob \times tob)_{jl} + (sex \times tob)_{kl} + e_{ijklmnp}}$$

Yijklmn= observation on the trait;
μ = population mean;
yob_i = kidding year (i=1998_2014);
sobj = kidding season (j= season1: November--January; season2: February --April);
sexk= sex of kids (k=1: male,2:female);
tobl= type of birth(l=1: single,2:multiple);
dalcm= age of dam at kidding (m=1,….,8);
wobn= weight of dam at kidding (n=1,2,3);
patp= the kid's colour pattern(p=1,.....,8);
$(yob \times sob)_{ij}$= interaction between year and season of birth;
$(yob \times sex)_{ik}$= interaction between year of birth and sex of kids;
$(yob \times tob)_{il}$ = interaction between year of birth and type of birth;
$(Sob \times sex)_{jk}$ =interaction between season of birth and sex of kids;
$(Sob \times tob)_{jl}$ = interaction between season and type of birth;
$(Sex \times tob)_{kl}$ = interaction between sex of kids and type of birth; and $e_{ijklmnp}$ = model random residual error.

3. Results and discussion

Descriptive statistics of birth weight of Tunisian local kids are shown in Table 1. The results showed that the mean and standard deviation of birth weight were 2.34 and 0.44kg, respectively. The lowest recorded weight at birth was 1.12 kg, while the maximum value was 3.95Kg. These results are similar to those reported by Najari (2005) and Mbayahaga et *al*,. (1996). A reduced weight at birth reflects the ability of this population to survive. It is considered as an adaptation character to hard environmental conditions in arid regions (Oltenacu, 1999). This adaptation is explained by an association between morphometric and physiological characters with a complex genetic determinism and the result allows the animal to reduce suffering in restrictive and irregular environment (Najari, 2005).

Table 1: Descriptive statistics of birth weight of Tunisian local kids.

Parameters	Value
Mean (kg)	2.34
Standard Deviation (kg)	0.44
Maximum (kg)	3.95
Minimum (kg)	1.12
Coefficient of Variation	5.32
Number of observations	964

Factors affecting birth weight were presented in Table2. The regression coefficient was 0.63. It seems that the model represent all the factors affecting this trait. The birth weight varied significantly from the different birth type and sex. The kidding year, the kidding season, the age and dam body weight groups, have significant effect (P<0.01) while the kid's colour pattern had no significant effect (P>0.05) on the studied trait.

Table 2: ANOVA for factors affecting birth weight of local kids.

Source of variation	Degree of freedom	Significance level
The kidding year	15	**
The kidding season	1	NS
The Sex	1	**
The type of birth	1	**
The Age of dam	12	**
The weight of dam	2	*
The kid color pattern	8	**
yob×sob	15	**
yob×sex	15	**
yob×tob	17	**
sob×sex	1	NS
sex×tob	2	**
Sex×dalc	7	NS
R^2		0.63

NS: no significant effect (P>0, 05);**: significant effect (P<0, 01); R^2: regression coefficient.

Similar results were found by Gebrelul et *al.*, (1993) and Gbangboche et *al.*, (2006). Djemali et *al.*, (1994) indicated that sex, kidding mode, age of dam and kidding year are the important sources of variation for growth traits from birth till 3 months of age. Gbangboche et *al.*, (2006) reported that the age of dam at first kidding was significantly (P<0.01) affecting kids' birth weight. Portoland et *al.*, (2002) reported that birth weight was significantly (P<0.01) affected by environmental factors, especially in arid regions. However, the impact of these non-genetic factors is improving relatively when farming conditions will be intensified (Najari, 2005).

Effect of kidding year on birth weight

Table 3 shows the effect of kidding year on birth weight. The kids obtained in the year 2001 were significantly (p<0.05) heavier in birth weight (2.66±0.44kg) than those kids born during the year 2007 (2.1± 0.33kg).

Table 3: Effect of kidding year on birth weight.

Year	Number of birth	Mean birth weight(Kg)
1998-1999	46	2.57 ± 0.36^{cd}
1999-2000	42	$2.21\pm0,50^{abc}$
2000-2001	65	$2.52\pm0,41^{bcd}$
2001-2002	51	$2.66\pm0,44^{de}$
2002-2003	56	$2.47\pm0,41^{abcd}$
2003-2004	66	$2.26\pm0,36^{abc}$
2004-2005	66	$2.18\pm0,40^{ab}$
2005-2006	71	$2.17\pm0,49^{ab}$
2006-2007	64	$2.35\pm0,44^{ab}$
2007-2008	46	$2.10\pm0,33^{abcd}$
2008-2009	80	$2.30\pm0,43^{a}$
2009-2010	65	$2.44\pm0,36^{abc}$
2010-2011	60	$2.45\pm0,34^{abcd}$
2011-2012	65	$2.18\pm0,40^{abcd}$
2012-2013	76	$2.25\pm0,41^{ab}$
2013-2014	43	$2.01\pm0,37^{abc}$

a,b,c,d,e: Means with different superscripts within a column are significantly heterogeneous class according to the SNK test (P＜0.05).

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 Alexander et *al.*, *(*1997), Zhang et *al.*,*(*2006) and Najari et *al.*,(2007).Ouni (2006) reported that the higher variation on birth 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.

Effect of kidding season on birth weight

The kidding season had a significant effect (P> 0.05) on birth weight (table 4). Similar results were obtained by Al-Shorepy et *al.*, (2002) and Djemali et *al.*, (1994). This could be explained by the same argument mentioned for the kidding year effect. The effect of the kidding season can be related to the different feeding conditions generated in each season by irregular climatic conditions, especially in the arid areas (Najari, 2005). Pastoral resources change from one month to another, which affect the goats feeding during their pregnancy (Sajlu et *al.*, 1999; Najari et *al.*, 2007).

Djemali et *al.*, (1994), cited that kids born in the summer months may be heavier at birth because dams may have access to proper nutrition in form of grazing during the spring season just prior to the onset of summer.

Table 4: Effect of kidding season on birth weight

Season of birth	Number of observations	Mean birth weight (Kg)
Season 1	605	2.40[a]
Season 2	341	2.19[b]

a,b: Means with different superscripts within a column are significantly heterogeneous class according to the SNK test (P ＜0.05).

Effect of type of birth on birth weight

The type of birth had significantly effect on birth weight (P<0.01). Kids born single were heavier than multiple (table5).Their means weights were 2.48 ± 0.42kg and 2.10 ± 0.36kg respectively. Similar results were concluded in several studies (Najari et *al.*, 2007; Gebrelul et *al.*, 1994). The weight difference between single and multiple kids was about 300g. Alexandre et *al.*, (1997) reported that single-born kids were found to be heavier at all ages than twin-born kids. They also observed that the discrepancy in body weight of twins initially increased by 15% from the birth till weaning. Heavier birth weight for singles kids might be attributed to uterine environment which the foetus does not have to share with its littermates, thereby attaining higher body weight than the twin or triplet born kids (Zhang et *al.*, 2006).

Table 5: Influence of type of birth on birth weight

Kidding mode	Number of observations	Mean (Kg)
Single	547	2.48 ± 0.42[a]
Multiple	417	2.10 ± 0.36[b]

a,b: Means with different superscripts within a column are significantly heterogeneous class according to the SNK test (*P* ＜0.05).

Effect of sex on birth weight

Male are all significantly heavier than female, which is in agreement with the results reported by Gebrelul et *al*., (1993). The weight difference between males and females was about 200g (table6). A similar result was found by Alexandre et *al.*, (1997). Ugur et *al.*, (2004) observed that the difference in weight between both sexes may be due to the fact that the pregnancy period of does carrying male kids is usually longer (1–2 days) than those carrying female.

The sexual dimorphism is common in the primitive unselected breeds and animal domestic populations. This dimorphism still existing along the life of animals from the birth until the adult age. It illustrates that the Tunisian local goat population is selected to promote the high capacity to reproduce richness in hard arid condition (Najari et *al.*, 2007).

Table 6: Effect of sex on birth weight

Sex of kids	Number of observations	Mean (Kg)
Male	541	2.46 ± 0.44^{a}
Female	423	2.20 ± 0.39^{b}

a,b: Means with different superscripts within a column are significantly heterogeneous class according to the SNK test ($P < 0.05$).

Effect of age of dam on birth weight

The age of dam has shown a significant effect ($P<0.01$) on birth weight. The maximum birth weight (2.64 ± 0.42Kg) was found in 5 year group and minimum (2.16 ± 0.37Kg) in one year group (figure1). Similar result has been obtained by Wenzhbong et *al.*, (2005). Djemali et *al.*, (1994) observed that kids born from young dams had a lower body weights than adults dams and the growth traits increased with the age of dam up to 5 years of age. Birth weight was affected by the nutrition of dam received during the pregnancy term. In fact, the maternal nutrition during this period plays an important role in the regulation of foetal and placental development.

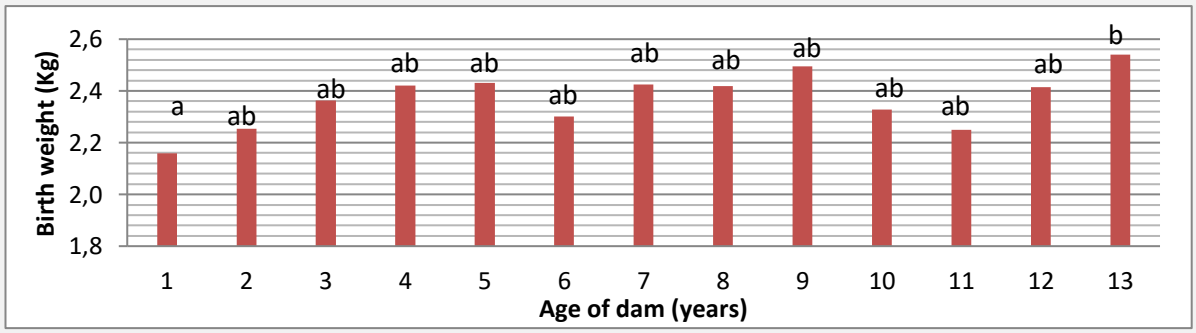

Figure 1. Effect of age of dam on birth weight.

Effect of dam body weight groups on birth weight of local goat population kids

The body weight of dam had significant effect ($P<0.05$) on birth weight. Kids born from small weight dams are always the most disadvantaged (table7). This type of effect is reported in the literature (Djemali et *al.*, (1994); Mbayahaga, 2000). A lower weight of dam may have a negative impact on birth weight of their kids which considered as one of the most important contributory factors for survival and for improving growth performances (Husain et *al.*, 1996). The improvement of feeding program of does before mating (flushing) is essential to increase fertility in small ruminants due to dynamic effects of nutrition on ovulation rate.

Table 7: Effect weight of dam on birth weight.

Dam body weight groups(Kg)	Number of observations	Mean birth Weight(Kg)
Weight <20.67	103	2.14 ± 0.43^{a}
20.67< Weight <29.65	626	2.33 ± 0.43^{b}
Weight >29.65	235	2.44 ± 0.46^{c}

a,b,c: Means with different superscripts within a column are significantly heterogeneous class according to the SNK test ($P < 0.05$).

The kid color pattern effect on kid's weight at birth

The local goat population shows a wide variability in morphology and genetically both (Najari et *al.*, 2007). It includes 8 classes of pigment type *'NOIRE', 'ROUGE', 'BLANCHE', 'SAGAA'* (a white patch on the forehead and the rest of the body is black), '*RABCHA' (*white and black patch on the body), '*HAWA'* (the Venter and a part of head are brown, the rest of the body is black), *'Theria'* (ears and nose are white and the rest of the body is black),'*GARRA'* (the head is white and the rest of the body is black).The effect of kid color pattern on the body weight of kids at birth was no significant ($P > 0.05$).

Interactions between factors

The interaction between sex and type of birth had a significant effect on birth weight ($P<0.01$). Male kids born as singles were heavier at birth as compared to multiples. Similar results were found by Mbayahaga (2000). Najari (2005) mentioned that this trend continued in the same way till four and six months of age. Least squares means for the interaction between type of birth and sex of kids are shown in table8.

Table 8: Means by sex-type of birth subclass for birth weight.

Interaction	Birth Weight (Kg)
Male×Singles	2.62 ± 0.12[a]
Male×Multiples	2.15 ± 0.09[b]
Female×Singles	2.32 ± 0.04[a]
Female×Multiples	2.01 ± 0.05[b]

a,b. Means with different superscripts within a column are significantly heterogeneous class according to the SNK test ($P < 0.05$).

A significant interaction between the kidding year and kidding season of birth ($P<0.01$) was found, suggesting that season effects differed across years. The study also revealed a significant interaction between kidding year and sex of kids for birth weight ($P<0.01$). This reflected that these two factors were not independent and that different estimates of sex effects were obtained during the years of the study. Figure 2 shows a graphical representation of fluctuations in least squares means for birth weight across years for the seasons 1 and 2. Similarly, Figure 3 shows changes in least squares means for male and female kids from 1998 to 2014. Similarly, the significant interaction between kidding year and type of birth of kids (Figure4) estimated here depicted different effects by different combinations of type of birth and years ($P<0.01$).

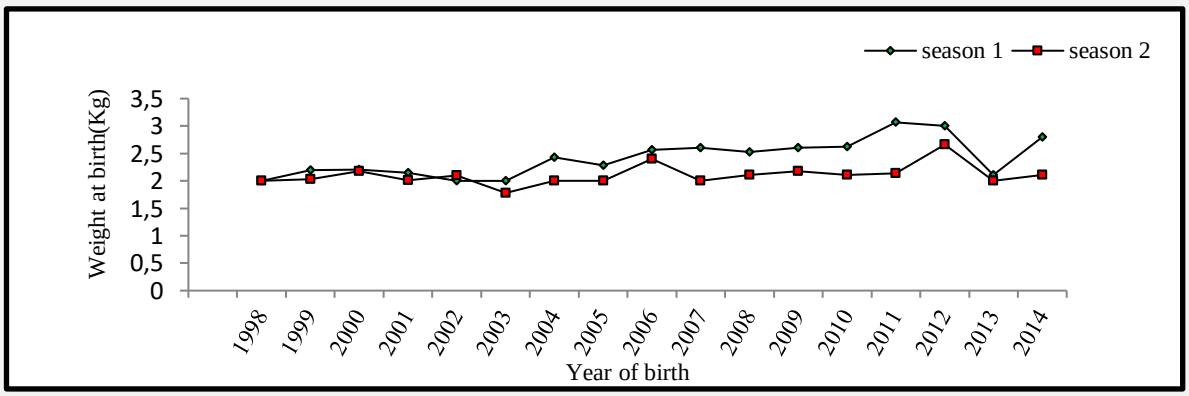

Figure 2: Means by year-season subclass for birth weight (Kg)

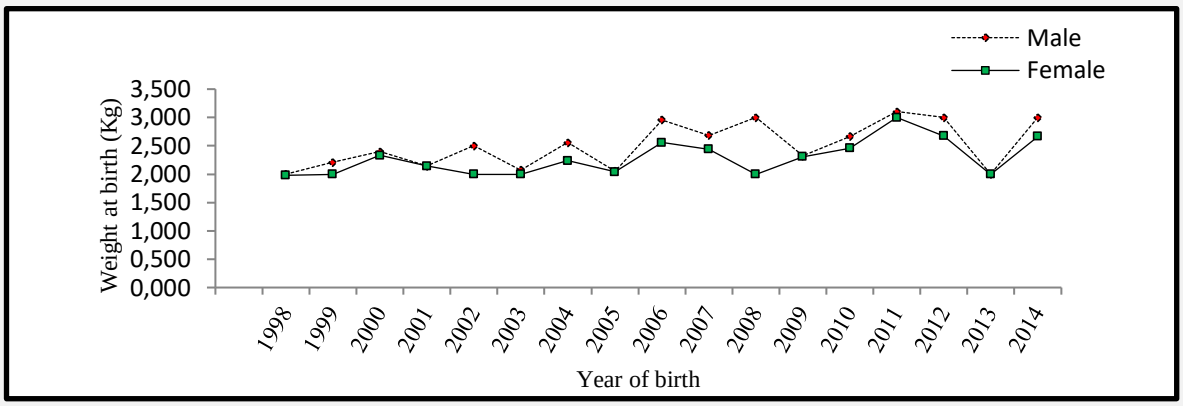

Figure 3: Means by year-sex subclass for birth weight (kg)

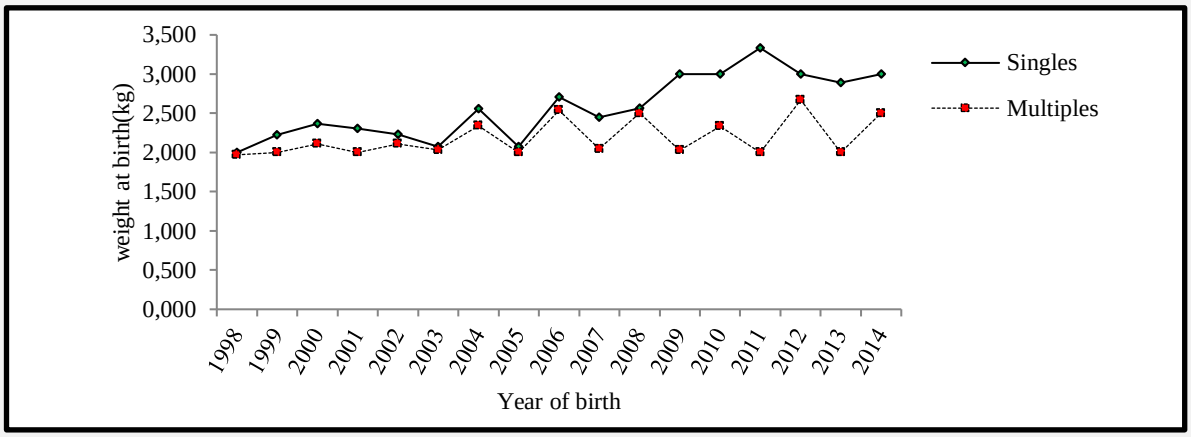

Figure 4: Means by year-type of birth subclass for birth weight (kg).

4. Conclusion

Tunisian local kids were characterised by small weight and confers a reduced foods requirements. It is a strategy adapted by the local goat population in face to difficult conditions of arid regions. Birth weight was influenced by genetic and non-genetic factors which show that environmental factors can be controlled to achieve higher gains. Results suggested that birth weight can be improved by selection and better management practices.

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