Trends in Applied Sciences Research

ISSN 1819-3579

Academic
Journals Inc.

www.academicjournals.com

Trends in Applied Sciences Research 7 (3): 231-239, 2012
ISSN 1819-3579 / DOI: 10.3923/tasr.2012.231.239

Indigenous Kids' Growth and the Effects of non Genetic Factors in Pastoral Husbandry in Tunisian Arid Zone

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ABSTRACT

To identify the impacts of some environmental factors upon kids' weights at some standard ages, a data set carried out on 722 kids in growth during four years was analyzed. A Gompertz model was applied to estimate kids' weights at standard ages: birth day, 10, 30, 60, 90, 120, 150 and 180 days. A GLM procedure and a means comparison test (SNK, $\alpha = 0.05$) were applied to identify the statistical effects of some factors and their homogenous classes at several ages. The determination coefficient R^2 remains lower than 87% of all studied traits due to the observed data structure. All traits seem to be affected ($p<0.001$ or 0.05) by the factors related to the restrictions and the irregularities of the technical and natural environment of pastoral husbandry. The non-genetic factors impact increases with kids' age and requirements. Growth traits varied depending to the natural and technical factors which illustrates the local population genetic response towards environmental resources in arid zone. The year and zone factors play an important role upon the kid's weight and it evolution till 6 months age due to the large interannual variation of rainfall. Also the technical level of the herder seems affecting highly the kids performances. So, arid environment affects both quantitatively and qualitatively individual kid's growing behaviour and have to be considered for local goat rational genetic improvement modelling and planning.

Key words: Kids weight, local population, arid environment, non-genetic factors, pastoral breeding, Tunisia

INTRODUCTION

Despite of the deep social evolution of the Tunisian arid zone, the pastoral breeding mode remains the main activity enable to valorise the rangelands resources by ambulant small ruminant herds under harsh irregular conditions (Ouled, 2006; Ouni *et al*., 2006; Koc and Ceylan, 2009). In fact, the zone allows raising more than 60% of the national caprine herd estimated about 1,500,000 goats (DGPA, 2005). Kids' meat represents about 75% of the local meat production (Najari *et al*., 2007; Sghaier *et al*., 2007; Das *et al*., 2007). The main product of the traditional breeding mode of the indigenous goat is the meat if kids slaughtered is summer season (Thavaprakaash and Velayudham, 2007).

Consequently, the kid's growth during this early age represents an important phenotype to yield the increasing income to the ambulant herds (Dharmaveer *et al*., 2007; Ouni *et al*., 2006). Under pastoral harsh conditions with restricted and irregular resources, the goat productivity is high influenced by non-genetic factors because of the extensive grazing management (Mahjoub *et al*., 2005; Maiti and Ahlawat, 2010).

Under arid conditions, rather than the classic effects of non genetic factors upon growth kids, a specific qualitative action of harsh condition was verified (Sundararaman *et al*., 2007; Najari *et al*., 2002). Indeed, severe conditions, do not allow the animals to express their real genetic potential (El-Hassan *et al*., 2009).

As quantitative phenotypes, kids' weights change by all factors affecting the growth rather than the individual genetic potential differences (Schinckel and de Lange, 1996; Alexandre *et al*., 1997; Bocquier *et al*., 1998; Oltenacu, 1999; Bughio *et al*., 2002).

The study aims to estimate the natural and technical non-genetic effects on indigenous kids' weights under pastoral conditions in the Tunisian arid region. Also, we purpose understanding kids' growing behaviour of indigenous kids towards arid environment factors by the analysis of a large data set collected within ambulant herds. Rather than the local population characterization, the results may improve the husbandry policy to optimise the herd production and land conservation considering the serious desertification risks in the studied area.

MATERIALS AND METHODS

All the experimental goats were raised in Arid Areas Institute of Medenine (IRA), in the south-east of Tunisia and is submitted to an arid continental Mediterranean climate, with irregular and sporadic rains, average annual rainfall of 200 mm, average annual temperature of 20.2 (Ferchichi, 1996).

The population of Local goats varied in coat colour, body weights, body size and morphostructural characteristic. The Tunisian goat is characterised by its small body size with an average height of 76 cm for the male and 60 cm for the female (Ouni *et al*., 2007; Sghaier *et al*., 2007). Native goat is hairy and basically black, with the fertility rate of about 87% and prolificacy rate of 110-130% (Najari *et al*., 2006). The season of kidding begins at October and continues till February, with a concentration during November and December.

About 4900 weights records were collected on 722 local kids born in 2001 to 2005 by a periodical weighing program from December (kidding period) to August. The records included ear mark of dam and kid, coat colour, birth type, birthday, sex, body weights and weighing dates of each kid and the age of dam at kidbearing. Body weights were recorded every two weeks with a precision as 0.05 kg using the routine method and then adjusted at the age of 1, 30, 60, 90, 120 and 150 days by the Gompertz model (Najari, 2005). The year of birth (2002-2005), kidding month (Jan., Feb., March and Dec.), birth type (single and twins), sex (male and female), coat color of kid and age of dam (2-10 years) were defined as the non genetic factors.

The effects of the non genetic factors on the body weights at different ages were obtained by an ANOVA analysis using the following model:

$$W_{ijklm} = Y_i + M_j + Z_k + H_l + C_{ijklm}$$

where, W_{ijklm} is a body weight of the individual (n = 1, 2, 3,,, 722) kids born in year i (2002-2005), Month j (Jan., Feb., March and Dec.), Z_k represents the zone (costal, steppic or mountains), H_l is the herd effects (1, 2,..., 9 herds), C_{ijklm} is a random error assumed to be normally and independently distributed.

Means comparison test (SNK = 5%) was performed to test the classes homogeneity.

RESULTS AND DISCUSSION

The test of significance for body weights at the age of 1, 30, 60, 90, 120 and 150 days according to different kidding year and month, the natural zone and the herd of Tunisian Local kids are

presented in Table 1. The body weights at the age of 1 day to 150 days of Tunisian Local kids significantly varied from the different kidding year, herd and natural zone. The birth month has significant effect ($p<0.01$) on all the body weights except the weight at the age of 30 days.

The non genetic factors were found to be statistically significant for body weights at the age of 1, 15 and 60 days. While for body weights at the age of 30 and 45 days, only the year and birth type effects were found to be statistically significant (Portolana *et al*., 2002; Koc and Ceylan, 2009). The mean body weight at the age of 150 days is almost five times with respect the body weight at birth. According to Ouni (2006) and Iheukwumere *et al*. (2008), the animals of this breed take approximately the stature of an adult with this age. However, our findings demonstrated that only 4/5 of the adult body mass is reached at 5 months age. Morand-Fehr (1981) and Bughio *et al*. (2001) announced that birth weight of a kid primarily depends on the body conformation and size of their parents. In fact, the body weight of the dam and the birth weight of their kids have positive correlation coefficient irrespective of the litter sizes (Morand-Fehr, 1981).

At the beginning of the summer, we have pointed out that the evolution of the growth is slow and the estimate of the adult body weight was 16.2 kg which is lower than the estimate (24 kg) by Najari (2005). It possibly resulted from the adaptive strategy to the different management and growth conditions (Le Gal Planchenault, 1993; Sundararaman *et al*., 2007).

The most important period of growth seems to be the first five month of life, when the growth rate allowed by the kids produce the main part of the adult (Dharmaveer *et al*., 2007; Najari *et al*., 2007; Najari *et al*., 2002).

Moreover, the considerable diversity found in all the reference ages tested in the population as it is demonstrated by the high values of the standard deviations.

The year of birth effects on kids' growth: The averages of body weights at the age of 1, 30, 60, 90, 120 and 150 days of Tunisian Local kids from the kidding year of 2002 to 2005 and kidding month of 1, 2, 3 and 12 are presented in Table 2 and 3, respectively.

Table 1: The test of significance for body weights at the age of 0, 30, 60, 90, 120 and 150 days according to different kidding year and month, the sex, birth type and coat color of kids and the age of dam of Tunisian local kids

		Body weights (kg)					
Factors	df	1 day	30 days	60 days	90 days	120 days	150 days
Year	4	*	**	**	**	**	**
Month	3	**	NS	*	**	**	**
Pastoral zone	2	**	**	**	**	**	**
Herd	8	**	**	**	**	**	**
R^2		0.69	0.80	0.79	0.55	0.87	0.89

NS: $p>0.05$; *: $p<0.05$; **: $p<0.01$

Table 2: The means of body weights at the age of 0, 30, 60, 90, 120 and 150 days of local kids from the kidding year of 2002 to 2005

	Body weights (kg)					
Years	1day	30 days	60 days	90 days	120 days	150 days
2002	2.57^{a}	4.83^{b}	6.58^{b}	8.03^{c}	9.55^{c}	12.17^{c}
2003	2.34^{b}	5.32^{a}	7.34^{a}	9.14^{b}	11.47^{b}	13.68^{b}
2004	2.46^{ab}	4.90^{b}	7.33^{a}	9.98^{a}	13.08^{a}	15.01^{a}
2005	2.41^{ab}	3.86^{c}	5.60^{c}	6.39^{d}	9.10^{c}	9.96^{d}

Means with different superscripts within a column are significant ($p<0.05$)

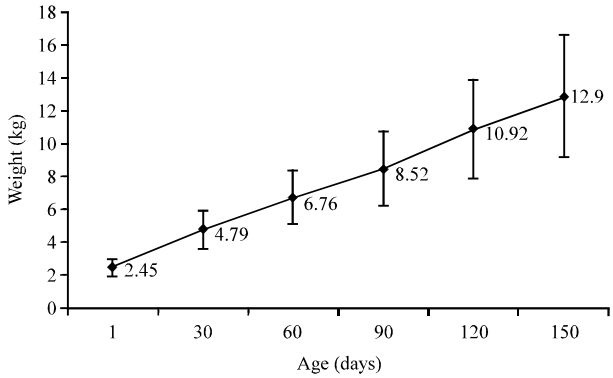

Fig. 1: The growth of body weight at the age of birth to 150 days of Tunisian local kids

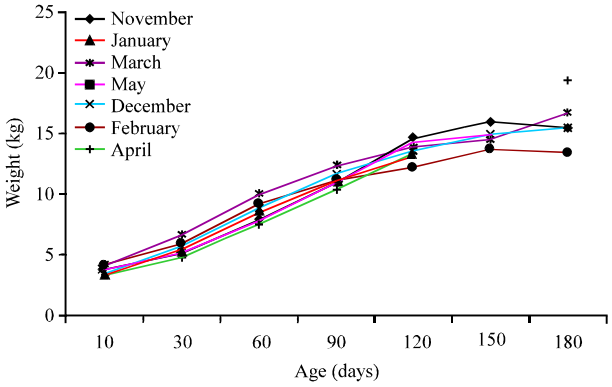

Fig. 2: Kids' weights till 6 months age according to the month of birth

The kidding year present a highly significant effect ($p<0.01$) on the kids body weights from birth to 150 days (Fig. 1). These factors have lower significant influence on the birth weight, probably because the maternal effects tampons in part the negative influence in bad years, such as the dam have to survive under harsh conditions in this period. Ndlovu and Simela (1996) and Bughio *et al.* (2001, 2002) obtained similar results for goats from Zimbabwe. Najari *et al.* (2007) also mentioned a significant influence ($p<0.05$) of the kidding year due to the annual resources variation which affect seriously the productivity of the pasture.

The rainfall scarcity and irregularity, as the heats and cold oscillations, are the main natural factors affect the growth of the animals, especially for the young kids. The year characterizes the arid environment, because it conditioned the food scarcity which is supposed the main reason for this source of variability (Ouni *et al.*, 2007; Najari *et al.*, 2007). The relevancy of the year effect on the growth performances under difficult conditions have been highlighted by other reports (Alexandre *et al.*, 1997; Zhang *et al.*, 2006; Mousa, 2011). Ndlovu and Simela (1996) reported that, the kids born in the hot dry season were heavier ($p<0.05$) at the age of 60 and 90 days than those born in the hot wet season.

The birth season effects on kids' growth: The effect of birth season on the body weight ($p<0.05$) varied at the different ages (Fig. 2). The kids born in the hot wet season are lighter than those born in the other two seasons.

As it is shown in Table 3, the month of birth have significant effect on the body weights from birth to 150 days, except for 30 days). Similar season effects have been found by several other authors (Nadarajah *et al*., 1995; Abebe, 1996; Mousa, 2011).

Effect of the month is due to the different food conditions generated in each season for the climatic conditions, especially in the arid areas (Ferchichi, 1996). Pastoral resources are consequently very variables in one month to another, affecting thus directly by the kids growth and indirectly by the means of the milk production (Sahlu *et al*., 1999; Dharmaveer *et al*., 2007). Zhang *et al*. (2008) reported that, the variations of weight for Boer goat in different years and seasons might be explained partly by differences in management and sample size, partly by differences of rainfall which in turn influenced grass production and food availability.

The ecological zone effects on kids' growth: The natural zone affects kid's growth through the resources and the herd management not homogenous in studied ecological zone such as steppic, costal and mountainous zone (Najari *et al*., 2002; Najari *et al*., 2007; Ouled, 2006; El-Hassan *et al*., 2009). In the coastal zone, the livestock plays a secondary role in the family incomes and the pastoral lands are regressing in favor to oil culture (Iheukwumere *et al*., 2008; Tavsanoglu, 2008). Whereas, in the second zone, the livestock remains he principal activity and herds graze extensively the vast communal lands and pasture without sensible mobility restrictions. While in mountainous zone, goatherds valorize accidental and vacant lands (Yadav and Yadav, 2007).

The zones corresponding growth curves are presented in Fig. 3. The most "regular", S-shaped growth curves are observed to the steppe and the mountain. The heaviest

Table 3: The means of body weights at the age of 1, 30, 60, 90, 120 and 150 days of local kids according to the kidding month of 1, 2, 3 and 12

	Body weights (kg)					
Months	1 day	30 days	60 days	90 days	120 days	150 days
1	2.56^{a}	4.73	7.23^{a}	9.33^{a}	11.78^{a}	13.25^{a}
2	2.52^{a}	4.89	6.81^{a}	8.02^{b}	9.46^{b}	13.44^{a}
3	2.11^{b}	4.24	6.07^{b}	6.90^{c}	8.17^{b}	9.45^{b}
12	2.43^{ab}	4.80	6.71^{ab}	8.45^{ab}	10.99^{a}	12.83^{a}

Means with different superscripts within a column are significant ($p<0.05$)

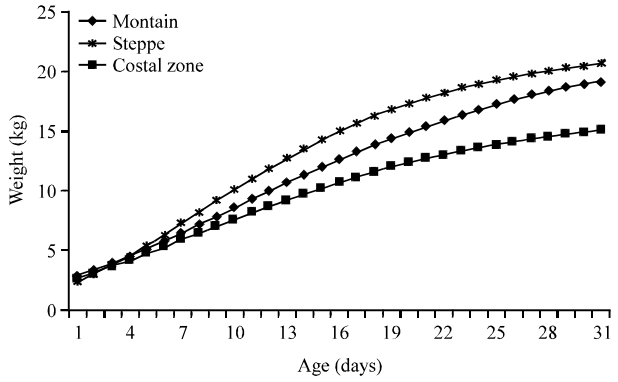

Fig. 3: Kids' growth curve adjusted by Gompertz model and by ecological zone

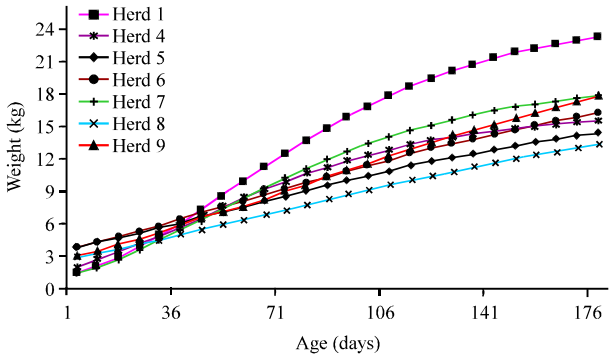

Fig. 4: Kids' growth curve adjusted by Gompertz model by goat herds

asymptotic weight was observed for the mountain kids having 22.72 kg while, the lowest kid's weight are those raised in the costal zone (El-Hassan *et al*., 2009).

The herd effect upon kid's growth: Rather than the classic effect of herd upon animal performances, this non genetic technical factor has a particular importance in the pastoral breeding system of the arid region. The management response toward the resources scarcity and irregularity is determining upon the herd production (Kanwal *et al*., 2004). One of the pastoral management principles is the herd's mobility, practiced since the nomadic period. Transhumance allows to valorize distinct pasture according to their vegetal state and thus, to stamp the arid resources restrictions and irregularities. Due to the herd mobility hardness and costs, only little number of herds remains able to practice duly the transhumance to satisfy the animal's requirements.

Also, in this extensive grazing mode, the herder ability remains the principal factor conditioning the herd cash flow (Najari, 2005). In fact, the herd management is based on the traditional knowledge to prevent natural stresses and to ensure the best offered conditions to satisfy animal requirements (Najari *et al*., 2002; Iheukwumere *et al*., 2008).

Rather than technical management differences, the genetic level varies between herds (Ouni *et al*., 2007). Morphologically, some herd specificities were easily revealed on the animals' morphology due long intra-herd consanguine mating. Traditionally, each family selects its own herd on some visible characters to avoid animals' mixture on pastures or during the watering days when many herds are gathered (Najari *et al*., 2006; El-Hassan *et al*., 2009). These simplified selection schemes, can affect productive performances such as kids' growth.

During the first month age, herds' differences are not enough clear (Fig. 4). Among the nine herds studied (Fig. 5) kids of the herd number 1 show the best growing performances since 2 months age and till the age of 6 months. The asymptotic weight corresponding to the herd 1 reaches 25.28 kg.

Differences between herds' performances increase with age to become remarkable after 40 days age (Fig. 2). At the age of 180 days, this difference reaches 17.4 kg.

Note that the interaction herd*region showed a significant effect upon the majority of analyzed traits; the herd management vary with respect to the natural resources of each region (Odeyinka *et al*., 2007; Mousa, 2011). In fact, herd management and the breeding mode differ according to herd importance and the forage availability.

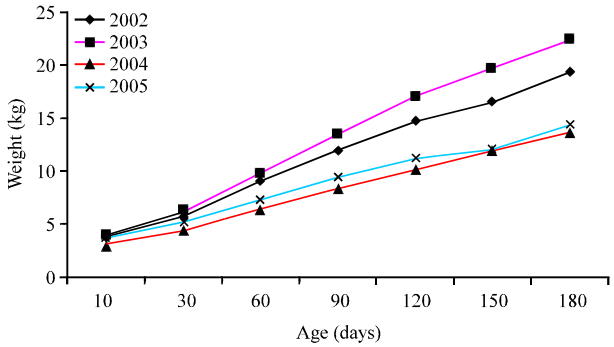

Fig. 5: Kids' weights till 6 months age by year of birth in pastoral mode

CONCLUSIONS

The non genetic effects such as kidding year and month are very important to the early growth of Tunisian local kids. The kidding year illustrates a significant effect ($p<0.01$) on body weights at the age of 1 day to 150 days. The birth month has significant effect ($p<0.01$) on all the body weights except the weight at the age of 30 days. Thus the herd productivity seems affected by the range lands resources and the climatic conditions both restrictive and irregular in arid zones. The non genetic factors affect directly the animal physiology and indirectly through the pastoral forage varying.

The Tunisian goats breeds is a local genetic resource perfectly adapted to the production of goat meat in semi-arid conditions. The phenotypical variability found in this study promises a good capacity of genetic response to selection when the breeding program could be implemented.

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