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Short Communication

STUDY OF SOME FACTORS INFLUENCING BIRTH WEIGHT OF ARBIA GOATS IN GUELMA DISTRICT, ALGERIA

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ABSTRACT

Arbia goat is the most common indigenous breed of North-eastern Algeria, and it has an acceptable production capacity in that region. The gender, litter size, parity, year and month of kidding were used as source of variation of birth weight. A total of 474 kids, reared by nine smallholders under extensive breeding conditions,, were weighed immediately after birth during two seasons of kidding. A Linear mixed effects model (in R software) was used to analyse our results and revealed that average birth weight was 2.63±0.31 Kg with a significance difference between sex (2.69 ±0.32 Kg and 2.60 ±0.30 Kg for males and females, respectively) (P≤0, 0001). Kids born as single were heavier (2.91 ±0.34 Kg) than those born as twins and triplets (2.61 ±0.26 Kg and 2.33 ±0.27 Kg, respectively) (P≤0,0001). A positive relationship between age of dam and birth weight was found (P≤0.01). Month of birth has a significant effect on birth weight. Synchronization of kidding during November and December is desired.

Key words: Algerian native goats, birth weight, extensive system, parity, sex, type of birth.

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INTRODUCTION

Goat (*Capra hircus*) is among one of the oldest domesticated animals which were domesticated around 8000 B.C. (Scanes, 2011). Their rusticity, fertility and selective grazing allow them to survive in harsh conditions (Lu *et al.,* 2010). Today over one billion heads of goats are widely distributed around the world, particularly in marginalized areas, where more than 90% of the world goats focus there (Miller and Lu, 2019). Accurate statistics of FAO (2018) estimated the population of Algerian goats by 4.9 million heads distributed across the country, especially the Northern part followed by the steppe and at oases (Madani *et al*., 2015). While sheep occupy the cereal plains in Northeastern of Algeria, the native goat called Arbia is kept on difficult mountains situated under extensive system with natural spontaneous grazing (Tefiel *et al.,* 2018). Native breeds are essential for the survival of rural populations, the breeding of ruminants in general and that of goats in particular ensure a permanent income. The Agenda for Sustainable Development 2030 adopted in 2016 by the United Nations is justly based on the least crossbreed that will enhance the livelihoods throughout the world (Monteiro *et al*., 2017).

However, very few studies in Algeria have been conducted on the potential of native goats including those of Djouza and Chehma (2018), Aissaoui *et al*. (2019) and Sahraoui *et al*. (2020), which have studied descriptively the growth performance of local breed in different areas of Algeria. Birth weight is of particular importance as it is a determinant factor of post-natal development. Jimenez-Badillo *et al*. (2009) reported that birth weight determined the future performance of kids. In addition to genetics effect, it is increasingly apparent that non-genetic factors have a role to play and can be controlled to achieve high birth weight (Wu *et al.,* 2006). In particular, sex, number of foetuses, age of dam and birth season. These non-genetic factors effect were illustrated in sheep (Kramarenko *et al*., 2021) and in goat (Singh *et al*., 2022). To our knowledge, no study of these factors effect on birth weight in goat has been undertaken in Algeria. So study of the factors affecting birth weight is essential to properly estimate the production performance of animals and flock.

The performance study of production provides pieces of information on the specific production conditions of breed and individual animals as well as the possibilities of improving this production system and their contribution to the agricultural sector. Therefore, the objective of the present study is to evaluate the factors influencing birth weight of Arbia goat kids reared under extensive system in the North-eastern of Algeria.

MATERIALS AND METHODS

Study area: The study took place at nine private farms located in Guelma province, which is situated in North-east Algeria (36°27′43″ N, 7°25′33″ E), with an elevation ranged from 667m to 1038m). The region has a typically Mediterranean climate characterized by a wet season extending from October to May and a dry season spanning from June to September. The mean annual rainfall is 468 mm (during 2016 & 2017). The average annual temperature is around 20.7°C during this period (Bneder, 2018). However, Arbia goat has been a native ruminant of this area and the production depends on native pasture grazing. The agro-pastoral systems dominate in this area. The main agricultural crops are wheat and barley.

Animals and experimental protocol: The Algerian local goats varied in coat colour (mainly black) and body size. The Arbia goats, most dominant breed in the study region, are characterised by its small body size with an average height of 67 cm (Sahi *et al*., 2018). Kidding season of Arbia goats begins at November and continues till March, with a births peak during November and December.

The extensive breeding system is a common practice in this region, in which goats graze on spontaneous rangelands and pastures throughout the year. However, breeders provide to goats a concentrated feed (mainly wheat and barley) and by-products of crops (straw and bran) only during the rainfall season, when animal is not able to access grassland. This study was based on a total of 474 kids of Arbia goats born between November 2015 and March 2017 with 164 males and 310 females belonging to nine farms. All the individuals included in the flocks were identified by plastic ear tags applied at birth. The ages of dams were determined by dentition (Deniz and Payne 1982). However, parity was determined previously according to follow up of the flocks. Kids were individually weighed immediately after birth for the two successive seasons of kidding. The weighing of kids was performed early in the morning before suckling. An electronic balance was used for measuring weights of kids to the nearest 0.01 kg. After birth, the following data were recorded: parity of goats, litter size (single, twin or triplet), sex of kid born, birth weight and month of birth.

Statistical analyses: Statistical analyses were carried out using R, version 4.0.2 (R Core Team, 2021). The values are presented as mean ± SD (Standard Deviation). Linear mixed-effects models were carried out to assess the effect of sex, litter size, parity, years, and month of birth (as fixed effect) on the birth weight of Arbia kids and using dams and farms as random intercept. The linear mixed model (LMM) can be formalised as follows:

Birth weight$_i \sim (\mu_{j[i],k[i]}, \sigma^2)$

$\mu = \alpha_{[i],[i]} + \beta_1(\text{Sex}) + \beta_2(\text{Year}) + \beta_3(\text{Month}) + \beta_4(\text{Litter size}) + \beta_5(\text{Parity})$

$\alpha_j \sim (\mu_\alpha, \sigma^2_\alpha)$, for Dams j = 1,…,J

$\alpha_k \sim (\mu_\alpha, {}^2_\alpha)$, for Site_ID k = 1,…,K

To avoid multicollinearity among covariates we calculated the variance inflation factor (VIF) for each variable using a package (car) (Zuur *et al*., 2010). The models were fitted using the lmer function in the R package nlm4 (Bates *et al*., 2015). The pairwise Post-hoc analyses between factors (litter size, months) were performed using LS means function in EM means package in R. Significance was considered at $P \leq 0.05$.

RESULTS AND DISCUSSION

Descriptive statistics of birth weight (BW) of Arbia kids for the two successive seasons of kidding are shown in Table 1. In general, birth weight ranged from 2.1 Kg to 3.6 Kg for the two years pooled. The overall mean of birth weight was 2.63±0.31 Kg , it was in agreement with the value of 2.60 Kg and 2.66 Kg reported for Omanian Batina goat (Kadim *et al.,* 2003) and native Croatian colored goat (Prpić *et al*., 2020), respectively.

The birth weight of Arbia goat obtained in the current study was higher than reported for the same breed by Djouza and Chehma (2018), Aissaoui *et al*. (2019) and Sahraoui *et al*. (2020), (2.48 Kg, 2.29 Kg and 2.53 Kg, respectively). Also, the present results were even higher than several birth weights described in other parts of world, like the Boran of Somali 2.28 Kg (Tucho *et al.,* 2000), Emirati native goat 2.43Kg (Al-Shorepy *et al.,* 2002), Abergelle in Ethiopia 1.91 Kg (Deribe *et al.,* 2013), Tunisian local goat 2.45 Kg (Najari *et al.,* 2013), Baladi of Egypt 2.45 Kg (Ibrahim *et al.,* 2020) and Croatian white goat 2.48 Kg (Prpić *et al.,* 2020).

In contrary, the average weight registered in the study was lower than the birth weights formerly published for several indigenous goats as the South African goats 2.7 Kg (Lehloenya 2005) and Damascus breed in Turkey 3.98 Kg (Güney *et al.,* 2006). Moreover, the birth weight was lower than reported for kids born from European selected breeds (3.22Kg, 3.38 Kg and 3.65 Kg) as Saanen, Toggenburg and Alpine, respectively) (McManus *et al.,* 2008).

The differences observed in birth weight might be due to breed differences, practices for flock management (Meza-Herrera *et al.,* 2014; Prpić *et al.,* 2020) and reflected availability of good feed in sufficient quantity for does usually during late gestation where goats required a high amount of energy either for development of fetus and for lactation preparation (Assan, 2020).

Table 1. Mean value of birth weights (kg) of Arbia kids according to sex, litter size, month and year.

	Effects	N	Mean±SD
Overall		474	2.63± 0.31
Sex	Female	310	2.60 ± 0.30
	Male	164	2.69 ± 0.32
Litter size	Single	71	2.91 ± 0.34
	Twins	361	2.61 ± 0.26
	Triples	42	2.33 ± 0.27
Months	Jan	139	2.61 ± 0.31
	Feb	79	2.61 ± 0.30
	Mar	4	2.53 ± 0.21
	Nov	75	2.65 ± 0.30
	Dec	177	2.65 ± 0.32
Year	2016	220	2.64 ± 0.36
	2017	254	2.63 ± 0.25
Parity	1	79	2.66 ± 0.30
	2	91	2.62 ± 0.25
	3	85	2.57 ± 0.26
	4	92	2.67 ± 0.37
	5	68	2.69 ± 0.34
	6	44	2.53 ± 0.30
	7	15	2.68 ± 0.31

Values are shown as mean ± SD

Table 2. Summary of LMM to model the Birth weight of Arbia kids in Northeastern Algeria.

Model Parameter	Estimate	Std.Error	d.f	t-value	P-Value
(Intercept)	2.51	0.056	19.7	44.5	$<2.00\ e^{-16***}$
Sex (Male)	0.095	0.021	412	4.40	$1.39\ e^{-05***}$
Years 2017	0.032	0.023	451	1.37	0.17
Months (December)					
November	0.0053	0.038	438	0.137	0.89
January	-0.084	0.03	436	-2.78	0.0057^{**}
February	-0.1	0.037	421	-2.83	0.0049^{**}
March	-0.14	0.12	456	-1.12	0.26
Litter size (Twins)					
Single	0.31	0.032	456	9.91	$<2.00\ e^{-16***}$
Triplet	-0.28	0.046	425	-6.05	$3.16\ e^{-09***}$
Parity	0.021	0.0085	207	2.55	0.01^{**}

***P<0.001 ; **P< 0.01 ; Not Significant : P>0.05; LMM: The linear mixed model.

Gender is also a significant source of variation of birth weight ($p \leq 0.01$) (Table 2). Indeed, the present study shows that male kids were born heavier than females. The difference in weight between sex was found by many authors over the world, like Lehloenya *et al*. (2005), Djouza and Chehma (2018) and Ibrahim *et al*. (2020). In contrast, only very few studies suggested that sex have no effect on birth weight of kids like Mioč *et al*. (2011) for the Croatian multicolored goat kids and Sahraoui *et al*. (2020) for the same breed. The difference in birth weight among sexes might be attributed to anabolic effect of male sex hormones (Mahgoub *et al*., 2004). Also, this difference may be due to the fact that pregnancy period for male kids is typically longer than for female kids (Afzal *et al., 2004*)

The distribution of parturitions is not uniform throughout the month of the year and the most of them occurred in the late autumn and early winter. The birth

weight differed significantly between December and January (P≤0.0057) and between December and February (P≤0.0049). Although, the kids which born in November and December were slightly heavier than those born in January and February (Table 2, Table 3).

Table 3. Pairwise Post-hoc analysis among month's differences in initial weight.

Months	Estimate	SE	Df	t.ratio	P-value
Dec-Feb	0.105	0.0373	424	2.803	0.0057
Dec-Jan	0.0838	0.0304	438	2.76	0.0049
Dec-Mar	0.140	0.125	456	1.12	0.797
Dec-Nov	-0.00529	0.0388	440	-0.137	0.999
Feb-Jan	-0.0208	0.0352	458	-0.591	0.976
Feb-Mar	0.0351	0.125	451	0.281	0.998
Feb-Nov	-0.11	0.0494	370	-2.22	0.173
Jan-Mar	0.0559	0.124	452	0.45	0.991
Jan-Nov	-0.0891	0.0424	377	-2.1	0.221
Mar-Nov	-0.145	0.128	458	-1.13	0.79

This can be explained by the fact that the last part of pregnancy of goats kidding on November and December coincide with autumn period which overlap vegetation recovery due to the first autumn rains. The coincidence of this period with cold season (December) for those kidding on January and February, in this area, affects negatively body condition of goats, which affects, in turn, seriously the birth weight of kids. This may be attributed to reducing time of grazing production. In other Mediterranean studies, like the one of Jimenez-Badillo *et al.* (2009) in Spain it is indicated that the Kids born in autumn were significantly heavier than those born in the other three seasons. Starting from this point, the control of mating is essential to get kids in the desired period, corresponding to the maximum vegetation. Regarding the year of kidding, it had no significant effect on birth weight (Table 2) and this may be due to that no changes in the rearing system, precipitation (430 mm and 506 mm for 2016 and 2017, respectively) as well as no annual resource variation which could affect seriously the productivity of the grassland.

Litter size ranged between 1 and 3. Twining was the most frequent (76%), whereas singleton and triplet frequencies were 15% and 9%, respectively (Table 1). Litter size exerted the main significant effect on birth weight of kids and shows that kids born as single were heavier than those born as twins and triplets (Table 2, Table 4). The differences were of 0.31 kg between single and twins (P≤0.0001), whereas, twins were 0.28 Kg heavier than triplets (P≤0.0001).

Table 4. Pairwise Post-hoc analysis among litter size differences in initial weight.

Contrast	Estimate	SE	Df	t.ratio	P-value
Twins-Single	-0.318	0.0322	456	-9.87	**<0.0001**
Twins-Triplet	0.281	0.0467	428	6.01	**<0.0001**
Single-Triplet	0.598	0.053	451	11.3	**<0.0001**

Previously Mioč *et al.* (2011) reported that increased litter size is associated with a significant decrease in birth weight which was in accordance to our findings. This effect might attribute to the fact that single kids do not have a competitor for space and nutrients during intrauterine life. In fact, many studies suggest that an increase in the number of placental cotyledons for nutrient transfer is negatively linked to birth weights in a litter (Dunlap *et al.,* 2015; Özyürek and Türkyilmaz, 2020) which was in agreement with our finding Arbia.

A positive relationship was shown between parity of goat and birth weight of Arbia kids (Figure 1, Table 2). Birth weight of Arbia goat increases by a value of (0.021 Kg) with the next partum (Table 2). Several studies have also revealed that birth weights increased with the advance of parity (Portolano *et al.,* 2002; Zahraddeen, 2008). Those differences might attribute to the conflict observed during first partum between fetal requirements and those of dams (Shrestha and Fahmy, 2007).

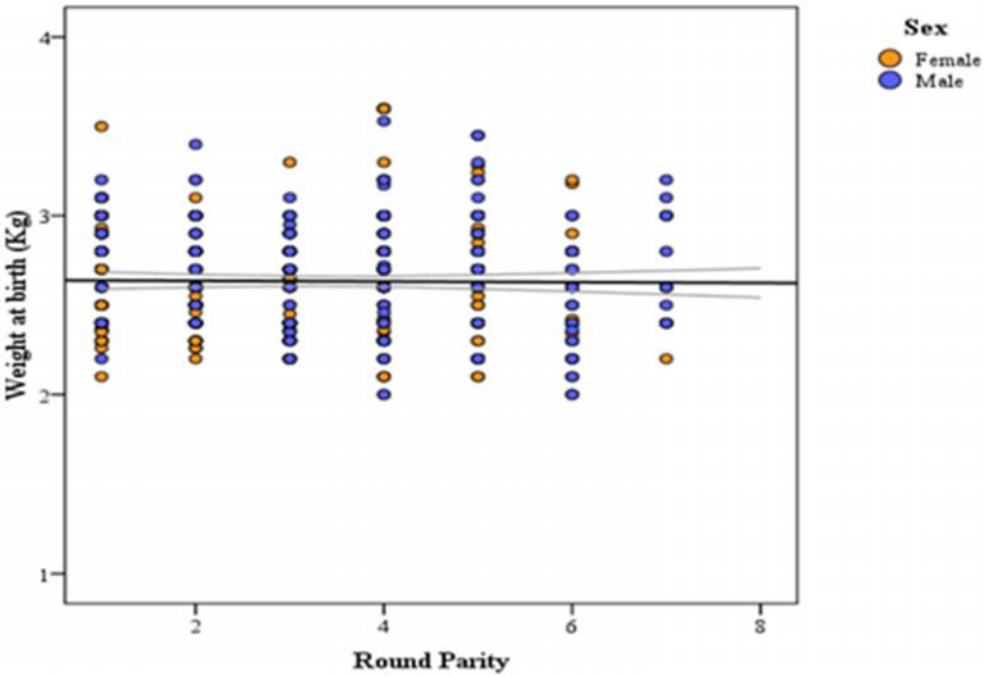

Figure 1. The relationship between birth weight and parity for both male and female of Arbia kids.

Conclusion: The Arbia kids demonstrated a satisfactory potential of birth weight which is very important and easy to measure. This study illustrated the effect of some factors on birth weight of Arbia kids. Indeed, a significant influence of the gender on the birth weight of kids was determined ($p<0.01$). Singles had a higher birth weight than twins and triplets respectively, meanwhile average birth weight increased as age of dam advanced. Furthermore, the heaviest kids were born during November and December. This means that birth weight can be improved by better management practices.

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