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COMPARATIVE STUDY OF ZOOTECHNICAL PERFORMANCES IN INDIGENOUS ARBIA GOAT BREED (HORNED VERSUS POLLED)

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Abstract

The polled goats are traditionally recognized infertile as intersex individuals. The present study aimed to compare between the reproductive traits and to evaluate the milk yield and kid's growth during lactation in the indigenous Arbia goat breed. The study was carried out during 2023–2025 on 238 indigenous goats (167 horned versus 71 polled), *their kids (n=281) and kids born from polled goats. We evaluated reproductive parameters: age at first service, male/females ratio and the rates of kidding, prolificacy, abortion, neonatal mortality and infertility. Moreover, we estimated productive parameters: milk yield, the weight of kids at different birth ages (30 and 60 days). The results revealed the age at first service of ≤10 months and the male/females ratio of 1:10–15 for all the goats. The rates of kidding, prolificacy, abortion, neonatal mortality and infertility were 80.2%, 116.1%, 9.5%, 9.5% and 1.7% versus 72.4%, 122.5%, 8.9%, 9.3% and 10.2% in horned and polled goats, respectively. The analysis of variance showed that the polled goat had a higher infertility rate (P=0.003), prolificacy rate (P=0.04) and lower kidding rate (P=0.02). The milk production and weight of kids did not differ between horned and polled goats (P=0.067). Whereas the weight of kids before weaning varied between kids (horned and polled) born from polled goats (P=0.04). This work proved the variability between the horned and polled goats only in terms of some zootechnical traits (kidding, prolificacy, infertility and weight of kids born from polled goats). This justifies the interest in the genetic analysis of Algerian polled goats for better understanding of their performances.*

Keywords: goat, horned, fertility, kids, production

Introduction

Herds of Algerian indigenous breeds are composed of very heterogeneous animals and the most important of these Algerian indigenous populations is the Arbia breed. It is related to the Nubian breed (Charlet and Le Jaouen, 1977) and presents economic interest related to good reproductive performances of fertility and prolificacy (Ouchene-Khelifi et al., 2018). It is mainly reared for meat; the limited milk production is merely for domestic consumption.

Moreover, the breed is able to survive under stressful environmental conditions, including poor nutrition and high temperatures (Houssou et al., 2023). One of the most important economic characteristics for goat production is reproduction potential (Houssou et al., 2023). The rates of kidding, prolificacy, abortion, and the number of kids born alive or dead are the most often used metrics to assess reproductive performance (Dijkstra et al., 2023). The age at first breeding in goats is determined by their weight, nutrition level, season of birth, and breed. Furthermore, too early introduction of does in breeding can lead to increased incidence of abortion and stillbirth (Šavorić et al., 2024). Several factors influence kidding rate including season, nutrition, age, and breed (Robertson et al., 2020). Prolificacy rate is influenced by a number of factors, including age, parity, breed, season, live weight, and nutrition (Robertson et al., 2020). Abortion rate varies depending on the breeders and the management system (Šavorić et al., 2024). Premature birth, dystocia, diseases, congenital abnormalities, climate, welfare and the number of kids are the most common causes of neonatal mortality in goats (Robertson et al., 2020).

Some breeders prefer polled goats as a valuable economic characteristic because the naturally hornless trait eliminates the need for invasive dehorning procedures, reducing costs and improving animal welfare. This genetic characteristic, which is a dominant trait, results in smoother-headed animals, making them easier to handle in herds and minimizing potential injuries between goats (Zhang et al., 2024). However, throughout breeding, the number of intersex individuals in the hornless goat population grew gradually (Guang-Xin et al., 2021). According to Simon et al. (2022), the polled locus, which has a negative impact on fertility, is conventionally linked to the homozygous polled females typically exhibiting infertility as intersex individuals, while homozygous polled males do not display any signs of intersexuality (Zhang et al., 2024). The proportion of intersex goats within the global population is 4 to 15% (Song et al., 2015; Guang-Xin et al., 2021). Reproductive system malformations in polled intersex syndrome (PIS) goats lead to the loss of reproductive capacity and are thus some of the great challenges encountered in the development of the goat industry (Guang-Xin et al., 2021). Several molecular methods have been used to refine the PIS locus. *FOXL2* is an important sex determination gene (Boulanger et al., 2014) with a key role in ovarian development (Pannetier et al., 2016).

The implementation of strategic plans for polled goats breeding has received attention from the researchers. Furthermore, the lack of an overview of performance of polled goats in this field, especially of the Arbia goat, has never been reported. Therefore, this is the first study undertaken to investigate the difference between horned and polled Arbia indigenous goats in productive and reproductive efficiency.

Material and methods

Ethical statement

The animals used in this study had their origin on semi-arid farms with a traditional management system. They were intended for the production of milk and meat for human consumption. These animals were submitted to practices standardized and regulated by international guidelines for animal welfare (Terrestrial Animal Health Code 2018, section 7, Art 7.1) and national executive decree No. 95-363 of November 11, 1995 (Algeria).

Description of the study area

The test was conducted in wilaya of Souk-Ahras located in the north-east of Algeria, near the Tunisian border. The northern part of the Souk-Ahras region is exposed to Mediterranean climatic influences, while the southern part is characterized by a semi-arid climate.

Data collection

The data collected was on the management of the farms (the age at first service, male/females ratio), and the reproductive performances (kidding, prolificacy, abortion, neonatal mortality and infertility) rates. The study was based on the accessibility of the farms, in 14 private farms using an intensive breeding system in Souk-Ahras. The dairy production estimation was based on an assessment of 238 indigenous Arbia goats aged up to 6 years, horned (n=167) versus polled (n=71). The research included 281 kids in total (during the first month of age). The kids' live weights, horned (n=194) versus hornless (n=87) were assessed at fasting and different ages: birth (W0), 30 days (W1) and 60 days (W2), using an electronic scale (maximum 180 kg). The characterization of the average daily weight gain is a part of advanced production characterization. The growth performance was determined by a rhythmic control of kids born from single births every 30 days.

Statistical analyses

All data were coded and recorded into Excel sheet. The descriptive analysis of the data was established using the SPSS version 20 tool focused on the determination of the mean values, standard deviations, minima, and maxima of the studied parameters.

Results

Table 1 shows the comparison of reproduction traits (the age at first service, male/females ratio) and reproductive performances (kidding, prolificacy, abortion, neonatal mortality and infertility) rates, and milk yield between horned and polled goats. The results revealed the age at first service (≤10 months) and the male/females ratio (1:10–15). The rates of kidding, prolificacy, abortion, neonatal mortality and infertility rates were 80.2%, 116.5%, 9.5%, 9.5% and 1.7% versus 72.4%, 122.5%, 8.9%, 9.3% and 10.2% in horned and polled goats, respectively. The milk production did not differ between horned and polled goats (P=0.067).

Table 1. Comparison of zootechnical performance between horned and polled Arbia goats

Parameters	Overall N=238	Horned N=167 N=50	Polled N=71	P
Age at first service (month)	9.90±0.44	9.82±0.70	9.97±0.20	0.08
Male/females ratio	0.90±0.27	0.10±0.10	0.07±0.14	0.12
Kidding %	76.2	80.2	72.4	0.03
Prolificacy %	119.3	116.1	122.5	0.04
Abortion %	7.2	9.5	8.9	0.15
Neonatal mortality%	9.4	9.5	9.3	0.14
Infertility %	5.95	1.7	10.2	0.003
Daily milk production (liter)	0.93±0.81	0.95±0.76	0.91±0.84	0.067

Table 2 shows the evolution of the weight of Arbia goat's kids in terms of horned and polled trait at birth (W0) and at day 30 (W1). The research included 281 kids in total (during the first month of age). The kids' live weights, horned (n=194) versus hornless (n=87), did not differ between horned and polled goats (P=0.067). Whereas polled kids born from hornless goats (n=22) were slightly heavier than horned kids (n=49) (P=0.04).

Weight at birth and 30 days of goat kids, was not significantly affected by horn presence in Arbia goat kids (P>0.05), although weight at birth of goat kids born from polled goats was significantly affected (P=0.04).

Table 2. The mean birth weight and weight at different ages (30 and 60 days) of Arbia goat kids and kids born from polled goats

Parameters	Overall (N=281)		Polled kids (N=71)	
	Horned (N=194)	Polled (N=87)	Horned (N=49)	Polled (N=22)
Weight at birth W0 (kg)	1.70±0.70	1.79±0.66	1.64±0.85*	2.02±1.04*
Weight at day 30 W1 (kg)	3.53±0.91	3.63±0.95	3.58±0.90*	3.98±1.08*
Weight at day 60 W2 (kg)	5.94±1.22	6.03±1.35	6.12±1.40	6.50±1.45
ADG1 (g/day)	61	61.33	64.66	65.33
ADG2 (g/day)	80.33	80	84.66	84

Discussion

The results of this research revealed that the age at first service (≤10 months) was close to the findings of Fernández et al. (2022) and Ashok et al. (2024), who reported that puberty in goats can occur between 6 and 12 months of age, and is dependent upon weight, nutrition, season of birth and breed. In addition, it occurs at minimum of 25 kg live weight (Fernández et al., 2022). Ali et al. (2022) report that goats mated by or after 8 months of age had more twins than those bred before that age, which may be related to changes in gonad sensitivity to gonadotropin hormones. In addition, age, parity and body condition/weight have been found to affect the endocrine system for extra ovulation that eventually establish the number of fertilization and litter size (Ali et al., 2022).

Multiple ovulations are thought to be caused by increased sensitivity of follicles to FSH and LH, a decrease in the negative effect of the dominant follicle on their accompanying subordinate follicles, or an increase in the ovary's sensitivity to IGF1 (Fatet et al., 2011). However, certain genes have been recognized to affect twining rate in goats (Chu et al., 2011).

The results revealed that the male/females ratio (1:10–15) is close to the findings of Djouza and Chehma (2018) (1:11) and Kouri et al. (2018) (1:15). The ratio is contingent on various factors, such as: buck specific sex initiative, the region, and whether he is raised in a pasture or by hand breeding (Ali et al., 2022). The authors recommended that the ratio of breeding females to reproductive males is 25–30. The presence of a male-to-female ratio of greater than 1:50 in goat flocks has been demonstrated to be a contributing factor to the occurrence of elevated levels of stillbirth. It is suggested that flocks be managed with a ratio of 1:25–50 and 1:<25 (Ali et al., 2022). The same authors reported that the increasing number of females to one male leads to overuse of the male. Consequently, overused males are frequently exhausted with low quality semen.

The kidding rate of Arbia goat in the present study is 76.2%: 80.2% in horned and 72.4% in polled goats, respectively (P=0.02). The obtained result is lower than the findings of earlier studies for other indigenous goats (Deokar et al., 2006; Ali et al., 2022). In contrast to that, Sahare et al. (2009) reported a low kidding rate in Osmanabadi goats. These differences might be due to the effect of different management practices, nutrition, lactation and level of possibilities to prompt re-conception after parturition. Kidding rate is an important parameter which reflects the reproductive efficiency affected by age, breed, season, body weight and condition, as well as health and management factors (Šavorić et al., 2024), but has a low heritability (0 to 0.15 according to Sahare et al., 2009; 0.23 for age at first kidding according to García-Peniche et al., 2012). The lower rate of kidding in polled goat may be attributed to the number of infertile goats due to intersexuality. In this regard, it is suggested to remove from breeding females with signs of intersexuality in order to improve the flock reproductive traits.

The prolificacy rate is 119.3%: 122.5% in polled versus 116.1% in horned goats (P=0.04). It is lower than the rate of 136% obtained by Djouza and Chehma (2018) for the same breed in Biskra (Algeria). The prolificacy rate is closer to 117% of local goats in Beni-Abbes (Algeria) as reported by Kouri et al. (2018). Prolificacy is an important pillar of herd productivity; it is determined by higher age, body weight, nutrition, parity and previous litter size (Djouza and Chehma, 2018; Šavorić et al., 2024), although some genes have been identified for influencing litter size in goats (Chu et al., 2011). The difference in prolificacy in this research between horned and polled does is in agreement with the findings of Constantinou et al. (1981), who reported larger litter size in polled (Pp) than in horned goats (pp), and concluded that the P gene in the heterozygous condition may have heterotic effects on female fertility.

The abortion rate is 9.5% versus 8.9% in horned and polled goats, respectively (P>0.05). The observed abortion rate is slightly higher. According to Šavorić et al. (2024), a rate between 2 and 5% is considered normal among small ruminants. However, the abortion rate recorded here is lower than in the previous study reported for the same breed (11.29%) (Djouza and Chehma, 2018), and among native Algerian Bedouin breed (13.8%) (Kouri et al., 2018). It should be pointed out that the abortion rate is an estimate and is based on the breeders; when infectious abortions are suspected, breeders may be less forthcoming in order to avoid potential economic losses. According to the breeders, most abortions occurred during the final two weeks of gestation, but many also occurred at earlier stages; such losses are often unperceived by inexperienced shepherds. The abortion rate was affected by management system (nutrition, hygiene and vaccination), as was previously reported by Kouri et al. (2018).

The neonatal mortality rate is 9.4%: 9.5% in horned versus 9.3% in polled goats, respectively (P>0.05). The mortality rate is lower than the previously reported for Bedouin kids (12.2%) (Kouri et al., 2018). According to Manyeki et al. (2022), such mortalities were primarily due to inadequate management practices, malnutrition, accidents, infectious diseases, breeders' practices and exposure to very high temperatures.

The rate of infertility was 1.7% versus 10.2% in horned and polled goats, respectively (P=0.003). There is a genetic condition called polled intersex syndrome (PIS) that can lead to infertility, particularly in homozygous polled females. According to Grobler et al. (2021) cited by Zhang et al. (2024), selective breeding for polledness poses challenges due to the risk of inbreeding and loss of genetic variance, as polled animals do not have the genetic level achieved as horned populations. With the development of science and technology, the application of modern animal breeding techniques, such as high-density genotyping and genome resequencing, will facilitate the resolution of this biological issue.

The daily milk production was estimated at 0.93±0.81 liter per day. The daily production of this goat is close to the Arbia goats which produces around one liter/day in Algeria (Houssou et al., 2023) and very close compared to the Arbia goat (0.89±0.91 kg per day) under extensive breeding conditions in Biskra province (south-east of Algeria) (Djouza and Chehma, 2018). In Algeria, mountain goats possess good genetic potential, although the actual efficiency of production is still not discovered due to the practicing of traditional management and nutrition. According to Houssou et al. (2023) milk production is affected by several factors, of which we can mention those related to the animal (female), including breed, size, weight, age, etc. and/or the environment (temperature, playtime). We have noted that polled goats produced slightly more milk (0.95 liter) than horned goats (0.91 liter) (P>0.05). Gall (1980) suggests that polled genetics can be associated with better udder health and potentially higher milk production. However, this is likely due to factors like reduced injury risk and calmer behavior in polled goats, rather than a direct genetic link to milk yield.

The effect of horn presence on Arbia kids' growth decreases relatively with weight at 60 days of age and it did not significantly differ, likely reflecting a maternal effect of the polled gene; indeed, breeders have opted for earlier weaning, from 45 days. Mioč et al. (2011)

reported that the birth weight of kids is highly variable, and is mostly under the influence of breed. In most cases, it is 1/15 of the body weight of an adult goat. Within the breed, variations of birth weight are conditioned by the type of birth, sex, parity, age of doe, length of pregnancy, feeding, season of kidding, health condition, genetic and environmental factors (Mioč et al., 2011). Heritability in goat weight, particularly birth weight, generally falls within low to moderate with estimates ranging from 0.06 to 0.37 for birth weight (Magotra et al., 2021). The effect of gender on weight was not studied in this research.

According to the values from Table 2, we calculated average daily gains (ADGs). The overall ADGs recorded in our study are comparable to the values reported by Djouza and Chehma (2018) for the same breed in an extensive breeding system. Up to weaning, the growth rate can vary significantly depending on milk supply, health, genetic and environmental factors (Houssou et al., 2023). Ricordeau et al. (1972) reported that maternal effect, favorable to offspring born to polled goats, complements the actions of the polled gene. Indeed, it is already known that this gene causes masculinization of females in the homozygous state, makes heterozygous polled females more prolific than polled ones (homozygote), and causes epididymal obstructions in more than half of homozygous polled males.

Conclusion

The results of the goat performance have shown that there are significant variations in some reproductive traits depending on horn trait. The horned Arbia goats reared under semi-arid Algerian region presented a high kidding rate compared to polled goats. However, an advantage in prolificacy of polled over horned goats was found in this study. The progeny of polled goats had higher weight at birth and one month than progeny of horned goats; this effect probably is an expression of the maternal effect of the polled gene. We believe that the results of this study will help future research to develop strategies to maximize the genetic potential of goats of this breed, as well as to contribute to limiting reproductive waste.

Authors' contributions: Hind Houssou designed experiments; Ines Nessaibia and Belkis Malek Beddiar collected samples and performed experiments; Hind Houssou and Ines Nessaibia analyzed data; Hind Houssou wrote the manuscript. All authors agreed to publish this article.

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