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Use of heat synchronization in the makatia goat to improve its productivity in Algeria.

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Abstract

Learning from the low-income level of the goat population in Algeria, and anxious to help them, the objective of our study is to proceed with the synchronization of heats and to evaluate the parameters of reproduction of 60 goats of the 'Makatia' breed from three regions of the wilaya of Mila. Mostly in the traditional breeding system (91.18%), the reproduction is in free mount. The heat synchronization rate is 100%, even with reduced doses of hormones. The average heat onset was 17.47 ± 1.31 h and the average heat duration was 26 h 30 min ± 2 h 13 min. The average non-return to heat rates observed from D17 to D21 after was 89.71%for the protocols with PMSG (1, 2, 3, 4, and 5), and 69.84% for the protocol without PMSG (6). Fertility rates varied from 64.47 to 53.51%. The gestation period was 144.83 ± 1.47 days, 148.5 ± 4.61, and 147.50 ± 2.59 days for single and double litters, and the average milk production was 160.9 ± 1.72 kg at 120 days, i.e. 1.34 ± 0.64 kg/d on average. These results show that efforts should be made to improve the breeding system and the genetic value of the Makatia goat through a coherent program of the application of reproductive biotechnologies.

Keywords: Algeria; Makatia goat; fertility; heat synchronization.

الملخص

انطلاقا من مستوى الدخل المنخفض لأعداد الماعز في الجزائر، وحرصا على مساعدتهم، الهدف من دراستنا هو المضي قدمًا في تزامنا لشبقو تقييم معايير تكاثر 60 ماعزًا من سلالة "مقاطية" من ثلاثة مناطق بولاية ميلة.في الغالب يكون نظام التكاثر تقليديا (91.18٪)،ويتم التكاثر الحر بمعدلتزامنالشبق100٪،حتى مع الجرعات المخفضة من الهرمونات. ان متوسط بداية الشفق 17.47 ± 1.31 ساعة و متوس مدة الشفق 26 ساعةو30 دقيقة ± 2 ساعة13 دقيقة. كان متوسط عدم العودة إلى معدلات الشفق التي لوحظت من يوم17إلى يوم 21بعد التحكم 89.71 ٪ و91.03 و69.84 ٪للبروتوكولات مع وبدونPMSG على التوالي. تراوحت معدلات الخصوبة من 64.47 إلى 53.51٪. كانت فترة الحمل 144.83 ± 1.47 يومًا، 148.5 ± 4.61 و147.50 ± 2.59 يومًا للولادات المفردة والمزدوجة، و كان متوسط إنتاج الحليب 160.9 ± 1.72 كغفي 120 يومًا، أي 1.34 ± 0.64 كغ/ يوم في المتوسط .تظهر هذه النتائج أنه ينبغي بذل الجهود لتحسين نظام التربية و القيمة الوراثية لماعز "مقاطية" من خلال برنامج متماس كل تطبيق التقنيات الحيوية الإنجابية.

الكلمات المفتاحية: الجزائر؛ الماعز مقاطية؛ خصوبة؛ تزامن الحرارة.

Introduction

In Algeria, goat rearing is attracting increasing interest due to its low cost and eases of maintenance in areas where fodder availability is precarious and goat milk is the staple of the family diet (Sahi et al., 2018). The low production capacity of these animals, compared to goats exploited in other regions of the world, is mainly due to the traditional mode of exploitation, which does not allow a rigorous selection of breeding stock with precise criteria of economic interest (Senoussi et al., 2014). Few studies have focused on the production and reproductive performance of the Makatia goat in a rural environment, which is found in the highlands and certain areas of the North (Takoucht, 1998). In addition, only little is known about the conduct of its reproduction, and knowledge of this will allow for better control of these animals (Saidani et al., 2019). Similarly, modern breeding methods have not been applied yet, although they remain one of the essential tools for accelerating the genetic progress of our herd, particularly the dairy potential of the Makatia goat.

The general objective of this work is to adapt the heat synchronization technique to the Makatia goat in the Mila region in order to control its reproduction and thus contribute to the improvement of its productivity and to evaluate the performance of reproduction and milk production of these goats.

Materials and Methods

Study environment and choice of animals

The study took place in three regions of the wilaya of Mila (Chelghoum Laid, Mila, and Gouga Grarem), The wilaya of Mila is located in the North East of Algeria and occupies a total area of 3480, 45 Km² is to say 0,14 % of the country. The population of the wilaya is estimated in the year 2011 as 810370. The chief place of the wilaya is located 50 km from Constantine, 100 km from Jijel, and 450 km from the capital Alger. Chalghoum Laid is a municipality located in the Wilaya of Mila, it is 50 km southwest of Constantine, crossed by the wadi "Rhmmel" and its tributary the wadi "Dekri". Its territory is a plain slightly broken by Djebl Grouz and the Mountain of Tikoua. The climate is Mediterranean with hot summers. The commune of Ain Tinn or also the typography Ain Tine is located in the East 12 km from the city of Mila. The village of Ain Tinn located at 680 meters of altitude is over-led by Djebl lakhal, which culminates at 1266 m. The climate of Ain Tinn is Mediterranean with hot summers.

The municipality of Grarem Gouga is located in the north of the wilaya. The village extends over 142.14 km^2 and had 42062 inhabitants in 2008. The population density is 298 inhabitants/Km^2 in the city: forest of Mouis – the forest of Tadrar. The climate is similar to the two previous regions.

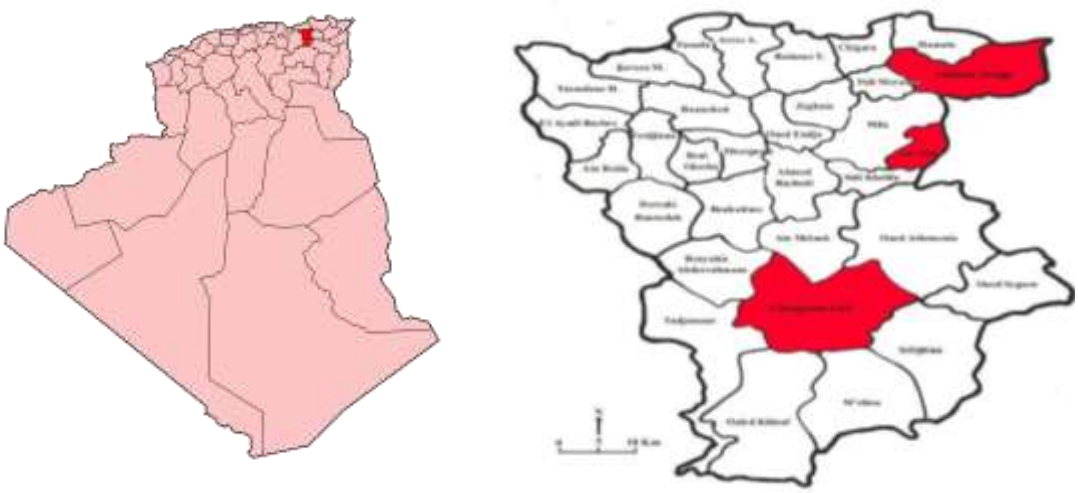

Figure 1: Location of the three regions studied on the geographical map of the Wilaya of Mila.

The survey was done randomly at the beginning. A questionnaire form was elaborated to collect information from 25 goat breeders (all breeds) in several communes of the wilaya, which allowed us to gather information in a more precise way. The choice of the farms was made according to the importance of the Makatia breed goats, the acceptance, and the availability of the breeders.

This breed was chosen because of its good adaptation to its environment (the case of the wilaya of Mila), particularly in terms of feeding and production. This breed continues to show interesting milk production abilities. Three local billy bucks were introduced for control after heat synchronization.

The animals used were goats of breeding age and not pregnant. They are isolated, grazed without contact with other animals, and given supplementary feed in the evening.

Methods of heat Synchronization

The 60 goats chosen for the experiment were separated for one month for their preparation. During this period, they were treated with deworming and vaccination. The body condition of each subject was assessed by palpation of the lumbocostal region using a 5-point scale adapted from the method of Hervieu et al. (1991). These goats were divided into six (06) experimental batches of 10 goats each. The allocation of animals into experimental batches varies according to the objective of the study, but is done taking into account the representation of the various ages in the treatment groups, to evaluate

the effect of reducing the FGA dose for reproductive control in the first two batches (1 and 2), and the combined effects of reducing the FGA and PMSG doses on the other four batches (Table 1).

Table 1. Distribution of goats according to FGA and PMSG doses.

Lot	Number of goatsby age range			PMSG (IU)	FGA (mg/sponge)
	2 years	*3 years*	*4 years*		
1	4	4	2	500	45
2	3	2	5	500	30
3	3	4	3	400	45
4	2	1	7	300	30
5	5	3	2	250	30
6	2	5	3	0	30

PMSG: Pregnant Mare Serum Gonadotropin, FGA: Fluorogestone acetate. Mg: milligram. IU: international unity.

Experimental protocol

The oestrus induction protocol consisted of the placement of the intra-vaginal sponges containing fluorogestone acetate (FGA) left in place for several days (9 or 11 days) (according to the protocol used). We proceeded to use 2 protocols of variable duration (Hervé, 2020), the first protocol of estrus induction consisted of the placement of the intravaginal device (sponge) containing 45 mg of fluorogestone acetate (FGA, Cronolone) by applying the minimum delay for vaginal sponges which is 7 days and left in place for 11 days for the second protocol. An IM injection of 50 µg cloprostenol (Estrumate) and freeze-dried PMSG (Pregnant mare serum gonadotropin) was given 2 days before the removal of the sponge (table 2). Permanent observation of the goats was always in place to determine the onset and duration of heat. Signs of heat were noted.

Table 2. Heat synchronization and control protocol as a function of protocol duration.

Operations	Protocols	
	short	classic
Sponge application	D0	D0
PGF2α injections and 250 IU or 0 IU PMSG	D6	D6
Removal of vaginal sponges	D9 (after 7 days)	D11 (after 9 days)
Heat detection	D10	D12
struggle after removal of vaginal sponges	D11	D13
Diagnosis of non-return to heat	D17 to D24 after the fight	

D: day.

Pregnancy diagnosis

Gestation is assessed by observing the non-return heat from day 17 to day 24. Finally, abortions (not systematically reported) and farrowing allow approximate fertility and abortion rates to be determined.

Milk production

The amount of milk produced was measured at each morning and evening milking to represent the daily production of each goat. A graduated cylinder is used to measure the quantity of milk milked.

Statistical analysis

The data were subjected to descriptive statistics (mean, standard deviation, chi-square test) and comparison of means (Student's t-test) using SPSS Statistics 25, analysis of variance (ANOVA) with the *Newmankeuls* multiple comparison test. The significance level used is $p < 0,05$.

Results

Effect of FGA doses on heat synchronization

All treated goats (n = 60) were seen in heat, the synchronization rate was 100% regardless of age, body condition, and hormone doses used ($p > 0, 05$). Regardless of the protocols, after the removal of the sponge, 100% of the females show signs of heat, an oedematous vulva with mucus secretion, grouping, and acceptance of overlap by conspecific. The heat appeared on average (17.47 ± 1.31) after

removal of the sponges for animals in batch 1 treated with 45 mg FGA, this average time was (17 h ± 38 min) for goats in batch 2 treated with 30 mg FGA per vaginal sponge. The proportion of goats in the heat for more than 28 h was 34.62% for 30 mg FGA, whereas it was 24% for goats treated with 45 mg FGA per vaginal sponge.

The difference was not significant for both FGA doses (p> 0.05). The average non-return to heat rates observed from D17 to D21 after control was 89.71%, 91.03 and 69.84% for the protocols with and without PMSG respectively. Batch 4 (30 mg FGA and 300 IU PMSG) had the highest return to heat with 40.19% of animals, followed by protocol 6 (30 mg FGA and 0 IU PMSG) with three goats. The difference was not significant between protocols (p> 0,05).

Table 3. Duration of heats after induction and synchronization according to FGA doses.

	<20 h (%)	20–27h (%)	<28h Cumulative (%)	> 28 h (%)
FGA 30 mg	7.69	57.69	65.38	34.62
FGA 45 mg	4.16	71.84	76.00	24.00

FGA: Fluorogestone acetate. h: hour.

Their average duration was 26 h 30 min ± 2 h 13 min, the longest heats came from goats in batch 5 (28 h 43 min ± 1 h 48 min with an absolute maximum of 30 h), while the shortest heats were observed in animals treated without PMSG (batch 6). The absolute minimum (23 h) was observed in goats of batch 3 (45 mg FGA and 400 IU PMSG). The duration of heat is not correlated with the hormone doses. 67.86% of the goats in lot 1 and all animals in lot 2 came into heat at 20 h after the removal of the vaginal sponges. There was no significant difference in efficacy between the two doses of FGA (p> 0,05).

Effect of combined reduction of FGA and PMSG doses on heat synchronization

A comparative reading clearly shows that good results were obtained; the average fertility rate was 63.50% in batch 1 and 36.36% in batch 6. However, the fecundity rate of Lot 5 had a clear superiority followed by lot 4 and lot 1, which gave very satisfactory results, protocols 2 and 3 have almost the same fecundity rate (58.83% and 58.32%). The difference is significant between protocols but does not seem to depend on the PMSG dose (p <0.5) (Table 4).

Table 4. Reproductive parameters of Makatia goats.

Lot	1	2	3	4	5	6
Fertility rate (%)	63.50	25.67	62.39	36.36	47.05	37.5
Fecundity rate (%)	59.45	58.83	58.32	64.47	89.71	53.51
Prolificity rate (%)	146.66	228.41	196.33	167.74	182.46	166.48
Abortion rate (%)	11.14	8.21	6.25	5	3.75	4.69

a

The prolificacy rate in the station was 228.41% for the goats of lot 2, the prolificacy of the goats varied between lots, and decreased to 146.66% (lot 1). However, the prolificacy was not significantly correlated with the doses of FGA and PMSG (p> 0.5).

Variations by level of supplementation and body condition score

There was a significant positive correlation between fertility rates (p<0,05), prolificacy (p <0.001), and body condition score (table 5). Optimal supplementation minimized abortions (r = 0.997) and resulted in good fertility (0.019) and farrowing rates.

The average gestation period was (144.83 ± 1.47) days, (148.5 ± 4.61) days, and 147.50 ± 2.59 days for single and double litters, respectively. It is shorter for triple litters: 143.50 ± 0.7 days.

Evaluation of milk production

The average daily production of the goats increased from 1.24±0.6 kg/d in the first month to 0.94±0.44 l/day in the third month of lactation. Milk production also increases with litter size during the first two months. The differences in production are not significant for calving rank or litter size (table 6).

Table 5. Calculation of some zootechnical parameters.

factor	Values	Gestation rate (%)	*P* value (p)	Prolificity rate (%)	*P value (p)*
BCS	2	67.86 [b]	0.997	100[a]	0.019***
	2.5	75.61 [a]		200[bc]	
	3	82.76		250[c]	
	4	73.39 [a]		166.76[b]	
Age (years)	2	76.85 [bc]	0.040*	190.91	0.006**
	3	91.31		181.48[a]	
	4	55.56 [a]		145.57[c]	

*a.b.c,d different letters indicate that the difference is significant in the same column. *: p <0,05, **: p <0,01 ***: p <0,001.BCS: Body condition score.*

Table 6. Average milk production of goats.

Quantity of milk (l)	Average± standard deviation	Calving rank			Number of litters		
		2nd (n=34)	*3rd* (n=13)	*4th* (n=13)	*Simple (n=11)*	*Double (n=32)*	*Triple (n=17)*
Month 1	1.24±0.6[a]	1.09±0.54	1.32±0.62[bc]	1.2±0.64	1.12±0.35[a]	1.48±0.86	1.47±0.4a
Month 2	0.97±0.58	0.89±0.57[a]	0.97±0.61[c]	1.03±0.55	0.92±0.42	1.10±0.06[b]	0.76±0.25
Month 3	0.94±0.44	0.65±0.44[c]	0.69±0.41	0.73±0.12[a]	0.5±0.45	0.33±1.49	0.38±0.43

L: litre, N: number of goats. a.b.c different letters indicate that the difference is significant in the same column.

Discussion

Reproductive control is a necessary practice in breeding; it consists of implementing the best management techniques of the herd to optimize reproduction, either naturally or by artificial insemination. In practice, hormonal synchronization of ovulation is one of the most effective tools for controlling reproduction in goat farms sheep.

The desire of breeders to improve milk production and to have mixed milk/meat production is an indication of the implementation of a modern policy of genetic improvement of goat production. Oestrus synchronization is the key element for any assisted reproductive technique protocol in domestic animals and especially in goats where the oestrus cycle and oestrus are highly variable (Baldassarre and Karatzas, 2004; Hashemi et al., 2006; Rahman et al., 2008).

Effect of FGA doses on heat synchronization

The success of the protocol depends on the choice of the females, concerning the timing and dosage of the protocol, and the respect of the conditions of use of the products.

All the goats had shown signs of oestrus. Indeed, synchronizing oestrus is a technique that offered us significant advantages, notably to anticipate the date of group births. Our overall synchronization results are superior to various data in the literature (Ataman et al., 2006; Kor et al., 2012). The induction rate observed by Senoussi et al. (2014) in imported Saanen goats is 100%,Meskini and Bousserouel (2016) reported that all goats responded to the treatment, Between 18 and 29 hours after the removal of the sponge, 100% of females show signs of heat (acceptance of overlap) in the Arbia breed of goat species in the Tiaret region. as well as for Ait Amrane et al. (2018). They noted that the manifestation of heat is located in great frequency between 21H: 05mn and 23: 30 after the withdrawal of the sponges.

Similarly, Nadjemi and Bourada (2016) proved that all 85 goats of the local breed "Arabia" subjected to heat synchronization had responded favorably to the treatment (2 protocols used) at the level of the demonstration farm and seed production (FDPS) of the technical institute of livestock (ITELV) of Kssar Chellala wilaya of Tiaret.

Bouhazam (2017) using 2 heat synchronization protocols showed that all goats of the first batch (12 days) show estrus behavior after sponge removal at 24h (12.5%), at 48h (37.5%), at 72h (87.5%) and extend to 96h with different durations from 12h to 72h. The goats of the 2nd batch (19 days) present heat grouped after the removal of the sponges at 24h (25%), at 48h (62.5%), 6/8 at 72h (75%) and 1/8 at 84h (12.5%), with different durations between 6h and 48h.

Injections of PMSG at the end of progestin treatment increase follicular growth, duration of oestrus, and ovulation rates and advance the onset of oestrus in treated females (Baldassarre and Karatzas, 2004). The efficacy of this treatment is because FGA prevents the formation of a new corpus luteum (Wildeus, 2000), while cloprostenol ensures luteolysis and PMSG improves timing by facilitating follicular maturation and ovulation. The results of Bouhazam (2017) on local goats have shown a variation in the timing and duration of the onset of estrus about the removal of the vaginal sponge impregnated with FGA and the application of hormonal treatment 1st protocol (11 days=PGF2+PMSG), which is longer than that of the 2nd protocol (17 days =PMSG).

It is noted that the reduction of the FGA dose, as well as the use of reduced or no PMSG doses, did not harm the heat synchronization rate. The same is true for the age and body condition of the goats. In the traditional environment, the low weight of Makatia goats due to difficulties in moving the herd in search of pasture, and difficulties in rationing could explain the effectiveness of reduced doses of hormones, which play a very important role in representing a capital too high, when the food requirements are covered (Mc Dermott et al., 2010).

In dairy goats, an intramuscular injection of PMSG at the end of progestin treatment (48 h before withdrawal), increases follicular growth, duration of oestrus, and ovulation rate and advances the onset of oestrus in treated females (Drion et al., 2001).

Fertility increases with weight, as the weight of the animal defines its body condition and muscle mass, with lighter animals at the time of treatment responding less well to FGA treatment. According to Grimard et al. (2006), a one-point increase in body condition score (BCS) is accompanied by a 13% increase in pregnancy rates. A loss of more than 0.5 body condition score points between farrowing and treatment decreased pregnancy rates. In this study, a BCS between 2.5 and 3 seems to be optimal in Makatia goats.

Leboeuf and al. (2008) showed that fertility after artificial insemination is higher when PMSG is injected 48 h before sponge removal than when it is injected at the same time, respectively 53% and 45%.

The shortest heat duration (23 h) was observed in batch 3 goats, a large proportion of goats had heats lasting more than 28 h, and it was mainly the animals given 30 mg FGA that had the longest heats. Goats in heat for less than 28 h would correspond to those that could be serviced a little earlier or at 43 ± 2h as recommended in standard protocols (Zarroukh et al., 2001; Le Bœuf et al., 2008). The signs of heat were clear on all animals, contrary to the observations made on Maradi red goats by Lapo et al. (2005). Ait Amrane et al. (2018) found that the average time of onset of heat was 23h: 23 min after removal of vaginal sponges, without exceeding 30h.

In sum, synchronization of estrus is a technique that has offered us significant advantages, including advantages, notably to anticipate the date of farrowing, which is expected to be to anticipate the date of births that are expected to be grouped.

Variations by level of supplementation and body condition score

The rate of pregnant females obtained, the fertility rate and the fertility rate is higher than those observed by Senoussiet al. (2014) in Saanen goats bred in Algeria, as is the percentage of abortions in the first two batches (1 and 2). This could be explained by several factors including season (Pierson et al., 2003), breed, age and control method (Romano, 2002).

Nadjemi and Bourada (2016) obtained convincing results with fertility rates of 73.34% and 97.78% for the second batch against 30.59% and 23.53% for the first batch respectively. Similarly, the abortion rate is much higher than our results for the first batch (30.76% and 15.38%) compared to the second batch (9.1% and 03.03%).

The decrease in prolificacy after 4 years could have motivated the breeders to cull their goats at 5 years. AL-Merestani et al. (2003) achieve better results in Damascus goats using 45 mg FGA for 14 days in combination with 500 IU eCG (equine chorionic gonadotrophin)on the day of withdrawal and Akoz et al. (2006) recommend the use of 30, 40 mg FGA with 700 IU eCG (equine chorionic gonadotrophin)to improve fertility. Although this FGA-based protocol has led to satisfactory pregnancy results, several authors propose combining it with the buck effect to improve fertility (Kojima et al., 2000; Wildeus, 2000; Lucy et al., 2001).

Our study showed that the best rate was observed if the sponges remain in the reproductive tract for 11 days and the PMSG injection is performed 9 days after sponging. This corroborates with the results of (David et al., 2007). The results of our work paradoxically show that the prolificacy rate does not depend on PMSG doses, while elsewhere LeBoeuf et al. (1994) reported that prolificacy increases with PMSG doses in local goats, which requires further studies on this breed.

Given the results, and considering the low weight of Makatia goats, FGA doses can be reduced and PMSG can be used only when the postpartum period is short in order to group heats. A good environment and appropriate supplementation will increase fertility rates, limit abortions and thus significantly reduce the current costs of operations, which exceed the average price of a goat.

Evaluation of milk production

The average milk production of the goats in our study at 120 days is 160.9 ± 1.72 kg, i.e. 1.34 ± 0.64 kg/d on average, which is within the range of production reported in the literature. Ouchene-Khelifet al. (2021) found that the Makatia, located in the south, particularly in the wilayas of Ouargla and El Oued. Its milk production reaches 1 to 2 L per day. Djouadi and Ouabed (2019) proved that the body condition score of the goat at farrowing had a significant effect on milk production during the whole milk recording period of eight (8) weeks and they recommended for the local breed Arbia aBCSof 2.75 at farrowing to allow a significant improvement in milk production. Boumendjel et al. (2017) proved that the milk yield of goats can show variations, influenced by various factors: climatic, genetic and feeding. As stated in some studies, rational feed supplementation significantly increases milk production. Hellal (1986) reports that this goat has a milk production of 1.5 l/d for 190 days, a prolificacy rate of 150% and a fertility rate of 90%. Lahrech (2019) showed that compared to other Algerian breeds, the Makatia breed gave the best cheese yields and was more compatible with processing and animal rennet, and that this milk would be the most recommended for possible processing.

Djaout et al. (2022) reported that the quality of goat milk varies according to various factors, Arbia goat milk deserves to be valorized and exploited in the Tlemcen region.

According to Belmihoub (1997), the Makatia is of considerable economic interest because of its prolific nature (150%), its fecundity easily reaches 110%, but it is less fertile than the Arbia goat. A good number of Makatia are found in Tlemcen where they are highly valued for their meat and especially for their milk production, which is much higher than that of the Arbia, since they can give up to 2.5 liters per day (Kebbab, 2016).

The results obtained in this study are very satisfactory and encouraging since we obtained a response rate to the synchronization treatment of 100% and a fertility rate that can reach up to 63.50%. Nevertheless, several studies are to be promoted on this breed to improve fertility using insemination, especially since the majority of published studies concern the Arbia, Sannen and or Alpine breeds and very few studies on the Makatia breed.

It is, therefore, necessary to focus our studies on this breed and try to improve it to meet the challenge of production especially as the national economy is shifting towards agriculture and the Algerian citizen is beginning to appreciate the meat and milk of goat recognized by its qualities.

Conclusion

In conclusion, the results indicate that overall, this study showed good efficacy of oestrus induction by hormone treatments in this breed. The Makatia goat responds favorably to heat induction and synchronization treatment even, when performed under unfavorable conditions, or when reduced doses of hormones are used. Better apparent fertility and fertility results are obtained especially in females with good body condition. The non-correlation of prolificacy with PMSG doses raises the question of the real effectiveness of the hormones.

This breed faces many constraints, especially in terms of food and pathology (reproduction). Several actions need to be taken in order to contribute more effectively to improve the productivity of this breed. By reducing these constraints, the grouping of heats could be a major asset for the application of biotechnology techniques such as artificial insemination.

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Author's Contributions

Author 1: Experimental studies, Literature search, drafting the article.

Author 2: revising it critically for important content.

Author 3: Final approval of the version to be submitted.

Author 4: Experimental studies, Data acquisition

Author 5: Data analysis, Statistical analysis.

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