

## Research Article

# Evaluation of Two Estrus Synchronization Protocols on Estrus Response, Conception, and the Kidding Rate during Lower Breeding Season for Abergele Goat in Northern Ethiopia

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Reproductive technologies are applied to accelerate genetic progress and enhance the reproductive performance of various livestock species. The experiment was conducted to investigate the effect of pregnant mare serum gonadotropins (PMSGs) and prostaglandin (PGF2 $\alpha$ ) hormones on the oestrus response, conception rate, and kidding rate during the lower breeding season of the Abergele goat breed. A total of 77 Abergele does (25 for PMSG and 52 for PGF2 $\alpha$  protocols) were used for the experiment. Experimental animals were allowed to graze (does) for approximately 8 hours and (bucks) for approximately 4 hours, followed by supplementation with a mixture of 300 to 350 g cowpea hay and wheat bran per day. For PMSG-treated does, a vaginal sponge impregnated with progesterone hormone was inserted and stayed for 12 days. After the removal of the vaginal sponge, 2 ml (400 IU) of PMSG hormone was injected for 25 does and allowed to be mated by selected bucks after 48 hours. While a single injection of PGF2 $\alpha$  hormone was administered for 52 does and allowed for mating after 48 hours of hormone administration. The PMSG and PGF2 $\alpha$  protocols resulted in estrus responses of 96% and 86.5%, respectively. The conception and kidding rates of does administered with the PGF2 $\alpha$  protocol were better, with values of 57.7% and 55.8%, respectively. From the result, it was concluded that Abergele does were better responsive to both prostaglandins and gonadotropin-based protocols in inducing estrus, which can be used as an alternative approach for the improvement of the reproductive performance of goats. However, for the reason of better conception efficiency, kidding rate, and ease of application, the PGF2 $\alpha$  protocol was found to be better responsive and effective for synchronizing Abergele does during the lower breeding season.

## 1. Introduction

Goats, known as the “poor man’s cow,” are the most prolific of all domesticated ruminants under tropical and subtropical conditions and are able to breed year round, making an important livelihood contribution for resource-poor farmers [1]. The goat population of Ethiopia is estimated to be more than 52.5 million [2], which has increased by 30% in the last 12 years [3] and is raised at a large proportion (58%) found in the lowlands of the country raised in large flocks by pastoralists, while 42% of the total is found in the highlands, where there is a strong complementary relationship between small ruminant keeping and cropping [4, 5].

Goats comprise 5.32% of the total tropical livestock units of Ethiopia and contribute an estimated 12 to 14% of annual meat products, 10.5% of milk production, 47% of the agricultural GDP [6], 30% of all domestic meat consumption [7], and 6% of all animals exported [3]. Together with sheep, goats contribute approximately 90% of the live animal/meat and 92% of the total skin export trade value [8]. Goat production has promising potential in the Wag Hemra area, as goats can thrive and reproduce in arid areas where cropping activity could not be possible and used as insurance during crop failure, as means of cultural and ceremonial functions, and as sources of different animal products in the traditional management systems of the area.

Despite the considerable contribution of goats to the traditional smallholder as well as to the national economy and better adaptive features to the harsh environment in the area, little effort has been made to improve their reproductive performance, and the sector is generally constrained by several factors in the area. Among other factors, poor reproduction management of goats is the most important component for lower productivity of the breed in the area, as reproduction is believed to be the primary factor affecting the profitability of any animal breeding enterprise. Smallholder livestock production in general is commonly unplanned, and births are thinly spread throughout the year, which complicates reproduction management and hampers overall livestock genetic improvement [9]. Synchronization of estrous assisted with other reproductive tools, such as artificial insemination, will allow the producers to control the overall reproductive management of procedures in their flocks. Some of the benefits include kidding at the desired time of the year, meeting religious and social occasions, utilization of limited feed resources during peak available seasons, fixed time breeding for meeting domestic markets, and for year-round demand fulfillment purposes [10].

In response to limited feed availability, a prolonged dry season, and overall ecological degradation at the research location, goats are experienced as seasonal breeders. In most cases, they bred during the entrance of rainy seasons. The main active breeding season of the breed extends from the beginning of June to the end of July. The remaining long time is considered as lower or mostly nonbreeding seasons. Moreover, during the lower breeding season, there will be a possibility to increase the kidding rate by artificially synchronizing goats. However, the efficiency of different estrus synchronization protocols for indigenous goats has not yet been evaluated. Therefore, this study was carried out with the objectives of evaluating two estrus synchronization protocols on estrus response, conception, and kidding rate in Abergele goats during the lower breeding season in northern Ethiopia.

## 2. Materials and Methods

**2.1. Description of the Study Area.** The study was conducted at the Aybra research station of Sekota Dryland Agricultural Research Center (SDARC), which is located approximately 797 km north of Addis Ababa. Geographically, the area is located at 12°43'651"N and 39°02'027"E with an altitude of 2258 m above sea level. The area receives an annual average rainfall from 400 to 780 ml of which higher rainfall records during the main rainy season between July and August (Kiremt). The mean annual temperature varies from 9.1 to 31.560°C, with an average temperature of 20.330°C (metrology data, 2014). The production system of the area is a mixed crop-livestock system with livestock dominance. According to a survey report [2], there are approximately 416,551 goats in the Wag Hemra zone. Approximately, 70% of household liquid cash income is generated from animal sales, especially from goats in the midland and lowland areas of Wag Hemra [11].

A map of the study area is presented in Figure 1.

**2.2. Experimental Animal Selection and Management.** A total of 77 Abergele does (25 for PMSG and 52 for PGF2 $\alpha$  protocols) aged from 2 to 4 years, minimum of first parity, body condition score of 2.5 to 3.5, with a normal health condition, and fit from different morphological criteria were selected for the experiment. Animals with the specified parity and body condition score are identified as better breeding flocks. The only limiting factor for varying the sample size between the two protocols was the availability of the hormone. Ten bucks (4 for PMSG and 6 for PGF2 $\alpha$  protocols) ranging in age from 3 to 5 years with normal health conditions, uniform body size, normal and uniform testicle size, having better mating abilities, and fit for different morphological criteria were also used for the experiment. Does were allowed to graze/browse daily for 8 hours at the natural pasture with dominantly abundant acacia and other browse species around the research site kept by a separate attendant, and equal proportions of a mixture of 300 to 350 g cowpea hay and wheat bran were supplemented daily for each animal according to their body condition for approximately one month before the actual experimental time. Similarly, bucks which were used for mating purpose were kept by separate attendant and allowed to graze around the research station for 4 hr a day and supplemented with similar ration as does and continue for about one and half months before they allowed for mating. Prior to the experiment, animals were quarantined and vaccinated against anthrax, which was common in the area during the experiment.

### 2.3. Experiment Procedures

**2.3.1. Protocol One: Pregnant Mare Serum Gonadotropin (PMSG) Hormone.** Pregnancy was checked before hormone administration with physical observation since there was no ultrasound scanner during the experimental period, followed by vaginal insertion of a progesterone-impregnated sponge (Syncro-part®; CEVA laboratories, Libourne, France) and stayed for 12 days and intramuscularly injected with 2 ml (400 IU) of PMSG hormone immediately after sponge removal. Gonadotrophin has the function of increasing the ovulation rate (Mahmoud and Abu, 2010), which can be used in conjunction with progesterone or progestagen intravaginal sponges before or after removal of the sponge in anestrous and cycling goats. The estrus record was taken for approximately 72 hours from PMSG injection, as the estrus duration is from 24 to 72 hours [12]. Forty-eight hours after PMSG injection, four selected and flushed bucks were introduced to the doe and stayed for approximately four days. Mating data, conception rate, abortion, and other important data were collected as routine follow-up activities.

**2.3.2. Protocol Two: Prostaglandin F2 Alpha (PGF2 $\alpha$ ) Hormone.** For this protocol, 52 doses were used, and pregnancy was checked very seriously before hormone administration with physical observation since there was no ultrasound scanner during the experimental period, as prostaglandin analogs cause immediate abortion for

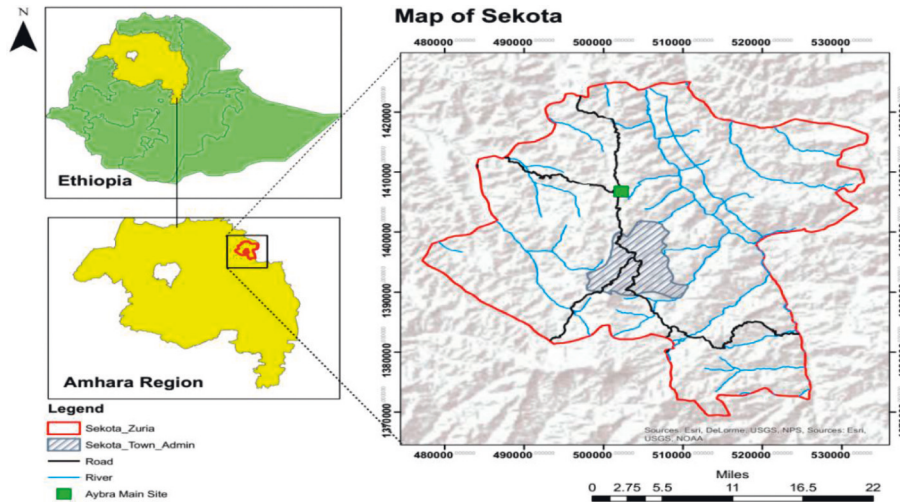


FIGURE 1: Map of the study area.

pregnant does. None of the pregnant does were intramuscularly administered 1 ml of Enzaprost® assingle injection so that this hormone has an effect on the regression of the corpus luteum and induces estrus in cyclic females. The estrus record was taken for approximately 72 hours from PGF2α injection, and 48 hours after PGF2α injection, six selected and flushed bucks were introduced to the doe's and stayed for approximately four days. Mating data, conception rate, abortion, and other important data were collected as routine follow-up activities. The schematic presentation of hormonal applications has been presented in Figure 2.

**2.4. Heat Detection.** After the end of the treatments, attendants were assigned to follow the signs of estrus, such as tail wagging, bleating, searching of the male, frequent urination, contraction of the vulva, vaginal mucus discharge, and mounting [13], who were monitored four times daily for 1 hour by visual observation for 4 days as the duration of estrus was from 24 to 72 [12].

**2.5. Data Collected.** Body condition score, parity, date of sponge insertion, date of sponge removal and PMSG administration, date of PGF2α, date of estrus sign, mating date, conception, kidding, and birth weight were collected.

**2.6. Data Analysis.** The collected data were coded and entered into Microsoft Excel of the 2007 software program for further analysis. Preliminary data analyses, such as normality and consistency tests, were employed. GLM procedure of the Statistical Analysis System SAS (9.0) was employed for the analysis. List square means for each of the variables were compute. In the model, onset and duration of estrus, litter size, and birth weight of kids were used as dependant variables. On the other hand, hormonal treatments, parity of the doe, and body condition scores were considered fixed effects. Each mean was separated with Tukey's Kramer test, and significant differences were tested at α = 0.05. The frequency procedure of SPSS version 16 was

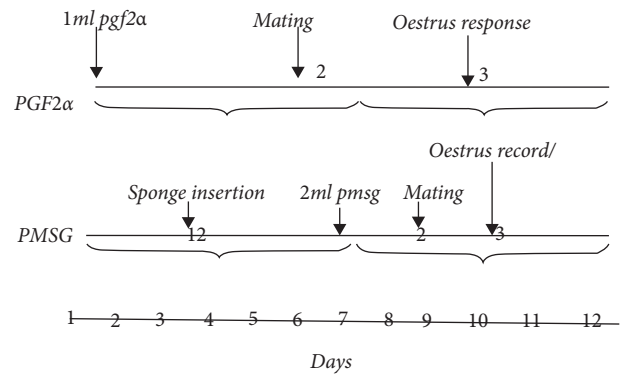


FIGURE 2: Schematic representation of oestrus synchronization and mating.

used to calculate the percentage of estrus response, conception, and the kidding rate for the two protocols with consideration of the following formula:

$$\text{Estrous response} = \frac{\text{Doesshowoestrus}}{\text{doesadministerdhormone}} \times 100,$$

$$\text{Conception rate} = \frac{\text{Doesconcieved/pregnant}}{\text{Doesin estrus}} \times 100, \quad (1)$$

$$\text{Kidding rate} = \frac{\text{Kidsborn}}{\text{Doesconcieved/pregnant}} \times 100.$$

### 3. Results

**3.1. Estrus Response.** As illustrated in Table 1, the estrus response was higher for PMSG hormone-treated does 24 (96%) than for those treated with PGF2α 44 (84.6%). The distribution of the onset of estrus after the end of PMSG and PGF2α treatment was significantly earlier in the case of PMSG hormone-treated does (8.5 ± 0.65 hours) in comparison with those treated with PGF2α (10.5 ± 0.53 hours). From the PMSG treatment, most of the does started to show

TABLE 1: Effect of hormones on estrus response (%), the onset of estrus (LSM±SE), and the duration of estrus (LSM±SE) of Abergele goats.

Protocols	N	Estrus response (%)	Onset of estrus (LSM ± SE)	Duration of estrus (LSM ± SE)
Treatments			*	NS
PMSG	25	24(96)	8.5 ± 0.65 <sup>b</sup>	38.6 ± 1.64
PGF2 $\alpha$	52	44(84.6)	10.5 ± 0.53 <sup>a</sup>	40.6 ± 1.24
Overall	77	90.3	9.8 ± 0.43	39.9 ± 0.99
CV			35	20

where PMSG = pregnant mare serum gonadotropin hormone, PGF2 $\alpha$  = prostaglandin f2 $\alpha$ , N = total population, LSM = least square means, and SE = standard error, \* =  $p < 0.05$ , \*\*\* =  $p < 0.001$ .

estrus after eight hours of hormonal treatment, as presented in Figure 2. In parallel, estrus duration was longer for the dose treated with PGF2 $\alpha$  (40.6 ± 1.24 hours) in comparison with the dose treated with PMSG (38.6 ± 1.64 hours) with an insignificant variation.

From the does treated with the PMSG protocol,  $n = 22$  (91%) of the does have estrus durations from 32 hours up to 48 hours, whereas for the PGF2 $\alpha$  protocol,  $n = 36$  (81%) of the does were accounted for those that had estrus durations from 32 hours up to 48 hours. Significant variation was observed in both of the protocols for the time of the onset of estrus and estrus duration, except that significantly longer estrus duration was observed at the 3rd parity dose (46.8 ± 1.1 hours) compared with the 2nd (38.9 ± 2.0 hours) and 4th parity doses (40.0 ± 2.7 hr) for the PGF2 $\alpha$  groups. The effects of hormonal treatments on the estrus response (%), the onset of oestrus (LSM±SE), and the duration of oestrus (LSM±SE) in Abergele goats are presented in Table 2.

**3.2. Conception Rate and Related Reproductive Parameters.** Does synchronized with PGF2 $\alpha$  hormone showed significantly higher 29 (65.9%) at  $p < 0.05$  conception rate and kidding rate (25 (86.2)) compared with those synchronized with PMSG hormone 9 (37.5%) at conception and 6 (66.6) kidding rate. Significantly higher litter size at  $p < 0.001$  was revealed in the PMSG group (1.5 ± 0.2) compared with the PGF2 $\alpha$  group, which had a litter size of 1.0 ± 0.0, with insignificant variation observed for birth weight from both protocols. The effect of the hormonal treatments on the conception rate and related reproductive parameters are presented in Table 3.

#### 4. Discussion

Both synchronization protocol (PMSG and PGF2 $\alpha$ ) injections were effective in inducing estrus in Abergele does. The higher estrus result of the current report was surprising since the experiment was conducted during the lower breeding season of the breed. However, the percentage of does which were injected with PGF2 $\alpha$  hormone in this experiment exhibited estrus with exceeded percentage than the result from Iranian downy goats reported by [14] which was 75% estrus response from the PGF-ECG protocol, even if there were differences in hormonal treatment, breed, and agroecology between the two studies. However, the current result of a similar protocol was comparable with the result of 94.4% reported by [15] in boar does. In the present study,

the estrus response of does injected with PMSG hormone (96%) was slightly higher than the estrus response of PGF2 $\alpha$  hormone (84.6%) observed, and the response of PGF2 $\alpha$  from this study was higher than the findings of others who reported (75%) estrus response of using PGF on Persian downy does [14] and lower than the reports (95%) found in indigenous Greek goats [16] and (97%) in Nadooshani goats [15].

The conception rate in this study in both of the protocols was relatively higher than the results reported 29.4% using natural mating and (44%) using AI on Rawa goats [17] and lower than the research findings reported by [14,16,18]. However, in comparison with the above reports, a relatively lower kidding rate was observed in this study in the case of the PMSG protocol. This might be due to the prolonged dry season during the experiment leading to serious early abortion.

The proportion between estrus response and conception rate and kidding rate was lower in the case of two of the protocols with a higher proportion in the case of PMSG, and the possible reason might be associated with the presence of estrus detection problem since there was no serum analysis conducted for FSH and LH levels rather only physical expressions were considered during estrus detection, and bucks efficiency to mate all of the does come to heat. Bucks were unable to mate all does which came to estrus effectively on time rather they stay longer time on a single doe. In this experiment, we observed the incompatibility of this protocol with natural mating, and this protocol is thought to be very effective for timed artificial insemination. The current result also revealed that a shorter set of oestrus and duration was shown from the PMSG hormone, which calls breeders for either fixed time AI or enough and ready bucks to cover the mating process with the available time. 3<sup>rd</sup> parity does show significantly longer estrus duration while the rest of the parities and body condition scores had no pronounced effect on the evaluated parameters, which differed from the finding of [19] who reported that the body condition score of ewes had a significant effect on kilogram lambs born per ewes, the birth weight of lambs, and the FSH concentration of ewes ( $P < 0.05$ ) in Sanjabi ewes. The above author also reported that ewes with a body condition score of 3 had normal estrus, while ewes with a lower body condition score had a shorter estrous period. A positive relationship between the body condition score and plasma leptin and FSH concentrations in Iranian fat tail ewes at the mating time [20] was also another finding that strengthened the current study.

TABLE 2: Effect of parity and BCS on the onset of estrus (LSM±SE) and the duration of estrus (LSM±SE) of Abergele goats synchronized with PGF2α and PMSG protocols.

Protocol	Variables	N	Onset of estrus (LSM±SE)	Estrus duration (LSM ± SE)
PGF2α	Parity		Ns	*
	2	17	9.2 ± 1.0	38.9 ± 2.0 <sup>b</sup>
	3	16	10.2 ± 0.6	46.8 ± 1.1 <sup>a</sup>
	4	11	11.0 ± 1.1	40.0 ± 2.7 <sup>b</sup>
	BCS		Ns	Ns
	2.5	36	10.6 ± 0.5	40.8 ± 1.3
	3	7	10.8 ± 1.8	37.9 ± 3.6
	3.5	1	8.9 ± 0.0	47.0 ± 0.0
	Overall		10.5 ± 0.5	40.6 ± 1.2
	CV		34	18
PMSG	Parity		Ns	Ns
	1	9	9.4 ± 1.2	41.2 ± 2.3
	2	13	9.0 ± 0.7	37.7 ± 2.4
	3	2	6.6 ± 2.0	34.8 ± 2.0
	BCS		Ns	Ns
	2.5	18	7.7 ± 0.7	37.1 ± 1.9
	3	4	8.0 ± 1.9	42.5 ± 3.0
	3.5	2	9.3 ± 2.0	34.1 ± 2.0
	Overall		8.5 ± 0.6	38 ± 1.6
	CV		39	20

where PMSG = pregnant mare serum gonadotropin hormone, PGF2α = prostaglandin f2α, N = total population, LSM = least square means, and SE = standard error, \* =  $p < 0.05$ .

TABLE 3: Conception rate (%), kidding rate (%), litter size (LSM±SE), and birth weight (LSM±SE) of Abergele goats synchronized with the PMSG and PGF2α protocols.

Protocol	N	Mating (%)	Conception (%)	Kidding (%)	Litter size (LSM±SE)	Birth weight (LSM±SE)
Treatments					***	*
PMSG	24	15 (62.5)	9 (37.5)	6 (66.6)	1.5 ± 0.20	1.8 ± 0.04
PGF2α	44	44 (100)	29 (65.9)	25 (86.2)	1.0 ± 0.03	2.1 ± 0.04
Overall		81.25	51.7	76.4	1.1 ± 0.05	2.0 ± 0.03
CV					24	10

Here, PMSG = pregnant mare serum gonadotropin hormone, PGF2α = prostaglandin f2α, N = total population, LSM = least square means, and SE = standard error, \* =  $p < 0.05$ , \*\*\* =  $p < 0.001$ .

## 5. Conclusions

In the situations where there are enough feed supplementation programs, estrus follow-up, pregnancy diagnosis prior to the administration of hormones, and overall improved animal husbandry practice, the value of estrus synchronization by the use of PMSG and PGF2α protocols in goats resulted in better estrus response during the lower breeding season. However, for the reason of better conception efficiency, kidding rate, and ease of application, the PGF2α protocol was found to be better responsive and effective for synchronizing Abergele does during the lower breeding season which can be used as an alternative for increasing the kidding rate. Strengthened further study on the evaluation of different estrus synchronization protocols with strengthened heat detection programs, such as conducting serum analysis for FSH and LH levels together with timed artificial insemination for indigenous goats, should become an important future research area.

## Data Availability

Data available on request due to privacy/ethical restrictions.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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