www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 2052-2059

www.thepharmajournal.com
Received: 20-05-2022
Accepted: 24-06-2022

Anil Kumar Reddy Kanduri
Ph.D. Scholar, Scientist & Head, Livestock Research Station, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India

KCS Reddy
Professor & University Head, Department of Veterinary Gynaecology & Obstetrics, College of Veterinary Science, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India

Venkata Ramana K
Professor, Department of Veterinary Gynaecology & Obstetrics, College of Veterinary Science, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India

Venkateshwarlu M
Professor, Department of Animal Nutrition, College of Veterinary Science, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India

Swathi B
Professor & University Head, Department of Veterinary Physiology, College of Veterinary Science, PVNRTVU, Hyderabad, Telangana, India

Uday Kannegundla
Scientist, Animal Genetics & Breeding, Livestock Research Station, PVNRTVU, Hyderabad, Telangana, India

Corresponding Author
Anil Kumar Reddy Kanduri
Ph.D. Scholar, Scientist & Head, Livestock Research Station, Mahabubnagar, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India

Study on estrus traits and progesterone profile during different estrus synchronization protocols in local goats

Anil Kumar Reddy Kanduri, KCS Reddy, Venkata Ramana K, Venkateshwarlu M, Swathi B and Uday Kannegundla

Abstract
The present study was conducted to estimate the efficacy of various estrus synchronization protocols on estrus response and progesterone profile in Mahabubnagar local goats. A total of 100 does aged between 2-5 years located at Livestock Research Station, Mahabubnagar were selected and randomly divided into 5 groups each with 20 does. First group were not treated with any protocol and considered as control. Second group (GPG) were treated with GnRH on day 0, $PGF_2\alpha$ on day 7 and GnRH on day 9. Third group (PPG) were treated with PGF2α on day 0, 7 and GnRH on day 9. Fourth group (SPG) were inserted with vaginal sponges and kept *in situ* for a period of 9 days, $PGF_2\alpha$ was given on day 8, on 9th day sponges were withdrawn and GnRH was administered. Fifth group (SP) does were inserted with vaginal sponges for 9 days, on 9th day sponges were removed and PMSG was administered. Estrus response was observed from day 9 to 14 and allowed for natural service. Synchronization protocols resulted significantly (p<0.05) higher estrus response rate than the control group. The onset of estrus was significantly (p<0.05) lower in the treatment groups and duration of estrus was significantly (p<0.05) higher in treated groups. The progesterone profile estimated at different time intervals on day 0, 3, 6 and 9 were shown significant (p<0.05) difference between the groups while, there was no significant (p<0.05) difference on day of estrus. In conclusion, the results of the present investigation revealed that SP group treatment regimen was the best in terms of estrus traits and reproductive performance in does followed by GPG, PPG and SPG groups.

Keywords: Local goats, estrus synchronization, Ovsynch, GnRH, $PGF_2\alpha$, PMSG

1. Introduction
The reproductive management of goats on a large scale becomes difficult due to poor estrus expression and lack of heat detection techniques. In large flocks, estrus synchronization and fixed time insemination is useful to augment the fertility in goats (Abdullah *et al.*, 2008) [1]. Assisted reproductive technologies (ARTs) are powerful tools to enhance reproductive efficiency of small ruminants by estrus synchronization, increasing estrus response rate, pregnancy rate and prolificacy in shorter duration even in non-breeding seasons.

The principle behind the estrus synchronization is controlling luteal phase of the estrus cycle either by providing exogenous progesterone or by pre-mature luteolysis by means of luteolytic agents. Estrus synchronization can be carried out by the conventional methods like alteration in the light exposure period, buck exposure and the use of hormonal treatments. Synthetic Gonadotropin Releasing Hormone (GnRH) preparations, equine chorionic gonadotropin (eCG), human chorionic gonadotropin (hCG), progestagens administered by different routes (oral, injections, vaginal pessaries) and prostaglandin ($PGF_2\alpha$) in different combination and regimen are used for estrus synchronization in ruminants.

Ovsynch is one of the popularly used synchronizing protocols which helps to ensure ovulation within a fixed period and produces good fertility (Panjaitan *et al.*, 2020) [22]. An easy method of estrus synchronisation in goats is by the use of prostaglandins ($PGF_2\alpha$) to cause luteolysis so as to induce the subsequent follicular phase of the estrus cycle. Several synthetic analogues have been used to induce rapid regression of the corpus luteum. Prostaglandins should be administered from day 3 of the estrus cycle, when the corpus luteum of the goat is responsive to $PGF_2\alpha$ (Rubianes and Menchaca, 2003) [28]. Another method of estrus synchronisation is by the use of natural progesterone impregnated in sponges, implants or silicon elastomers or the use of its synthetic analogues such as norgestomet, fluorogestone acetate (FGA), methyl acetoxy progesterone (MAP) and medroxy progesterone acetate (MPA). The progesterone or progestagen treatment is popularly delivered though an intravaginal sponge, intramuscular or

subcutaneous routes. Traditionally, intravaginal sponges are inserted over periods of 9–21 days and in most cases, eCG or $PGF_2\alpha$ is administered two days before at the end of pessaries removal. The administration of eCG at the end of fluorogestone acetate treatment enhances estrus response. Effective dose of eCG in goats ranged from 200 to 400 IU. Besides, repeated administration of eCG is reported to produce antibodies against eCG (Anti-eCG), thereby causing reduced ovarian stimulation after subsequent treatments (Rekwot *et al.*, 2001) [26]. The use of long-term progestagen treatments have been shown to result in lowered fertility rates (Rubianes and Menchaca, 2003 [28], Fonseca *et al.*, 2018) [9]. On the other hand, decreased periods of progestagen treatment may minimize vaginal discharge and infection, and increase fertility (Ungerfeld and Rubianes 2002) [32]. Currently, short-term intravaginal progestagen treatment is advocated.

Although several studies have attempted to improve the breeding efficiency in goats, only few studies have been conducted in Mahabubnagar local goats. Hence, the present study was conducted to evaluate the efficacy of various estrus synchronization protocols by administration of Synthetic Gonadotropin Releasing Hormone (GnRH), prostaglandin ($PGF_2\alpha$), Pregnant Mare Serum Gonadotropin (PMSG) and Progesterone sponges to evaluate the efficacy of various estrus synchronization protocols.

2. Materials and Methods

2.1 Experiment & experimental animals

The study was conducted at Livestock Research Station, Mahabubnagar, PV Narasimha Rao Telangana Veterinary University (PVNRTVU) with 16.737509 of longitude, 78.008125 latitude and 504 mts. above the mean sea level. A total of 100 does and 10 bucks aged between 2-5 years were included in the present study. The does and bucks were properly identified (ear tagging), dewormed and vaccinated as per schedule. Does having good body condition score (BCS) of 2-4, normal kidding history and without any reproductive problems during previous kidding were selected. The does were selected after completion of 60 days post-partum period. Pregnancy verification was done by ultrasonography using a B-mode ultrasound scanner (Aloka, Prosound 2, Japan) with 5 to 7.5 MHz convex transducer trans abdominally. The selected does were randomly divided into 5 groups consisting of 20 in each.

2.2 Treatment groups

Group I (Control group)

This group comprised of 20 does which were not treated with any treatment protocol and termed as control group to compare with the animals treated with GPG, PPG, SPG and SP protocols and depicted in Figure 1.

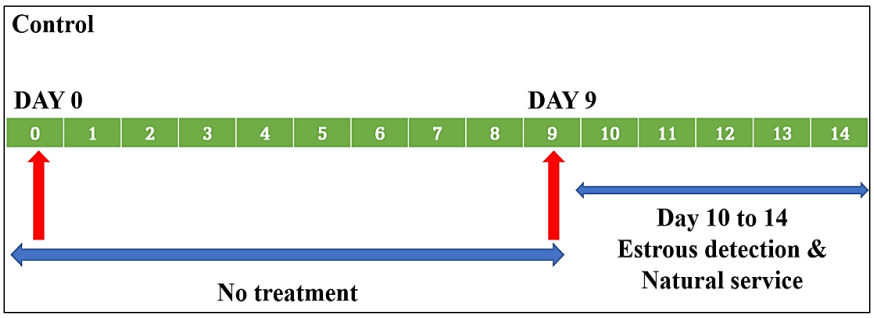

Fig 1: Treatment regimen for group I (Control)

Group II (GPG group)

This group comprised of 20 does which were treated with Inj. GnRH (10µg) on day 0, Inj. $PGF_2\alpha$ (125 µg) on day 7 and Inj. GnRH (10 µg) on day 9, intramuscularly. The protocol was showed in Figure 2.

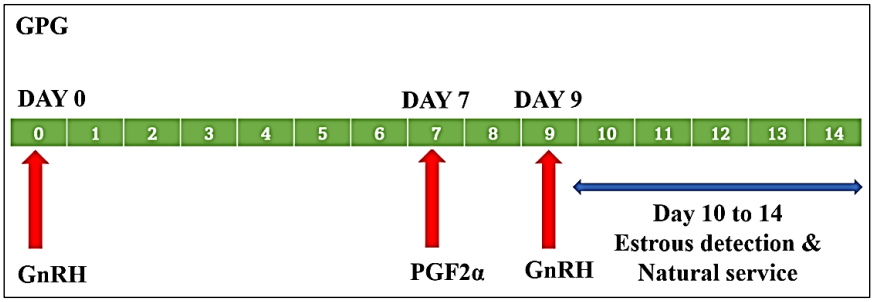

Fig 2: Treatment regimen for group II (GPG)

Group III (PPG group)

This group comprised of 20 does which were treated with Inj. $PGF_2\alpha$ (125 µg) on day 0, Inj. $PGF_2\alpha$ (125 µg) on day 7 and Inj. GnRH (10 µg) on day 9, intramuscularly (Figure 3).

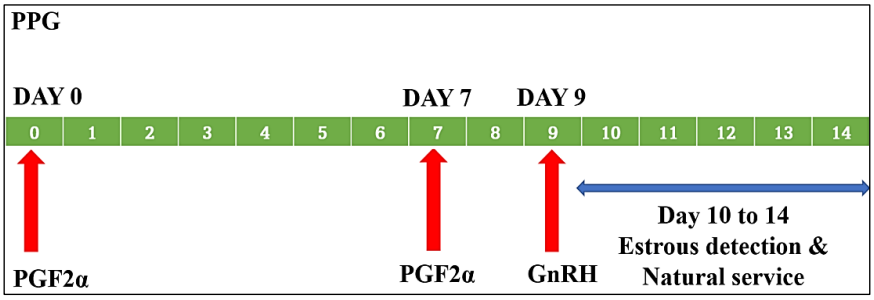

Fig 3: Treatment regimen for group III (PPG)

Group IV (SPG group)
This group comprised of 20 does which were inserted with vaginal sponges and kept *in situ* for a period of 9 days. Inj. $PGF_2\alpha$ (125 µg) was given intramuscularly on day 8 i.e. 24 hours prior to sponge removal. On 9th day sponges were withdrawn and Inj. GnRH (10µg) was administered intramuscularly (Figure 4).

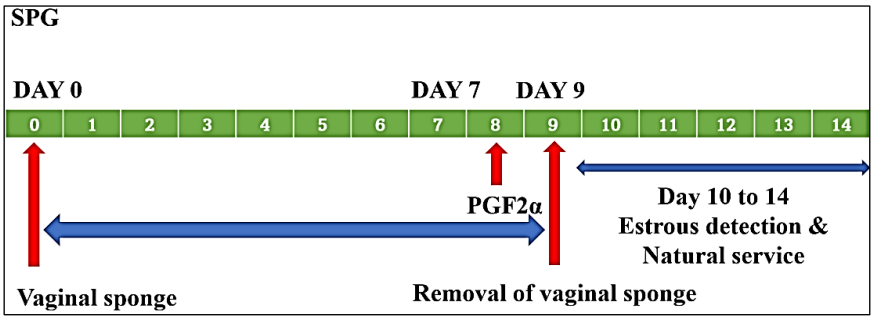

Fig 4: Treatment regimen for group IV (SPG)

Group V (SP group)
This group comprised of 20 does which were inserted with vaginal progesterone sponges and kept *in situ* for a period of 9 days. On 9th day sponges were withdrawn and Inj. PMSG (300 IU) was administered intramuscularly (Figure 5).

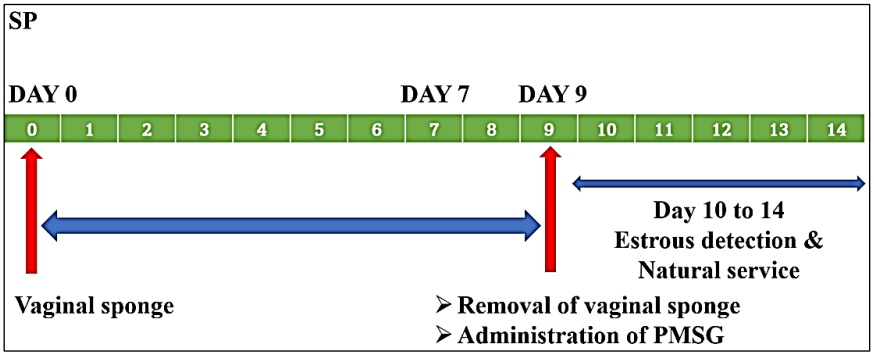

Fig 5: Treatment regimen for group V (SP)

2.3 Progesterone estimation
Progesterone concentrations of experimental does were measured on before treatment (day 0), Day 3, Day 6, Day 9 and on the day of estrus by enzyme- linked immunosorbent assay (ELISA) using progesterone kits.

2.4 Estrus traits estimated
The efficacy of different estrus synchronization protocols utilized in the present study were expressed in terms of onset of estrus (time taken for induction of estrus), duration of estrus and estrus response rate (%).

2.4.1 Estrus response
The post treatment estrus response was calculated by the number of does in estrus divided by the number of does treated and multiplied by hundred and expressed in per cent.

2.4.2 Time to onset of synchronized estrus
The onset of synchronized estrus was calculated from 9th day after GnRH injection in GPG and PPG groups and after sponge removal to the time of first appearance of estrus symptoms. The time taken for exhibition of estrus was expressed in hours.

2.4.3 Duration of estrus
The duration of behavioral estrus from the time of first acceptance of mating to the last acceptance of mating by the buck was recorded. The duration of estrus was expressed in terms of hours.

2.5 Statistical analysis
The data collected were subjected to suitable statistical procedures as described by Snedecor and Cochran (1994) [30]. One-way ANOVA was applied and statistical significance

was set at $p<0.05$.

3. Results

3.1 Progesterone profile

The overall mean of progesterone concentration observed in the present study on day 0, Day 3, Day 6, Day 9 and on the day of estrus were 1.40±0.07, 2.78±0.10, 4.67±0.11, 2.70±0.08 and 0.74±0.70 ng/ml respectively.

The mean serum progesterone concentration in Control, GPG, PPG, SPG and SP on the day of estrus were 0.72±0.05, 0.76±0.03, 0.77±0.02, 0.78±0.04 and 0.68±0.03 ng/ml respectively and ranges 0.51-0.93, 0.41-0.98, 0.52-1.02, 0.39-0.99 and 0.42-0.95 ng/ml respectively.

The statistical analysis of the data revealed that, the serum progesterone concentration in the present study were significantly ($p<0.05$) differed in different treatment groups on day 0, day 3, day 6 and day 9 whereas, there is no significant ($p<0.05$) difference on day of estrus.

Table 1: The serum progesterone concentration levels (ng/ml) in different groups of does (Mean ± S.E.)

Group	Day 0	Day 3	Day 6	Day 9	Day of estrus
Control	1.10±0.11^{a}	2.09±0.17^{a}	3.21±0.26^{a}	3.60±0.24^{b}	0.72±0.05
GPG/Ovsynch	1.48±0.15^{ab}	2.49±0.14^{a}	3.85±0.18^{a}	1.32±0.13^{a}	0.76±0.03
PPG	1.38±0.12^{ab}	1.81±0.10^{a}	3.80±0.26^{a}	1.63±0.18^{a}	0.77±0.02
SPG	1.83±0.21^{b}	3.50±0.23^{b}	6.16±0.25^{b}	3.77±0.15^{b}	0.78±0.04
SP	1.22±0.12^{a}	4.01±0.16^{b}	6.34±0.28^{b}	3.22±0.16^{b}	0.68±0.03
Overall	1.40±0.07	2.78±0.10	4.67±0.11	2.70±0.08	0.74±0.70
F-Value	0.015^{S}	0.001^{S}	0.001^{S}	0.001^{S}	0.332^{NS}

S: Significant.
NS: Non-significant.
Means with similar superscript(s) does not differ significantly.

3.2 Synchronized estrus

3.2.1 Estrus response

The overall estrus response rate (%) observed in the present study was 76 per cent. The estrus response rate found in different groups were 50, 80, 80, 75 and 95 per cent in Control, GPG, PPG, SPG and SP groups, respectively. The statistical analysis revealed that, there was significant ($p<0.05$) difference in estrus response rate (%) among the does treated with different protocols (Tab. 2, Fig. 6)

Table 2: Effect of different estrus synchronization protocols on estrus response rate

Group	Number of animals under treatment	Number of animals shown estrus response	Estrus response rate (%)	Chi-square value
Control (n=20)	20	10	50	7.90* ($p<0.05$)
GPG/Ovsynch (n=20)	20	16	80	
PPG (n=20)	20	16	80	
SPG	20	15	75	
SP	20	19	95	

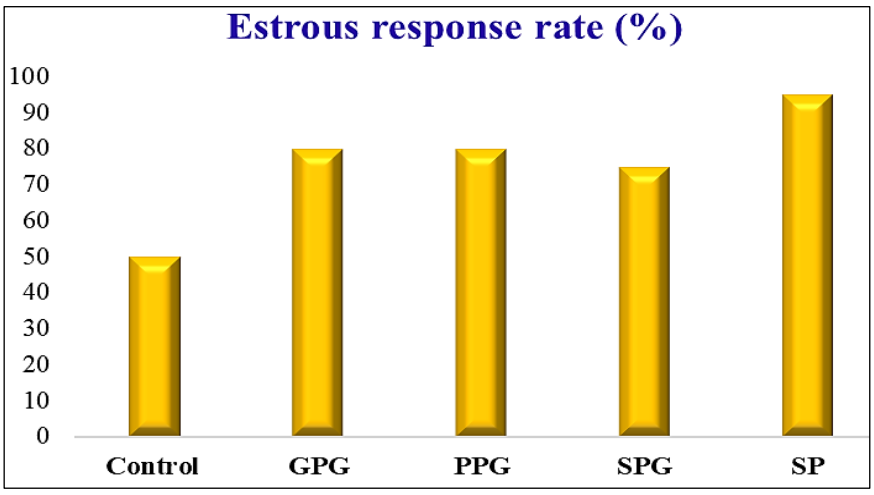

Fig 6: The estrus response rate in different groups of does

3.2.2 Time taken for onset of estrus

In the present study, the overall mean of time taken for onset of estrus was 63.87±1.56 hours and the range was 26.51-132.44 hours. The time taken for induction of estrus in different groups were 124.30±4.08, 52.38±3.23, 65.25±3.23, 45.00±3.34 and 32.42±2.96 hours in Control, GPG, PPG, SPG and SP groups, respectively. The data analysis revealed that, there was significant ($p<0.05$) difference in time taken for onset of estrus among the does treated with different protocols (Tabble 3, Figure 7).

3.2.3 Duration of estrus

The overall mean of duration of estrus was 39.29±0.89 hours and the range was 23.50-55.69 hours. The duration of estrus in Control, GPG, PPG, SPG and SP groups of does were 28.30±2.41, 38.25±1.90, 45.38±1.89, 32.33±1.97 and

52.21±1.75 hours, respectively. The statistical analysis revealed that, there was significant (p<0.05) difference in duration of estrus among the does treated with different protocols (Table 3, Figure 8).

Table 3: Effect of different treatment protocols on the onset of estrus and duration of estrus in does (Mean ± S.E.)

Group	Number of animals kept for study	Number of animals shown estrus response	Onset of estrus (hours)		Duration of estrus (hours)	
			Mean±S.E.	Range	Mean±S.E.	Range
Control	20	10	124.30±4.08^{a}	116.16-132.44	28.30±2.41^{d}	23.50-33.10
GPG/ Ovsynch	20	16	52.38±3.23^{bc}	45.94-58.81	38.25±1.90^{bc}	34.45-42.04
PPG	20	16	65.25±3.23^{b}	58.81-71.69	45.38±1.89^{ab}	41.58-49.17
SPG	20	15	45.00±3.34^{cd}	38.35-51.64	32.33±1.97^{cd}	28.42-36.25
SP	20	19	32.42±2.96^{d}	26.51-38.33	52.21±1.75^{a}	48.73-55.69
Overall	100	76	63.87±1.56	26.51-132.44	39.29±0.89	23.50-55.69
F-value			0.001^{S}		0.001^{S}	

S: Significant.
NS: Non-significant.
Means with similar superscript(s) does not differ significantly.

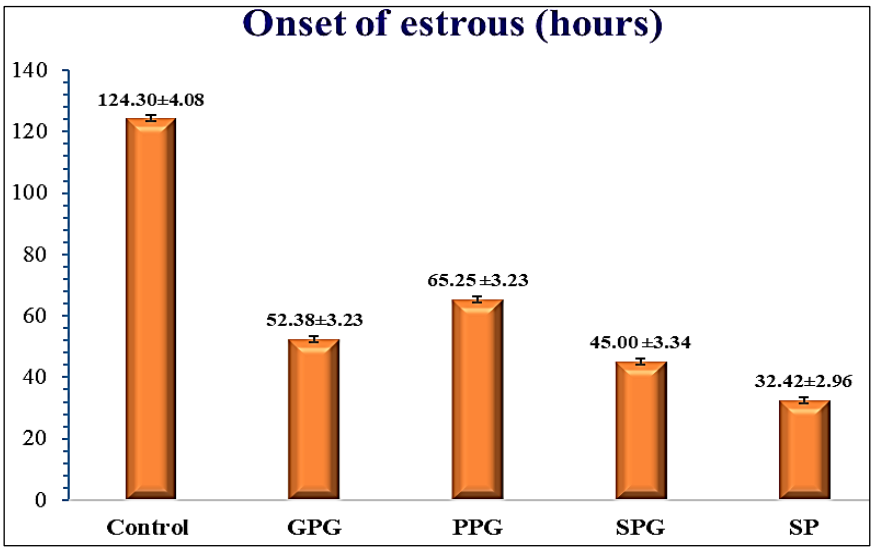

Fig 7: The onset of estrus (hours) in different groups of does

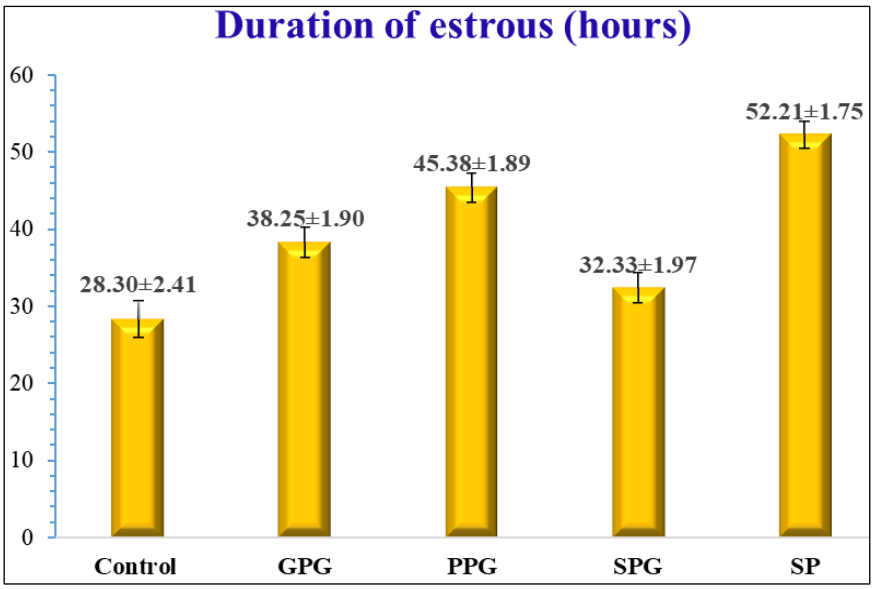

Fig 8: The duration of estrus (hours) in different groups of does

4. Discussion

4.1 Progesterone profile during synchronization protocol

The progesterone profile estimated at different time intervals on before treatment i.e. day 0, 3, 6 and 9 were shown significant (p≤0.05) difference between the groups (Table 1). In the GPG protocol the mean serum progesterone concentrations on day 0, 3, 6 and 9 were 1.48±0.15, 2.49±0.14, 3.85±0.18 and 1.32±0.13 ng/ml, respectively. The concentration was increased from day 0 to day 6 and it fallen by day 9. The progesterone changes observed during the protocol were similar with the findings of Holtz *et al.* (2008) [13] in Boer goats, Gupta *et al.* (2021) [11] in Salem goats.

Whereas the mean concentration of progesterone at different days of treatment ovserved by Holtz *et al.*, 2008 [13] (10.9, 15.6, 1.9, 1.1 and 0.9 ng/ml on day 0, 7, 8, 9 and10, respectively) and Gupta *et al.*, 2021 [11] (5.13, 5.64, 1.62, 1.90 and 2.41 ng/ml on day 0, 7, 8, 9 and10, respectively) were slightly higher. Similar findings were observed by Yede *et al.* (2021) [33] in Surti Goats and the serum progesterone concentrations on 0, 5 and 11 were 1.44±0.17, 1.60±0.13 and1.48±0.10 ng/ml.

The changes may be due to first GnRH injection used in Ovsynch protocol which initiates the release of FSH and LH from anterior pituitary. If the ovulation occurs following the first GnRH of Ovsynch, follicular wave emergence may be synchronized. A follicle on the ovary grows and becomes a dominant follicle and the progesterone concentration is decreased by regression of corpus luteum after $PGF_2\alpha$ on day 7. Follicular growth continues and preovulatory follicle grows. The second GnRH injection on day 9 reinitiates the release of LH from pituitary and ovulation of pre-ovulatory follicle is achieved (Pursley *et al.*, 1997 [25]; Geary *et al.*, 1998 [10] and Stevenson *et al.*, 1999) [31].

In the PPG protocol the mean serum progesterone concentrations on day 0, 3, 6 and 9 were 1.38±0.12, 1.81±0.10, 3.80±0.26 and 1.63±0.18 ng/ml, respectively. The concentration was increased from day 0 to day 6 and it fallen by day 9. The progesterone changes observed during the protocol were in accordance with the findings of Gupta *et al.* (2021) [11] in Salem goats. The corpora lutea can be responsive to $PGF_2\alpha$ from day 3 of the estrus cycle (Rubianes *et al.*, 2003) [28] to the day of natural luteolysis, therefore, animals in anestrus or in early or late luteal or follicular phase at the time of injection will not respond to the treatment. Having in mind the impossibility of knowing the phase of the estrus cycle in a group of females, it is thus necessary to administer two injections of $PGF_2\alpha$, 9–10 days apart; therefore, almost all the animals in the group will be in mid-luteal phase at the second dose and will respond to the treatment.

In the SPG protocol the mean serum progesterone concentrations on day 0, 3, 6 and 9 were 1.83±0.21, 3.50±0.23, 6.16±0.25 and 3.77±0.15 ng/ml, respectively. The concentration was increased from day 0 to day 6 and it fallen by day 9. The literatures reported on these findings were scanty to compare and contrast the present findings. In this protocol progesterone or its analogues, are based their effects on the luteal phase of the cycle, simulating the action of natural progesterone produced in the corpus luteum after ovulation, which is responsible for Controlling LH secretion from the pituitary. Thus, Control of the life of the corpus luteum or manipulation of circulating progesterone concentrations allows for regulation of estrus and ovulation (Hansel and Convey, 1983) [12].

In the SP protocol the mean serum progesterone concentrations on day 0, 3, 6 and 9 were 1.22±0.12, 4.01±0.16, 6.34±0.28 and 3.22±0.16 ng/ml, respectively. The concentration was increased from day 0 to day 6 and it fallen by day 9. The literatures available on these findings were scanty to compare and contrast. Principally, the reason for the use of gonadotrophin especially PMSG, is to induce a mild super ovulation. This phenomenon is reported to cause increased twining percentage in less prolific breeds of goats and sheep (Delgadillo *et al.*, 2009) [8].

There was no significant (p<0.05) difference in the progesterone concentration in Control, GPG and PPG groups and the concentrations were significantly (p<0.05) lower, when compared with the SPG and SP groups on day 3, day 6 and day 9. The higher mean progesterone concentration observed on day 6 in SPG and SP protocols were due to the progestagens inserted in vagina and the immediate falling of progesterone is due to the removal of sponges.

The mean serum progesterone concentrations in Control, GPG, PPG, SPG and SP on the day of estrus were 0.72±0.05, 0.76±0.03, 0.77±0.02, 0.78±0.04 and 0.68±0.03, respectively. The statistical analysis revealed that, there was no significant (p<0.05) difference among the groups treated with different protocols when compared with the Control. The concentrations observed in the study were in accordance with the findings of Kunbhar *et al.* (2019) [15] in Kamohri goat does, Yede *et al.* (2021) [33] in Surti goats.

4.2 Estrus Synchronization

4.2.1 Estrus response rate

In the present investigation, the estrus response rate is significantly (p<0.05) higher in the treated groups (GPG, PPG, SPG and SP) over the Control. It is an indication that the synchronization protocols resulted higher estrus response rate than the Control.

The estrus response rate in GPG (ovsynch) protocol is 80 per cent. However, lower estrus response of 71% was reported by Riaz *et al.* (2012) [27] in beetal and dwarf does and 75% estrus response reported by Panicker *et al.* (2015) [21] in Malabari crossbred goats. Whereas, higher estrus response of 100% was observed by Senthil Kumar *et al.* (2016) [29] in Tellicherry goats, Cinar *et al.* (2017) [6] in hair goats and Panjaitan *et al.* (2020) [22] in Kacang goats.

The estrus response rate in PPG protocol was 80% whereas, higher estrus response of 97% was observed by Bitaraf *et al.* (2007) [4] in Nadooshani goats, 100% by Riaz *et al.* (2012) [27] in Beetal and dwarf goats, Osman and Elzagafi 2016[20] in Desert goats, Biradar *et al.* (2019) [3] in Malabari goats and Parmar *et al.* (2020) [23] in Surti goats.

Estrus response rate in SPG protocol was 75%; the present findings were in agreement with Martemucci and Alesandro (2011) [16] in dairy goats and the literature available on this protocol is scanty.

In the present study estrus response rate observed in SP protocol was 95%, the similar findings (100%) were observed by Holtz *et al.* (2008) [13] in Boer goats. Whereas, lower findings were reported by Omontese *et al.* (2013a) [19] in Red Sokoto does (82.1%) and 73.8% in Sahel goats (Omontese *et al.*, 2012) [18].

The estrus response rate was 50% in the Control group which were not received any treatment in the present study. Whereas Dash *et al.* (2019) [7] reported 55% estrus response in Black Bengal does and Kavitha *et al.* (2018) [14] reported 70% in non-descript does. 100% estrus response was observed by Parmar *et al.* (2020) [23] in Surti goats and Osman and Elzagaffi 2016 [20] in Desert goats. 88% estrus response was observed by Bowdridge *et al.* (2013) [5] in Boer goats.

In the present investigation estrus response rate found in different groups were 50, 80, 80, 75 and 95% in Control, GPG, PPG, SPG and SP, respectively. The statistical analysis revealed that, there was significant (p<0.05) difference in estrus response rate among the does treated with different protocols. The highest estrus response rate was found in SP protocol (95%). The GPG and PPG protocols were shown 80% estrus response rate in each, followed by SPG (75%) and Control (50%). The results revealed that through the SP

protocol significantly (p<0.05) higher estrus response can be achieved in the local goats.

4.2.2 Onset of estrus

The present study, the time taken for onset of estrus in GPG group from second GnRH injection (9th day) was 52.38 ± 3.23 hours whereas, lesser time for onset of estrus was reported that in Tellicherry goats as 36.55 ± 0.60 hours (Senthil Kumar *et al.*, 2016) [29] and malabari cross bred goats as 49.92 ± 1.94 hours (Panicker *et al.*, 2015) [21].

The present findings shown the time taken for onset of estrus from GnRH injection in PPG protocol from 9th day was 65.25 ± 3.23 hours whereas, higher time for onset of estrus was recorded by Osman and Elzagafi 2016 [20] in desert goats as 69.60±0.65 hours, lesser time for onset of estrus was reported by Bitaraf *et al.* (2007) [4] in Nadooshani goats as 26 hours, Riaz *et al.* (2012) [27] in Beetal and dwarf goats as 36.0±1.2 hours, Omontese *et al.* (2013) [17] in Red sokoto does as 32.1±2.3 hours and Parmar *et al.* (2020) [23] in Surti goats as 52.33±1.35 hours.

In the present study time taken for onset of estrus in SPG group from GnRH injection on 9th day was 45.00 ± 3.34 hours whereas, lesser time (34.7±6.70 hours) for onset of estrus was reported by Martemucci and Alesandro (2011) [16] in dairy goats and the literature available is scanty to compare and contrast the present findings.

In the SP protocol time taken for onset of estrus was 32.42±2.96 hours after removal of sponges; the present findings were within the range of the reports of Omontese *et al.* (2013) [17], Andhrabi *et al.* (2015) [2], Holtz *et al.* (2008) [13], Omontese *et al.* (2012) [18] 29.3 ± 4.6, 30.6 ± 10.1, 37 and 38.4 ± 9.6 hours, respectively.

The time taken for onset of estrus was 124.30 ± 4.08 hours in the Control group. Whereas, higher time for onset of estrus observed by Osman and Elzagaffi 2016 [20] (181±45.51 hours) in desert goats. In the present investigation onset of estrus found in different groups were 124.30±4.08, 52.38±3.23, 65.25±3.23, 45.00±3.34, and 32.42±2.96 hours in Control, GPG, PPG, SPG and SP, respectively. The statistical analysis revealed that, there was significant (p<0.05) difference in onset of estrus among the does treated with different protocols. There was no significant (p<0.05) difference between the SP and SPG (32.42±2.96 & 45.00±3.34); GPG and PPG (52.38±3.23 & 65.25±3.23); GPG and SPG (52.38±3.23 & 45.00±3.34) protocols. The Control group was shown significantly (p<0.05) higher time for onset of estrus (124.30±4.08 hours) than the treatment groups.

4.2.3 Duration of estrus

The duration of estrus observed in GPG protocol was 38.25±1.90 hours. This was in agreement with the findings of Pujar *et al*. (2016) [24] in Osmanabadi goats. Whereas, higher duration (44.7±4.9) was reported by Riaz *et al.* (2012) [27] in Beetal and Dwarf goats, lower duration of estrus was observed in Telicherry goats (Senthil Kumar *et al.* 2016) [29] and Malabari crossbred goats (Panicker *et al.* 2015) [21] were 32.60±0.73, 35.05±4.79 hours, respectively.

The duration of estrus observed in present study using PPG protocol was 45.38±1.89 hours, which was in agreement with the findings of Omontese *et al.* (2013) [17] in Red sokoto does (41.1±0.9 hours) and Riaz *et al.* (2012) [27] in Beetal and dwarf goats (47.1±2.9 hours). Whereas, lower duration of estrus was reported by Bitaraf *et al.* (2007) [4] in Nadooshani goats as 22.0±0.3 hours, Osman and Elzagaffi (2016) [20] in Desert goats as 20.80±0.13 hours and Parmar *et al.* (2020) [23] in Surti goats as 28.72±0.54 hours.

The observed duration of estrus in SPG group was 32.33±1.97 hours; the present findings lower when compared with the findings of Kavitha *et al.* (2018) [14] in non-descript goats (42.20±1.32 hours). The duration of estrus observed in SP protocol was 52.21±1.75 hours; which was higher than the reports of Holtz *et al.* (2008) [13], Omontese *et al.* (2012) [18] and Kavitha *et al.* (2018) [14] as 26.6±4.8, 23.1±5.2, 49.50±0.94 hours, respectively. The observed duration of estrus in Control group was 28.30±2.41 hours. Higher duration was reported by Kavitha *et al.* (2018) [14] in non-descript does as 40.93±1.49 hours. Whereas lower duration of 22.20±0.53 hrs observed by Osman and Elzagaffi (2016) [20] in Desert goats.

In the present study the mean duration of estrus in Control, GPG, PPG, SPG and SP groups of does were 28.30±2.41, 38.25±1.90, 45.38±1.89, 32.33±1.97 and 52.21±1.75 hours, respectively. The data analysis revealed that, there was significant (p<0.05) difference among the does treated with different protocols. The higher duration of estrus was observed in SP group (52.21±1.75 hours); However there was no significant (p<0.05) difference between SP and PPG (52.21±1.75 vs 45.38±1.89 hours); PPG and GPG (45.38±1.89 vs 38.25±1.90 hours); SPG and GPG (32.33±1.97 vs 38.25±1.90) while lower duration was found in Control group (28.30±2.41 hours).

5. Acknowledgments

Authors thank the higher authorities of PVNRTVU, Telangana for providing the necessary facilities and financial support throughout the research program. Thanks to In-charge Livestock Research Station for their help throughout the research work. We wish to acknowledge the hard work and sincerity of the staffs of the Livestock Research Station, Mahabubnagar.

6. Conflict of interest

The authors have no conflict of interest to declare.

7. Appendix

GnRH - Gonadotropin Releasing Hormone.
$PGF_2\alpha$ - Prostaglandin F_2 Alpha.
PMSG - Pregnant mare serum gonadotropin.

8. References

1. Abdullah R, Wan Khadijah WE, Rahman ANMA. Estrus synchronization and superovulation in goats: A review. Journal of Biological Sciences. 2008;8:1129-1137.
2. Andrabi SMH, Anwar M, Mehmood A. Efficacy of Short term estrus synchronization protocols and timed artificial insemination in sub-tropical goats. Journal of Animal and Plant Science. 2015;25:298-300.
3. Biradar V, Magnus Paul K, Simon S, Kurien MO, Lali FA, Gleeja VL. Efficiency of three different protocols of oestrus synchronization in malabari goats. The Pharma Innovation Journal. 2019;8:143-146.
4. Bitaraf A, Zamiri MJ, KAF FM, Izadi FJ. Efficacy of CIDR, fluogestone acetate sponges and cloprostenol for estrus synchronization of Nadooshani goats during the breeding season. Iranian Journal of Veterinary Research. 2007;8:218-224.
5. Bowdridge EC, Knox WB, Whisnant CS, Farin CE. NC Synch: A novel, progestagen-free protocol for ovulation

synchronization and timed artificial insemination in goats. Small Ruminant Research. 2013;110:42-45.
6. Cinar M, Ceyhan A, Yilmaz O, Erdem H. Effect of estrus synchronization protocols including PGF2α and GnRH on fertility parameters in hair goats during breeding season. Journal of Animal Plant Sciences. 2017;27:1083-1087.
7. Dash S, Mohanty DN, Mohapatra SK. Comparison of efficacy in different protocols for induction and synchronization of estrus and pregnancy diagnosis methods in black Bengal does. The Pharma Innovation Journal. 2019;8:799-802.
8. Delgadillo JA, Gelez H, Ungerfeld R, Hawken PA, Martin GB. The 'male effect' in sheep and goats-revisiting the dogmas. Behavioural Brain Research. 2009;200:304-314.
9. Fonseca JF, Torres CAA, Costa EP, Maffili VV, Carvalho GR, Alves NG, *et al*. Progesterone profile and reproductive performance of estrus-induced Alpine goats given hCG five days after breeding. Animal Reproduction. 2018;2:54-59.
10. Geary TW, Whittier JC, Downing ER, Le Fever DG, Silcox RW, Holland MD, *et al*. Pregnancy rates of postpartum beef cows that were synchronized using Syncro-Mate-B® or the Ovsynch protocol. Journal of Animal Science. 1998;76:1523-1527.
11. Gupta PP, Nikhil Kumar Tej J, Johnson P, Nandi S, Mondal S, Kaushik K, *et al*. Efficiency of different synchronization protocols on oestrus response and rhythmic changes in 17β-oestradiol and progesterone hormone concentration in Salem Black goats. Biological Rhythm Research. 2021;52:11-21.
12. Hansel W, Convey EM. Physiology of the estrus cycle. Journal of Animal Science. 1983;57:404-424.
13. Holtz W, Sohnrey B, Gerland M, Driancourt MA. Ovsynch synchronization and fixed-time insemination in goats. Theriogenology. 2008;69:785-792.
14. Kavitha K, Joseph C, Sarath T, Pugazharasi C. Effect of different doses of PMSG for synchronisation of estrus in progesterone primed goats. Int. J Curr. Microbiol. App. Sci. 2018;7:3066-3071.
15. Kunbhar HK, Memon AA, Leghari RA, Memon MI, Korejo NA. Determination of early pregnancy through plasma progesterone concentration in kamori goat: Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences. 2019;35:63-66.
16. Martemucci G, D Alessandro AG. Induction/synchronization of oestrus and ovulation in dairy goats with different short term treatments and fixed time intrauterine or exocervical insemination system. Animal reproduction science. 2011;126:187-194.
17. Omontese BO, Rekwot PI, Ate IU, Ruwaan JS, Makun HJ. Oestrus behaviour and conception rates of red sokoto goats following treatment with equine chorionic Gonadotrophin and Prostaglandin. Nigerian Veterinary Journal 34, 2013.
18. Omontese BO, Rekwot PI, Makun HJ, Ate IU, Rwuaan JS. Induction of estrus in Sahel goats using Fluorogestone acetate (FGA) sponges and equine chorionic gonadotrophin (eCG). Sokoto Journal of Veterinary Sciences. 2012;10:21-25.
19. Omontese BO, Rekwot PI, Makun HJ, Ate IU, Rwuaan JS, Kawu MU. Oestrus induction using fluorogestone acetate sponges and equine chorionic gonadotrophin in Red Sokoto goats. South African Journal of Animal Science. 2013a;43:68-73.
20. Osman EEI, Elzagafi MH. Effect of two PF2α injections on estrus synchronization and some reproductive traits during non-breeding season in desert goats. International Journal of Veterinary Science. 2016;5:299-301.
21. Panicker SS, Kanjirakuzhiyil P, Koodathil R, Kanakkaparambil R. Oestrus response and conception rate in Malabari cross-bred goats following two different oestrus synchronization protocols. Journal of Animal Health and Production. 2015;3:39-42.
22. Panjaitan B, Dewi A, Nasution FF, Adam M, Siregar TN, Thasmi CN, *et al*. Comparison of Estrus Performance and Progesterone Level of Kacang Goats Induced by PGF2α versus Ovsynch Protocol. In E3S Web of Conferences. 2020;151:01-045.
23. Parmar CP, Dhami AJ, Patel JA, Belsare VP. Efficiency of different estrus synchronization protocols in Surti goats. The Indian Journal of Veterinary Sciences and Biotechnology. 2020;15:21-23.
24. Pujar C, Puro NA, Markandeya NM, Mali AB, Kumawat BL. Studies on efficacy of selectsynch and ovsynch protocols for induction and synchronization of estrus in Osmanabadi goats. International Journal of Science Environment and Technology. 2016;5:4069-4073.
25. Pursley JR, Wiltbank MC, Stevenson JS, Ottobre JS, Garverick HA, Anderson LL. Pregnancy rates per artificial insemination for cows and heifers inseminated at a synchronized ovulation or synchronized estrus. Journal of Dairy Science. 1997;80:295-300.
26. Rekwot PI, Ogwu D, Oyedipe E, Sekoni VO. The role of pheromones and biostimulation in animal reproduction. Animal reproduction science. 2001;65:157-170.
27. Riaz H, Sattar A, Arshad MA, Ahmad N. Effect of synchronization protocols and GnRH treatment on the reproductive performance in goats. Small Ruminant Research. 2012;104:151-155.
28. Rubianes E, Menchaca A. The pattern and manipulation of ovarian follicular growth in goats. Animal Reproduction Science. 2003;78:271-287.
29. Senthil Kumar K, Selvaraju M, Napolean RE, Doraisamy KA, Mohan B. Pattern of Oestrus and Fertility Rate Following Synchronization of Ovulation in Tellicherry Goats. International Journal of Science Environment and Technology. 2016;5:3289-3296.
30. Snedecor GW, Cochran WG. Statistical methods. Eighth Edn. Iowa State University Press, 1994.
31. Stevenson JS, Kobayashi Y, Thompson KE. Reproductive performance of dairy cows in various programmed breeding systems including Ovsynch and combinations of gonadotropin-releasing hormone and prostaglandin F2α. Journal of Dairy Science. 1999;82:506-515.
32. Ungerfeld R, Rubianes E. Short term primings with different progestogen intravaginal devices (MAP, FGA and CIDR) for eCG-estrous induction in anestrus ewes. Small Ruminant Research. 2002;46:63-66.
33. Yede AB, Khasatiya CT, Singh VK, Kumar D. Rhythmic Changes in Serum Progesterone and Estradiol-17β in Surti Goats under Different Synchronization Protocols. Indian Journal of Animal Research. 2021;1:6.