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Synchronization of ovulation in goats using prostaglandin F2α based protocols during the breeding season

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ABSTRACT

The main aim of this review was to describe the feasibility of prostaglandin F2α (PGF2α) based protocols used as a tool for ovulation synchronization in cycling goats. There is a reproductive seasonality in small ruminants. However, from latitudes 45° towards equator, the intensity of anoestrus progressively decreases and tends to disappear in local breeds. Consequently, PGF2α or their synthetic analogues as luteolytic substances can assume a great importance in reproductive management of flocks from these regions. However, a single or double (9–11 days apart) PGF2α administration provokes a good induction but a moderate synchronization of ovulations if timed artificial insemination is considered, and a significant short oestrous cycle can occur with detrimental effects on fertility rate when compared with conventional progesterone-based protocols. In order to minimize this constraint, some gonadotropin-releasing hormone-PGF2α-gonadotropin-releasing hormone (Ovsynch)-based protocols and their modifications, manipulating the dominant follicles and corpora lutea, were successfully tested in goats. Similar to cows, these PGF2α based protocols seem to be a promising and more cost-effective tool for reproductive management in cycling goats.

1. Introduction

Goats and ewes show a marked reproductive seasonality mainly due to a photoperiod effect. The annual variation of the daily luminosity duration is perceived by the retina of these animals and a neurohormonal pathway involving suprachiasmatic nucleus, sympathetic neurons, and the pineal gland was responsible for production of melatonin, a key hormone, during short days/darkness periods[1-3]. Consequently, melatonin stimulates a neuronal network which modulates the hypothalamic secretion of gonadotropin-releasing hormone (GnRH)[3], and the hypothalamic-pituitary-gonadal axis is stimulated. From a latitude > 25°, most of the local breeds progressively present an anoestrous period with variations in duration (3 to 7–8 months) and intensity (originating up to 100% of anoestrous females), during the natural long days[4,5].

In order to inseminate females out of season, several hormonal, natural or mixed protocols were developed for estrus and ovulation synchronization. These protocols were recently reviewed[6]. However, a demand of artificial inseminations also occurs during breeding season. Moreover, from regions at latitude less than 45° towards the equator, a progressive percentage of females remain (Spain; latitude 37° N) or can remain (Mexico; latitude 26° N) cyclic during whole year[5,7]. In fact, parturitions of goats can occur in all months under natural circumstances of mating (Figure 1).

Although classical hormonal protocol used during anoestrous season can also synchronize ovulations during the breeding season, other protocols more cost-effective can be used in cyclic goats during the breeding season, mainly in regions showing less marked seasonal reproductive activity of small ruminants.

The main aim of the present review was to describe useful methods for ovulation synchronization in goats, based on prostaglandin F2α (PGF2α) protocols during breeding season and to suggest the pathways for a more rational use of hormones for

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reproductive management in goats industry.

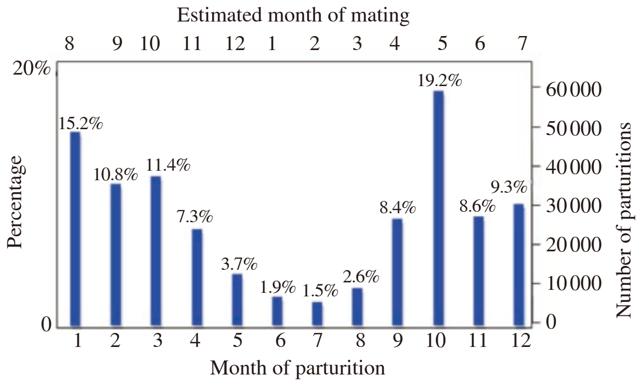

Figure 1. Monthly distribution of natural parturitions (n = 292 950) after natural mating in Serrana goats (an indigenous Portuguese breed) from 1987 to 2015 (mainly at latitude 39° N–41° N), according to the data obtained at Ruralbit (online Genpro® software; www.ruralbit.pt/).
Data of abortion was removed. Estimation of natural mating (month) = month of parturition – 5 months (Unpublished data).

2. The classical hormonal protocol for ovulation synchronization in flocks

The classical hormonal protocol in goats, during non-breeding and breeding season, is based on a 11-day progesterone (P4) or their synthetic analogs (progestagens) priming + equine chorionic gonadotropin (eCG) + PGF2α substances followed by a timed artificial insemination (TAI) with frozen or refrigerated straws 43 to 46 h after sponge withdrawal[4,8].

Progestagens modulate the pituitary luteinizing hormone secretion, inducing a negative feedback, modifying the hypothalamic GnRH activity[9], followed by a preovulatory luteinizing hormone surge after device withdrawal, in order to improve the development of follicles, including the preovulatory follicle(s), in females. In anoestrous goats, the eCG or a similar effect (such as male effect) is absolutely necessary for preovulatory follicles development. At time of progestagen/P4 device withdrawal or before 24–48 h[10], PGF2α or their synthetic analogues and eCG are administered intramuscularly in order to promote the quickly functional luteolysis of the corpora lutea (if present), and the development of antral (preovulatory) follicle(s), respectively. The occurrence of the luteolysis is crucial for ovulation occurrence in goats that present corpora lutea.

Leyva *et al*. observed that the progestagen/P4 priming increased the number of follicles stimulated by eCG and consequently the ovulation rate in anestrous ewes[11]. Moreover, the progestagen priming can synchronize the ovulatory wave[12]. At 5 to 7 days, short progestogen priming protocols were used, at least in some regions, in order to rationalize the use of progestagens or exogenous P4 without fertility decrease[12,13].

The exogenous P4 also can play an important role in order to improve fertility in cyclic females. This aspect was well evidenced in high lactating dairy cows. In fact, subluteal levels of endogenous P4, due to their high hepatic metabolism provoked by an increase of hepatic blood flux (greater ingestion of dry matter), appear to be a major cause of fertility decrease in this species[14].

Probably due to the expected fertility rate more than 50%, the usefulness of conventional protocols and the well-defined anoestrus season in countries located at high latitudes, progestagens/P4 based protocols were highly used in flock reproductive management. However, PGF2α based protocols can be more used during breeding season, at least in regions at latitude < 45°, followed by (timed) artificial insemination or natural mating.

3. Use of PGF2α based protocols

Like cows, the induction of estrus/ovulation can be made in cycling ewes and goats with PGF2α or their synthetic analogues by a single administration or two administrations 9–11 days apart[15,16]. In this last case, all irresponsive females at proestrus, estrus or early metaestrus (up to 2–3 days after ovulation) to first administration can be also synchronized at the second administration time.

The PGF2α induced ovulation is effective under different

Table 1
Estrus, time of ovulation and fertility rate after single or double administration of PGF2α in goats.

PGF2α protocol		Estrus response	Onset of behavioural estrus[a] (h)	Time of ovulation[a] (h)	Fertility rate	References
Cloprostenol 100 μg [single administration intramuscularly (n = 30)] on:	Early luteal phase[1]	100%	43.4 ± 3.2	-	-	
	Mid-luteal phase	80%	57.0 ± 2.6			[18]
	Late luteal phase	80%	56.7 ± 2.7			
Cloprostenol 30 μg (two doses, 10 days apart into vulvar submucosa)		79% (11/14)	47.7 ± 10.1	87.5 ± 12.8	55% (6/11)[b]	[19]
PGF2α 7.5 mg (double intramuscular injection 12 days apart)		95% (n = 38)	59.5 ± 4.2	-	80% (16/20)[c]	[20]
Cloprostenol 37.5 μg (double intramuscular injection 10 days apart)		100% (14/14)	36.0 ± 1.2	66.0 ± 2.7	78% (11/14)[c]	[21]

[a]: After (last) PGF2α administration; [b]: Fertilization (frozen-thawed semen 16 to 18 h after the onset of estrus); [c]: Fertilization (natural mating); [1]: The early luteal phase showed a tendency (P = 0.07) for a higher estrus response percentage and for an early (P < 0.01) onset of behavioural estrus in goats than the mid- or late luteal phases.

environmental-nutritive conditions[17]. Normally, the estrus occurs 22 to 78 h after PGF2α administration (Table 1), but the synchronization of the ovulation considering all goats is more disperse than P4 priming protocols. Bowdridge *et al*. suggested that two injections of prostaglandin separated by a period of 14 days can aid to synchronize estrus and ovulation[22]. However, the rate of response is high, reaching 90%–100%, for example, the PGF2α alone promotes a good induction but a moderate synchronization of ovulation in flocks for TAI.

In order to minimize this problem, the detection of estrus should be implemented and a single TAI should be performed 12 h or even 16 to 18 h after the onset of estrus[23].

Gonzalez-Bulnes *et al*. suggested that the better response to PGF2 observed during the early than middle or later oestrus cycle phases is due to the lack of ovarian follicular waves synchronization in goats regarding the previous estrus phase, when normally a new follicular wave emerge[18]. However, no difference on periovulatory events were observed at latitude 3° N when cyclic goats were synchronized with the administration of 125 μg of cloprostenol or the aplication of a controlled internal release device impregnated with 0.3 g of P4 suggesting that this PGF2α based single protocol can be useful in their region[24].

In order to reduce the PGF2α dose, Duque-Bonisoli *et al*. at latitude 10° N observed that the percentage of goats in estrus and the interval between treatments to onset of estrus remained similar when 87.50, 43.75 or 26.25 μg of cloprostenol were administered intramuscularly[25]. These researchers also evidenced that the subsequent corpora lutea generated were similar among all three groups.

A major limitation of the PGF2α use is the surge of short oestrous cycles and consequentially a detrimental effect on fertility. A lower fertility rate of PGF2α than P4 sponges protocol (67% *vs*. 80%) was observed by Kusina *et al*.[26], and this can be due to deficiencies in the growth and functionality of luteal tissue[27]. In fact, a greater limitation of PGF2α, used mainly without P4, priming is the occurrence of short estrus cycles (luteal insufficiency)[28]. It also shows in superovulated goats; this early luteal regression is caused by the premature release of endogenous PGF2α and can be minimized by use of progestagens/P4[29,30].

Meanwhile, the GnRH–PGF2α–GnRH (Ovsynch)-based protocols given on Day 0, 7 and 9, respectively, or their subsequent modifications with and without P4 priming similar to those used on cows, were tested with success in goats[14,31,32]. The Ovsynch protocol is based on the premise that the first GnRH administration can control the evolution of a healthy dominant follicle before the induced luteolysis of the corpora lutea[33]. The Ovsynch protocol reached a pregnancy rate of 58% (14/24) when TAI was performed 16 h after the second GnRH administration and 66% (6/10) after natural mating in goats[21,31].

Bowdridge *et al*. reported that the NCSynch-TAI treatment protocol (PGF2α-GnRH-PGF2α-GnRH) is based on an Ovsynch protocol plus a presynchronization treatment using PGF2α with TAI (thawed frozen semen) at 72 h after the second PGF2α administration (Figure 2)[22]. The proportion of goats (n = 66) in estrus was 73%. Moreover, all 66 goats were inseminated with frozen semen and the overall pregnancy rate was 68% (45/66). This protocol is similar to some Presynch-Ovsynch protocols used in cows, which aimed to induce the presence of a mature dominant follicle at onset of the Ovsynch treatment.

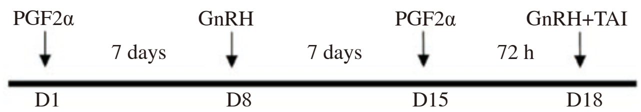

Figure 2. Schematic representation of the NCSynch-TAI protocol in goats[22].

These preliminary results indicate that the Ovsynch protocols or their modifications are promising to synchronize ovulations in goats.

4. Conclusion

PGF2α based protocols and their evolution, without P4 or progestagens sponge can be used in cycling goats during the breeding season, reaching reproductive indexes similar to the conventional protocols. In consequence, the reproductive management of flock can be more economical and improve the green production.

Conflict of interest statement

I declare that I have no conflict of interest.

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