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An update on oestrus synchronisation of goats in Nigeria

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ABSTRACT

This review is aimed at providing information on current status of oestrus synchronization as a management tool in goats in Nigeria. Oestrus synchronisation is a reproductive tool that enables goat farmers breed their animals within a short pre-determined period. The principle of oestrus synchronisation is chiefly the control of the luteal phase of the oestrous cycle and two basic mechanisms are employed. These include the use of prostaglandins or its analogues to shorten luteal life/induce premature luteolysis or the use of exogenous progesterone to prolong luteal life, thereby simulating the activity of natural progesterone produced by the *corpus luteum*. The latter is advantageous where the reproductive status of the flock is unknown. However, the former is easy to apply and only effective in cycling animals. Pharmaceutical products that have been employed in ES protocols in Nigeria include Lutalyse®, Estrumate®, EstroPLAN®, Fluorogestone acetate®, Sil-Oestrus®, Medroxyl-progesterone acetate®, Synchromate-B®, PMSG®, and more recently, the Controlled Internal Drug Release® (CIDR) devices. Over the last three decades, many attempts have been made at assessing the response of goats to various oestrus synchronisation agents and protocols in Nigeria. However, the low availability of these pharmaceutical agents and cost preclude the widespread use of oestrus synchronisation technique in goat production. The inclusion of gonadotrophins in oestrus synchronisation protocols have been reported to improve oestrus responses in goats, while season has been reported to influence the efficiency of oestrus synchronisation programmes. Increasing the dose levels of exogenous hormones in oestrus synchronisation protocols has caused variable and sometimes inconsistent effects. The effects of combining the male stimulus with exogenous hormones, seasonal variation, extra-label use of products and short-term nutritional manipulation on oestrus responses in goats require further evaluation. It is concluded adoption of oestrus synchronisation practice portends enhanced goat production in Nigeria.

1. Introduction

Goats, also known as the “poor man's cow” are an important source of food in Nigeria [1,2]. They are the most prolific of all domesticated ruminants under tropical and subtropical conditions and are able to breed throughout the year [3]. They provide meat, milk and skin, and other by-products such as manure to maintain soil fertility [4]. Goats are hardy animals and are ubiquitous in Nigeria. The Nigerian goat population is the largest in Africa and the 4th largest in the world after India, China and Pakistan [5,6]. Goat production in Nigeria is essentially a traditional management system, involving mainly household units [2]. The three recognized breeds of goats in Nigeria are: Red Sokoto, which accounts for over 65% of the goat population and is the usual village goat in the Northern two-thirds of Nigeria; the West African Dwarf, found predominantly in the tropical rainforest and derived Savannah ecological zone; and the Sahel breed of goats, also called White Borno goats, found in the Northern fringes of the country [7–9]. The rapid population growth and increased cost of living have necessitated a shift in the meat consumption habit of urban

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elites, who now own backyard goat and sheep flocks to supplement beef, fish and poultry sources [9]. In order to meet this growing demand for animal protein, an intensive goat production industry, involving oestrus synchronisation, twice yearly kidding and feedlot fattening of kids in Nigeria, is advocated [10].

Over the years, many attempts at controlling the productivity of goats have been evaluated by investigators in Nigeria. The application of techniques and practices to ensure genetic improvement in livestock is referred to as assisted-reproductive technologies (ARTs) [11–13]. Oestrus synchronization is one of such reproductive management technologies that enables concentrated breeding that ensures uniform kid crop and proper management of pregnant does. With this technology, farmers are able to use more efficiently complementary techniques for reproductive management, including artificial insemination (AI), multiple ovulation and embryo transfer (MOET), such that genetic material is more easily obtained or transferred domestically and internationally [14,15]. Exogenous hormones are used to modify the physiological chain of events involved in the sexual cycle, while the non-hormonal methods of oestrus synchronisation involve the use of light control or exposure to a male. In the doe, the window of opportunity is generally greater during the luteal phase, which is of longer duration and more responsive to manipulation [14,16]. It is essential that any oestrus synchronisation technique should not only establish synchrony, but also ensure reasonable levels of fertility in the synchronized cycle [11].

The advantages of oestrus synchronisation in goats include, amongst others, better oestrus detection, increased application of AI, MOET, shortening of kidding intervals, concentration of kid crop, improved management of pregnant does, induction of puberty in doelings and the more efficient use of labour and animal facilities [11,12,17]. Importantly, oestrus synchronisation is vital in does because there exists some variability in the duration of both the oestrous cycle and oestrus; and, especially, because oestrus detection cannot be accomplished safely without a buck [18]. Does are in oestrus when they stand to be mounted by a buck. In addition, creamy vulval discharge may be observed during oestrus in oestrual goats [19,20]. It is important to note that the effectiveness of an oestrus synchronisation programme depends on many intrinsic and extrinsic factors [21]. The objective of this review is to describe common agents and protocols that have been used for oestrus synchronisation of goats in Nigeria, and to provide an insight into future research considerations in this area of endocrine control of reproduction in goats.

2. Prostaglandins and their synthetic analogues

An easy-to-apply method of oestrus synchronisation in goats is by the use of prostaglandins to cause luteolysis so as to induce the subsequent follicular phase of the oestrous cycle. In small ruminants, prostaglandin $F_{2\alpha}$ is the primary luteolytic agent [22]. Since consumers demand food produced by "clean, green and ethical" methods [23], prostaglandins are a good alternative to progestagens. This is because prostaglandins are rapidly metabolized in the lungs and therefore, do not accumulate in tissues [24]. Prostaglandins are mainly administered intramuscularly and subcutaneously, although the intravulvo-submucosa route has been investigated with varying success [25–28].

Several synthetic analogues have been used to induce rapid regression of the *corpus luteum.* Although natural $PGF_{2\alpha}$, causes normal luteolysis through gradual degenerative changes, synthetic analogues of $PGF_{2\alpha}$ usually have a more rapid and dramatic effect on progesterone synthesis in the lutein cells [17]. *Dinoprost thromethamine* marketed as Lutalyse® and Carboprost® are frequently used natural prostaglandins, while cloprostenol sodium, marketed as Fenprostenol®, Estrumate® and EstroPLAN®, is a synthetic prostaglandin [29,31]. The earliest report on the use of prostaglandin $F_{2\alpha}$ for oestrus synchronisation in goats in Nigeria was by Ogunbiyi *et al.* [32], who demonstrated that double administration of prostaglandin, administered 11 days apart, resulted in higher oestrus response in Red Sokoto goats (64% versus 84%; single versus double, respectively). Akusu MO and Egbunike GN [33] administered two *i.m.* injections of 0, 5, or 10 mg of dinoprost thromethamine (Lutalyse®; Pharmacia and Upjohn Co., Kalamazoo, MI), 11 d apart (0 dose was administered sterile water only) to WAD does. Dinoprost thromethamine treatment synchronised oestrus by decreasing average time to first oestrus by approximately 2 weeks. Kawu [10] found that 7.5 mg of dinoprost thromethamine, administered *i.m.* was effective in synchronising oestrus in the three different seasons (hot-dry, rainy and harmattan) in Nigeria, although the highest oestrus response of 80% was recorded in the cold-dry (harmattan) season compared to the 20% response observed both in the hot-dry and rainy seasons. In the same study, Red Sokoto does exhibited oestrus within 96 h after treatment, with 25% of does experiencing short cycles. In Red Sokoto goats, Umaru *et al.* [34] evaluated single doses of 50 μg, 75 μg and 100 μg of cloprostenol sodium (Estrumate®; Schering-Plough Animal Health) administered *i.m.*, with 100% of does in oestrus at the end of treatment. This finding suggests that the three doses were equally efficient in oestrus synchronisation in Red Sokoto does. In another study to evaluate the effect of equine chorionic gonadotrophin (eCG) administration at the end of prostaglandin treatment on oestrus response in Red Sokoto and Sahel does, higher response was observed in does treated with a combination of eCG and $PGF_{2\alpha}$ than does treated with $PGF_{2\alpha}$ or eCG alone [35,36]. The results suggest that eCG enhances the efficacy of prostaglandin based oestrus synchronisation in does.

Factors reported to affect oestrus response and subsequent fertility following administration of prostaglandin or its analogues include the dose level of the prostaglandin [10,30,33,37], the interval between administration of the prostaglandin [10,33,38], the responsiveness of the *corpus luteum* to the prostaglandin/stage of the oestrus cycle [10,39], season [10] and the inclusion of gonadotrophins as co-treatment [35]. Several gonadotrophins such as follicle-stimulating hormone (FSH), pregnant mare serum gonadotrophin (PMSG) and gonadotrophin-releasing hormone (GnRH) have been included in the prostaglandin protocols, resulting in improved oestrus response rates [12,17,35]. Prostaglandins should be administered from day 3 of the oestrus cycle, when the *corpus luteum* of the goat is responsive to $PGF_{2\alpha}$ [40].

Prostaglandins have the major advantage of being administered by intramuscular injection besides the reduction in hormonal residues, since it is rapidly and almost completely metabolized in the lungs [41]. Following prostaglandin administration, compromised follicular function has been reported leading to variability in the timing of ovulation [42].

However, this variability may be eliminated by the use of the male effect [43–45], pre-treatment with progestagens or concurrent administration of gonadotrophins so as to increase LH secretion [19,31,35]. Prostaglandins may be used throughout the entire year in tropical breeds, although Kawu [10] reported that the highest oestrus response of Savannah Brown does to prostaglandin treatment occurs during the cold-dry season. It is worthy of note that administration of $PGF_{2\alpha}$ will cause abortion at any trimester of pregnancy in goats [46]. Akusu and Egbunike [33] reported oestrus response to range from 87%–100% in WAD does, treated with 5 mg or 10 mg dinoprost thromethamine, respectively. This finding is similar to the 100% reported by Oyeyemi *et al*. [47] in WAD goats treated with 10 mg natural prostaglandin 11 days apart. In another study, Akusu [48] observed that the efficacy of prostaglandin treatment may be influenced by parity in WAD does. In a related study to evaluate the effect of dose of prostaglandin on oestrus response, Alemede and Fasanya [49] reported higher oestrus response in Red Sokoto does treated with 10 mg $PGF_{2\alpha}$ than in does treated with 7.5 mg $PGF_{2\alpha}$ (Table 1). However, Akusu and Egbunike [33] reported that 100% of WAD does in the 5 mg $PGF_{2\alpha}$ group treatment were in oestrus within 72 h post-

Table 1

Some exogenous hormones used for oestrus synchronisation of goats in Nigeria.

Name	Active ingredient	Dose	Route
Lutalyse®	Dinoprost thromethamine	5 mg/mL	Intramuscular
Estrumate®	Cloprostenol sodium	250 µg/L	Intramuscular
Synchromate-B® ear insert	Progesterone & oestradiol	6 mg	Subcutaneous
Depo provera® (MPA)	Medroxyprogesterone acetate	5 or 10 mg	Intramuscular
PMSG	Equine chorionic gonadotrophin	5000 IU	Intramuscular
Eazi-Breed® CIDR™	Progesterone	330 mg	Intravaginal
Provera® (MPA)	Medroxyprogesterone acetate	5 or 10 mg	Oral
Chronogest sponges	Fluorogestone acetate	30 mg, 45 mg	Intravaginal

Table 2

An update on oestrus synchronisation of goats in Nigeria.

Breed	Hormone	Protocol	N	Oestrus response (%)	Conception (%)	References
Red Sokoto	PGF2α	7.5 mg 1st & 2nd IM (flushing)	25	64 (1st) & 84 (2nd)	90	Ogunbiyi *et al.*, 1980
WAD	PGF2α	5 mg, 10 mg	10	100, 100	–	Akusu and Egbunike, 1984
Red Sokoto	FGA	30 mg	25	–	–	Pathiraja *et al.*, 1991
Red Sokoto	PGF2α	7.5 mg & 10 mg	18	70 & 75		Alemede and Fasanya, 1999
Savannah Brown	Synchromate-B	3 mg Subcut for 9 days (post-partum interval)	15	40–100		Kawu, 2000
Red Sokoto	$PGF_{2\alpha}$	–	–	–	–	Jatau, 2002
Red Sokoto	$PGF_{2\alpha}$	250 µg 1st & 2nd IM	28	75 & 92.86		Voh (Jr.) *et al.*, 2003
WAD	P_4	100 mg IM	28	–		Egbunike and Ola, 2003
WAD	P_4	–	–	–	–	Ola and Egbunike, 2005
WAD	P_4	12.5 mg, 25 mg, 37.5 mg IM daily for 14 days	24	66, 33 & 36	–	Abu *et al.*, 2008
WAD	MPA	25 mg, 50 mg IM; 5 mg, 10 mg oral for 5 days	40	77, 85; 66, 88	71.4, 62.5, 75, 77.7	Imaseun and Ikhimioya, 2009
Red Sokoto	$PGF_{2\alpha}$	5 mg, 7.5 mg, 10 mg (dose and parity effects in the mid rainy season)	80	4.3, 15.8, 4.8	100, 66, 100	Tauheed, 2010
Red Sokoto	FGA, CIDR	30 mg, 300 mg for 21 days IV	20	20, 55	–	Omontese *et al.*, 2010
Savannah Brown	$PGF_{2\alpha}$	7.5 IM (season)	30	80 (cold-dry), 20 (hot-dry), 20 (rainy)	–	Kawu, 2011
Red Sokoto	FGA, $PGF_{2\alpha}$, Control	30 mg for 12 days IV, 12.5 mg (double) IM	52	33, 55, 37		Bello *et al.*, 2011
Sahel	FGA, FGA + eCG	30 mg for 12 days IV plus 200 IU IM	100	73, 58	–	Omontese *et al.*, 2012
Red Sokoto	$PGF_{2\alpha}$	50 µg, 75 µg, 100 µg	24	100, 100, 100	–	Umaru *et al.*, 2012
WAD	$PGF_{2\alpha}$, P_4, MPA	10 mg IM, 375 mg SC, 60 mg IV	24	100, 100, 100	100	Oyeyemi *et al.*, 2012
Red Sokoto	FGA & CIDR ± eCG	30 mg or 330 mg for 14 days IV, 400 IU, IM	110	22, 84 & 45, 95	100, 87, 89, 80	Omontese *et al.*, 2013a
Sahel	FGA & CIDR ± eCG	30 mg or 330 mg for 14 days IV, 400 IU, IM	110	47, 100 & 57, 74	75, 88, 62, 100	Omontese *et al.*, 2013b
Sahel	$PGF_{2\alpha}$ + eCG	10 mg plus 200 IU IM	36	66, 91, 41		Omontese *et al.*, 2013c
Red Sokoto	$PGF_{2\alpha}$ + eCG	10 mg plus 200 IU IM	30	90, 50, 20	77.78, 80, 100	Omontese *et al.*, 2014

Key: $PGF_{2\alpha}$ = Prostaglandin, CIDR = Controlled Internal Drug Release devices, eCG = Equine chorionic gonadotrophin, IM = Intramuscular, IV = Intravaginal.

treatment as compared to 87.5% of the 10 mg treatment. Thus, it appears that the dose of prostaglandin is less significant compared to the administration protocol, where double injection consistently resulted in higher oestrus response rates than single injection [50]. In female domestic animals, it is often difficult to know the phase of the oestrous cycle in each animal, thus, it is essential that two injections of prostaglandin $F_{2\alpha}$ is administered 9–11 days apart. By so doing, almost all the animals would be in the mid luteal phase of the oestrus cycle and would better respond to the second treatment [12]. Double treatment with cloprostenol sodium administered *i.m.*, 11 days apart, resulted in higher oestrus response (92.8% versus 75%) than single treatment in Red Sokoto does [51]. In studies in WAD goats, parity did not significantly influence the outcome of prostaglandin treatment [33,48] (Table 2).

3. Progesterone and its synthetic analogues

Another method of oestrus synchronisation is by the use of natural progesterone impregnated in sponges, implants or silicon elastomers [13,20,47,52–54], or the use of its synthetic analogues such as norgestomet, fluorogestone acetate (FGA), methylacetoxy progesterone (MAP) and medroxyprogesterone acetate (MPA) [47,54,55]. The progesterone or progestagen treatment is popularly delivered though an intravaginal sponge, intramuscular or subcutaneous routes. Natural progesterone is mainly marketed as Sil-Oestrus® implant and Eazi-Breed® controlled internal drug release devices™ (CIDR). Synthetic analogues are marketed as Chronogest® (Intervet, Angers, France) and Veramix sponges® (Pharmacia & Upjohn, Orangeville, Canada). 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. Factors that affect the success of an oestrus synchronisation programme when progestagens are applied include species, breed, co-treatment, management, stage of the oestrus cycle, duration of treatment and mating system [14].

The use of long-term progestagen treatments have been shown to result in lowered fertility rates [40,56]. On the other hand, decreased periods of progestagen treatment may minimize vaginal discharge and infection, and increase fertility [50,57]. Currently, short-term intravaginal progestagen treatment is advocated [36,40,56–60]. Following withdrawal, does usually show overt oestrus within 48 h. More recently, an alternative means of supplying continuous, exogenous progesterone has been the CIDRs, developed for sheep and goats in New Zealand [52]. It is made from medical silicone elastomer moulded over a nylon core and impregnated with natural progesterone (330 mg). CIDRs are preferable than sponges because they are easy to use, do not cause as much discomfort as sponges and do not adhere to the vaginal wall during use [61]. The addition of gonadotrophins to progestagen protocols ensure a tighter synchrony and/or induces a superovulatory response in treated does [27,62,63].

In a study to evaluate the effect of daily administration of different doses of progesterone (12.5 mg, 25 mg, 37.5 mg) for 14 days on oestrus behaviour of WAD does, Abu *et al.* [20] reported higher oestrus response (66%) in the does treated with the lowest dose of progesterone. Thus, suggesting that oestrus response may not rise with increased dose of progesterone. This is contrary to the report of Imaseun and Ikhimioya [55] in the same breed of goats, where oestrus response increased with higher doses of medroxyprogesterone acetate administered intramuscularly or orally (Table 1). However, a comparison of Sil-oestrus implant (375 mg progesterone) and Veramix® intravaginal sponge (60 mg medroxyprogesterone acetate) showed no difference between doses in the percentage of WAD does in oestrus (100%) [47]. The interval from treatment to onset of oestrus was longer in does treated with Veramix® sponges (66 h) than in does treated with Sil-Oestrus® implant (42 h). The efficacy of norgestomet ear implant known as Synchromate-B (SMB: Rhone-Merieux, Athens, GA), developed for use in cattle was evaluated in post-partum Savannah Brown goats in Nigeria [10]. An oestrus response range of 40–100% was observed in Savannah Brown goats treated with 3 mg norgestomet subcutaneously for nine days [10]. Since it is an extra-label use in small ruminants, it is commonly split into half or one-third of the original implant which contains 6 mg of synthetic progestagen norgestomet [23]. Comparison of natural and synthetic progesterone in Red Sokoto does showed higher oestrus response in primiparous doelings treated with CIDR (55%) than intravaginal sponges (20%), containing 30 mg fluorogestone acetate. The administration of eCG at the end of fluorogestone acetate treatment enhanced oestrus response in Sahel goats [28]. Similarly, eCG administered at the end of CIDR treatment, containing natural progesterone tightened oestrus synchrony in both Sahel and Red Sokoto does [53,54]. Thus, it can be concluded that priming goats in the tropics with progesterone intravaginal sponge improves oestrus response to treatment with gonadotrophins [35,53]. The use of gonadotrophins increases the cost of oestrus synchronisation and is reported to reduce fertility of does in the long-term [14]. Besides, repeated administration of eCG is reported to produce antibodies against eCG (Anti-eCG), thereby causing reduced ovarian stimulation after subsequent treatments [64].

In Red Sokoto does, an interval of 29–45 h from the end of progestin treatment to onset of oestrus and oestrus duration ranging from 22 to 39 h were obtained [35,53]. However, Bello [30] reported an interval of 15–18 h and duration of oestrus period of 42–45 h in Red Sokoto does, following treatment with 30 mg cronolone (Chronogest®). Principally, the reason for the use of gonadotrophin, especially FSH and eCG, is to induce a mild superovulation. This phenomenon is reported to cause increased twining percentage in less prolific breeds of goats and sheep [65]. A dose range of 375–750 IU. of eCG is popularly chosen to synchronise oestrous in sheep and goats. In Nigeria, studies conducted using Sahel and Red Sokoto goats showed that effective dose of eCG in goats ranged from 200 to 400 IU [28,31,35,53]. Nonetheless, inclusion of eCG in a progestin protocol principally increases the cost of oestrus synchronisation technique.

4. The male effect

In an attempt to reduce the amount of exogenous hormones employed in animal production worldwide because of the growing concerns in terms of residues in food products (meat, milk), there has been an increasing interest in the use of clean, green and non-hormonal methods in improving livestock productivity [23]. One of such method is the use of the “male effect”, otherwise known as biostimulation [23,64–66]. The “male effect” is described as the influence of a male on oestrus behaviour and ovarian activity in female co-species. This phenomenon is mediated via pheromones or cues, which are received and processed by the females. The response to the "male effect" is influenced by the aggressiveness of the buck, serving capacity of the buck, intensity of the stimulation, body condition and nutritional status of the buck and does [23]. The use of the "male effect" is reported to improve oestrus efficiency and fertility when used in combination with prostaglandins [23,45], and progestagens [52]. The stimulation of auditory, tactile, olfactory and visual sensations plays essential roles in the overall response to the "male effect", although the olfactory stimulation is suggested to be the most important. The application of biostimulation in goat reproduction in Nigeria and the tropics require more attention as it offers a potentially-useful, cheaper and practical way to improve reproductive efficiency in goats.

5. Conclusion

The variability in the length of the oestrus cycle and oestrus has necessitated the use of oestrus synchronisation in the reproductive management of goats. A number of studies have been carried out to evaluate various techniques and protocols for oestrus synchronisation in to synchronize oestrus in indigenous breeds of goats in Nigeria though the use of prostaglandins, progestagens and more recently the "male effect". Combination treatments using gonadotrophins and the male effect are currently being evaluated to improve synchrony, ovulation rates and overall reproductive performance of indigenous breeds of goats. Although more farmers need to be encouraged to adopt this technique, it is pertinent that adequate nutrition and good farm management practices be provided to ensure a successful oestrus synchronisation programme in goats and other domestic ruminants.

Conflict of interest statement

We declare that we have no conflict of interest.

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