Short-term oestrous synchronisation protocol following single fixed-time artificial insemination and natural mating as alternative to long-term protocol in dairy goats

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Highlights

- Short and long-term synchronisation protocols following fixed-time artificial insemination and natural mating have comparable influence on fertility in dairy goats.
- Short-term synchronisation protocol can be alternative to long-term protocol following fixed time artificial insemination or natural mating in dairy goats.
- Short and long-term synchronisation protocols equally influence oestrous response, onset of oestrus and duration of oestrus in dairy goats.

Abstract

This study investigated the hypothesis that the use short-term synchronisation protocol following single fixed-time artificial insemination (AI) with extended cooled semen and natural mating in fertility management of dairy goats could be as good as or better than traditional long-term protocol. This was tested by designing an experiment using Toggenburg dairy goats raised under semi-intensive production system in the tropics. Twenty-eight (28) females Toggenburg dairy goats were randomly allocated to two synchronisation protocols in completely randomised design and within each synchronisation protocol the animals were further subdivided into two mating methods. Oestrus was synchronised using short (7 days) and long-term (12 days) protocols and animals mated using natural mating and AI. The onset and the duration of oestrus were monitored using two intact-aproned bucks following controlled internal drug release (CIDR) devices withdrawal. The non-return to oestrus method was used to determine conception rate. The onset and duration of oestrus, response to oestrus and conception rate were evaluated. The onset and duration of oestrus was analysed using one-way ANOVA, while response to oestrus, conception rate and kidding rate were analysed by using Chi-Square test. Generally, the two protocols realised 100% response to oestrus. Onset and duration of oestrus in short-term protocol were 31.75hrs and 31.70hrs, respectively, while the corresponding values for long-term protocol were 33.33 and 30.93hrs. The two protocols did not significantly differ in onset and duration of oestrus, conception, kidding and twining rate. Similarly, the two mating methods did not differ significantly on conception, kidding and twining rates. The current study has an overall of conception rate, kidding and twinning rate of 71.42, 64.29 and 44.50%, respectively. The short-term protocol following single fixed-time AI and natural mating therefore, can be alternative to long-term oestrous synchronisation protocol in dairy goats.

Key words: Conception rate, oestrous response, reproductive performance, Toggenburg goats

1. Introduction

The traditional long-term progestagen based oestrous synchronisation protocols normally range from 10-19 days (Pietroski et al., 2013; Harl, 2014). The long-term protocol, however, has been associated with low fertility rates (Diskin et al., 2002; Pietroski et al., 2013). This low fertility has been linked to sub luteal serum progesterone concentrations which is associated with some abnormalities in follicular development, ovulation, oocyte health, luteal function (Evans et al., 2001; Menchaca and Rubianes, 2001; Viñoles et al., 2001). Given the above reasons and long duration of treatment for the traditional synchronisation protocol, short-term protocol have been suggested (Viñoles et al., 2001; Menchaca and Rubianes, 2004; 2007; Karaca et al., 2010; Menchaca et al., 2018). These studies demonstrated that, the short-term protocol is associated with supraluteal levels of progesterone concentrations, which positively influence follicular turnover, increases the number of healthier young large follicles with the potential to ovulate and improve pregnancy rate.

It has been documented that fertility can be influenced depending on whether fresh, cooled or frozen semen is used. On the other hand, timing of insemination or natural mating following synchronised oestrus plays crucial role in determining the fertility of an animal. Therefore, it is important to conduct studies looking at how different types of synchronisation protocols and mating methods influence fertility.

Comparative studies have been conducted comparing short and long-term oestrous synchronisation protocols following artificial insemination (AI) and natural mating (Karaca et al., 2010; Ramukhithi et al., 2012; Pietroski et al., 2013). In these studies, does were inseminated with fresh raw semen using cervical or laparoscopic technique either 48 hrs following CIDR removal or according to the onset of oestrus at 48 and 60 hrs following sponge removal. Use of invasive technique such as laparoscopy is not convenient especially, in routine breeding of animals by farmers. Also application of AI at different time intervals takes long time in performing breeding activities of animals and may cause inconvenience in terms of management. Therefore, use of single fixed-time AI could offer an alternative convenient option in breeding of goats. There are, however, no studies to the best of our knowledge comparing short and long-term synchronisation protocols following single fixed-timed AI with extended cooled semen and natural mating. We reasoned that synchronising oestrus using short-term protocol following single fixed-time artificial insemination with extended cooled semen and natural mating could be as good as or better than long-term protocol in fertility of exotic dairy goats in the tropics. This is because short-term protocol is associated with high progesterone, which could lead to improved follicular development and health, rate of ovulation and sperm transport. We tested this hypothesis by designing an experiment comparing short and long-term oestrous synchronisation protocol following single fixed-time AI and natural mating using Toggenburg dairy goats raised under semi-intensive production system in the tropics.

2. Materials and methods

2.1 Ethical approval

The materials and procedures of this study had been approved by Kenya Institute of Primate Research under the permit No: ISERC/10/19 and National Commission of Science and Technology under the permit No: NACOSTI/P/19/76927/28821.

2.2 Experimental site

This study was conducted between August and September, 2019 at the Tatton Agriculture Park (TAP), Egerton University, Njoro. Njoro is approximately within latitude 00º 19'00" S and longitudes 36º 06'00" E, and at an elevation between 2168 m and 2800 m above sea level. The site receives monthly total rainfall of 86.3 mm, and its temperature varies between minimum of 10.2 and maximum of 23.3ºC (Wangui et al., 2018).

2.3 Experimental animals and design

In this study, 28 females Toggenburg goats in their third lactation were used and allocated into two synchronisation protocols with mean initial body weight (Short-term=59.00±2.76 kg and Long-term= 58.50±2.76 kg) not significantly different in a completely randomized design. Within each synchronisation protocol the animals were further subdivided into two mating methods with mean initial weight (AI= 58.71±2.76 kg and Natural mating= 58.79±2.76 kg) not significantly different. The does and the bucks were kept under semi-intensive system on natural pastures, supplemented with commercial concentrate and mineral licks as well as water offered *ad libitum*. Supplementation with concentrate commenced one month before the start of the study for both does and the bucks.

2.4 Synchronisation of oestrus

Two synchronisation protocols were used; short and long-term progestagen treatment. All does in both groups were treated intravaginal with progesterone using controlled internal drug releasing device (CIDR-G) (Pfizer, New Zealand) containing 0.3 g progesterone. The CIDR-G device was left for 7 days and 12 days for short and long-term progestagen treatment, respectively. At CIDR removal, all does in both groups were injected with 150 µg of prostaglandin F2α (PGF2α) analogue and 200 IU of equine chorionic gonadotropin (eCG) (Intervet Schering-Plough Animal Health, South Africa). Literatures for this protocol includes (Greyling and Van der Nest, 2000; Romano, 2004; Fonseca et al., 2005; Menchaca and Rubianes, 2007: Karaca et al., 2010; Pietroski et al., 2013).

2.5 Semen collection and evaluation

Semen collection; Semen was collected using electro-ejaculator for small ruminants (Lane Manufacturing, Denver, Colorado, USA). The collection procedures followed was according to instructions from the company. Buck was restrained in a standing position and the urethral opening cleaned. Then the rectal probe was lubricated with a lubricant before inserted in to the rectum. A collecting tube was fitted to the artificial vagina to collect the semen.

Semen evaluation; The semen samples collected were evaluated for volume, semen density, mass motility, progressive motility, live sperm cells, spermatozoa concentration. Semen volume and density, mass motility and progressive motility were evaluated as described by Steyn, (2005) using a phase contrast microscope (Richter Optica, Model U2, China) mounted with a camera. Sperm concentration was determined using the standard procedures with an aid of Neubauer improved haemocytometer (Marienfeld Company, Lauda-Königshofen, Germany) under phase contrast microscope at magnification power of (x40). Semen was extended using OPTIXcell extender, (IMV Technologies, France) as described by Juma, (2017).

2.6 Monitoring and recording parameters of oestrus

The onset and the duration of oestrus were monitored using two aproned intact bucks with high serving capacity following CIDR withdrawal. The does were monitored for total of 72 hrs following CIDR withdrawal at 8-hour interval for the detection of onset and duration of oestrus. Onset and duration of oestrus were detected as described by Romano et al. (2018) with few modifications. Briefly, oestrus was detected once during the first 12 hrs after CIDR removal and then every 4 hr thereafter, at 10:00, 14:00, 18:00, 22:00, 02:00, and 06:00 hr for 72 hrs.

2.7 Natural mating and artificial insemination

Mating was done using natural mating and timed AI using diluted cooled semen. For the natural mating group, one male was mated to maximum of three (3) does following CIDR withdrawal for a period of 12 hrs. In the AI group, a speculum with a built-in light source and pipette connected to a 1 ml syringe was used to cervically inseminate the does (Steyn, 2005). All does were inseminated cervically at single fixed-time of 48 hrs following CIDR withdrawal. Each doe was inseminated with 0.4 ml of diluted cooled semen with sperm concentration of 500×10^6 sperm cells.

2.8 Pregnancy diagnosis

The pregnancy diagnosis was carried out using non-return to oestrus method as described by Mellado (2016) with few modifications. The does were monitored twice a day using two aproned bucks (Morning and evening) to detect does that returned to oestrus from day 16-26 following natural mating and artificial insemination.

2.9 Evaluation of reproductive parameters

The following parameters were evaluated. The onset and duration of oestrus as well as the response to oestrus were evaluated as described by Romano et al. (2018). The conception rate as the number of does that conceived out of the total number of does synchronised multiplied by 100. Kidding rate was calculated as the number of does that kidded out of the total number of does synchronised multiplied by 100. Twining rate was calculated as the number of does that kidded two (2) kids per total number of does kidded. None of the does among those that kidded gave birth to more than two kids.

2.10 Statistical analysis

The onset and duration of oestrus were analysed using one-way analysis of variance (ANOVA). The model fitted was: $Y_{ij} = \mu + SP_i + \varepsilon_{ij}$

where: -

Y_{ij} − Observation on the dependent variables, μ −Overall mean, SP_j − Fixed effect of synchronisation protocol, ε_{ij} − Random error

Response to oestrus, conception rate, kidding rate and twining rate were analysed using Chi-Square test procedures of SAS (Version 9.0; 2002). Differences were considered significant at $P < 0.05$.

3. Results

Our finding confirmed the premise that, synchronising oestrus using short-term protocol following single fixed-time AI with extended cooled semen and natural mating would be as good as the traditional long-term protocol in fertility of dairy goats raised in the tropics. This was confirmed by no observable significant different between the two protocols on response to oestrus cycle, onset of oestrus, duration of oestrus, conception rate, kidding rate and twining rate when single fixed-time AI with extended cooled semen and natural mating was applied.

3.1 Effect of synchronisation protocols on response to oestrus, onset of oestrus and duration of oestrus.

The mean response to oestrus (%), onset and duration of oestrus (hours) following short-term and long-term oestrous synchronisation protocols are presented in (Table 1). There was no significant difference (P>0.05) between short and long-term protocol in terms of response to oestrus, duration of oestrus and onset of oestrus.

Table 1: Response to oestrus (%), onset and duration of oestrus (hours) (LSMeans±standard error) following short-term and long-term oestrous synchronisation protocol in Toggenburg goats.

Synchronisation protocol	No of goats	Response to oestrus	Onset of oestrus	Duration of oestrus
P-value		NS	NS	NS
Long-term	14	100	33.33±0.86	30.93±0.54
Short-term	14	100	31.75±0.84	31.70±0.52
Overall	28	100	32.54±0.85	31.32±0.53

** NS: Not significant at P> 0.05*

In all the two protocols, all does showed signs of oestrus at least 28 hrs after CIDR withdrawal. More does showed oestrous signs earlier in the short-term than in long-term protocol. Additionally, at 40 hrs after CIDR withdrawal all the does in different groups showed signs of oestrus.

3.2: Effect of synchronisation protocol and mating methods on conception rate, kidding rate and twining rate

The current study had an overall conception, kidding and twinning rates of 71.42 %, 64.29 and 44.50%, respectively (Table 2). There was no significant difference with each synchronisation protocol and mating method. When the data were pooled based on the oestrous synchronisation protocols and mating methods, no significant difference was observed between the synchronisation protocols and mating methods on conception, kidding and twinning rates (Table 2).

Table 2: Fertility performances following different oestrous synchronisation protocols and mating methods in Toggenburg goats

Treatments	No of goats	Conception rate (%)	Kidding rate (%)	Twining rate (%)
P-value		NS	NS	NS
SP				
LT	14	10/14 (71.43)	8/14(57.14)	50
ST	14	10/14 (71.43)	10/14(71.43)	40
MM				
NM	14	11/14 (78.57)	10/14(71.43)	50
AI	14	9/14 (64.29)	8/14(57.14)	38

Overall	28	71.43	64.29	44

NS: Not significant at P> 0.05

AI: Artificial insemination, **NM:** Natural mating, **ST:** Short-term, **LT:** Long-term, **MM:** Mating method, **SP:** Synchronisation protocol

4. Discussion

The findings of the current study, supported reasoning that short-term synchronization protocol could be as good as traditional long-term protocol even with single fixed-time AI with extended cooled semen and natural mating. These findings are supported by previous studies, which did not find the difference in response to oestrus, duration of oestrus and conceptions rates in goats in temperate and tropical production environments (Karaca et al., 2010; Ramukhithi et al., 2012; Pietroski et al., 2013). The onset and duration of oestrus in the current study, however, were longer compared to those reported by Pietroski et al. (2013). In their study, the onset and duration of oestrus were 26.7 and 28.5 hrs in short and 25.2 and 25.2 hrs in the long-term protocol, respectively. Similarly, Karaca et al. (2010) reported onset of oestrus of 28.8 and 28.0 in long and short-term synchronisation protocol, respectively. Moreover, Ramukhithi et al. (2012) reported longer onset of oestrus (34.7 vs 33.4) and duration of oestrus (37.9 vs 35.2) in short and long-term synchronisation protocols, respectively, than in the current study. These differences could be attributed to different types of progestagen devices used, use of gonadotropins, breed of goats, nutrition, season and male presence (Orihuela, 2000; Dogan et al., 2008). They used progestagen sponges during the non-breeding season while in the current study CIDR was used during the breeding season. These devices have different concentration levels of progesterone (Motlomelo et al., 2002).

The lack of significant difference in conception rate between short and long-term synchronisation protocols found in this study concurs with previous studies in goats (Karaca et al., 2010; Pietroski et al., 2013) and cows (Kasimanickam et al., 2015). On the contrary, to our findings Ramukhithi et al. (2012) reported higher pregancy rates in Boer and indigenous goats when short-term protocol was used. These differences could be attributed to differences in breed, type of progestagen and quantity of equine chorionic gonadotropin used. Although there were no significant differences between the two synchronisation protocols, short-term protocol can be a better alternative than long-term protocol. This is because short-term protocol takes few days to synchronise animals and thus reduce time spent by farmers to breed their animals. In addition, CIDR from short-term protocol can be re-used with effective oestrous synchronisation and pregnancy rate (Vilarino et al., 2011).

In terms of kidding rate, there was no significant difference between short and long-term protocols. Short-term protocol, however, tended to have higher kidding rate (71.43 %) than in long-term protocol (57.14 %). This tendency could be attributed to the fact that short-term protocol achieved high progesterone concentration at the end of the synchronisation protocol, normal follicular turnover and ovulation of newly formed follicles (Viñoles et al., 2001; Menchaca and Rubianes, 2007). This study concurs with the previous finding by Karaca et al. (2010) who reported kidding rate of 76.5 % and 61.1 % in short and long-term protocol, respectively.

On the method of mating, regardless of oestrous synchronisation protocol, there were no differences recorded on conception rate, kidding rate and twining rate between natural mating and AI using cooled extended semen. This finding is in agreement with the previous study which reported no differences in pregnancy rate and parturition rate between natural and AI (Pietroski et al., 2013). This similarity is despite the fact that in the current study single fixed-time AI was carried out 48 hrs following CIDR withdrawal irrespective of whether a doe shown signs of oestrus or not, while in the study by Pietroski et al. (2013), they inseminated animals at different time intervals according to signs of oestrus (48 and 60 hrs). Contrary to the current study, other studies reported significant differences on pregnancy rate between natural mating and artificial insemination with 93% and 70 %, respectively (Agossou and Koluman, 2018). This inconsistency could be attributed to different semen types and site of semen deposition used.

The current study confirmed that short-term protocol could replace long-term oestrous synchronisation protocol following single fixed-time AI and natural mating in dairy goats. It also demonstrated that, short and long-term oestrous synchronisation protocols have no effect on oestrous response, onset of oestrus and duration of oestrus and conception rates of dairy goats in the tropics.

Conflict of interest

The authors declare no any conflict of interest.

Acknowledgement

This material is based upon work supported by the United States Agency for International Development, as part of the Feed the Future Initiative, under the CGIAR Fund, award number BFS-G-11-00002, and the predecessor fund the Food Security and Crisis Mitigation II grant, award number EEM-G-00-04-00013. Also the authors acknowledged Egerton University and Centre of Excellence for Livestock Innovation and Business (CoELIB)) for providing the experimental animals and allowing us to use the laboratory.

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