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Evaluation of hormone-free protocols based on the “male effect” for artificial insemination in lactating goats during seasonal anestrus

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ABSTRACT

Goat estrous and ovulatory responses to the “male effect” were characterized to determine the time range over which fertile ovulations occur after buck exposure. The results were used to explore the efficacy of different hormone-free artificial insemination (AI) protocols aimed at diminishing the number of inseminations needed to optimize fertility. Adult bucks and does were exposed to artificially long days during winter and then exposed to a natural photoperiod before buck exposure (Day 0). Most goats (>70%) ovulated twice, developing a short cycle followed by a normal cycle over 13 days after buck exposure. Among them, 21% were in estrus at the short cycle and 94% at the normal cycle. This second ovulation occurred within 48 hours of Day 6 and was the target for AI protocols. In protocol A (n = 79), goats were inseminated 12 hours after estrus detection from Day 5 to Day 9. Up to six AI times over 4 days were needed to inseminate goats in estrus. Forty-nine percent of the inseminated goats kidded. In protocol B (n = 145), estrus detection started on Day 5. The earlier (group 1) and later (group 2) buck-marked goats received one single insemination at fixed times on Days 6.5 or 7 and 8, respectively; unmarked goats (group 3) were inseminated along with group 2. In protocol C (n = 153), goats were inseminated twice on Days 6.5 or 7 and 8 without needing to detect estrus. Goats induced to ovulate by hormonal treatment were used as the control (n = 319). Fertility was lower in protocol B than in protocol C and controls (47% vs. 58% and 65% kidding; $P \leq 0.05$), whereas this was higher in buck-marked goats than in unmarked ones (64% vs. 33%; $P \leq 0.05$). In protocol B, fertility can increase (>60%) when only goats coming into estrus are inseminated. The best kidding rate (~70%) was achieved when does were inseminated within 24 hours of the LH surge. Protocols involving insemination on Day 7 instead of Day 6.5 led to more goats being inseminated during this favorable time.

1. Introduction

In Europe, goat farming for milk and cheese production is an important industry involving high-yielding breeds subjected to genetic selection programs based on

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reproduction by artificial insemination (AI) to accelerate genetic progress. Reproduction using AI also contributes to the improvement of sanitary conditions on farms and the safety of derived foodstuffs as it adds traceability and a sanitary barrier.

Synchronization of ovulation is crucial to the development of goat AI methods. Higher synchronous ovulations allow the protocols to be simplified and minimize costs by reducing the number of inseminations needed to optimize fertility.

Hormonal treatment has been developed in goats to induce and synchronize ovulations during or out of the breeding season for AI purposes. The most commonly used treatment consists of a progestagen (i.e., fluorogestone acetate), eCG, and cloprostenol (F2α prostaglandin analogue) [1]. This allows insemination only once at a fixed time and gives fertility rates of up to 60% kidding.

Several problems are associated with these hormones. Societal trends and European legislation (96/22/CE, 2003/74/CE, and 2008/97/CE) encourage producers to adopt practices that reduce or completely avoid the use of synthetic chemicals and hormones [2]. Indeed, because eCG is purified from animal tissues, risks associated with the presence of pathogens in commercial eCG extracts remain. Progestagen residues in animal products and effluents could also act as hormonal disrupters and denote possible threats to human health. Regulation forbids milk to be sold for several days, whereas progestagen residues in milk remain higher than the maximal residue limits that are authorized. Moreover, hormonal treatment (HT) for the control of reproduction is forbidden in organic farms (2007/834/CE and 2008/889/CE), although the demand for organic products is increasing. In parallel, the repeated administration of eCG leads to the production of anti-eCG antibodies, reducing the efficacy of the treatment and decreasing fertility after AI [3].

The "male effect" may be an efficient non-pharmacological alternative to the use of hormones for estrus synchronization in AI programs. Indeed, exposure of anovulatory does to bucks can induce synchronous ovulations during seasonal anestrus. After the introduction of a buck into a herd of does, they ovulate around Day 3. A normal cycle (NC) may follow this first ovulation, but more frequently goats develop an infertile short cycle (SC) and ovulate again after 5 to 7 days, the second ovulation usually being fertile [4,5].

The current treatment of does with progestagens or progesterone is the only practical way of obtaining a major peak of conception around Day 3 [6–8]. New AI protocols based on buck exposure to induce and synchronize ovulations during seasonal anestrus have been developed in goats treated with progesterone and cloprostenol [9], or only with progestagens [10]. These involve a single AI at a fixed time after buck introduction without the need for prior estrus detection and leading to good pregnancy rates (60%–70%). Such protocols have been introduced on-farm and are starting to be used in Europe.

In contrast, AI protocols using the "male effect," but excluding all classes of hormones or other exogenous substances, require estrus detection and many AIs over at least 5 days after buck introduction [11,12]. These protocols are neither practical nor economically viable and therefore need to be improved to reduce the number of inseminations needed for good fertility. The validation of such "zero-progestagen" protocols would also be an undisputed advantage for farmers, given the legislative constraints concerning the presence of progestagen residues in milk and the issues with organic farming.

Our first objective was to characterize the estrous and ovulatory responses to the "'buck effect" to determine the time range in which the first fertile ovulation occurs after buck exposure. This objective involved investigating numerous goats in several herds over several years. The results were used in the second objective, which was to design and study the efficacy of different kinds of hormone-free AI protocols aimed at diminishing the number of inseminations needed to optimize fertility. Three AI protocols involving different AI times, with or without the need for estrus detection, were studied.

2. Materials and methods

2.1. Ethical note

Experiments were conducted in private farms. Daily care and handling of animals were performed by farmers in accordance with the Council Directive 98/58/EC concerning the protection of animals kept for farming purposes. Experimental procedures were carried out by experienced researchers in accordance with the guidelines for the Care and Use of Agricultural Animals in Agricultural Research and Teaching.

2.2. Experimental design

Experiments were carried out during seasonal anestrus over six consecutive years on three herds of Alpine (A, B, and C) and two herds of Saânen goats (D and E) located in the Poitou-Charentes region in France (latitude, 46°N). Goats were kept under intensive management.

The animals totaled 765 (375 Saânen and 390 Alpine breed) healthy primiparous and multiparous lactating goats with normal reproductive histories that had kidded during the preceding year. Does were not cycling (based on progesterone plasma concentrations; [8]) and did not show any signs of hydrometra (confirmed by echography [13]) before starting experiments. The adult bucks belonged to the corresponding herds.

2.2.1. Preparing animals and carrying out the "male effect"

Bucks and does were given artificially long days followed by natural days to enhance the response to the "male effect" in the spring [8,10]. Briefly, bucks and does were first located in separate barns under the natural daylight conditions. The long-day treatment started between ninth December and seventh January (depending on herds) and consisted of exposing the animals to 16 hours of light and 8 hours of darkness for about 90 days. This treatment ended between seventh March and seventh April (depending on herds), and the animals were then returned to natural daylight hours.