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Mini Review

Nonhormonal Reproductive Management in Goat Breeding

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Abstract

Goats belong to the „short day breeders“ group of seasonal polyoestrous animals. In the temperate climate zone, their season lasts from mid-summer till mid-autumn, being regulated by epiphysis' melatonin secretion, as well as by genetics and environment factors. Therefore, the presence of goat milk and dairy products, as well as goat meat, at the food market, is exclusively seasonal. In order to provide goat food products throughout the whole year, reproductive herd management should be established.

This paper presents a brief overview of the nonhormonal methods of reproductive management in dairy goat herds (natural mating and artificial insemination, nonhormonal synchronization methods). Proposed protocols are consisted of light treatment, male effect and timed artificial insemination which could be combined with or without injection of prostaglandin. Application of reproductive and breeding programs allow efficient diffusion of desirable genetic traits in a selection program.

Introduction

There are many reasons why goat farming is spreading to all continents. Most important are the high adaptive mechanisms of goats to different climate and production conditions. In unfavourable conditions of karst by scrubbing the thicket they reduce the likelihood of fires [1] and increase the overall efficiency of agricultural activity of the country. Modern goat farming tends to respond to demands and trends of the market needs in order to produce healthy, often organic products. Starting from this, the use of reproductive and genetic selection programs is the basis for the high productive goat industry [1]. Goats are seasonally polyoestrous animals. The season of sexual activity in the temperate climate zone runs from mid-summer to midwinter, i.e. in the period when the shortening of the day length begins (after summer solstice), which is why they are called „short day breeders“. The whole process is brought by melatonin secretion (derived from amino acid tryptophan) from the pineal gland during the night hours. The seasonality is also genetically and environmentally influenced. In other words, this means that the kidding season is also determined and runs from January to early summer, with the most prominent period in the spring when climate and nutrition conditions are optimal for offspring survival. The rest of the year (from March till June) goats are sexually inactive (anoestrous period). Considering the above, the market supply of goat milk, dairy products and kid meat is markedly seasonal. The reproductive features of the tropical breeds are highly influenced by the environmental factors such as nutrition quality and temperature [2]. If farmers want to respond to market demands and supply it with products throughout the year, it is necessary to implement the reproductive management of the herd in order that such requirements can be met. Non-hormonal management methods integrate two criteria: avoid of use of steroid hormones and obtaining the high synchronization of estrous and ovulations.

Non-hormonal methods of estrous synchronization

Non-hormonal methods (light treatment and male effect) are in accordance with modern market demands and increasingly stringent legislation concerning the use of hormones in human food production.

Photoperiodic treatments

Seasonality of reproduction in goats is controlled by day-length. Therefore, by changing the length of the photoperiod, the synchronized mating out of breeding season (anoestrous period) or during the transition period can be achieved. However, it is advisable not to advance the sexual period more than one cycle per year (i.e. 21 days) in order not to compromise the genetically rhythm of sexual activity. Photoperiodic treatments are based on alternation of periods of long days and periods of short days and can be used in closed barns by imposing an artificial light treatment [3]. It is consisted in submitting the animals alternatively to long days (16 hours of continuous lighting or using natural long days during spring and summer) and short days (using the natural short days when natural days are sufficiently short until the end of the short day treatment or administration the melatonin implants). Short day means 8h to maximum 12h of daylight or administration of a melatonin subcutaneous implants which are used when the long day treatment ends too late in the year. The switching from the long day to short day is called „short day effect“ which provokes the appearance of the sexual activity. A photoperiodic treatment is often combined with the male effect which is always planned 60 days after the beginning of the short day treatment. The photoperiodic treatment of both goats and bucks is necessary to optimize the response to the male effect in the middle of the anoestrus period [4]. Different photoperiodic treatments allow the use of the male effect during the non-breeding season by making the females receptive to the male effect and stimulating the male's sexual activity. Photoperiodic treatments during the breeding season block the female cyclicity.

Classical photoperiodic treatments allowing reproduction out of breeding season are consisted of a treatment with 16h daylight (long day treatment, 90 consecutive long days) which start during winter term. The animals returning to natural



photoperiod conditions after long day treatment at this time are exposed to 4 hour decrease in day length what provides a sufficient stimulatory short-day signal, which leads to improved response to the male effect in April-May [5]. If long day treatments ends in April-July period, melatonin implants should be used. Classical photoperiodic treatments that allow reproduction in summer consist of a treatment with 16h daylight photoperiod during spring, ending in May. At this time, animals are only exposed to a 1-2 hour decrease in day length which is not sufficient to provide a short day signal. For this reason, the long day treatment must be followed by a melatonin treatment (short day treatment). In case long day treatment ends before 15 of March, natural days are short enough to be considered as a "short days". If long day treatment ends after 01 of April, melatonin implants or use of light proof barn should be applied. In latter case, the farms shouldn't be exposed to any artificial light sources (street lamps, headlamps, farmer's supervision of the flock during the darkness periods, etc.) which can compromise the animals' response. The alternative protocol can be used to make animals synchronously reproducing with natural mating or AI performed during the natural breeding season. The protocol is consisted of alternating 90 long days/90 short days/90 long days/90 short days. In this treatment melatonin implants are used to simulate short days during springtime and natural short days during winter time. It is important to mention that both males and females should undergo light regime. In case of melatonin, 1 implant is applied to every goat and 3 to every buck. Regarding light treatment, a light intensity of 200-250 lux at eye level of the goats should be reached.

Male effect

Male effect or buck effect is the deliberate introduction of males among a group of goats meant to be bred and previously isolated from the males, in order to induce and synchronize heat and ovulation [6]. It could be performed without light treatment during transitional period, i.e. several weeks before the start of natural sexual season in order to synchronize and advance the sexual activity. The bucks are introduced after being separated from females for 2 months in a facility located at least 100 m apart in order to assure complete olfactory and audiovisual isolation. Sudden introduction of bucks among goats (constant contact, ratio 1 male per 10 females should be assured) will result in a synchronous appearance of fertile oestrus in goats 5-11 days after (mostly 7-8 days). The male effect can be used to induce and synchronise oestrus during seasonal anestrus, in anovulatory but not in cycling females [4]. It is also proved that only sexually active and not inactive bucks are capable to induce ovulations in anovulatory goats [7]. To improve its efficiency and better synchronize heat, the buck effect may be combined with a photoperiodic treatment. Also, supplementary feed prior to the mating season can improve ram sexual behaviour traits [8]. Flock synchronization by non-hormonal methods is usually consisted of a combination of two methods (light treatment and male effect). After the herd is submitted to a long day regime for 90 d (16h light per day) it is switched to a short-day treatment (4 hours shorter daylight or melatonin implants). Concurrently with the start of short day treatment the bucks are removed to remote object. Sixty days after the end of long day treatment the bucks are introduced among the females. This will result with synchronous occurrence of fertile oestrus in goats.

Flock-reprod insemination protocols

Recently the non-hormonal FLOCK-REPROD protocols including photoperiodic treatment, male effect and the use of A.I. of goats have been created [6]. Some of them are hormone free while others include the application of prostaglandin injection(s). The aim of those protocols is to reach acceptable fertilization rate after A.I. and to meet the requirements of stringent legislation. There are 3 FLOCK-REPROD protocols [6]: The first one is called PG1 (Prostaglandin 1) and can be used to breed animals during the non-breeding season with classical photoperiodic treatment application. Also, it can be used during the breeding season with photoperiodic treatment consisted of alternation of 3 months of long days and 3 months of short days starting one year before. The protocol is consisted of one prostaglandin injection (75µg cloprostenol) applied intramuscularly 17 days after male introduction which is introduced 60 days after the beginning of the short day treatment. Artificial Insemination is performed 70h after injection. The second protocol is called PG2 (Prostaglandin 2) and can be used during breeding season without necessity for previous photoperiodic treatment. It is consisted of two prostaglandin injections applied 9 days apart. The first injection is applied concurrently with the male introduction. Sixty hours after the second prostaglandin injection, Artificial Insemination is performed.

The third protocol is called HF (Hormone Free protocol). It can be used to breed the animals either during non-breeding season after classical photoperiodic treatment, or during breeding season provided that animals received photoperiodic treatment consisted of alternation of 3 months long days and 3 months short day periods

starting one year before. The buck which is introduced within the group of females (Day 0) is equipped with an apron. Five days later a colour marker is fixed on male's apron and marked goats are recorded twice a day (during milking). The goats will be considered in oestrus if they get marked by the male, meaning they accepted to be mounted. From 5th to 8th day after male introduction, marked females are recorded and positive detection is considered when more than 40-50% of females are marked. Artificial Insemination of marked goats is performed 24h after positive detection. The development of automated heat detection methods such as collars will facilitate the deployment of hormone-free AI protocols [9].

The ratio of goats and bucks in the herd

It is important to mention that for optimal results in the traditional goat farming and seasonal mating (without using synchronization methods) one buck per 30-50 goats should be provided, keeping in mind that every day about 5% of goats are in oestrus. If synchronization is used, then one buck should be provided for every 10 goats during the breeding season (10% of bucks), or one male per 5 goats (20% males) outside of sexual season. In order to reduce the required number of males on the farm and to prevent excessive exploitation of bucks and consequentially lower fertility then desired, artificial insemination should be carried out. In case artificial insemination is used, bucks equipped with an apron and colour markers that will mark the females in oestrus should be provided. For herds with more than 30 goats, bucks that will shift in oestrus detection should be provided.

Artificial insemination

Artificial insemination is a routine practice in the goat industry of developed countries. Goat cervix doesn't present an insuperable obstacle, so when transcervical insemination is performed fresh and frozen semen can be used. A.I. does not present a significant financial cost for the intensive goat industry farmers who can significantly improve the reproductive management of the herd by reducing the required number of bucks on the farm (teaser bucks), increase efficiency of the best quality bucks and reduce transfer of sexually transmitted diseases. When A.I. is used it is important to identify goats which allow being mounted ("standing heat"). If the goat continues to show signs of oestrus long time after insemination, re-insemination can be performed 12h after, especially if frozen or chilled semen is used. In 10-30% of goats; Amoah & Gelaye [10] report even 50%, if A.I. is performed near ovulation, it is possible to pass through the cervix and deposit the semen in the very corpus of the uterus, while in others the semen is deposited at the entrance of the cervix (1-2 cm deep). It is important not to force and to work very gently and quickly in order to avoid the stress which decreases the uterine peristaltic and movements of the sperm. It is better to deposit the semen on the entrance of the cervical canal, rather than force passing through cervix because it may lead to mucosal lesions and spermicide effect of the blood.

The intravenous application of oxytocin (25-50i.u.) leads to a greater dilation and depth of cervical penetration, obtaining higher pregnancy rates and prolificacy [11]. Cervix at the time of insemination is pink in colour, volcano or bud like, 3-4 cm long with 3-4 circular folds. Vulva is to be washed with soap and dried with cellulose paper. All that is applied into vagina must be sterile. Hind legs should be lifted by two workers or goat should be fixed in the rack. Some goats permit insemination while standing in milking parlour. A lubricated speculum with light source is applied in the vulva. After the cervix is being visualized, atraumatic insemination gun is introduced through a speculum into the entrance of the cervix. The cervix is passed through by rotating and gently pushing the insemination gun forward and depositing semen into the uterus. Straws are thawed at 37 °C (35-38 °C), during 30-60 s. Total number of motile sperm when the fresh semen is used is 80-150 million or 100-200 million when frozen semen is applied. The volume of straws is 0.20-0.25 ml.

Conclusion

New trends and consumer needs created the necessity of synchronization protocols implementation for goats avoiding the use of hormones to induce oestrus and synchronize the ovulation, but also enabling the use of Artificial Insemination. Photoperiodic treatments allowing reproduction out of breeding season are consisted of a long day treatment (90 consecutive long days), followed by stimulatory short-day signal (60 consecutive short days), which leads to improved response to the male effect at the end of the short-day treatment period. Those protocols are consisted of the photoperiodic treatment application concurrently with male effect and the application of prostaglandin injection(s). Sudden introduction of bucks result in a synchronous appearance of fertile oestrus in goats 5-11 days after (mostly 7-8 days). Three protocols are designed which combine one or two prostaglandin injection(s) after male



introduction and timed Artificial Insemination. The third protocol provides artificial insemination 24h after positive detection (40-50% of goats marked) of estrus among goats after male was introduced.

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