Artificial Insemination in Goats: An Update
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Abstract

The success of the artificial insemination in goats is associated with the sperm collection, storage and use. Furthermore the technique of insemination dictate the fertility rate, the vaginal insemination with the fresh semen provide high fertility rate when using the frozen thawed semen the fertility rate is low. Therefore the deeper semen is deposited increase the fertility. The cervical insemination increases the fertility and the insemination intrauterine by laparoscopy has the highest fertility. Due to the expensive equipment and requiring skilled inseminator of laparoscopic insemination, the trans-cervical insemination has been developed to replace its. The trans-cervical insemination is performed by passage the inseminating pipette through the cervical canal and deposit semen intrauterine. The complexity of cervical anatomy limits the success rate of the trans-cervical insemination. Therefore the cervical relaxation is required to achieve this technique.

Keywords: Artificial insemination, goat, semen, buck

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Introduction

Artificial insemination (AI) has an important role in goat breeding especially in the intensive systems of production. It is to control the reproduction which conjunction to an accurate progeny test. The progeny test with AI speed up the identification of superior buck at a younger age. Then it allows extensive use of the available superior buck results in faster genetic progress then increases the rate of genetic improvement. At the farm level the control of reproduction in particular population of goats allow kidding at a precise season of the year taking advantage of oestrus synchronization with its precise control of ovulation and parturition and furthermore allows the advantage of out of season breeding. Other benefits of AI include more efficient genetic selection schemes and the manipulation and storage of the genetic material by the production and cryopreservation of goat semen for the artificial insemination with frozen thawed semen. In addition AI is associated with other animal health benefits. This technique helps avoid disease transmission and allows the transport of semen and AI reduces the risk of spreading sexually genital infections by natural mating. AI allows rapid widespread diffusion of improved genotypes and exchange of genotypes without transmitting diseases.

The success of an AI program depends on the proper management of semen collection, storage and use, the proper oestrous synchronization and the insemination technique which also relate to the time of insemination. The storage of semen especially in the frozen state causes the intrastructural, biochemical and functional damage to the spermatozoa resulting of motility, viability, impaired transport and fertility (Leboeuf et al., 2000). The fertility of stored semen is generally lower than that of fresh semen. Furthermore the site within the genital tract where the semen is deposited also relates to the fertilization rate of does. The artificial insemination techniques utilized in goats are the vaginal AI, cervical AI, Trans cervical AI and Laparoscopic AI.

Artificial insemination techniques

Artificial insemination techniques and semen deposited site affect the fertility in goats (Arrebola et al., 2012). There are four AI techniques that have been used in goat breeding, vaginal insemination, cervical insemination, trans-cervical AI and laparoscopic intrauterine insemination. The laparoscopic AI technique allows the semen deposit intrauterine which ease the spermatozoa transportation toward the site of fertilization resulting the higher pregnancy rate than those the insemination techniques such as cervical or vaginal insemination where the semen are deposited at the cervical canal or at the deep end of the vagina.

Vaginal Insemination (VAI)

The vaginal insemination method involves depositing semen deep in the vagina without any attempt to locate the cervix then the semen is deposited at an anterior end of vagina (Fig. 1). Vaginal insemination using fresh diluted semen is the simplest and quickest method but requires a large semen dose (150-400 x 10^6 spermatozoa per insemination). The study in the Norwegian Dairy goats illustrates that the vaginal insemination with 200x 10^6 liquid spermatozoa resulted in 25-day non-return and kidding rates of 85.5 and 74.3%, respectively (Paulenz et al., 2005). While, the vaginal insemination with the frozen thawed semen gave the lower fertilization. The field trial in the Norwegian dairy goats show that non return rate and kidding rate after the vaginal deposition of 400 x 10^6 frozen-thawed spermatozoa were 64% and 58.3% (Nordstoga et al., 2010). This information suggests that the vaginal insemination with the fresh diluted spermatozoa gave higher fertility rate than those with frozen-thawed spermatozoa.

a) The doe is put on the rail helping allow the hind quarter of her body elevated. The vaginal speculum is utilized to locate an anterior of vagina.

b) The frozen semen is thawed prior deposited into the vagina.
The inseminating pipette is used for the deposition of the frozen thawed semen.

d) The red arrow presents the semen deposition at an anterior of vagina.

**Figure 1** The vaginal artificial insemination in goat.

The number of semen deposition does not affect the fertility rate when inseminations vaginally as long as the total number of inseminated spermatozoa are equal. Nordstoga et al. (2010) showed that fertility rates earned from the single insemination with $400 \times 10^6$ frozen-thawed spermatozoa and the double insemination with $200 \times 10^6$ frozen-thawed spermatozoa had not different statistically. In fact, when the number of spermatozoa per insemination reduces the fertility rate is lower. The further investigation on reducing the number of spermatozoa is presented. The data suggest that non return rate at 25 day after the insemination and kidding rate follow the vaginal insemination with $200 \times 10^6$ frozen-thawed spermatozoa were 37.3% and 24% respectively (Nordstoga et al., 2011). Even though the vaginal insemination technique is a simple and less cost but the fertility follow the use of frozen thawed semen is poor that prevents the extensive utilize of the best available buck lead to delay the rate of genetic improvement in goat breeding. Therefore the investigation for increase the fertility rate follow the insemination with frozen thawed semen is required.

**Intra-cervical insemination (CAI)**

Intra-cervical insemination using fresh diluted semen is commonly used in AI of goat at the farm level. When performed properly, cervical insemination with fresh diluted or undiluted semen results in high fertility, whereas the fertility obtained following intra-cervical insemination with frozen-thawed (F-T) semen is lower. The cervical insemination with $200 \times 10^6$ liquid spermatozoa resulted in 25-day non-return and kidding rates of 87.0 and 78.0%, respectively (Paulenz et al., 2005). When the cervical insemination with the frozen thawed semen gave the lower fertility rate, the experiment in mixed bred goat in Thailand illustrate that pregnancy rate after the cervical insemination with $150 \times 10^6$ frozen thawed spermatozoa were 15.789 % when performed single insemination and 38.70% respectively ($p<0.05$) when performed double insemination (Leethongdee et al., 2013). The semen deposition affects the pregnancy rate, the deeper the semen was deposited in the genital tract, the higher is the rate of pregnancy obtained, being greater when the catheter reach the uterus. The experiment during non breeding season in Murciano-Granadina goats in Spain shows that post-cervical insemination with the frozen-thawed semen had the pregnancy rate 57% (Salvador et al., 2005). The depth of cervical penetrability is associated with the cervix anatomy. The study in Thai breed goat shows that multiparous does have longer cervices than the nulliparous does (4.2±0.2 cm vs 3.5±0.2 cm; $p<0.05$) without any difference in the number of internal rings ($p>0.05$) (Intrakamhaeng et al., 2011). The depth of penetration in multiparous does was greater than in nulliparous does (3.8±0.2 cm vs 2.3±0.2 cm; $p<0.05$) (Intrakamhaeng et al., 2011). The deeper cervical penetration in multiparous does suggests a potential of deeper semen deposition which lead to the higher pregnancy rate.

**Trans-cervical intrauterine insemination (TCAI)**

Trans-cervical AI (TCAI) is a method of insemination where semen is deposited deep in the cervix or even into the uterus via the cervix (Fig. 2). This method involves depositing semen as deeply as possible; it aims to reach the uterus. The greater the depth of insemination, the higher the expected pregnancy and lambing rates. The success of the trans-cervical insemination is related with the cervical penetrability. However the complexity of the cervix prevents the passage of inseminating pipette through the cervix. Goat cervix has long tubular shape and the internal cervical ring. These factors limit the cervical penetration. The study of Intrakamhaeng et al. (2011) illustrates that an average length of multiparous does is 4.2±0.2 cm. The local cervical administration of Follicle stimulating hormone or Prostaglandin E2 increase the cervical penetration in cervix of Thai goats (Chatsumal et al., 2011). The expression of Prostaglandin receptor (EP) such as EP2 and EP4 indicating the relaxation mechanism in the cervix (Leethongdee et al., 2011). The cervical relaxation allows the passage of the inseminating pipette into the uterus. The trans-cervical intrauterine insemination
has been reported that the kidding rate follow the insemination with the frozen semen was 71% and the litter size was 1.76 (Sohnrey and Holtz, 2005). The passing of the inseminating pipette may cause the injury of cervical epithelium which may affect the fertility. The trans-cervical artificial insemination provides and acceptable kidding rate in goats. However the further investigation to increase the depth of cervical penetration without the trauma of cervical canal is warranted.

![Figure 2](image1.png)

**Figure 2** The semen deposition by the trans-cervical intra artificial insemination using the inseminating pipette passage through the cervical canal into the uterus. The arrow represents the direction of the inseminating pipette.

**Laparoscopic intrauterine artificial insemination**

Semen is deposited directly into the uterus through the uterine wall with the aid of a laparoscope (Fig. 3). Sedation and local anaesthesia are required. Fertility and pregnancy rates are high with either fresh or frozen thawed semen. A lower number of spermatozoa can be used, typically 40 to $80 \times 10^6$ spermatozoa per insemination.

![Figure 3](image2.png)

**Figure 3** The laparoscopic intrauterine artificial insemination in goat.

The pregnancy rate follows the laparoscopic insemination with frozen thawed semen in cashmere does was 64.5% when does were oestrous synchronization by CIDR and 62.7 % when oestrus was induced using progestagen sponge (Ritar et al, 1990). It seem like the method of oestrous synchronization does not affected the pregnancy rate after the laparoscopic insemination. Whereas the time of insemination had affected the pregnancy rate, the insemination later than 65 hour after hormonal treatment tends to reduce the pregnancy rate (Ritar et
benefit of spermatozoa is deposited close to the site of fertilization in the genital tract. The fertility rate when insemination with 10 million spermatozoa has not differed from the insemination with 20 million spermatozoa, 6.15% vs. 63.7% respectively (Ritar et al., 1990). Even though, laparoscopic insemination is requiring high skillful inseminator using the laparoscope which is expensive tool and consider not animal friendly welfare. The technique provides the high fertility rate which it may be considered use to inseminate the goat with superior genetic value.

Conclusions

The review has addressed mainly the insemination techniques that have provided in the goat breeding. The insemination technique gave the different fertility rate according to the site of insemination and the storage method of semen. The fresh semen gave the higher fertility rate compare to the frozen thawed semen which has been stored in liquid nitrogen which may damage the spermatozoa. The site of semen deposition affects the fertility, the deeper the semen deposition into the genital tract the increase of the fertility. Therefore the insemination intrauterine earns the highest fertility rate comparing to others techniques. The reducing of spermatozoa per insemination has been investigated. For the laparoscopic insemination, the reducing of the spermatozoa did not affect the fertility rate. This technique has the benefit of high fertility rate and uses lesser number of spermatozoa per insemination. However laparoscopic insemination is limited because of its expensive protocol and equipment. Alternatively the trans-cervical insemination provide the high fertility rate either and it is simpler technique as deposition of semen in uterine via cervical canal. But the complexity of the cervical anatomy limits the success of the cervical penetrability. The depth of cervical penetration has been investigated to improve this technique aims to replace the laparoscopic insemination and make it available at the farm level.

References


