ARTIFICIAL INSEMINATION OF FIBRE-PRODUCING GOATS

A.J. RITAR*

INTRODUCTION

Interest in the rapid dissemination of Angora and Cashmere genotypes and the need for increases in productivity through genetic improvement have stimulated research in the development of artificial insemination (AI) regimes for commercial application. Synchronization of ovulation and the use of frozen-thawed semen are essential for AI to be cost-effective and to allow large numbers of animals to be treated together. This paper discusses the control of ovulation, freezing of semen, AI of fibre-producing goats and the application of these techniques under commercial conditions.

CONTROL OF OVULATION

Natural breeding activity in the goat reaches a peak in autumn (range Feb-June; southern hemisphere) in response to decreasing daylength (Shelton 1978; BonDurant et al. 1981), during which time females display oestrus for 24-36 h once every 20-21 days, with ovulation occurring towards the end of oestrus (Corteel 1973; Shelton 1978). Hence, only 5% of all does are in oestrus each day. For AI, does in oestrus can be detected daily with vasectomised bucks. However, this is time-consuming, does not best utilise available manpower and can be overcome by control of oestrus and ovulation.

Management practices and environmental factors affect ovulatory responses. These include the sudden introduction of the buck to does previously isolated from males (Shelton 1978) which is repeatable throughout the year (Restall 1987). Unseasonal rains may also induce breeding activity (Moore 1985). Seasonally anoestrous does subjected to artificially decreasing light exhibit cyclic sexual activity and are fertile to natural mating 2-3 months before the breeding season (BonDurant et al. 1981), and this can be mimicked in goats by a commercial implant containing melatonin (McPhee et al. 1987). These strategies, however, do not induce a synchronised oestrus for the purpose of fixed-time AI.

Ovulation may be controlled accurately by hormonal treatment, either by the administration of progesterone (or analogues – progestagens) or prostaglandins. Progestagens extend the luteal phase in the breeding season or mimic the luteal phase in the non-breeding season, whilst injection of pregnant mare’s serum gonadotrophin (PMSG) at the end of progestagen treatment induces ovulation. Progestagens are administered intravaginally as controlled internal drug release (CIDR, AHI, NZ; containing progesterone) devices or sponges. Two types of sponge used widely are Chronogest (Intervet, France) containing fluorogestone acetate and Repromap (Upjohn, U.S.A.) containing medroxy progesterone acetate.

Ovulation after CIDR removal occurs some 10-15 h earlier than after sponge removal at the same dose of PMSG (Ritar et al. 1984, 1989; Table 1). Similarly, injection of PMSG at -48 h induces ovulation 10 h earlier than when injected at removal. Ovulation time is also advanced and ovulation rate increases as the dose of PMSG increases. These interactions between type of progestagen and PMSG administration need to be taken into account when conducting fixed-time AI.

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Table 1. Ovulation in does injected with PMSG at (0 h) or 48 h before (-48 h) sponge or CIDR removal

<table>
<thead>
<tr>
<th>Dose of PMSG (I.u.)</th>
<th>Mean ovulation time (final ovulation rate) after removal of:</th>
<th>Sponge</th>
<th>-48 h</th>
<th>CIDR</th>
<th>-48 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td></td>
<td>60-65h(1.6)</td>
<td>50-55h(1.7)</td>
<td>45-50h(1.7)</td>
<td>35-40h(2.2)</td>
</tr>
<tr>
<td>400</td>
<td></td>
<td>55-60h(2.0)</td>
<td>45-50h(2.3)</td>
<td>40-45h(2.6)</td>
<td>30-35h(3.1)</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>50-55h(2.2)</td>
<td>45-50h(3.0)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Control (0 PMSG)</td>
<td></td>
<td>4/20 does ovulated</td>
<td>7/10 does ovulated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prostaglandin F\(_\alpha\) (PGF\(_\alpha\)) and its analogues effectively terminate ovarian luteal activity (i.e. only in the breeding season) when injected between day 5 and 19 of the oestrous cycle (Hearnshaw et al. 1974). Two prostaglandin injections at an interval of 10-14 days induce oestrus within 72 h of the last injection (Moore and Epplleton 1979). The method is simple but has the danger that inadvertent treatment of pregnant does will cause abortion.

**DILUTION AND STORAGE OF GOAT SEMEN**

Semen dilution produces an inseminate volume (between 0.02 – 0.30 ml) convenient for either intrauterine or cervical insemination. The dilution medium provides nutrients and protection for spermatozoa for fresh use, chilled or frozen storage. Semen storage considerably enhances the potential utilization of an individual buck so that it can be used over a large number of females, over a wide geographical area, outside the normal breeding season, or many years after its death (preservation of unique genetic material). Collection of semen into the artificial vagina is the preferred method as it closely simulates natural ejaculation. Ejaculate volumes range between 0.5-1.2 ml and concentrations between 2.0-4.5 x 10\(^6\) spermatozoa/ml, but are reduced with poor body condition, after frequent collection (more than twice/day), or in the non-breeding season.

**Fresh and chilled semen**

Fresh semen may be diluted and held at 30°C in heat-treated skim milk or a Tris-based buffer (containing no egg yolk or glycerol) for insemination within 30 minutes of collection. The inclusion of egg yolk allows diluted semen to be cooled gradually to and be held at 5°C, but the presence of egg yolk coagulating enzyme (phospholipase A) in goat seminal plasma limits cell viability during chilled storage (Roy 1957). This enzyme hydrolyses lecithin (in egg yolk) producing a toxin to the spermatozoa and coagulation of the diluted semen. However, the presence of a safe margin of only 1.5% egg yolk does not depress survival of spermatozoa (Ritar and Salamon 1982).

**Frozen-stored semen**

Metabolism of spermatozoa is completely arrested when semen is frozen in liquid nitrogen (196°C) allowing cells to be preserved virtually indefinitely, thereby conserving genetic material for future use and providing insurance against loss of valued sires. Semen is usually frozen in pellets or straws, and numerous diluents and techniques have been developed (reviewed by Ritar 1984). Pellet-freezing is rapid, simple and gives consistently satisfactory post-thawing recovery rates for ejaculates with at least 3 x 10\(^6\) spermatozoa/ml and 80% motile spermatozoa at collection. A suitable method of processing in pellets was described by Salamon and Ritar (1982) which incorporated dilution of semen at 30°C with a Tris-based diluent containing glucose, egg yolk and glycerol, followed by cooling to 5°C in 1.5 h and freezing on dry ice followed by storage in liquid nitrogen.

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In contrast to the pellet method, straw-freezing allows accurate identification of individual semen doses but may be more labour intensive and time-consuming especially when seminal plasma removal (washing) is involved resulting in some loss of spermatozoa (Corteel 1981). Although recovery after thawing was slightly lower than for pellets, a much simplified method of straw-freezing was recently reported (Ritar et al. 1990) entailing dilution with the above Tris-based diluent containing 1.5% egg yolk without the need for washing. The post-thawing recovery was higher for straws filled with diluted semen at 30\(^\circ\)C than at lower temperatures and was similar for 0.25 ml and 0.50 ml straws.

**ARTIFICIAL INSEMINATION**

Cervical insemination should only be performed on adult does that have previously kidded to allow deep deposition of semen into the cervix. Fertility is lower for frozen-thawed than for fresh-diluted semen but is related to the depth of insemination into the reproductive tract (Ritar and Salamon 1983; Table 2), possibly due to altered transport of thawed cells through the cervix as previously noted in the ewe (Lightfoot and Salamon 1970; Robinson 1972). The improvement in embryonic survival (Ritar and Salamon 1983) and with increasing depth may be attributable to less ageing either of spermatozoa or oocytes, or to less exposure of spermatozoa to hostile cervical mucus following hormonal treatment. Fertility after single and double insemination is similar when a dose of 120 x 10^6 motile spermatozoa is used either at the natural or hormonally-induced oestrus (Ritar and Salamon 1983).

Table 2  Effect of depth of insemination with fresh and frozen-thawed semen

<table>
<thead>
<tr>
<th>Depth of cervical insemination</th>
<th>No. of does kidding/does inseminated (%)</th>
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<tbody>
<tr>
<td>up to 1 cm</td>
<td>36/88 (40.9)</td>
</tr>
<tr>
<td>1.0 to 3.0 cm</td>
<td>74/127 (58.3)</td>
</tr>
<tr>
<td>into the uterus</td>
<td>56/101 (69.1)</td>
</tr>
<tr>
<td>Frozen-diluted semen</td>
<td>17/63 (27.0)</td>
</tr>
<tr>
<td>0.25 ml straws</td>
<td>39/89 (45.9)</td>
</tr>
<tr>
<td>0.50 ml straws</td>
<td>70/102 (60.6)</td>
</tr>
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</table>

Laparoscopic insemination entails minor surgery (Killeen and Caffery 1982), is labour intensive and requires expensive equipment thereby making the procedure costly. However, our results (Ritar unpublished) showed that fertility in adult females is better than for the cervical method (Table 3), is similar in 18 month-old maidens but is reduced in 7 month-old kids.

Table 3  Percentage of adult females pregnant (number inseminated) after cervical and laparoscopic insemination with frozen-thawed semen

<table>
<thead>
<tr>
<th>Main effect</th>
<th>Cervical</th>
<th>Laparoscopic</th>
</tr>
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<tbody>
<tr>
<td>Intravaginal treatment</td>
<td>CIDR</td>
<td>40.7 (204)</td>
</tr>
<tr>
<td></td>
<td>Sponge</td>
<td>37.4 (198)</td>
</tr>
<tr>
<td>Time of insemination</td>
<td>Before ovulation</td>
<td>44.0 (200)</td>
</tr>
<tr>
<td></td>
<td>After ovulation</td>
<td>34.2 (202)</td>
</tr>
</tbody>
</table>

#Before (45 h, CIDR; 55 h, sponge) or after (55 h, CIDR; 65 h, sponge) ovulation

Table 3 also shows that fertility is better when does are inseminated before rather than after ovulation regardless of the insemination method or progestagen treatment used. Results are similar for laparoscopic inseminate
doses from $60 \times 10^6$ to as low as $5 \times 10^6$ motile frozen-thawed spermatozoa (Ritar unpublished) allowing more females to be inseminated/ejaculate than by cervical insemination.

**CONCLUSION**

The efficiency and intensity of selection of bucks can be increased with the aid of techniques for the manipulation of reproduction. Frozen semen offers much wider use of bucks than does fresh semen. The freezing of goat semen by either the pellet or straw procedures is quick and simple. For frozen-thawed semen, insemination by the laparoscopic method is recommended whereas the cervical method requires further study to obtain acceptable results. Hormonal control of ovulation allows a large group of females to be inseminated on a single day rather than over a full oestrous cycle and best employs the available resources.

**ACKNOWLEDGMENTS**

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**REFERENCES**


