Hayvansal Üretim (1997) 37: 8-17

THE SUPPRESSION OF OESTRUS IN BEEF HEIFERS AND ITS EFFECTS ON PERFORMANCE: A REVIEW

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Abstract: Oestrous behaviour is associated with an increase in behavioural activity and incidence of mounting. This is likely to cause disturbance and stress in a group of cattle which is believed to result in reduced feed intake, weight gains, and feed efficiency in the finishing period in beef production systems. There is, however, no clear evidence whether oestrous behaviour, in itself causes such reductions in performance. Where benefits from the suppression of oestrus have been observed, the effect has been confounded by some other factor e.g. the oestrous suppressant also creates an anabolic effect of endogenous origin. This review discusses the effects of oestrous suppression methods, ovariectomy, hysterectomy, pharmacological and immunological suppression of oestrus, on the weight gains and efficiency of gains in beef heifers.

Besi sığırı düvelerinde kızgınlığın baskı altına alınması ve bunun performansa etkileri

Özet: Davranışsal kızgınlık, bazı davranış aktivitelerinde ve başka hayvanlara atlama olaylarındaki artışla gerçekleşir. Bu tür aktiviteler, et sığırı yetiştiriciliğinde, bir takım huzursuzluklar ve stresin yol açtığı yem tüketiminde, canlı ağırlık artışında ve yemden yararlanma oranlarında belirgin azalmalara neden olabilir. Bununla birlikte, kızgınlık davranışlarının belirtilen üretim faktörlerinin düşmesine neden olup olmadığı konusunda belirgin deliller yoktur. Kızgınlığın baskı altına alınmasıyla olumlu etkilerin gözlendiği durumlarda, gözlenen etki, kızgınlığı denetleyici araçların hayvan vücudunda anabolik bir etki oluşturması gibi başka faktörlerle birlikte ortaya çıkar. Bu derlemede, ovariectomy, hysterectomy, farmakolojik ve immunolojik olarak kızgınlığın denetlenmesi gibi kızgınlığı baskı altına alma metodlarının, besi sığırı düvelerinin canlı ağırlık artışı ve canlı ağırlık artış etkinliğine etkileri tartışılmıştır.

Introduction

The expression of recurrent heat periods in heifers being reared for beef can increase management problems during the finishing period. Oestrous behaviour is characterized by increased behavioural activity and incidence of mounting. These result in disturbance and stress in the herd, accompanied by reduced feed intake and lower weight gains (Gordon, 1983). It is, therefore, necessary to separate heifers from entire and castrate males to avoid both disturbance and pregnancy within the herd. In addition performance and utilisation of feed are poorer in heifers in comparison to steers (Bradley *et al.*, 1966; Broadbent *et al.*, 1970) and they have to be sold at lighter carcass weight as they tend to lay down fat earlier in life (Berg *et al.*, 1979). A practical method of preventing or suppressing oestrous behaviour which would simultaneously increase the efficiency of conversion of food into lean meat, would be

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desirable for finishing beef heifers. Management tools used to suppress oestrus fall into three main categories:

1. Surgical removal of ovarian tissue (ovariectomy/spaying) or surgical removal of uterine tissue (hysterectomy).

2. Pharmacological suppression using progesterone or a progesterone analogue e.g. Melengestrol Acetate (MGA).

3. Active immunization against gonadotrophin releasing hormone, prostaglandin F2α or oestradiol.

This review summarizes the effects of oestrus suppression on the growth performance and carcass characteristics of female cattle.

1. Ovariectomy and Hysterectomy

Ovariectomy or spaying was first used to prevent oestrous cycles in cattle by Wilson and Curtis in 1896 (Klindt and Crouse, 1990). Ovariectomy performed on female calves at 8 weeks of age was found to have negligible effect on weight gains and allowed the neutered female to mingle with bullocks in the same feedlot without lowering the feed intake of either due to "bulling" heifers (Oldham, 1963).

Ovariectomy removes the ovaries and by doing so removes the source of endogenous gonadal steroids known to have anabolic actions (Preston, 1975). Many investigations into the effects of ovariectomy on the performance of beef females have found wight gains and feed efficiency to be reduced (Ray *et al.*, 1969; Hubard-Ocariz *et al.*, 1970; Horstman, *et al.*, 1982; Dunbar *et al.*, 1989; Lunt *et al.*, 1990; Adams *et al.*, 1990; Garber *et al.*, 1990) and others (Robertson *et al.*, 1970; Hamernik *et al.*, 1985; Klindt and Crouse, 1990) report weight gains and efficiency of gain in ovariectomized females to be similar to those of intact control animals. Ovariectomy has not been shown to have a major effect on carcass characteristics (Hubard-Ocariz *et al.*, 1970; Hamernik *et al.*, 1985; Adams *et al.*, 1990; Garber *et al.*, 1990; Klindt and Crouse, 1990). However an increase in the percentage of marbling and body fat content can be observed (Adams *et al.*, 1990).

Variation in results between studies may be due, in part, to differences in management and feeding, group sizes, slaughter weights and breed. Klindt and Crouse (1990) drew attention to the effect of the age of animal at ovariectomy. Many earlier studies involved ovariectomy later in life (e.g. 2-3 years old). Hubard-Ocariz et al. (1970) suggested that ovariectomy should be carried out as early in life as possible. Calves recover quickly from operation, which is carried out via flank incision, and appear apparently unaffected (Oldham, 1963).

Ovariectomy can be both laborious and stressful on the animal. Vaginal spaying using a Willis instrument was evaluated by Garber *et al.* (1990). The technique was found to be

a practical and effective one in terms of eliminating reproductive competence, with 96% of heifers succesfully spayed. The results, however, were in agreement with previous work, with feed intake, average daily weight gains and feed conversion efficiency reduced in spaying animals. Carcass characteristics were not significantly affected by treatment.

In an attempt to solve the problem of reduced performance in ovariectomized/spayed females, autografting or autotransplantation techniques were tried. In these techniques a small piece of ovarian tissue is grafted to another site e.g. the flank muscle. Alternatively, the removed ovary may be "dropped" into the abdomen. Klindt and Crouse (1990) examined feedlot performance as measured by average daily gain, feed efficiency and carcass characteristics in ovariectomized, sham ovariectomized, ovarian autografted and intact heifers. No significant differences were detected between treatments in the rate or efficiency of gain. No differences were evident for the major carcass traits of dressing percentage and leanness or lib-eye area. Of the ovarian autografted heifers, 20% exhibited ovarian cyclicity. Approximately 20% of autografted ovaries were reabsorbed. It was concluded that transplantation of the ovary either in total or part had no positive effect on the performance of feedlot heifers (Klindt and Crouse, 1990).

Anabolic agents have been used to maximise growth performance and achieve acceptable weight gains in ovariectomized females (Shoop *et al.,* 1984; Adams *et al.,* 1990; Garber *et al.,* 1990). Garber *et al.,* (1990) implanted vaginally spayed heifers with either Synovex-H (20 mg oestradiol benzoate + 200 mg testosterone) or Synovex-S (20 mg oestradiol benzoate + 200 mg progesterone). The overall response in average daily gain was shown to be fourfold greater in spayed implanted heifers than intact implanted heifers (32 vs 8%). Spayed heifers treated with Synovex-S had higher weight gains in the finishing period than heifers treated with Synovex-H. Behavioural oestrus was displayed in 71-76% of spayed implanted heifers despite the success of spaying operation. Adams *et al.* (1990) reversed the suppression of weight gain induced by ovariectomy by administration of Synovex-H implants thus achieving performance comparable to intact control (untreated) animals.

Hysterectomy involves removal of the uterus and hence the source of the luteolytic agent prostaglandin F2α (PGF2α). In the normally cycling bovine this results in a persistent corpus luteum and, consequently, there is an absence of behavioural oestrus. Elevated progesterone levels and the subsequent block to ovulation and oestrous activity in hysterectomized heifers might be expected to increase feedlot performance. Hamernik *et al.* (1985) investigated the effect of hysterectomy on feedlot performance. Hysterectomized heifers showed greater total weight gain (130.2 ± 3.8 kg vs 118.1 ± 3.7 kg) and higher average daily weight gain (1.16 ± 0.04 kg vs 1.05 ± 0.03 kg) compared to intact control heifers. Hysterectomized heifers also finished more efficiently using 7.44 ± 0.22 kg vs 8.12 ± 0.22 kg feed/kg gain. This difference was not

statistically significant. There was no significant effect of hysterectomy on the carcass traits examined. Progesterone levels in the hysterectomized animals were consistently high. It is possible that hysterectomy creates an advantageous endocrine environment in comparison to ovariectomy. However it is laborious operation and also stressful on the animal. An immunological approach to inhibiting PGF2α release has been suggested as a more practical option (Hamernik *et al.*, 1985).

In conclusion:

- Ovariectomy inhibits oestrous cyclicity but has deliterious effects on weight gain and efficiency of gain.
- Ovariectomy does not have any significant effect on carcass traits although the proportion of body fat may be increased.
- Trasplantation of the ovary either in total or part has no positive effect on the performance of ovariectomized heifers.
- Administration of anabolic agents is necessary to maximise growth performance in ovariectomized heifers.
- Hysterectomy results in elevated progesterone levels and suppression of oestrus. Hysterectomized heifers show increased weight gains with no effect on carcass traits.

2. Pharmacological Suppression of Oestrus

Pharmacological control of the oestrous cycle involves the use of exogenous hormones to manipulate the oestrous cycle to the benefir of the cattle breeder or producer. Control of the cycle is dependent on the manipulation of the hormonal events which occur during the normal ovarian cycle. The over-riding event controlling the development of the ovarian follicle to the point of ovulation is the process of luteolysis (regression of the corpus luteum). As a result of luteolysis, brought about by PGF2α secretion from the uterus, progesterone levels decrease. Control of the oestrous cycle is based on two approaches to the manipulation progesterone levels (Kuran, 1995):

(i) Extending the life of, or substituting for the corpus luteum, by administration of progesterone or one of its analogues for a period of time followed by its abrupt removal.

(ii) The artificial induction of premature luteolysis by administration of a luteolytic agent such as PGF2α or one its analogues.

Administration of a progestogen causes a negative feedback action on gonadotrophin release and results in a suppression of follicular maturation and hence oestrus and ovulation until the removal of the exogenous source. This technique is commonly used to synchronise oestrus in cattle (Gordon, 1983; Peters, 1986; Odde, 1990; Larsen and

Ball, 1992; Macmillan and Peterson, 1993; Bo *et al.*, 1995; Macmillan and Burke, 1996). The inhibition of oestrus and follicular maturation consequent on progestogen treatment results in the growth of persistent large follicles secreting an uninterrupted supply of oestrogen, which is known to have growth promoting effects in cattle (Preston, 1975). Work in the 1960s showed that administration of the potent, orally active, progestogen melengestrol acetate (MGA) had a growth promoting effect over and above its oestrus inhibiting capacity. Bloss *et al.* (1966) were able to achieve consistent improvements of weight gain and efficiency of gain by feeding MGA to feedlot heifers. In one trial, animals receiving 0.37 mg MGA per head per day showed an 18% improvement in weight gain compared to untreated control animals.

Similar responses to oral MGA treatment have been observed by other workers (Burroughs *et al.*, 1966; O'Brien *et al.*, 1968; Hawkins *et al.*, 1972). O'Brien *et al.* (1968) achieved a 21% increase in overall weight gain and an 11% increase in efficiency of gain in heifers receiving 0.3 mg MGA per head per day compared to control animals. Seven of the 32 heifers treated with MGA showed oestrus. All the MGA treated heifers had enlarged follicles present on the ovary. In a review of the subject Zimbleman *et al.* (1970) reported mean improvements of 11.2% in daily gain and 7.6% in feed efficiency over control animals from extensive trials in the USA. Feed intake was shown to be increased by MGA treatment in other studies (Bloss *et al.*, 1966; Burroughs *et al.*, 1966; Hawkins *et al.*, 1972; Dunbar *et al.*, 1989). Carcass characteristics do not appear to be affected by MGA treatment (Burroughs *et al.*, 1966; O'Brien *et al.*, 1968;Young *et al.*, 1969; Utley *et al.*, 1972).

In some cases MGA has proved effective in suppressing oestrus but it has not resulted in significant improvements in growth performance (O'Brien *et al.*, 1968; Young *et al.*, 1969; Utley *et al.*, 1972). The growth promoting action of MGA may not take effect or have a reduced effect in sexually immature heifers (O'Brien *et al.*, 1968). This may, in part, explain some of the differences in response observed.

Possible synergistic effects of MGA in combination with antibiotics have been investigated. Utley *et al.* (1972) found no beneficial effect of MGA in combination with oxytetracycline treatment. Horton *et al.* (1980) reported a benefit from using MGA in combination with monensin. Hereford heifers increased weigth 17% faster and utilised feed 8% more efficiently than control animals in their study.

Oral administration of MGA may not be practical under pastural conditions. Roche and Crawley (1973a; 1973b) administered MGA by means of an implant inserted subcutaneously in the dewlap. The implant (impregnated with 500 mg MGA) gives slow release of MGA for as long as it is in place (The predicted useful life of the implant is in excess of 2 years). Only one such implanted animal showed signs of oestrus. The daily gain of implanted animals was significantly higher than control animals and those which received MGA orally. The average increase in gain of implanted animals was 8-10%.

Carcass weight showed a corresponding increase and 90% of this increase was attributable to deposition of lean tissue.

Mosely *et al.* (1986) described a system for administration of MGA through a single subcutaneous injection of a "depo formulation" of MGA (depo-MGA) in the ear of beef heifers. A single depo-MGA injection suppressed oestrus for an average of 325 days. Depo-MGA treatment increased daily weigth gains compared to control animals (1.67 kg vs 1.58 kg). This increase was not significant. No effect of depo-MGA on average daily gain at pasture or in feedlot conditions was detected by Hill *et al.* (1988). However, depo-MGA was 90-100% effective in inhibiting pregnancy in pastured females (Hill *et al.*, 1988).

The progestogen 6 α-methyl-17α-acetoxyprogesterone (MAP) has also been shown to inhibit oestrus in heifers when administered orally or by injection (Surjoatmodjo *et al.*, 1984).

In conclusion:

- Administration of progestogen by the oral route, by injection or subcutaneous implant is effective in suppressing oestrus.
- Treatment with melengestrol acetate (MGA) can improve daily weight gains and feed efficiency by an average of 11% and 8%, respectively.
- Carcass characteristics do not appear to be affected by MGA treatment.
- Sexually immature females show a lower growth response to MGA than sexually mature heifers.
- The beneficial growth response to MGS is believed to be due to the joint effects of suppression of oestrous activity and the creation of an uninterrupted supply of endogenous oestrogen.

3. Immunological Suppression of Oestrus

Immunization against gonadotrophin releasing hormone (GnRH) is a means of establishing an immunological barrier between the hypothalamus and anterior pituitary that specifically neutralises GnRH, resulting in the arrest of follicular development and suppression of oestrus (Adams and Adams, 1990; Gong *et al.*, 1995; Macmillan and Burke, 1996). GnRH immunization has however resulted in reduced liveweight gains in feedlot heifers and performance was comparable to those observed in ovariectomized heifers (Dunbar *et al.*, 1989; Adams and Adams, 1990).

Active immunization against prostaglandin F2α (PGF2α) would create an adventagenous endocrine environment similar to that observed following hysterectomy (Hamernik *et al.*, 1985). Active immunization against PGF2α was found to prolong the

oestrous cycle in cows and ewes (Fairclaough *et al.*, 1981). Chang *et al.* (1987) evaluated the sterilization potential of active immunization against PGF2α and its effect on feedlot performance. A PGF2α-ovalbumin conjugate was developed. Its administration resulted in antibody production against PGF2α. Corpus luteum function was maintained for 2.5 months and ovulation apparently blocked. However no difference in average daily gain was observed between immunized and control heifers over a 5 month period. These results do not agree with those of Hamernik *et al.* (1985), who showed increased weight gains in hysterectomized heifers.

Immunization techniques against oestradiol have also been developed. Wise and Ferrell (1984) reported increased feed efficiency in heifers immunized against oestradiol compared to control animals. The authors suggested that immunization caused the availability of oestrogen to target tissues to be increased.

Other techniques which have been tried in an attempt to suppress recurrent oestrus include the insertion of metal balls into the uterus and the use of plastic intravaginal devices known as Hei-Gro (Gordon, 1983). Claims that this device inserted into the vagina of heifers at 200 kg liveweight would improve the rate and efficiency of weight gain have not been substantiated by experimental investigations (Utley *et al.*, 1978; Lesmeister *et al.*, 1978). A high loss rate of devices has been observed (Horton *et al.*, 1979) and chronic-vaginal infections were common (Etches *et al.*, 1979).

In conclusion:

- Immunization against GnRH suppresses oestrus but results in reduced liveweight gains in feedlot heifers.
- Active immunization against PGF2α is effective in maintaining corpus luteum function, and blocks ovulation, however no improvement in feedlot performance has been reported.

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