Pregnancy Status and Feedlot Performance of Beef Heifers Actively Immunized Against Gonadotropin-Releasing Hormone

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ABSTRACT: The contraceptive effect of active immunization against GnRH was evaluated in beef heifers. Crossbred heifers were randomized by breed and weight (initial weight = 227.3 ± 1.2 kg) and assigned to one of three treatment groups. Animals in Group IB (n = 48) were actively immunized against GnRH; heifers in Groups NB (n = 48) and NN (n = 49) did not receive the anti-GnRH vaccine. Sixteen weeks after primary immunization, bulls of proven fertility were introduced into pens containing Groups IB and NB. Bulls were maintained with heifers for 2 mo. Heifers in group NN were not intentionally exposed to fertile males. At the end of the breeding period, heifers received Synovex H implants and entered a commercial feedlot. Heifers were slaughtered after 116 d of feedlot confinement. Anti-GnRH titer was evident in all heifers (48 of 48) immunized against GnRH. Gravid uteri were present at slaughter in 40 of 48 (83.3 %) NB heifers. In contrast, only four (8.3 %) IB and two (4.1 %) NN heifers carried gravid uteri at slaughter. Although ADG did not differ between groups during feedlot confinement, ADG during the breeding period was higher (P < .05) in IB heifers than in NN control animals. Dressing percentage and longissimus muscle area were decreased (P < .05) and marbling and quality grade were increased (P < .05) in NB heifers compared with NN control heifers. Carcass traits of IB heifers were intermediate between those of the NB and NN groups. Taken together, these data indicate that active immunization against GnRH reduces the fertility of terminal heifers. These observations suggest that immunoneutralization of GnRH may be an effective management tool that will reduce the incidence of unintended pregnancy in heifers destined for feedlots.

Key Words: Anti-GnRH, Heifers, Feedlots, Carcass Composition, Pregnancy, Contraception

Introduction

The sale of feeder heifers brings less income to cow-calf producers than sale of feeder steers of comparable size and condition (Meyer, 1987). This difference in value is due to the lower efficiency of feed conversion that is characteristic of heifers (Garber et al., 1990; Kreikemeier and Unruh, 1993). In addition, despite rigorous management programs designed to prevent pregnancy, a significant proportion of feeder heifers are pregnant when they enter the feedlot (Kreikemeier and Unruh, 1993).

Several alternate management procedures designed to reduce the economic liabilities associated with feedlot heifers have been proposed. Generally, these involve suppression of reproductive activity in the feedlot by spaying (Horstman et al., 1982) or feeding synthetic progestins (Bloss et al., 1966). We (Adams and Adams, 1990) and others (Wettemann and Castree, 1994; Prendiville et al., 1995) have demonstrated that active immunization against gonadotropin-releasing hormone (GnRH) suppresses ovarian function in beef heifers. In the study presented here, we examine the fertility and carcass characteristics of feeder heifers after active immunization against GnRH.

Materials and Methods

Experimental Design. One hundred forty-five commercial crossbred yearling heifers were obtained from a northern California cattle producer (Stegall Bros. Cattle Co., Colusa, CA). Heifers were randomized by breed and weight (initial weight = 227.3 ± 1.2 kg) and assigned to one of three treatments. Animals in Group IB (n = 48) were actively immunized against GnRH using the procedure detailed below. Heifers in Groups NB (n = 48) and NN (n = 49) served as control animals and did not receive the anti-GnRH vaccine.
The mean initial weight of heifers in the three treatment groups did not differ (P > .05; Table 1). Bulls of proven fertility (bull:heifer ratio = 1:24) were introduced into the pens containing treatment Groups IB (Immunized + Bull) and NB (Nonimmunized + Bull) 16 wk after primary immunization (PI). Bulls remained with heifers for 2 mo. Animals in Group NN (Non-immunized and Not exposed to bulls) were not intentionally exposed to fertile males during the breeding period. However, the producer reported inadvertent commingling of bulls and NN heifers for less than 1 h during routine cleaning and waste removal procedures. During the prebreeding and breeding periods, heifers had unlimited access to water and a pelleted ration composed of alfalfa and almond hulls.

At the end of the 59-d breeding period heifers received Synovex H (200 mg testosterone propionate and 20 mg estradiol benzoate; Syntex Agribusiness, Des Moines, IA) implants and entered a central California feedlot (Harris Ranch Feeding Co., Coalinga, CA). During feedlot confinement heifers had unlimited access to water and a pelleted ration composed of alfalfa and almond hulls.

Pregnancy status, hot carcass weight, and dressing percentage were determined at slaughter, and marbling score and quality and yield grades were determined by a USDA meat grader 24 h postmortem. Longissimus muscle cross-sectional area and backfat were measured at the 12th rib.

Immunization. At PI, 3 mL of an emulsion composed of equal volumes of Freund's complete adjuvant, Freund's incomplete adjuvant, and saline containing 5 mg equivalents (mEq) of a GnRH-KLH conjugate was delivered to two s.c. sites on the dorsal aspect of the upper neck. The GnRH-KLH conjugate was prepared as described previously (Adams and Adams, 1986; Adams et al., 1996). The efficiency of conjugation of GnRH to the carrier protein was 65% (Adams and Adams, 1990). Each milligram equivalent of GnRH-KLH was estimated to contain .65 mg of GnRH covalently linked to 1 mg of KLH. Heifers in group IB received a single secondary immunization 8 wk after PI. The secondary immunization consisted of 2 mL of an emulsion composed of equal volumes of Freund's incomplete adjuvant and saline containing 2 mEq of the GnRH-KLH conjugate. The emulsion was administered to s.c. sites in the upper neck.

**Determination of Anti-Gonadotropin-Releasing Hormone Titer.** The percentage of total [125I] GnRH bound by components in serum was used as a measure of anti-GnRH titer in immunized heifers. The proportion of radiolabeled GnRH bound was determined by incubating 8 fmol of [125I] GnRH (20,000 cpm) in .1 mL of .1 M PBS containing .1% gelatin (Gel-PBS) with .1 mL of a 1:100 or 1:1,000 serum:Gel-PBS dilution (Adams and Adams, 1986; Adams et al., 1996). After incubation for 24 h at 4°C, the radiolabeled GnRH bound to antibody was separated by precipitation with 95% ethanol. Anti-GnRH titer is expressed as a percentage of the total [125I] GnRH that was bound to antibody in a 1:100 or 1:1,000 serum dilution.

**Statistical Analyses.** Data were analyzed with ANOVA (Gill, 1978). When significant treatment effects were noted, mean comparisons were made using Tukey’s mean separation test. Data are presented in the text as means ± SEM.

**Results**

**Pregnancy.** Gravid uteri were present at slaughter in 40 of 48 (83.3%) NB heifers. In contrast, the incidence of pregnancy was markedly reduced (P < .05) in heifers immunized against GnRH (group IB). Indeed, only 4 of 48 immunized heifers (8.3%) carried gravid uteri at slaughter. Two of the heifers (4.1%) in Group NN were pregnant at slaughter. In all cases, the mass of the uterus and attendant fetal tissue was consistent with that generally associated with early to mid gestation.

**Anti-Gonadotropin-Releasing Hormone Titer.** All immunized heifers (48 of 48) developed significant anti-GnRH titer (> 5% of total [125I] GnRH was bound by a 1:100 serum dilution) 8 wk after primary immunization and antibody titer remained elevated to slaughter. Mean anti-GnRH titer (percentage of total [125I]
GnRH bound by a 1:1,000 serum dilution) at the beginning of the breeding period and at slaughter was 42.8 ± 2.7 and 50.1 ± 2.9%, respectively. The mean anti-GnRH titer at the beginning of the breeding period in IB heifers that failed to conceive during the 59-d breeding period was 45.4 ± 2.4% (percentage of total $^{[125]I}$ GnRH bound by a 1:1,000 serum dilution; n = 44). In contrast, anti-GnRH titer (13.4 ± 1.4% of total $^{[125]I}$ GnRH bound by a 1:1,000 serum dilution) at the beginning of the breeding period was significantly lower in IB heifers (n = 4) that became pregnant during the period of exposure to bulls. Antibodies against GnRH were not evident (< 1% of total $^{[125]I}$ GnRH was bound by a 1:100 serum dilution) in unimmunized heifers.

Feedlot Performance and Carcass Traits. Total weight gain and ADG before breeding and during feedlot confinement did not differ (P > .05) among treatment groups (Table 1). Similarly, weight gain during the breeding period did not differ (P > .05) between IB and NB heifers. However, ADG during the breeding period was significantly lower in NN heifers than in IB heifers.

Although final live weight did not differ (P > .05) among groups, dressing percentage and cross-sectional area of the longissimus muscle were reduced (P < .05) in NB heifers relative to NN control animals (Table 2). Conversely, the content of intramuscular fat (marbling) and USDA quality grade were increased (P < .05) in NB heifers relative to NN control animals. The dressing percentage and longissimus muscle area of immunized heifers were comparable to values for NB heifers and significantly lower than values noted in NN heifers. Marbling score and USDA quality score of immunized heifers were intermediate between the values for the NN and NB control groups.

Discussion

The mass of the uterus and associated fetal tissue of all pregnant heifers was consistent with that generally associated with early to mid gestation (Bennett, 1985). This indicates that conception in IB and NB heifers occurred during the designated breeding period. Surprisingly, two heifers in group NN became pregnant without intentional exposure to bulls. Conception in these animals probably occurred during that brief period when NN heifers were inadvertently penned with bulls. This unintended introduction of fertile males occurred during the deaning and waste removal that is a routine component of normal ranch management in the commercial setting used for this study. Although the discovery of pregnancy among heifers that were not to have had contact with bulls was unexpected, this observation serves to emphasize that maintaining “open” heifers is difficult, even under the most highly controlled conditions. Indeed, a recent survey of feedlots in the Midwest indicates that the incidence of pregnancy among feeder heifers may be as high as 25% (Kreikemeier and Unruh, 1993).

Immunoneutralization of GnRH interrupts the endocrine cascade that leads to follicular growth and ovulation (Sakurai et al., 1992). Thus, ovarian activity and secretion of estradiol and progesterone are reduced in cattle actively immunized against GnRH (Adams and Adams, 1990; Prendiville et al., 1995). These observations would suggest that fertility is markedly impaired in heifers immunized against GnRH. Indeed, we show here that immunization with the GnRH-KLH conjugate results in a 10-fold reduction in incidence of pregnancy in yearling heifers maintained with fertile bulls during a 2-mo breeding period. These data indicate that active immunization against GnRH has a contraceptive effect in beef cattle and suggest that immunization may prove to be an effective management tool that will reduce the incidence of pregnancy in heifers destined for feedlots.

Although high anti-GnRH binding activity was evident in most immunized heifers at the beginning of the breeding period (16 wk after PI), some heifers seemed to be relatively insensitive to the immunogenic potential of the GnRH-KLH conjugate. In this small subset of heifers, anti-GnRH titer at the beginning of the breeding period was low and apparently of insufficient magnitude to block follicular growth and development and ovulation. Indeed, all immunized heifers that became pregnant during the breeding period were from this subset of unresponsive animals. Additional research is required to improve the consistency of the immune response among immunized heifers.

Although ADG did not differ among groups before breeding and during the feedlot phases, ADG was significantly reduced during the breeding period in nonimmunized control heifers denied access to fertile bulls. The lower ADG in these control heifers is likely due to recurrent displays of behavioral estrus and the increased energy expenditure and reduced feed efficiency associated with estrus (Ray et al., 1969; Horstman et al., 1982). That comparable reductions in ADG were not noted in heifers immunized against GnRH is likely due to the suppression of reproductive function and the associated decline in mounting and riding activity, resulting from immunoneutralization of GnRH. Similarly, recurrent displays of estrus are probably reduced in nonimmunized heifers housed with bulls, assuming that most heifers conceived during the first estrus of the breeding period.

During the period of feedlot confinement the ADG of immunized and nonimmunized heifers did not differ. Similarly, the magnitude of feedlot gain did not differ among nonimmunized heifers housed with and without contact with fertile males during the breeding period. It is important to note that all heifers received implants containing anabolic steroids at feedlot entry.
Implants containing anabolic steroids markedly improve the feedlot performance of heifers by increasing ADG and feed efficiency (Unruh, 1986; Adams, et al., 1990; Garber et al., 1990). The growth-promoting effect of these implants is likely to override the effects of treatment on ADG during feedlot confinement. Indeed, we have previously demonstrated that active immunization against GnRH reduces ADG of feedlot heifers (Adams et al., 1990). However, this suppressive effect of immunization is reversed by administration of Synovex H implants.

In comparison with control heifers (NN), mean carcass weight was reduced by nearly 8 kg in NB heifers. Dressing percentage was also significantly reduced in NB heifers. This reduction in carcass weight and dressing percentage is likely due to the high incidence of pregnancy in NB heifers. Similar effects of pregnancy on carcass weight and dressing percentage have been noted in previous studies (Simms et al., 1983; Edwards and Laudert, 1984; Stanton et al., 1988). This effect of pregnancy status on carcass characteristics in feedlot heifers is accentuated during late gestation, when the gravid uterus may account for 5 to 10% of total body weight (Bennett et al., 1984). In the study reported here, pregnant heifers were in early to mid gestation (116 to 175 d of gestation) at slaughter. Bennett and coworkers (1984) indicate that this stage of gestation results in a reduction in carcass weight and dressing percentage that is consistent with the 1.8% reduction in dressing percentage noted in the study presented here. Dressing percentage was also significantly reduced, relative to nonimmunized control heifers (Group NN), in heifers immunized against GnRH (Group IB). This immunization-induced reduction in dressing percentage may be due, at least in part, to the additional trimming required at the sites of immunization for carcasses from immunized heifers.

Although cross-sectional area of the longissimus muscle was reduced in NB heifers, relative to NN control animals, the content of intramuscular fat (marbling) was increased in the treatment group (NB) consisting of heifers predominantly in early to mid gestation. The increased level of marbling in pregnant heifers probably accounts for the high quality grade received by those carcasses. The pregnancy-dependent improvement in quality grade noted here is consistent with observations published previously (Walker et al., 1988; Kreikemeier and Unruh; 1993).

**Implications**

These observations suggest that active immunization against gonadotropin-releasing hormone (GnRH) suppresses reproductive function in beef heifers and may be a practical and effective means of preventing unintended pregnancy in heifers destined for feedlots. Although feedlot gain did not differ among animals in pen lots composed predominantly of pregnant or nonpregnant heifers, dressing percentage and longissimus muscle area were reduced and marbling and quality grade were increased in pregnant heifers. Heifers immunized against GnRH had carcass characteristics that were intermediate between the characteristics of carcasses from pregnant and nonpregnant heifers.

**Literature Cited**


