Efficacy of a *Fusobacterium necrophorum-Arcanobacterium pyogenes* Bacterin-Toxoid as an Aid in the Prevention of Liver Abscesses in Cattle

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Introduction

Condemnation of bovine livers because of liver abscesses causes a substantial economic loss to meat packers. *Fusobacterium necrophorum* and *Arcano-bacterium pyogenes* are believed to act synergistically to cause liver abscesses in cattle on high energy diets. A leukotoxin and a hemolysin have been shown to be important virulence factors of *F. necrophorum* and *A. pyogenes*, respectively. The lysis of neutrophils and macrophages by the leukotoxin is thought to lead to the release of reactive oxygen radicals and cytolytic enzymes that damage the hepatic cells. The studies reported herein were done to test the efficacy of single-dose, bivalent *F. necrophorum-A. pyogenes* bacterin-toxoid to aid in the reduction of liver abscess incidence and severity under field conditions and natural challenge.

Materials and Methods

Two studies were done to test the efficacy of a single-dose, bivalent *F. necrophorum-A. pyogenes* bacterin-toxoid to reduce liver abscess incidence and severity when given to cattle entering a feedlot. In each study, crossbred beef breed steers, body weight 718 to 757 lb (326 to 344 kg), were randomized to pens, and the pens, arranged in three blocks, were assigned to treatment groups, resulting in ~300 steers per treatment group. Treatment groups in study 1 were 1) steers vaccinated with a high-antigen dose bacterin-toxoid, 2) steers vaccinated with with a low-antigen dose bacterin-toxoid, 3) non-vaccinates and 4) non-vaccinates fed a ration containing tylosin (~ 90mg/head). Treatment groups in study 2 were fed rations without tylosin or rations with tylosin (~90mg/head). Groups that were not fed tylosin-medicated feed were 1) placebo-vaccinated, 2) vaccinated with a high-antigen dose bacterin-toxoid, or 3) vaccinated with a low-antigen dose bacterin-toxoid. Groups fed tylosin-medicated feed were 1) placebo vaccinated, or 2) vaccinated with the high-antigen dose bacterin-toxoid. Treatment groups were not commingled. Therefore, pen was the experimental unit for growth performance outcomes, and steer was the experimental unit for liver abscess incidence. The study period was from arrival at the feedlot to harvest for each study. Steers were weighed by pen at the start and end of each of the studies. Steers were followed to slaughter and liver abscesses were recorded and scored. Normal livers were scored as 0, and abscessed livers were scored from mild to severe as A- (1), A (2), or A+ / A++ (3). Feed delivered to each pen and the percent dry matter of the feed were recorded daily. The USDA carcass and yield grades were recorded, and pen average daily gain (ADG) and feed conversion calculated.

Results

In each study, a severe natural challenge produced a high (>30%) liver abscess incidence in the unvaccinated control, non-medicated steers. Pen effects were not detected in the analysis of liver abscess incidence data ($p>0.05$). The incidence and severity of liver abscesses was significantly reduced in both studies in steers vaccinated once with a bivalent, high-antigen dose bacterin-toxoid. In study 1, steers vaccinated with the high-antigen dose bacterin-toxoid had an incidence of liver abscesses (15.5%) that was significantly lower ($p = 0.0001$) than that of the non-vaccinated controls (31.2%) and that of the steers given the low-antigen dose bacterin-toxoid (26.3%, $p = 0.002$). The liver abscess incidence of steers vaccinated with the low-antigen dose bacterin-toxoid did not differ significantly from the non-vaccinated steers ($p < 0.19$).

The liver abscess incidence of steers fed tylosin-medicated feed (8.8%) was significantly lower than that of the non-vaccinated controls and of the steers vaccinated with the low-antigen dose bacterin-toxoid. The liver abscess incidence of steers vaccinated with the high-antigen dose bacterin-toxoid was significantly lower than that of the non-vaccinated steers ($p = 0.044$),

and did not differ significantly from that of steers fed tylan-medicated feed ($p = 0.17$). The number of steers with the most severe and the most economically important liver lesions (A+ or A++) was greatest in the non-vaccinates and least in the tylosin-medicated group. There were no overall significant differences in USDA carcass and yield grade, average daily gain or feed conversion (deads and rejects out), adjusted for dressing percentage.

In study 2, the liver abscess incidence of the placebo-vaccinated, non-medicated steers (48%) was significantly greater than that of steers given either the high-antigen dose (30%, $p < 0.001$) or the low-antigen dose bacterin-toxoids (36%, $p < 0.004$). The odds that a placebo-vaccinated steer would develop a liver abscess were 2.2 times greater (95% CI, $1.74<OR<2.78$) than that of a steer given the high-antigen dose bacterin-toxoid, and 1.67 times greater (95% CI, $1.05<OR<2.66$) than that of a steer given the low-antigen dose bacterin-toxoid in the steers fed non-medicated feed. Scores of liver abscesses were significantly greater in the placebo-vaccinated steers than in steers vaccinated with the high-antigen dose ($p = 0.0001$) or low-antigen dose ($p = 0.0047$) bacterin-toxoids. Odds of a higher liver abscess score for placebo-vaccinated steers were 1.52 times greater than for steers vaccinated with the high-antigen dose (95% CI, $1.15 < OR < 2.00$) and 1.36 times greater (95% CI, $1.03 < OR < 1.78$) than for steers vaccinated with the low-antigen dose bacterin-toxoid. The incidence of liver abscesses of steers fed tylosin-medicated feed was significantly less than that of any group fed non-medicated feed ($p < 0.0001$). The incidence and severity of liver abscesses in steers vaccinated with the high-antigen dose bacterin-toxoid did not differ significantly from the placebo-vaccinated steers in the groups fed the tylosin-medicated ration ($p = 0.108$, GEE, and $p = 0.214$, Wilcoxon Rank Sum Test, respectively). The odds of a placebo-vaccinated, tylosin-medicated steer having a liver abscess was 1.40 times greater than that of a vaccinated steer (95% CI, $0.90 < OR < 2.15$). The differences between the odds of a liver abscess in the tylosin-medicated vaccinates compared to the tylosin-medicated placebo-vaccinates approached significance ($p = 0.135$). Vaccinated pens generally had slightly more favorable results numerically than did the placebo-vaccinated steers for ADG and feed conversion, but the differences were not significant. The difference in feed conversion between tylosin-medicated, vaccinated pens and the placebo-vaccinated, non-medicated pens approached significance ($P = 0.079$). The differences in feed conversion between placebo-vaccinated pens fed tylosin-medicated or non-medicated feed were not significant ($P = 0.22$). The proportion of carcasses graded Y1 and Y2 was significantly lower in the placebo-vaccinated group (55%) than in steers given the high-antigen dose bacterin-toxoid (64%, $p = 0.04$) in steers fed non-medicated feed. The steers given the high-antigen dose bacterin-toxoid and tylosin-medicated feed had a significantly greater proportion of carcasses graded Y1 and Y2 (64.4%, $p = 0.009$) than did the placebo-vaccinated steers on the same ration.

Significance

A single-dose bivalent *Fusobacterium necrophorum-Arcanobacterium pyogenes* bacterin-toxoid given to cattle entering a feedlot reduced the incidence and severity of liver abscesses in a dose-dependent manner. Protection was demonstrated against a severe natural challenge. Vaccinates also had significantly more favorable USDA yield grades than placebo-vaccinates. Measures of performance, although not significantly improved, tended to be more favorable in vaccinates than in control groups.