

Research from the United States on Alternative Treatments for Mastitis in Dairy Cattle: Efficacy of Phyto-Mast

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Introduction

The organic industry of the United States is growing steadily with increasing consumer demand. The United States Department of Agriculture defines the standards for organic production in the United States. Organic dairy farmers must follow strict healthcare guidelines: organic animals may not receive synthetic antibiotics or anti-inflammatory drugs unless the animal is very sick, in which case the farmer must not withhold conventional treatment to preserve the cow's organic status. If a substance that is not allowed in organic production is used, the animal permanently loses its organic classification (United States Department of Agriculture, 2013).

USDA organic regulations are constrictive for dairy farmers confronting the challenge of mastitis. Mastitis is typically caused by a bacterial infection and is traditionally treated by using an intramammary antibiotic. Antibiotics are also used prophylactically to prevent mastitis from occurring during the non-lactating period prepartum (as "dry cow therapy"). Organic dairy farmers in the United States use a variety of alternatives to antibiotics for treating mastitis. I have evaluated two of these alternatives for use as dry cow therapy: Phyto-Mast and Cinnatube. Phyto-Mast™ (Penn Dutch Cow Care, Narvon, PA, USA) is an intramammary product labeled for milk quality issues. Phyto-Mast contains essential oils of *Thymus vulgaris* (garden thyme), *Angelica* sp., *Glycyrrhiza uralensis* (Chinese licorice), and *Gaultheria procumbens* (wintergreen). Cinnatube™, contains a blend of essential oils as well as beeswax to act as an internal teat sealant (New AgriTech Enterprises, Locke, NY, USA).

Effect of Phyto-Mast on Milk Quantity and Quality

The first study evaluated the effects of Phyto-Mast on milk production and somatic cell score (SCS) in cows and heifers when used as dry cow therapy to determine if the treatment was inducing an immune response (increasing SCS) or negatively affecting milk production. 150 dairy cattle with Holstein, Jersey, or crossbred genetics were used in the study. Treatments included Phyto-Mast, no treatment, and conventional intramammary antibiotic (penicillin dihydrostreptomycin) + internal teat sealant (bismuth subnitrate) treatment (Quartermaster + Orbeseal, Zoetis, USA) at dry off. Treatments were balanced by breed, age, and calving due date and contained 40 cows and 10 heifers each. Heifers in the "conventional" group received no treatment prior to calving; heifers in the Phyto-Mast group were infused with Phyto-Mast 2 weeks prior to calving. Milk weights and SCS from the first test date in the first month postpartum as well as average milk production and SCS in the lactation following treatment were compared among treatment groups. No significant difference was observed between treatments for any of the measured variables. Milk production at the first test day postpartum was similar among multiparous cows, but the first-calf heifers in the Phyto-Mast group tended to have higher milk production at the first test than heifers in other groups. Neither lack of treatment nor the use of an herbal treatment differed from a conventional dry cow therapy for milk production or SCS at the start of lactation (Mullen et al., 2010). These results were encouraging in that Phyto-Mast appeared not to have a significant negative effect on animal productivity or well-being.

Antibacterial Effect of Phyto-Mast and Cinnatube as Dry Cow Therapies

The teat sealant used in the previous study could have conferred an advantage to the conventional treatment by keeping the antibiotic in the mammary gland; for this study, I used an organic teat sealant (Cinnatube) to make the treatments more even. Data were taken from 3 private herds and a research herd over 2 years with treatments balanced by breed, age, calving due date, and farm. Five intramammary dry cow therapies were assessed: 1) Phyto-Mast; 2) Cinnatube; 3) Phyto-Mast + Cinnatube; 4) no treatment; 5) Quartermaster + Orbeseal (Conventional). Milk

samples were aseptically collected from each functional quarter of each cow (n = 264) before treatment and once within 3 to 10 d post-calving for microbiological assessment. A mixed linear model was used to obtain least squares means and comparisons between treatments were obtained using the Tukey-Kramer adjustment. The scope of the analysis is limited by the positive fact that 130 cows had no infection present pre-treatment and no infection post-calving. There were no differences among treatments for percentage of quarters per cow with new infections. For percentage of quarters per cow cured, analyzed from the subset of cows with infections pre-calving (n = 134), there were no differences among treatments (Mullen et al., 2012). Though no dry cow treatment was significantly more effective in this trial, the proportion of non-infected cows was encouraging. The comparable success of Phyto-Mast to conventional antibiotic therapy in curing existing infections was encouraging and warrants further investigation.

Pharmacokinetics of Phyto-Mast

In order to be effective as a dry off treatment, an intramammary treatment must persist in the udder for a long period of time. A veterinary student at North Carolina State University named Claire McPhee pursued a project to determine the longevity of Phyto-Mast within the cow. Her group developed an assay for thymol, one of the chemical constituents of *Thymus vulgaris* essential oil in Phyto-Mast. Five alpine dairy goats in late lactation were used as a model for cows. They analyzed blood and milk samples for thymol residues for 10 days after treatment with Phyto-Mast. Thymol was detectable in plasma 15 minutes post-infusion up to 4 hours post-infusion. Residues of thymol in milk were only detectable 12 hours post-infusion. The authors noted that further analysis is needed, as thymol is not the only chemical component of Phyto-Mast and other components may have different pharmacokinetic behaviors (McPhee et al., 2011).

Antibacterial Effect of the Ingredients of Phyto-Mast *in vitro*

Despite the low persistence of Phyto-Mast in the late-lactation mammary gland, we were still interested in examining its antibacterial activity. Specifically, we were looking to see if any of the herbal essential oil constituents of Phyto-Mast had antibacterial activity against three common mastitis pathogens. The essential oil components evaluated were *Thymus vulgaris*, *Gaultheria procumbens*, *Glycyrrhiza uralensis*, *Angelica sinensis*, and *Angelica dahuricae*. Isolates of *Staph. aureus*, *Strep. uberis*, and *Staph. chromogenes* were obtained from clinical mastitis samples from dairy herds in North Carolina. The essential oils were provided by the manufacturer of Phyto-Mast, and were tested using a modified CLSI standard (Clinical and Laboratory Standards Institute, 2008) for broth dilution testing using pasteurized whole milk. Controls included milk only (negative control), milk + bacteria, and milk + penicillin-streptomycin (positive control, at 1% and 5% dilutions). Essential oil of *Thymus vulgaris* was tested by itself and not in combination with other oils. The other essential oils were tested alone and in combination for a total of 15 treatments, each replicated three times and tested at 4%, 2%, 1%, and 0.5% to simulate concentrations achievable in the pre-dry off udder quarter. Of all the individual essential oils tested, only *Thymus vulgaris* oil had consistent antibacterial activity against all three pathogens tested, and activity was seen at or above 2%. Though the combinations of oils did not show typical dose-response effects, some concentration levels were consistently antibacterial across all three replications. The limited antibacterial activity of Phyto-Mast *in vitro* prompts further study on the action of its essential oils in the mammary gland.

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