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# Effects of supplementation with a phytobiotics-rich herbal mixture on performance, udder health, and metabolic status of Holstein cows with various levels of milk somatic cell counts

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## ABSTRACT

This study evaluated the effects of dietary supplementation of a novel phytobiotics-rich herbal mixture (PRHM) on feed intake, performance, udder health, ruminal fermentation, and plasma metabolites in cows with moderate or high somatic cell counts (SCC) in the milk. Twenty-four Holstein dairy cows (117 ± 26 d in milk and 46.3 ± 4.7 kg of milk/d at the start of the experiment) were blocked by parity and days in milk and split into 2 groups, based on SCC in the milk; 12 cows were with moderate SCC (260,000 < SCC <500,000 cells/mL), whereas 12 other cows had high levels of SCC (>500,000 cells/mL) in the milk. Within each SCC group, cows were blocked by milk yield and parity, and were randomly assigned to 2 different feeding regimens. Half of the cows in each SCC group (n = 6) were supplemented with PRHM (185 g/cow per day, providing 12.4 g of phenolic compounds per day), and the other half (n = 6) were not supplemented in their diets. The experiment lasted 36 d, whereby the first 24 d were used for adaptation to the diets and the last 12 d for sampling. Data showed that supplementation of PRHM decreased somatic cell score in the milk, indicating improved udder health of cows with high initial SCC, but not in cows with moderate SCC. Also, cows supplemented with PRHM consumed more feed DM, produced greater amounts of milk, and showed an improvement of feed utilization efficiency. However, these cows also lost more back-fat thickness during the experiment. Supplementation of PRHM increased fat- and energy-corrected milk yields in cows with high initial SCC, but not in cows with moderate SCC. Supplementation of PRHM decreased milk fat content, whereas other milk components were not affected by PRHM feeding. The PRHM supplementation decreased the acetate-to-propionate ratio in the rumen fluid, but increased β-hydroxybutyrate and cholesterol concentration in the plasma, irrespective of the initial SCC level in the milk. Other plasma metabolites and liver enzymes were not affected by PRHM supplementation. Apparent nutrient digestibility did not differ among treatments. Overall, supplementation of PRHM seems to be an effective strategy to enhance performance and lower SCC, particularly in cows having high SCC levels in the milk. Further research is warranted to evaluate long-term effects of PRHM supplementation, especially with regard to metabolic health status and reproduction.
**Key words:** phytobiotics supplementation, mammary health, milk production, dairy cow

## INTRODUCTION

Elevated SCC in milk indicate poor udder health status and milk quality, representing a major concern of modern dairy herds (Schukken et al., 2003). Cows with elevated SCC produce less milk than their healthy counterparts, leading to significant economic losses to the dairy industry. Indeed, approximately 70% of the costs related to subclinical mastitis are associated with temporary or permanent decreases in milk production, mainly due to inflammatory damage of the mammary tissue (Zhao and Lacasse, 2008).

In general, nutritional factors have been discussed to play a key role in enhancing resistance against mammary infections (Politis, 2012), and supplementation of diets with excessive amounts of micronutrients with potent antioxidant and immune-enhancing properties, such as vitamin E, Se, Zn, and Cu, are reported to enhance udder health (Scaletti et al., 2003; Politis, 2012). Yet, in contrast to early published literature, newly published data unexpectedly has shown that an overload of vitamin E may adversely affect udder health and increase mastitis incidence (Bouwstra et al., 2010). It is also known that the status of vitamin C is compromised during mammary infections (Weiss et al., 2004), suggesting a depletion of water-soluble antioxi-

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dants during mammary infections, with consequences of lower vitamin E efficiency and health status. These data also highlight the importance of seeking alternative antioxidants, especially from hydrophilic sources, for improving the antioxidant status of the body, and possibly increasing the efficiency of vitamin E, to improve udder health (Gobert et al., 2009; Bouwstra et al., 2010).

Phytobiotics, commonly known as herbal plant bioactive compounds, have been used in human and veterinary medicine to prevent diseases, enhance performance in stress-related syndromes, and increase resistance against infections (Rochfort et al., 2008). Phytobiotics are largely used in ruminant nutrition due to their antimicrobial activity to mitigate methane emissions and improve ruminal fermentation efficiency (Khiaosa-ard and Zebeli, 2013). Besides their antimicrobial activity, a large body of evidence has shown that phytobiotics have strong antioxidant and antiinflammatory activities. Previously, it has been reported that clove, rosemary, cinnamon, and turmeric, which were used in the present study, were at the top of the list regarding their antioxidant potential in vitro (Dragland et al., 2003). These compounds also were previously tested for their strong in vivo antioxidant and antiinflammatory activity. For example, Roussel et al. (2009) reported that inclusion of aqueous extract of cinnamon in the diet could improve antioxidant status of obese people with impaired fasting glucose. It has also been demonstrated that rosemary and turmeric extract as well as clove bud could inhibit the lipid peroxidation and alleviate oxidative stress of healthy mice or diabetic rats (Asai et al., 1999; Bakırel et al., 2008; Shukri et al., 2010). Additionally, it has been demonstrated that synergism between phytobiotics in herbal plants are mainly responsible for their potent health-enhancing properties. Therefore, combinations of antioxidants with possible synergism are preferred for preventing free-radical-induced disorders (Liu, 2004). Our preliminary experiment showed that quaternary mixtures of herbs, which are used in the present study, exhibited synergistic antioxidant activity (20 to 29%) relative to the activity of each single herb (unpublished data). This suggests that the combining of herbs potentiates positive response of each single herb, leading to an increased antioxidant activity due to a potential additive effect.

Gladine et al. (2007) demonstrated that extracts of 4 herbs, including rosemary, marigold, citrus, and grape, kept their antioxidant capacity in vivo in sheep as a ruminant model. In an ongoing later study, Gobert et al. (2009) demonstrated that combinations of the mentioned herbal extracts, when supplied in association with vitamin E, were able to reduce oxidative stress in lactating cows given a diet rich in n-3 FA. Those researchers stated that the combination of herbal extracts as a hydrophilic antioxidant may synergistically interact with lipophilic antioxidants such as vitamin E and result in an enhanced antioxidant status. New evidence suggests that phytobiotic supplementation may be more efficient in animals that are under physiologic or environmental stress conditions (Gobert et al., 2009). With regard to the earlier mentioned beneficial effects of phytobiotics, we hypothesized that supplementation of phytobiotics-rich herbal mixtures (**PRHM**) to high-producing dairy cows that are prone to subclinical udder health disorders may alleviate this stressful condition and, consequently, improve their lactation performance and health status. The objective of this study was to determine the effects of supplementation of a novel PRHM on feed intake, lactation performance, udder health status, ruminal fermentation, and blood metabolites in dairy cows with moderate or high SCC in the milk.

## MATERIALS AND METHODS

### *Cows, Diets, and Experimental Design*

The study was conducted at the facilities of a dairy farm (FKA Animal Husbandry and Agriculture Co., Isfahan, Iran), and was previously approved by the Animal Care and Use Committee of the Iranian Council of Animal Care (1995). Twenty-four multiparous lactating Holstein cows, averaging 117 ± 26 DIM and 46.3 ± 4.7 kg of milk/d at the start of experiment, were blocked by DIM and parity, and split into 2 groups, based on the pre-experimental SCC in their milk: 12 cows with moderate SCC (260,000 < SCC <500,000 cells/mL; mean ± SD: 325,833 ± 36,168 cells/mL) and 12 cows with high SCC (>500,000 cells/mL; mean ± SD: 775,750 ± 239,813 cells/mL). Cows in the moderate-SCC group were 115 ± 21 DIM and of parity 4.08 ± 0.90, whereas cows in the high-SCC group were 118 ± 17 DIM and of parity 4.00 ± 0.79. Within each group, cows were blocked by milk yield and randomly allocated to 2 different feeding regimens, resulting in a 2 × 2 factorial arrangement of treatments: (1) moderate-SCC level supplemented with PRHM, (2) moderate-SCC level unsupplemented with PRHM, (3) high-SCC level supplemented with PRHM, and (4) high-SCC level unsupplemented with PRHM. The experiment lasted 36 d, with the first 24 d used as adaptation to diets and the last 12 d as sampling period. Throughout the experiment, cows were housed in individual 8 × 4 m stalls, had free access to water, and were fed a TMR twice daily at 1000 and 1600 h for ad libitum intake to allow for 5 to 10% refusals. Ingredients and chemical composition of the experimental diet are given in Table 1.