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Short communication: Effect of oregano and caraway essential oils on the production and flavor of cow milk

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ABSTRACT

Many essential oils and their terpene constituents display antimicrobial properties, which may affect rumen metabolism and influence milk production parameters. Many of these compounds also have distinct flavors and aromas that may make their way into the milk, altering its sensory properties. Essential oils from caraway (*Carum carvi*) seeds and oregano (*Origanum vulgare*) plants were included in dairy cow diets to study the effects on terpene composition and sensory properties of the produced milk, as well as feed consumption, production levels of milk, and methane emissions. Two levels of essential oils, 0.2 and 1.0 g of oil/kg of dry matter, were added to the feed of lactating cows for 24 d. No effects on feed consumption, milk production, and methane emissions were observed. The amount and composition of volatile terpenes were altered in the produced milk based on the terpene content of the essential oils used, with the total amount of terpenes increasing when essential oils were added to the diet. Sensory properties of the produced milk were altered as well, and milk samples from animals receiving essential oil treatment were perceived as having a fresher aroma and lower stored aroma and flavor. The levels of essential oils used in this study mimic realistic levels of essential oils in herbs from feed, but were too low to affect milk production and methane emissions, and their inclusion in the animal diet did not adversely affect milk flavor.

Key words: caraway, flavor, methane, oregano

Short Communication

Herbal plants are commonly included in bovine feeding as a result of their presence in pasture (Søegaard et al., 2011), but they can also be actively included in the diet to obtain an effect on milk production parameters, such as milk yield and methane production (Abo El-Nor et al., 2007; Hristov et al., 2013). Rather than using whole herbal matter, essential oils can be derived from plants and seeds by steam distillation. These oils contain large amounts of monoterpenes and sesquiterpenes and have strong flavor and smell notes (Simon, 1990). They can be included in animal feeding, as they contain numerous secondary plant metabolites that have been identified as potentially beneficial feed additives for ruminants to improve milk productivity and animal health (Benchaar et al., 2008; Giannenas et al., 2011) as well as to reduce methane emissions of which domesticated ruminants are a large contributor (Bodas et al., 2012). In addition to milk production parameters, the addition of essential oils to animal feed could potentially affect the milk flavor. The sensory quality of the milk can be affected by feeding essential oils due to either a direct transfer of aroma compounds from the feed to the milk or due to the formation of aroma compounds during digestion of the feed (Carpino et al., 2004). Terpenes are common in many types of animal feed and can readily be transferred into milk, both through the gastrointestinal tract and through the lungs of the animal (Viallon et al., 2000; Prache et al., 2005; Lejonklev et al., 2013). The objective of the present study was to explore how the addition of caraway and oregano essential oils to the feed of Holstein dairy cows, at 2 levels comparable to those that could be obtained by adding herbs to the diet, would affect milk production, milk composition, methane emissions, and the volatile composition and sensory properties of the produced milk.

The essential oils used for the study were obtained commercially from New Directions (Hampshire, UK), and were produced by steam distillation of caraway

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seeds and oregano herbs. Essential oils were added to the feed at 0.2 g of oil/kg of DM for the low level and 1.0 g of oil/kg of DM for the high level. Assuming an essential oil content of 20 g/kg of DM, this corresponded to a diet with 50% of DM from grass forage, where 2 to 10% consists of herbal matter, which is feasible in Danish grazing systems (Søegaard et al., 2011). Fifteen Danish Holstein cows, with a live weight ranging from 500 to 700 kg and a BCS between 2.5 and 3.5, were used for the experiment, which lasted 24 d. Cows were blocked according to lactation (first, second, and more than 2) and randomly allocated within block to the 5 different treatments: control, low caraway content, high caraway content, low oregano content, and high oregano content (3 animals for each treatment). Days in milk ranged from 46 to 142 at the start of the experiment. The TMR fed to the cows were identical, except for the added essential oils, and consisted of barley (12.1%), soybean meal (11.2%), rapeseed cake (10.1%), grass-clover silage (30.2%), maize silage (35.0%), and minerals (1.4%). Chemical composition of ration, in percentage of DM, was ash (6.5%), CP (16.8%), NDF (32.3%), fat (3.5%), linolenic acid (1.0%), and linolenic acid (0.4%). Fresh feed and essential oil mixtures were prepared once a day. The TMR was mixed as one batch per day and divided into 5 portions, approximately 150 to 200 kg each. The essential oils were added to the individual portions and mixed further. Separate mixers were used for the oregano and caraway treatments, and the treatments with the low concentration of essential oils were always mixed before the treatments with high concentration.

During d 1, all cows received feed without added essential oils. Feed consumption was recorded daily throughout the experiment. Samples of individual feed items for proximate and fatty acid analysis of the diets were taken once a week and stored at −20°C. The feed samples were later pooled to 2 samples; one covering the first 2 wk of the experiment and the other covering the last 2 wk of the experiment. The TMR samples for terpene analysis were obtained in the morning of d 2, 9, 16, and 23, collected in glass containers, and stored at −20°C. During d 1, 3, 10, 17, and 24, milk production data were recorded, and milk samples, as mixtures of morning and evening milk, were collected in glass containers and stored at −20°C until analysis for milk composition and terpenes. Milk samples for sensory testing were obtained at 2 occasions by mixing evening milk from d 23 with morning milk d 24, and evening milk from d 24 with morning milk d 25. Within 6 h after morning milking, the mixed milk was pasteurized (72°C, 15 s), poured into glass containers, placed on ice, and kept at 1°C until sensory analysis was carried out the following day. Concentrations of fat, protein, and lactose were analyzed using a Milkoscan 4000 (Foss Analytical, Hillerød, Denmark). The fatty acid content was analyzed in feed samples as well as milk samples, as described by Larsen et al. (2012), with the exception of heptane being used as solvent instead of pentane. Feed samples were freeze-dried and ground through a 1-mm mesh before chemical analyses of DM, ash, nitrogen, crude fat, and NDF. The DM concentration of feed samples was determined by drying the samples for 48 h at 60°C. Ash was determined by combustion at 525°C for 6 h. Nitrogen was determined by the Dumas principle, as described by Hansen (1989), using a Vario MAX CN (Elementar Analysesysteme GmbH, Hanau, Germany). Crude protein was calculated as 6.25 times the measured nitrogen concentration. Crude fat was determined by Soxhlet extraction with petroleum ether (Soxtec 2050, Foss Analytical) after hydrolysis with hydrochloric acid (Stoldt, 1952). Ash-free NDF was measured using a Fibertec M6 System (Foss Analytical) using heat-stable amylase and sodium sulphite, as described by Mertens (2002). The gross energy concentration was calculated according to Volden and Nielsen (2011).

Methane emission was measured for 48 h, once for each cow during the experiment in the period 8 to 17 d after the start of the experiment, similar to the method described in Hellwing et al. (2012). One control cow was measured twice to maximize the use of measuring equipment. Terpene analysis of milk samples was performed using dynamic headspace sampling according to Lejonklev et al. (2013). Feed samples were analyzed the same way, but by using 5 g of the final mixture for each type of feed suspended in 20 mL of Milli-Q water. A trained sensory panel of 8 to 10 assessors, consisting of 7 to 9 females and 1 male, aged 26 to 61 yr, evaluated the 5 milk samples quantitatively using sensory profiling. The assessors were tested and trained in accordance to international standards (ISO, 1993). The sensory evaluation was carried out in a sensory evaluation laboratory fulfilling the requirements provided by the ASTM (1986). Prior to each sensory evaluation, the assessors attended a 2 h-training session, where the assessors were introduced to 3 milk samples that differed significantly in several of the selected attributes. The samples consisted of a commercial milk sample and the milk samples from cows fed with high levels of oregano and caraway. As inspiration, the assessors were introduced to reference samples as described by Hedegaard et al. (2006). Based on this, a sensory profile of 15 attributes for milk was developed by the panelists before the evaluation. The milk samples were served in small plastic beakers with lids (Abena A/S, Aabenraa, Denmark) in amounts of approximately 50 mL at a temperature of 16 to 18°C. The samples were coded and