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Effects of grazing cow diet on volatile compounds as well as physicochemical and sensory characteristics of 12-month-ripened Montasio cheese

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ABSTRACT

The aim of this study was to evaluate the effects of pasture type and cow feeding supplementation level on a 12-mo-ripened Montasio protected designation of origin (PDO) cheese, which is one of the most important PDO cheeses produced in northeast Italy. Cheeses were characterized for volatile compounds, color, mechanical variables, and sensory descriptors. Pasture type significantly affected most of the instrumental variables considered and, as a consequence, sensory properties were affected as well. Cheeses from the pasture characterized by a nutrient-rich vegetation type were higher in protein and lower in fat content. Furthermore, such cheeses, evaluated by a sensory panel, were more intense in color with a more pungent and less cow-like odor, in agreement with what found through instrumental analyses. Supplementation level resulted in less pronounced effects, limited to volatile compounds and texture properties, which were not detected by sensory analysis. The characterization of the 12-mo ripened Montasio cheese reported here is an important step for the valorization of this PDO product.
Key words: pasture type, supplement level, ripened cheese, volatile organic compound, sensory property

INTRODUCTION

Cheese quality depends on chemical, rheological, and microbiological characteristics of the milk, which are affected by, among other factors, the cow's diet (Coulon et al., 2004; Martin et al., 2005). In grazing cows, which are mainly widespread in mountain areas in Italy, the characteristics of the diet depend on the type of pasture (i.e., productivity, floral composition, herbage maturity) as well as feeding supplementation (i.e., quantity, quality, pattern of distribution).

The different floral compositions of alpine pastures affect cheese quality by means of transferring volatile organic compounds (**VOC**) from the grass to the milk and finally to the cheese (Noni and Battelli, 2008; Revello Chion et al., 2010), or, with regard to color, providing different carotenes (Noziere et al., 2006). However, the botanical composition of different grasses can also have indirect effects, mediated by the proteolytic enzymes present in milk. Buchin et al. (1999), for example, ascribed sensory differences of cheeses made from the milk of cows grazing in different types of pastures to the presence of specific toxic plants (e.g., *Ranunculus*) able to increase the concentration of plasmin in milk. In relation to cheese made from raw milk (not pasteurized), a different microbial contamination resulting from different floristic composition of the pastures or during grazing period may occur (Hagi et al., 2010; Montel et al., 2014).

Less investigated are the effects of feeding supplementation on cheese quality; however, many studies show its effects on milk composition and on the rheological characteristics. In fact, the supplements may modify the quantity and quality of herbage intake (Bovolenta et al., 2005, 2008) and the metabolic pathways that, starting from the rumen, lead to the formation of VOC in milk (Jenkins and McGuire, 2006).

During ripening, VOC production depends on the effect of fermentation of lactose not lost in the whey, proteolysis, and lipolysis. In particular, proteolysis of caseins results in the production of small- and medium-sized peptides of and free AA. These are important precursors of different volatile compounds, such as amines, aldehydes, alcohols, acids, phenols, and sulfur compounds. The lipolysis implies the release of short- and medium-chain fatty acids. Free fatty acids can be further metabolized to produce methyl-ketones, secondary alcohols, lactones, and esters (McSweeney, 2004).

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The quantity of VOC and the sensory quality of cheese are often not closely related. The compounds with low detection thresholds are, in many cases, those that contribute most to sensory attributes (Curioni and Bosset, 2002). In addition, different compounds affect the relationship between the concentration and perceived intensity (Thomsen et al., 2012). Sensory sciences provide standardized methods to determine the product characteristics perceived by human senses and to study consumer behavior (Drake, 2007).

The link between cow diet and cheese quality is essential for Protected Designation of Origin (**PDO**) cheeses because it is the basis of the terroir concept, defined by French researchers to identify a production system based on peculiar environmental conditions, animal ability to exploit local resources, and sustainable agricultural practices (Barham, 2003). Montasio, a semihard and semicooked cheese, is one of the most important PDO cheeses produced in northeast Italy. The production area of this cheese includes mountains (Montasio takes its name from a mountain plateau), but also the plain (Romanzin et al., 2013). During the summer, farmers maintain their cows grazing on high-altitude pastures. In this context, Montasio made from the milk of grazing cows is sold on site the same year of production (with a minimum ripening of 2 mo) or the following summer season (12 mo or more). Therefore, for the producers it is important to assess the effects of feeding management of grazing animals on fresh cheese and on 12-mo ripened cheese.

In a previous paper (Bovolenta et al., 2014), we focused on fresh Montasio PDO cheese with 2 mo of ripening. In this study, our aim was to analyze the volatile compounds as well as physicochemical and sensory characteristics of 12-mo-ripened cheeses produced from the milk of Italian Simmental cows grazing on different alpine pastures and receiving different levels of concentrate supplementation.

MATERIALS AND METHODS

Experimental Design and Treatments

The experiment was carried out in a summer alpine farm (Malga Montasio, Udine, Italy; 46°24′45″N, 13°25′53″E; altitude = 1,500–1,800 m). Two pastures with different vegetation types (nutrient-rich or nutrient-poor) were grazed at the same phenological stage by 72 Italian Simmental cows. During the 10-d experimental period, 36 cows (high group) were supplemented with 3 kg/head per day, on average, of a commercial mixed concentrate. The other 36 cows (low group) were supplemented with 1.5 kg/head per day, on average, of the same concentrate. More details on the experimental design, animal performances, pasture types, and diet characteristics have already been described in Bovolenta et al. (2014).

Cheese Manufacture

The experimental cheeses were produced from whole and raw milk from 2 consecutive milkings. Cheesemaking was repeated for the last 3 consecutive days of the experimental period for each experimental group (12 cheesemaking sessions) in accordance with the product specification of PDO Montasio, as reported in Bovolenta et al. (2014). Cheeses were ripened for 12 mo in a cellar with controlled temperature (12°C) and humidity (85%) until sampled for analysis.

Chemical and Physical Analysis

Cheese samples were analyzed for DM, fat, total N, and soluble N at pH 4.6 according to the AOAC International (2000) methods. Protein content was obtained by multiplying total N × 6.38. The ripening index was calculated as ratio (×100) between soluble and total N. The color of the cheese paste was measured with a chroma-meter (CR 400, Minolta, Osaka, Japan) and expressed as lightness (L*), redness (a*), and yellowness (b*) using the CIE standard illuminant D65.

The rheological properties of cheeses were evaluated with a texture analyzer (TA Plus, Lloyd Instruments, Sussex, UK) using the procedure described by Gunasekaran and Ak (2003). The rheological variables considered were hardness, cohesiveness, adhesiveness, springiness, gumminess, and chewiness.

Volatile Compound Profiling by Solid Phase Microextraction GC-MS

Volatile compounds in the headspace of the cheese samples were analyzed according solid phase microextraction GC-MS technique following the same procedure and the same instruments used and described in Bovolenta et al. (2014). Each sample was prepared and analyzed in triplicate. Results are reported as milligrams per kilogram equivalent to the internal standard (ethyl heptanoate for the esters; isobutanoic acid for the carboxylic acids; 4-methyl-2-pentanone for all the other compounds). The 3 standards were chosen to partially compensate for the different fiber compound responses.

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