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Cheesemaking in highland pastures: Milk technological properties, cream, cheese and ricotta yields, milk nutrients recovery, and products composition

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ABSTRACT

Summer transhumance of dairy cows to high Alpine pastures is still practiced in many mountainous areas. It is important for many permanent dairy farms because the use of highland pastures increases milk production and high-priced typical local dairy products often boost farm income. As traditional cheese- and ricotta-making procedures in Alpine pastures are central to this dairy system, the objective of this study was to characterize the quality and efficiency of products and their relationships with the quality and availability of grass during the grazing season. The milk from 148 cows from 12 permanent farms reared on a temporary farm located in Alpine pastures was processed every 2 wk during the summer (7 cheesemakings from late June to early September). During each processing, 11 dairy products (4 types of milk, 2 by-products, 3 fresh products, and 2 ripened cheeses) were sampled and analyzed. In addition, 8 samples of fresh forage from the pasture used by the cows were collected and analyzed. At the beginning of the pasture season the cows were at 233 ± 90 d in milk, 2.4 ± 1.7 parities, and produced 23.6 ± 5.7 kg/d of milk. The milk yield decreased with the move from permanent to temporary farms and during the entire summer transhumance, but partly recovered after the cows returned to the permanent farms. Similar trends were observed for the daily yields of fat, protein, casein, lactose, and energy, as we found no large variations in the quality of the milk, with the exception of the first period of Alpine pasture. The somatic cell counts of milk increased during transhumance, but this resulted from a concentration of cells in a lower quantity of milk rather than an increase in the total number of cells ejected daily from the udder. We noted a quadratic trend in availability of forage (fresh and dry matter weight per hectare), with a maximum in late July. The quality of forage also varied during the summer with a worsening of chemical composition. The evening milk (before and after natural creaming), the whole morning milk, and the mixed vat milk had different chemical compositions, traditional coagulation properties, and curd-firming modeling parameters. These variations over the pasture season were similar to the residual variations with respect to chemical composition, and much lower with respect to coagulation and curd-firming traits. Much larger variations were noted in cream, cheese, and ricotta yields, as well as in nutrient recoveries in curd during the pasture season. The protein content of forage was correlated with some of the coagulation and curd-firming traits, the ether extract of forage was positively correlated with milk fat content and cheese yields, and fiber fractions of forage were unfavorably correlated with some of the chemical and technological traits. Traditional cheese- and ricotta-making procedures showed average cream, cheese, and ricotta yields of 6.3, 14.2, and 4.9%, respectively, and an overall recovery of almost 100% of milk fat, 88% of milk protein, and 60% of total milk solids.

Key words: cow, transhumance, milk, cheese manufacture

INTRODUCTION

In addition to their economic function, mountain farms have an important role in many countries in terms of the preservation of landscape, conservation of historical traditions, and production of typical local products (Penati et al., 2011; Haddaway et al., 2013; Battaglini et al., 2014). One of the most distinctive and important traditional practices for both landscape preservation and typical local product manufacture is the summer transhumance of cows and small ruminants from permanent farms in the valleys to temporary farms in highland areas to exploit the Alpine pastures. This tradition still has particular significance in many

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mountainous areas of several European countries, especially the Alps region (Sturaro et al., 2013) where the making of typical cheeses on Alpine pastures allows the maximum benefits to be obtained from milk production. The quality of dairy products is closely connected with production conditions and the feeding strategies adopted (Bovolenta et al., 2009), and their fatty acid profiles are generally favorable to human health (Dewhurst et al., 2006; Ferlay et al., 2006; Coppa et al., 2011).

Some studies have shown that the botanical composition of pasture and the type of diet the cow is fed have an effect on the quality of milk and cheese (Agabriel et al., 1999; Ferlay et al., 2006; Romanzin et al., 2013). The importance of pasture as a key factor in the traceability and quality of dairy products has also been demonstrated (Martin et al., 2005, 2009; Buchin et al., 2006). However, few studies have been carried out on the evolution of the technological properties of milk during Alpine summer pasturing and the efficiency of traditional cheese production practices on temporary farms. Moreover, no information is available on by-products of traditional cheesemaking, such as cream for butter production and ricotta from whey processing.

In light of this, a study on production efficiency and the relationships between dairy products derived from cheese- and ricotta-making in term of their physico-chemical composition is of particular interest. The aim of our study was to investigate (1) the quality and technological properties of milk produced; (2) cream, cheese, and ricotta yields from traditional cheese making procedures; and (3) the qualitative characteristics of dairy products derived from cheese- and ricotta-making during the course of summer pasturing on a temporary highland farm.

MATERIALS AND METHODS

Environmental Conditions and Pasture Characteristics

The study was conducted from June to September on a temporary summer highland farm (1,860 m above sea level) located in the northeastern part of the Italian Alps (Malga Juribello, Trento, Italy). The climate at the site is characterized by long, cold winters and warm, wet summers. The pasture was characterized by a high biodiversity and the prevalent pasture type was a typical *Nardetum alpigenum* association, which has replaced the native woodland and shrub land as a result of continuous human and animal action (Orlandi et al., 2000). The feeding strategy was pasture-based and the cows were free to graze day and night. The pastures covered a total of 180 ha and the herd was composed of 148 cows, on average; the herd was moved to different areas of the pasture according to grass availability without a rigid rotation.

Grass Availability and Composition

Every 2 wk on the day before experimental cheesemaking, the grass available in the pasture sections grazed by cows was sampled by cutting the grass in 8 sites of 1×1 m at an approximate height of 3 cm from the ground. Samples were weighed and a fixed proportion of each was pooled into a composite sample of the 8 sites, representing the grass available to the cows on a given date. The proportions varied on the different sampling dates to obtain composite samples weighing about 2 kg.

The composite samples were frozen and stored at −20°C until chemical analysis at the laboratory of the Department of Agronomy, Food, Natural resources, Animals and Environment (**DAFNAE**) of the University of Padova (Legnaro, Italy). The content of DM, CP, ether extract, NDF, ADF, acid detergent lignin, and ash of the composite samples were analyzed in duplicate using the methods of AOAC International (2000) and the Van Soest et al. (1991) procedure.

During the experiment, the grazing cows were given a supplement of compound feed (5.0 ± 1.5 kg/d), which included a mixture of corn, wheat barn, soybean meal, and molasses of sugarcane distributed twice daily in the milking parlor according to milk yield. The compound feeds were sampled and analyzed in duplicate.

Animals and Milking

A total of 148 dairy cows were moved to Malga Juribello (Italy) from 12 permanent farms located in the province of Trento. The main characteristics of these farms and cows are given in Table 1. The farms represented mainly traditional farming systems (Sturaro et al., 2013), with tiestalls and feeding based on hay and compound feeds, although a few farms and cows from modern dairy systems were present. Cow breeds were mainly Brown Swiss (75.0%), dual-purpose Simmental (18.2%), and crossbreeds, with only a few head of Rendena and Holstein-Friesian. The mean and standard deviation of the cows' DIM, parity, and milk yield on their move to the summer pastures are shown in Table 1. This table clearly shows that the animals were prevalently multiparous lactating cows in the second half of lactation. Some of the permanent farms produced milk for traditional cheese making according to European Union Protected Designation of Origin (PDO) criteria, whereas others produced milk for processing into fresh cheese, fluid milk, and other dairy products.