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Short communication: Chemical-sensory and volatile compound characterization of ricotta forte, a traditional fermented whey cheese

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ABSTRACT

Ricotta forte is a traditional whey cheese, obtained through natural fermentation of fresh ricotta, that is getting increasing attention by food traders. In view of possible initiatives for its valorization, the chemical and sensory characteristics were investigated. Samples were obtained from 14 different manufacturer, and were subjected to chemical, biochemical, volatile organic compound, and sensory analyses. All samples presented low pH with high moisture (62–66%) and fat content (57–60% on dry matter). From a biochemical point of view, the electrophoretic patterns evidenced that β-lactoglobulin was the main protein present at all sample ages. Only intermediate levels of proteolysis (20.69% ripening index) took place during aging, whereas the main biochemical event in this dairy product was lipolysis (2.10 mEq/g of acid degree value). Accordingly, free fatty acids dominated the volatile organic compound profile and strongly influenced the sensory characteristics with flavor described as rancid, pungent, acrid, and smelly feet: all associated with short-chain fatty acids such as acetic, propionic, butyric, and caproic. Finally, the sample age did not influence chemical composition, whereas it had significant effect on lipolysis and flavor intensity.
Key words: fermented whey cheese, chemical characterization, sensory evaluation, volatile organic compound profile

Short Communication

Ricotta forte is an Italian traditional dairy product manufactured through natural fermentation of ricotta, the whey cheese "par excellence." It appears as a spreadable ivory-colored cream, with piquant taste and strong aroma. Besides having unique sensory characteristics, it has historical and socio-ethical importance, as it is an example of food by-product recovery. In fact, its production technology was developed in ancient times to recover leftover ricotta by converting it into a shelf-stable new product. Nowadays, harvesting of food by-products is not always in line with the modern approach to food safety, and the production technology has thus been modified. The modern manufacturing protocol has been recently described by Mascaro et al. (2010): briefly, freshly produced ricotta is put into a small tank and thoroughly mixed, then the tank is covered and kept in a cool place for at least 6 mo in a cool place at room temperature. During this time natural fermentation takes place (no starter is added), and the only operations that are performed are daily mixing to avoid formation of molds and draining off whey that is progressively released. At the end of the ripening period salt is added (20–40 g/kg), and the product, which has become shelf-stable at room temperature, is packaged in glass jars, with normal shelf-life being 2 yr or more. After being sold exclusively in local markets, ricotta forte is now receiving the appreciation of gourmets, restaurant owners, and experts in food tourism, who are boosting marketing on broader areas. Despite increased interest, scientific information about the chemical, nutritional, microbiological, and sensory features of this dairy product is very scarce. A small amount of information about the chemical and nutritional characteristics has been reported by the Italian National Research Council (CNR, 1996), Mascaro et al. (2010), and Rea et al. (2010). A microbiological study of Baruzzi et al. (2000) described the evolution of the *Lactobacillus* community during manufacturing and concluded that safety of the product is guaranteed by the long ripening period at low pH values. No information is available about the sensory characteristics and volatile compound profile of ricotta forte. The aim of the present work was to close this information gap by exploring the chemical-sensory characteristics and volatile compounds associated with ricotta forte samples taken from a broad range of different producers.

Samples were collected in duplicate from 14 different manufacturers and were grouped into 3 classes according to age: young (4–6 mo, group A, samples no. 3, 6, 7, 8, and 14), matured (8–9 mo, group B, samples no. 5, 9,

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and 11), and long-stored (13–15 mo, group C, samples no. 1, 2, 4, 10, 12, and 13). Gross composition was assessed by determining pH (glass electrode-pH meter, Hanna Instruments, Woonsocket, RI), moisture (IDF, 1986), total protein (total N × 6.38, AOAC International, 1995), fat (IDF, 1988), and lactose (enzymatic assay, Trani et al., 2017). The protein fraction was characterized by SDS-PAGE according to the procedure reported by Harper et al. (1989), and proteolysis was measured by calculation of the ripening index (**RI**; water-soluble N/total N × 100). The fat fraction was characterized by GC determination of the total fatty acid profile (Trani et al., 2010), and lipolysis was estimated by measuring the acid degree value (**ADV**) as reported by Park (2001). The volatile compounds were studied by head space solid-phase microextraction coupled to GC/MS. The fiber used for microextraction was a 50/30 μm of divinylbenzene/carboxen/polydimethylsiloxane (DVB-CAR-PDMS, Supelco, Bellefonte, PA). It was maintained for 30 min at 37°C into the headspace of a 12-mL vial containing a 1-g cheese sample, tightly capped with a PTFE-silicon septum and previously conditioned for 10 min. Desorption of the volatile compounds was obtained into the split-splitless injector of the GC system set at 220°C (split ratio 1:70). The GC system was a Trace 1300 coupled with a single quadrupole ISQ MS (Thermo Scientific, Waltham, MA), equipped with a VF-WAXms column (20 m length × 0.1 mm i.d. × 0.1 μm film thickness, Agilent J&W, Folsom, CA). The chromatographic conditions were oven temperature 50°C for 0.1 min, then to 180°C at 13°C/min and to 220°C at 18°C/min, hold for 3 min; source temperature 250°C; transfer line temperature 250°C; carrier gas helium at 0.4 mL/min constant flow rate. The impact energy was standardized at 70 eV. Data were acquired in full-scan mode in the range of 33 to 200 m/z, dwell time of 0.1 s/scan. The volatile components were identified using computer matches to standard reference mass spectra of the National Institute of Standards and Technology library (NIST, Gaithersburg, MD), and when possible, identification was confirmed by comparison to reference compounds. Their relative abundance in the chromatograms was calculated by considering the relative peak area. Sensory evaluation was performed by 9 trained panelists (5 female and 4 male, aged 35–58 yr) selected following international standards (ISO, 1993). They carried out a quantitative descriptive analysis according to the protocol reported in a previous paper (Trani et al., 2016). The panel had 2 open training sessions on 4 samples of ricotta forte purchased from a supermarket and created a series of sensory descriptors. All descriptors were quantified on a 6-point scale from 0 (low) to 5 (high) and were selected based on weight percentage (frequency of citations × perceived intensity; AFNOR, 1994). Only descriptors with a weight percentage greater than 30% were considered. The panelists then performed 4 sessions on different days for evaluating the samples under study. For sensory analysis, the discrete variables were described by their mode value and compared using the Kruskal–Wallis test. For chemical parameters, the means and standard deviations were calculated and compared using *t*-test. Analytical data of the volatile organic compounds (**VOC**) were processed by 1-way ANOVA. All data were statistically processed using SPSS 19 software (IBM, Armonk, NY).

The mean chemical characteristics of ricotta forte are reported in Table 1, with rather high standard deviations observed for most of the parameters, suggesting that the production technology and compositional targets are not well standardized. The mean values of pH (4.69) and moisture (64.1%) were in accordance with the data reported by CNR (1996) and Baruzzi et al. (2000), fat content was approximately 59.7% on DM, protein averaged 12.2%, and lactose was present in negligible amounts. We did not find any correlations between gross composition and sample age. Indices of proteolysis and lipolysis showed wide variability, but in contrast to chemical composition, we observed a significant correlation with cheese age. The RI values ranged from a minimum of 13.59% in a 6-mo-old sample, to a maximum of 26.11% in a 15-mo-old sample, with a mean value of 20.69%. Such results indicate only a moderate level of proteolysis and were unexpected, considering the high moisture content, ripening under uncontrolled conditions, and storage at room temperature. Comparison of the means revealed that the RI value was highest in sample group C, suggesting that the rate of proteolysis significantly increases after at least 8 to 9 mo of ripening. This result is probably connected with the composition of the protein matrix (Figure 1), which is mainly composed of β-LG, a protein that is highly resistant to enzymatic hydrolysis (Reddy et al., 1988; Santoro and Faccia, 1996). Lipolysis was measured by

Table 1. Gross composition (% except pH) of ricotta forte samples grouped per age: A (4–6 mo), B (8–9 mo), and C (13–15 mo)

Item	A	B	C	Mean	SD
pH	4.69	4.75	4.65	4.69	0.32
Moisture	62.06	63.00	66.30	64.08	5.84
Fat	22.82	21.20	20.39	21.43	5.69
Protein	11.64	10.94	13.35	12.22	3.75
Lactose	0.28	0.20	0.13	0.20	0.12
RI	19.72	17.07	23.30[a]	20.69	3.43
ADV	1.50[a]	2.53[b]	2.39[b]	2.10	1.22

[a,b]Values in the same row with different superscripts are different at $P < 0.05$.

[1]RI = ripening index (% water-soluble N on total N); ADV = acid degree value (mEq/g of fat).