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# Fatty acid profile of milk and Cacioricotta cheese from Italian Simmental cows as affected by dietary flaxseed supplementation

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## ABSTRACT

The study aimed to determine the effects of adding flaxseed to the diet on the fatty acid profile of the milk of Italian Simmental cows and on the Cacioricotta cheese thereby produced. The experiment involved 24 Italian Simmental cows divided into 2 groups of 12 animals according to the diet fed: a control diet (CO) with no flaxseed supplementation, and a diet supplemented with whole flaxseed (FS). Milk yield and composition was not significantly changed by diet, whereas saturated fatty acids, monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) were increased by flaxseed supplementation. Cows fed flaxseed showed higher percentages of long-chain fatty acids: in particular, linolenic acids, mainly represented by C18:3n-3, and n-3 series were higher in the FS group than in the CO group. The percentage of MUFA was higher by about 12% in FS than in CO, mainly due to the contribution of C18:1–9 *cis*-9. The percentage of conjugated linoleic acid (CLA) in milk was not significantly changed by flaxseed supplementation. Furthermore, atherogenic and thrombogenic indices were lower by about 30 and 16%, respectively, in the FS group compared with the CO group. The fatty acid profile of Cacioricotta cheese produced using Italian Simmental cow milk showed higher levels of MUFA, PUFA, and n-3, and improved atherogenic and thrombogenic indices in FS than in CO, confirming the ability to transfer beneficial molecules from milk into cheese. In particular, cheese-making technology contributed to the increased CLA content in Cacioricotta cheese.
**Key words:** flaxseed, Italian Simmental cow, fatty acid, Cacioricotta cheese

## INTRODUCTION

Milk fat contains substantial concentrations of SFA and relatively low concentrations of MUFA and PUFA; therefore, it has been criticized because it contains a less desirable balance of fatty acids than vegetable fat or fish oil (Kennelly, 1996). Health-conscious consumers have gained awareness that MUFA and PUFA are healthier than SFA; in particular, research has shown several health benefits of n-3 fatty acids (including α-linolenic acid) to humans, including a decrease in the incidence of cancer, cardiovascular diseases, hypertension, and arthritis and an improvement in visual ability (Simopoulos, 1996; Wright et al., 1998). Therefore, consumer demand today is oriented toward dairy products with a valuable fatty acids profile to meet their health concerns.

In recent years, several experiments conducted on dairy cows have shown that a supplementation of oilseeds (rich in n-3 fatty acids) such as flaxseed, rapeseed, or soybean is an effective strategy for improving the nutritional value of milk fat (Shingfield et al., 2008) through an increase of the levels of PUFA and MUFA. Few studies have investigated the fatty acid profile of cheese made from milk produced from livestock receiving oilseed supplementation; the majority have involved cheese from small ruminant milk (Luna et al., 2005; Nudda et al., 2005; Gòmez-Cortés et al., 2009, Mele et al., 2011) whereas less research has been conducted on cheese produced from Friesian cows fed oilseeds (Dhiman et al., 1999; Caroprese et al., 2013; Cattani et al., 2014).

Several factors play a role in the efficiency with which milk components are transferred into cheese, and these are related to the feeding regimen of the animals (Banks et al., 1986), milk features, and cheese-making conditions (Lucey and Kelly, 1994). In particular, milk-processing temperature may affect lipid composition of cheese; high processing temperatures and addition of whey protein concentrates have been found to increase the formation of CLA in the processed cheese as the result of oxidation processes (Shantha et al., 1992; Garcia-Lopez et al., 1994). In southern Italy, a typical and traditional cheese is Cacioricotta cheese, which is usually produced from goat milk; this type of cheese is made using an unusual technology—a high heat treatment at 90°C of whole milk that allows the recovery

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of whey proteins in the curd, giving high cheese yields (Albenzio et al., 2006).

To the best of our knowledge, no studies have been reported on the production of Cacioricotta cheese from bovine milk. It is unclear whether the unusual cheese-making technology could affect the transfer of valuable nutritional fat components of milk into Cacioricotta cheese. In the light of this, the present paper aimed to evaluate the effects of flaxseed supplementation on the composition and the fatty acid profile of milk and Cacioricotta cheese from Italian Simmental cows.

## MATERIALS AND METHODS

### *Experimental Design*

The experiment was conducted in June and July 2014 in a dairy farm located in Cisternino (Brindisi, Apulian region, Italy). The experiment involved 24 Italian Simmental cows during mid lactation (175 ± 12 DIM); animals were homogeneous for age (46 ± 6 mo), BW (475 ± 18 kg), BCS (3.68 ± 0.5), parity (2.58 ± 0.28), milk production (19.8 ± 0.80 kg/d), milk fat content (3.72 ± 0.5%), milk protein content (3.35 ± 0.1%), and fatty acid composition. Animals were assigned randomly to 1 of 2 groups subjected to different diets: (1) the control group (**CO**) received a diet based on 9.5 kg of concentrate mainly constituted by corn (51%), soy (22%), barley flour (4%), and bran (4.8%), 5 kg of corn grains, and 6.5 kg of vetch and oat hay; (2) the flaxseed group (**FS**) received the same diet but 1 kg of concentrate was substituted with the same amount of whole flaxseed (Lin Tech, Tecnozoo srl, Torreselle di Piombino Dese, Italy). The chemical composition of the diets is reported in Table 1.

**Table 1**. Ingredient and chemical composition of the experimental diets (% on DM basis)

| Item | Diet[1] | |
|---|---|---|
| | CO | FS |
| Concentrate | 45.00 | 40.24 |
| Corn | 24.00 | 24.00 |
| Vetch and oat hay | 31.00 | 31.00 |
| Whole flaxseed | — | 4.76 |
| Ether extract | 2.67 | 4.72 |
| CP | 15.38 | 15.41 |
| ADF | 25.43 | 25.45 |
| NDF | 42.60 | 42.48 |
| ADL | 3.34 | 3.45 |
| $NE_L$[2] (Mcal/kg) | 1.56 | 1.68 |

[1]CO = control group; FS = flaxseed group.

[2]Calculated according to NRC (2001).

The experiment lasted 7 wk; the first 2 wk were considered an adaptation period and measurements were made during the last 5 wk. Cows were housed in straw-bedded barns with free access to water and were fed twice daily (at 0800 and 1600 h). The total amount of flaxseed was given before the morning feeding to each cow of the FS group and we verified that each animal consumed the total quantity of supplement given. Cows were milked mechanically twice daily at 0600 and 1800 h, and milk production was recorded at each milking. Milk collection was done once a week on the same day throughout the experiment. Individual milk samples were obtained by mixing milk from the morning and afternoon milkings in an amount proportional to milk yield. Individual milk samples were stored under refrigeration and transferred to the laboratory for analyses.

At the end of the wk 6 and 7 of the experiment, bulk milk was collected and pooled from the evening and morning milkings from each experimental group. Pooled milk from each group was divided into 2 aliquots and processed to Cacioricotta cheese using the following protocol: raw milk was heated at 90°C, held for 2 min, and then cooled to 40°C. Then, 1% of saturated brine (23% NaCl, 0.06% $CaCl_2$) was added. Subsequently, 150 g/100 L of rennet (Chr. Hansen s.p.a., Parma, Italy) containing 77% chymosin was added, and curdling was obtained in about 10 min. The subsequent steps were cutting of the coagulum to rice-grain size, putting the curd into reed containers, and manual pressing of the curd to facilitate the draining off of the whey. The curd was held at controlled temperature (22°C) for 24 h, dry-salted for 1 d, and then ripened for 7 d at 12°C and 80% relative humidity. At the end of the ripening time, cheeses were transferred to the laboratory under refrigeration, and 3 cheeses from each cheese-making were analyzed in triplicate.

### *Analyses of Milk*

Individual and bulk milk samples were analyzed for fat, protein, casein, and lactose contents (MilkoScan FT 120; Foss Electric A/S, Hillerød, Denmark), and SCC (Fossomatic Minor, Foss-Electric A/S). Individual and bulk milk renneting characteristics (clotting time, rate of clot formation, and clot firmness after 30 min) were measured using a Formagraph (Foss Electric A/S).

Fatty acids extraction from milk samples was performed as described by Feng et al. (2004), with some modifications. Briefly, 30 mL of bulk milk was centrifuged at 17,800 × *g* for 45 min at 4°C. Then, 1.0 g of the fat layer was transferred into a microtube, left at room temperature for 30 min, and centrifuged at 19,300 × *g* for 40 min at 20°C. Fatty acids methyl esters were