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Quality differences in cheeses produced by lowland and highland units of the Alpine transhumant system

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RIASSUNTO – Differenze qualitative di formaggi prodotti a fondovalle e in alpeggio nell'ambito del sistema transumante alpino. *I sistemi transumanti alpini utilizzano foraggi di fondovalle d'inverno e pascoli d'estate. Il latte prodotto da 2 gruppi omogenei di 25 bovine Pezzate Rosse Italiane, allevate rispettivamente in fondovalle e in alpeggio, è stato caseificato separatamente per 3 giorni consecutivi nel mese di luglio. Sui formaggi, stagionati per 3 mesi, sono state condotte analisi chimiche, reologiche, sensoriali e dei composti aromatici. I risultati hanno evidenziato differenze tra i due tipi di formaggio in termini di composizione chimica, caratteristiche sensoriali e componenti aromatiche.*

Key words: cheese quality, Italian Simmental cows, lowland, highland.

INTRODUCTION – The characteristics of ripened cheeses depend on a large number of factors, of which animal feeding plays an important role. Several researches showed influences of factors linked to forage, such as quality or method of conservation (Verdier-Metz *et al.*, 1998). In relation to grazed herbage, altitude and botanical composition are particularly important (Buchin *et al.*, 1999; Zeppa *et al.*, 2003; Bailoni *et al.*, 2004). The aim of the present study, part of a project for valorisation of alpine transhumant systems in North-East Italy, was to demonstrate chemical, rheological and sensory differences between lowland and highland cheeses. The influence of other factors was limited by controlling technological parameters during cheese-making.

MATERIAL AND METHODS – The trial was carried out on July 2004 using 50 lactating Italian Simmental cows (days in milk 205±35, milk yield 21.2±3.4 kg/d): 25 maintained in lowland cowshed and 25 in alpine pasture. The first group fed local hay (lucerne and ryegrass) and mixed concentrate (based on maize, barley and soybean); forage:concentrate ratio was 60:40. The second one fed alpine pasture (rich in *gramineae*) and mixed concentrate (based on beet pulp, maize, soybean), given when the production exceeded 10 kg/d (1 kg of concentrate per 2.2 kg of Energy Corrected Milk (ECM)). Morning raw milk produced by each of the 2 experimental groups was processed for 3 consecutive days in an experimental mini-cheese dairy, under controlled technology manufacturing conditions. Milk samples were collected for the determination of protein, fat, lactose, urea and somatic cell count (SCC). Three cheeses for each cheese-making (18 totally) were placed in a ripening cellar for 12 weeks with controlled temperature and humidity. Cheese samples were collected to determine moisture, protein and fat. Textural properties (cohesiveness, adhesiveness, springiness, gumminess, chewiness) of cheeses were then determined by a Texture Analyser and volatile compounds were studied using Solid Phase Micro-Extraction (SPME) coupled to Gas Chromatography-Mass Spectrometry (GC-MS) according to Kataoka *et al.* (2000). Triangular test of cheese (UNI-ISO 4120) was performed, employing 36 cheese's usual consumers.

RESULTS AND CONCLUSIONS – Table 1 shows milk and cheese chemical composition. Fat and urea contents were higher in highland milk while protein was lower. SCC was not statistically different and meanly lower than 300.000 n/ml. As waited, highland cheese presented lower protein and higher fat content.

Table 1. Chemical composition of milk and cheese.

	Lowland	Highland	S.E.
Milk			
Protein (%)	3.27[a]	3.22[b]	0.0183
Fat (%)	3.23[b]	3.68[a]	0.1295
Lactose (%)	4.92	4.91	0.0227
Urea (mg/100ml)	21.13[B]	25.33[A]	0.6642
SCC (.000 n/ml)	192	266	48195
Cheese			
Moisture (%)	33.5	31.9	0.98
Protein (%)	42.80	40.27	1.3197
Fat (%)	47.10[B]	51.47[A]	0.9883

a, b: $P<0.05$; A,B: $P<0.01$.

A comparison of the values obtained by the TPA test showed that any attribute was useful to discriminate between cheeses instrumentally. Some studies revealed that rheological properties of cheese are mainly influenced by milk fat content and by the stage of ripening of cheese (Beal and Mittal, 2000). The absence of statistically differences between cheeses could be assigned to the same stage of ripening and to fact that both types of cheese were made from full fat milk. On the contrary, triangular test showed that cheeses were statistically different; thirty consumers on thirty-six recognized the difference between cheeses (Table 2).

Table 2. Triangular test on cheese.

Lowland (L) – Highland (H)	Right answers	Wrong answers	Assessors
Presentation with 2L, 1H (HLL, LLH, LHL)	1	2	18
Presentation with 1L, 2H (LHH, HHL, HLH)	14	4	18
Total	30	6	36

Required correct responses for $P<0.001$: 22.

Analysis of cheese aroma (main results in Table 3) showed 60 volatile compounds, belonging to 10 chemical families, which were different between lowland and highland cheeses. Some compounds were of plant origin but mainly were the products of microbial metabolism. The largest chemical families were represented by esters, alcohols acids and ketones. Fifteen possible combinations of esters were detected, which probably contributed to floral and fruity notes of cheese aroma (Pinho *et al.*, 2003). Among esters ethyl acetate was present only in highland cheese and Lecanu *et al.* (2002) showed that this compound had solvent and fruit aroma impact. Different alcohols (primary and secondary) were found in both of cheeses and these compounds probably gave alcholic and floral note (Pinho *et al.*, 2003). Concerning acid compounds, heptanoic and octanoic acids can be associated with rancid and cheesy flavour (Lecanu *et al.*, 2002). They had strong aromatic notes and were present in lowland and highland cheese. Presence of 2-nonanone is less strong in highland cheese and is responsible for floral fruity aroma (Frank *et al.*, 2004). Other chemical families showed a smaller amount of compounds. In particular, some studies revealed that sulphuric compounds play an important role giving

Table 3. Volatile compounds(1) in cheeses on the basis of chemical families.

Chemical family	Total number	Main compounds	Lowland	Highland
Esters	15	ethyl acetate	-	+
		hexanoic acid, 3-hydroxy ethyl ester	+	++
		butanoic acid, 1-methyl butyl ester	++	+
Alcohols	15	3-hexanol, 2-methylpropanol	+	++
		1 butanol, 3 methyl formate	+	++
Acids	7	heptanoic acid	+	++
		octanoic acid	+	-
Ketones	7	2-nonanone	++	+
		6-tridecanone	+	-
Hydrocarbons	3	octane	+	-
Sulphurated	2	carbon disulfide	+	++
Aldehydes	2	2,2-dimethyl-3-hydroxypropionaldeide	+	-
Terpens	1	β cariophyllene	-	+
N compounds	1	imidazole 1-benzyl	+	++
Unknown/other	7	-		

(1) Intensity of the compounds: - absence; + presence; ++ strong presence.

cooked cabbage and garlic aromas in cheeses (Frank *et al.*, 2004). Bugaud *et al.* (2001) showed that cheeses from pastures rich in *gramineae* contained sulphuric compounds which originated from the degradation of amino acids by the bacteria. The same study showed that cheese made on the basis of poor dicotyledonous pasture had low presence of terpens and it could explain the presence of only one terpen compound in highland cheese. In conclusion, the study showed sensory differences between lowland and highland cheese; probably these differences were the results of a delicate balance of a complex blend of volatile compounds.

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