Highland Cheeses

Composition of fatty acids in cow's milk fat in the Lowlands, Mountains and Highlands

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Does grass plants influence milk fatty acid content? In the Lowlands, the Mountains and the Highlands of Switzerland a multidisciplinary investigation was carried out. From flowers to the milk...

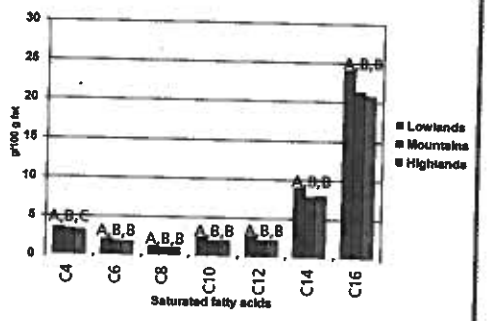
By M. Collomb, U. Bütikofer, R. Sieber, B. Jeangros and J-O. Bosset

The relationship between the characteristics of the grass plants and those of the milk produced in the Lowlands (600-650 m), the Mountains (900-1210 m) and the Highlands (1275-2120 m) of Switzerland has been studied within a large-scale multidisciplinary investigation. One of the hypotheses to be tested consisted of determining whether under natural conditions a relationship exists between the botanical composition of grassland and the corresponding fatty acids in the milk fat, and if so, what type. Natural conditions imply that this study was conducted *in natura* under the usual conditions of pasture, and management of herds rather than under strictly defined and controlled experimental conditions.

STUDY ON PLANTS AND MILK

The botanical composition of the plants was determined as a function of size and diversity (16 botanical records in the Lowlands, 31 in the Mountains and 55 in the Highlands). The phenological state of the plants was also noted on a scale of 1 to 8. At

Fig.1: the most present fatty acids of milk fat in the Lowlands



A>B>C: significant differences (P≤0.05)

Fig.2: the most present fatty acids of milk fat in the Mountains

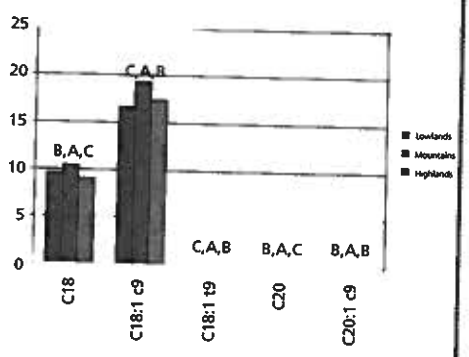


Fig.3: the most present fatty acids of milk fat in the Highlands

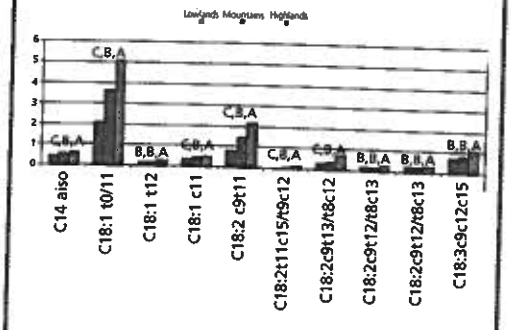
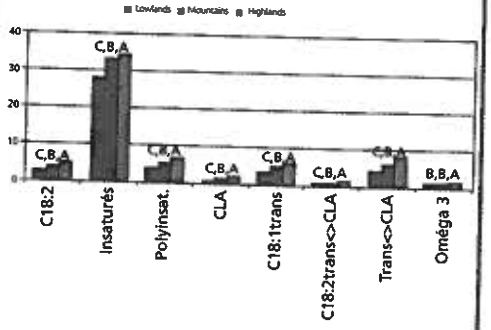


Fig.4: the most present pools of fatty acid of milk in the Highlands



the three vegetation sites, 12 observations per site were carried out: 2 sites in Highlands (pooled into a single zone since their fatty acid composition did not differ significantly), one site in Mountains and one site in Lowlands (= 48 mixtures of milk of which 44 were analysed in this work) over a period of 3.5 months (from June to mid September). The cows (45 to 50 in the Lowlands, 60 to 90 in the Mountains and 57 to 88 in the Highlands) were in the middle of the lactation period and were in excellent health.

We observed large significant ($P \leq 0.05$) differences in the fatty acid composition between Lowlands, Mountains and Highlands. With the exception of butanoic acid, the concentrations of saturated fatty acids C4 to C16 were significantly higher in milks from the *Lowlands* than in those from the two other observation sites (Fig. 1). Milk fat from the Lowlands contained a significantly higher level of endogenous fatty acids (e.g. fatty acids synthesized in the mammary gland) than milk fat from the Highlands.

***The concentrations of different fatty acids were highest in milks from the* Mountains**

The concentrations of different fatty acids were highest in milks from the *Mountains* (Fig. 2). The levels of the compounds C18 and C20 were lowest in milks from the Highlands and that of t (trans) 9 octadecanoic acid (C18:1 t9) was lowest in milks from the Lowlands. The concentrations of the oleic acid (C18:1 c (cis) 9) and of the fatty acid C20:1 c9 were comparable in milks from the Highlands.

The concentrations of 10 fatty acids were highest in milks from the *Highlands* (Fig. 3). Some fatty acids, principally monounsaturated trans isomers of C18 (except C18:1 c11) and many C18:2 trans compounds increased with elevation from the Lowlands to the Mountains to the Highlands. The highest increases were observed for the rumenic acid (C18:2 c9t11) and C18:1 t10+t11 fatty acids.

The figure 4 present the main variations of concentrations of the pools of fatty acids obtained in this study (Fig. 4). All the pools of fatty acids of C18:2, unsaturated, polyunsaturated, CLA (conjugated linoleic acids), C18:1 trans, C18:2 trans and omega 3 fatty acids were highest in milk from the Highlands and, except for the omega 3 fatty acids, increased with elevation from the Lowlands to the Mountains to the Highlands.

Milk fat from Highlands appears interesting from the nutritional point of view because of the great reduction of saturated and the increase of polyunsaturated fatty acids, including the CLA. The high concentrations (e.g. as high as 2.87 g 100 g^{-1}) of the total CLA in the Highland milk fat could provide a positive opportunity for the promotion of alpine milk and meat as healthy products. The latter fatty acids have anticarcinogenic, antiatherogenic, immunomodulatory, growth-promoting and lean body mass-enhancing properties. The concentration of CLA in milk fats is influenced by several factors such as the feeding of dietary oils, full fat rapeseeds, soybeans, fish meals, graz-


1


2


3


4


5


6

(1), (6), Leotodon Hispidus
(3) Leotodon Hispidus Flower
(2), (4), (5) Lotus Corniculatus
(7) Trifolium Pratense


7

Unsatured, and even more polyunsaturated, fatty acids have no tendency to agglomerate in the blood, as to say **no dangerous** for heart

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ing, forage: concentrate ratio, animal factors (e.g. stage of lactation, breed). In our study, the content of the CLA isomer c9t11 obtained with pasture feeding was in the range from 1.8 to 2.6 g 100 g^{-1}. In comparison, other authors found a content of the CLA isomer c9t11 from 0.1 to 1.9 100 g^{-1} of milk fat when analysing 1756 milk fat samples from different regions of Germany. The c9t11-isomer of CLA, which is regarded as the most effective in cancer prevention, generally accounts for >82% of the total CLA concentration in milk fat.

Milk fat from Highlands appears interesting from the nutritional point of view because of the great reduction of saturated and the increase of polyunsaturated fatty acids, including the CLA

The increase in trans vaccenic acid (C18:1 t11) and CLA as a function of the altitude, from the Lowlands to the Highlands, resulted in a higher degree of biohydrogenation in the rumen of the cows. Indeed, the trans fatty acids (which are thermodynamically more stable than their cis forms), and CLA are considered to be intermediate products in the biohydrogenation of linoleic acid and other polyunsaturated fatty acids from plants in the rumen of the cow by the bacteria *Butyrovibrio fibrisolvum*.

A maximal recommended ratio of ω-3 to ω-6 fatty acids of < 1 : 5 is generally considered highly valuable from a nutritional point of view. In this study, we obtained values of ~1 : 2, which were markedly lower than the recommended maximum values, in milk from the Highlands.

The higher content of unsaturated fatty acids in milk fat from the Highlands and Mountains, compared to milk fat from the Lowlands have also an effect on the rheological properties of milk products, and thereby improve the spreadability of butter and give a more desirable consistency (lower friability) to Mountain and Highland cheese. The high levels of the **CLAs** could be also considered as an additional indicator for the authenticity of cheese from the Mountains and Highlands; currently the volatile mono- and sesquiterpenoids and other specific compounds such as polycyclic aromatic hydrocarbons (which are due to the use of an open log fire for smoking of cheese in the alpine cabins) are used as indicators of the origins of these cheeses.

Significant correlation coefficients have been calculated between the occurrence of plant species and the concentrations of groups of fatty acids in milk fats from the Mountains and Highlands regions where the botanical composition of the pasture was more similar than in the Lowlands. Apart from various factors associated with altitude in Mountains and Highlands (e. g. walking), the percentage of five plant species *(Leontodon hispidus, Plantago alpina, Aposeris foetida, Lotus corniculatus (& alpina)* and *Deschampsia cespitosa)*, dominant in the Mountains and Highlands, correlated negatively with the concentration of saturated fatty acids. The percentage of three species *(Leontodon hispidus (Fig 5)), Lotus corniculatus (Fig. 6) (& alpina)* and *Trifolium pratense (Fig. 7)*) correlated positively with the concentration of polyunsaturated fatty acids and with the concentrations of CLA and monounsaturated trans C18:1 fatty acids in milk fat. Indeed, the correlations obtained between the concentration of different fatty acid groups and the percentage of the plant species should be considered carefully since a large number of plant species, some of which are present only at low concentrations, are encountered in the Mountains and Highlands.

Figure 5 - *Leodonton hispidus*

Figure 6 - *Lotus corniculatus*

Figure 7 - *Trifolium pratense*

FURTHER STUDIES

Verification of the preliminary correlations between the concentrations of different groups of fatty acids and the presence of different grass species (at different levels in the pasture) require further investigation in which the

feeding conditions of the cows on pastures with specific plant species are defined and the fatty acid composition of the fat in both the grasses and milk are measured.

References

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Highland Cheeses

Odor profile of typical Sicilian cheeses: Maiorchino, Pecorino, Provola dei Nebrodi and Ricotta Infornata

By Stefania Carpino, Silvia Mallia, John Horne and Giuseppe Licitra

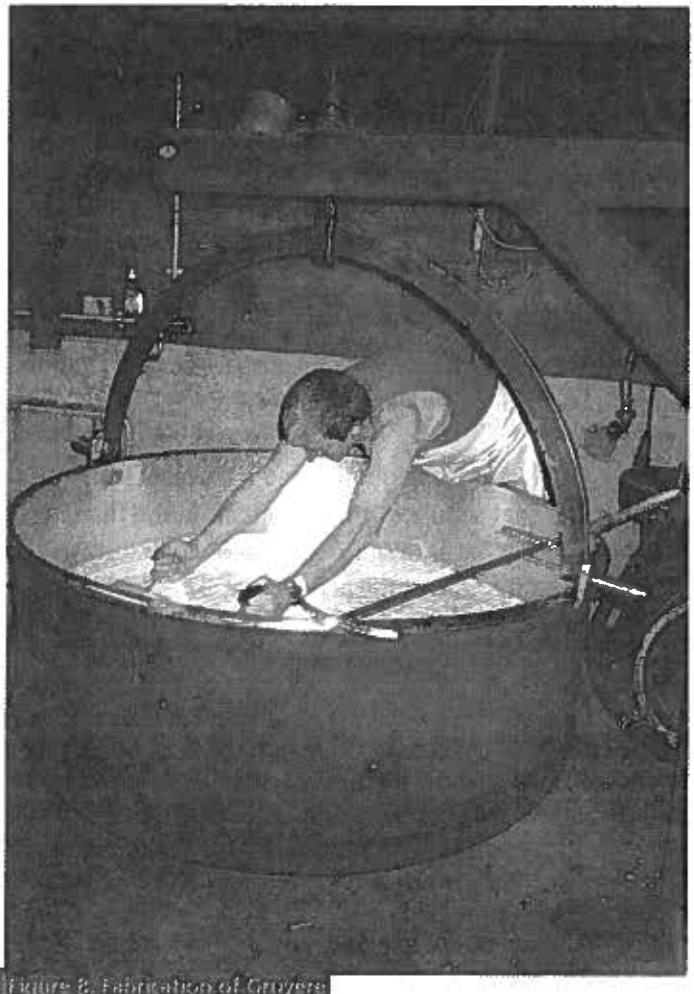

Figure 8. Fabrication of Gruyere cheese on the Highlands.

In many foods, Aroma is an important element for description. Four traditional Sicilian cheeses were evaluated in order to determine which aroma compounds were present by two different methods. Both revealed a perfect correspondence in element

Odor active volatiles in many foods are important in how those foods are perceived. Butyric acid for example is concentrated in blue-veined cheeses such as the Italian Gorgonzola, the French Roquefort and the English Stilton. This compound is readily recognizable to the nose and the palate because it is principally responsible for the rancid/sour taste/smell of those cheeses. Additionally, to a person who enjoys such cheeses, the presence of these sensory attributes, and the butyric acid responsible for them, is an important indicator of quality.

Artisan food products, including the traditional Sicilian