

DAIRY COWS FEEDING CHANGES THE BIOCHEMICAL COMPOSITION AND THE SENSORY PROPERTIES OF THE DAIRY PRODUCTS, BUTTER AND CHEESE.

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Introduction

The characteristics of dairy products depend of a large number of factors, in particular dairy cow feeding practices. After a short recall of the feeding factors that can modify the composition of milk, we will evoke the impact of feeding and in particular forage on the quality of milk and the sensory properties of butters and cheeses. The concept of forage implies at the same time its nature, its mode of conservation and its floristic diversity. The mechanisms explaining the sensory differences between dairy products in relation with feeding of dairy cows will be studied.

Feeding factors can modify the composition of milk

Milk protein content

The increase in energy supply increases milk yield and milk protein content. Energy level is most often increased by higher concentrate supplementation, which induced great changes: increased volatile fatty acid production especially propionic acid, larger amount of starch digested in the small intestine, higher synthesis of microbial proteins....(Rulquin and Hurtaud, 1994). The source of energy supply can also have an effect on milk protein content. For example, lipids usually induce a decrease in protein content (Chilliard et al, 2001).

Improving nitrogen nutrition, in terms of crude protein content of diets, has been thought to have a beneficial effect mainly on milk yield, and to slightly increase protein content (Rulquin and Hurtaud, 1994). Optimizing the amino acid composition of protein supplements can constitute a means of increasing the protein content of milk. With diets based on maize silage alone, or mixed with grass silage, using a mixture of soya and rapeseed meal, induces higher milk protein production than with peanut meal, maize gluten or cotton meal. It's due to the supply of Lys and Met, most limiting amino-acids with maize silage (Rulquin and Hurtaud, 1994).

Milk fat content

Compared to maize silage diets, conserved grass as hay or grass silage, or pasture induced a decrease in milk fat content. Milk fatty acid composition is also modified. The main fatty acids in milk fat from cows on pasture are palmitic acid (23-28%) and mono-unsaturated fatty acids (23-32%), the main one being oleic acid. Diets containing more than 60% of maize silage result in 30-34% palmitic acid. Fat supplementation of dairy rations generally decreased milk fat content except encapsulated or protected fat (Chilliard et al, 2001).

Impact of dairy cow feeding on the quality of milk and on the sensory properties of butter and cheese

The specific effects of dairy cow feeding on the sensory characteristics of the dairy products have been studied following the requests of the AOC cheese producers who want to have objective references on the effect of dairy cow feeding. The trials consisted in comparing the

characteristics of products resulting from animals receiving different feeding rations. They tested the effect of maize silage compared to grass and for grass, various types of conservation and various floristic compositions.

Effects of type of feeding and conservation of grass

Various work comparing dairy products obtained from milk of cows fed with maize silage or grass (grazed or conserved as hay or as silage), shows that the maize silage leads to whiter, firmer and generally less appreciated butters or cheeses because of their less developed flavour (Carpino et al., 2002; Coulon and Priolo, 2002; Houssin et al., 2002; Hurtaud and al, 2002a, 2002b). The differences seem to be reduced when grass is used in the form of hay.

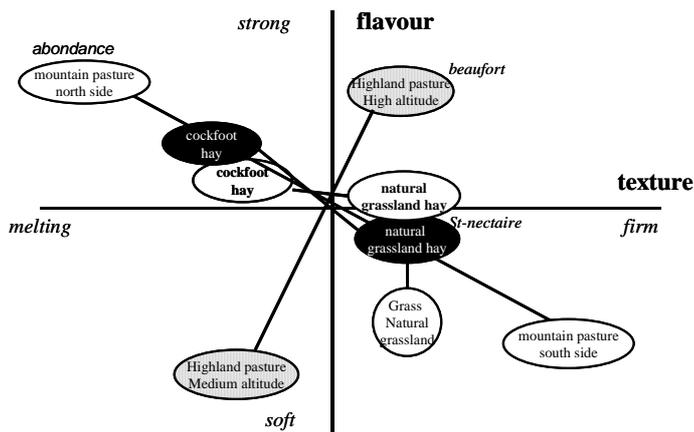
For the feeding only based on grass, the conservation of grass can have a significant impact on the characteristics of cheeses and butters; the cheeses and the butters obtained with the pasture are yellower, less firm and the cheeses have a more developed flavour than those obtained with feeding containing hay and grass silage (Coulon and Priolo, 2002, Verdier-Metz et al., 2002). For cheeses, the differences in flavour seem to be reduced when milk is pasteurized (Martin et al., 2004).

The conservation of grass as silage is for a long time a subject of debate within AOC cheeses producers. Some specific defects can be observed with badly preserved silages, in particular in manufacture of cooked pressed paste where the presence of butyric spores in the silage and milk is responsible for late swellings and bad tastes and odours. On the other hand, when the silages are good, the mode of conservation (hay vs ensilage), has only a limited effect, apart from the colour of the paste (yellower with the silage) on the sensory characteristics of cheeses. These experimental results have been confirmed by observations in farm cheese producers but it is however possible that these effects are variable according to the type of cheese. Indeed, according to Martin et al. (2003), grass silage compared to hay induces more significant sensory differences on Cantal cheeses than on Saint Nectaire cheeses.

Effect of the botanical nature of forage

The effects of the botanical nature of the meadows, in particular of the permanent meadows of mountain have been studied on various cheeses with pressed paste or cooked and pressed paste. In all the trials concerning cheeses, the differences of texture and flavour could be shown when the animals received grass with different floristic composition, whether the grass is grazed or preserved in the form of hay. The cheeses coming from altitude grass and/or more diversified meadows had a more various and more intense flavour (Figure 1).

Figure 1: Sensory characteristics differentiation of cheese according to grass botanical composition (Coulon et al, 2004)



Mechanisms explaining the sensory differences between dairy products

Some cheese sensory characteristics are due to certain components directly derived from forages. Cheese colour is dependent of carotene content of forages. Carotene is destroyed during forage drying and conservation. Cheeses made with spring grass are much yellower than cheeses made with maize silage, containing very little carotene. Terpenes have also recognized aromatic properties. But even if their concentration increases in cheeses with specific plants, it appears that changes in their concentration in cheese is not sufficient to have a direct effect on sensory properties (Coulon et al, 2004).

Some of the effects of the feeding factors on cheese properties are due to modifications in the milk protein and fat composition. Milk fat composition, closely dependent on animal feeding is at the origin of differences in texture and flavour of butter and cheese. The C16:0+C18:0 /C18:1 ratio, an indicator of butter spreadability decreased with conserved grass compared to maize silage (Hurtaud et al, 2004) and with pasture (Hurtaud et al, 2002a), inducing less firm cheeses and butter. The native milk fat globules affect physico-chemical properties and sensory properties of Camembert cheeses such as meltability, elasticity and colour of the curd (Michalski et al, 2003). Reduced disruption of the protein matrix, probably accounts for the observation that a higher percentage of small native fat globules are transferred to cheese than larger globules (Hill, 1995). Plasmin, implicated in cheese proteolysis, is involved in the texture and flavour (Bugaud et al, 2002). Differences in the rate of proteolysis, due to different feeding systems can be responsible for different cheese flavour as ammoniac flavour (Hurtaud et al, 2004). The intake of certain plant species, as buttercup, could also induce an increased cellular permeability of mammary gland

followed by an increase of plasmin in milk. Lastly, as some of the differences induced by feeding are only observed with raw milk, (Martin et al., 2004), it can't be ruled out that the type of forage influence the microbial ecosystem of milk or its activity. It has also been recently suggested that terpenes, whose plant-specific origin has been documented, may have an indirect impact on cheese sensory properties by modifying the dynamics of the microbial ecosystem activity during cheese making and ripening (Coulon et al., 2004).

Conclusion

Dairy cow feeding has a relatively great impact on cheese and butter. But the effects may vary according to the type of cheese. Some studies have to be conducted to compare the effects of feeding treatments of dairy cows on different types of cheeses.

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