exchange understand progress

How to improve milk fatty acid composition?

Contents

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About this document

Purpose: this fact sheet summarises the current knowledge about milk fatty acids and the factors that may influence their composition.

Targeted public: this fact sheet can be used by advisors, teachers, farmers, consumers or anyone else interested.

During the past years, dairy products have often been incriminated. The main reason was that milk fat and more specifically saturated fatty acids, were associated with cardiovascular diseases. However, a lot of studies have given rise to new positive facts about milk fat in general and some specific fatty acids in particular and therefore make it easier to understand their effects on human health.

Abstract

- There are a lot of different milk fatty acids and they don't all affect human health in the same way. It is now possible to describe the "ideal" milk fatty acid composition.
- Today, animal nutrition is the most efficient way to change milk fatty acid composition. The effects of genetics were more recently studied and could open new possibilities.
- A pasture-based diet gives the best answer in terms of milk fatty acid composition because grass is particularly rich in n-3 acids (ω3).
- Some fat containing concentrates can improve milk fatty composition, in addition to fodder.
- To meet consumer expectations in terms of human health, some firms have developed specific brands and promote the healthy fatty acids concentration in their dairy products.


2

About milk

Not all physiological effects of milk fatty acids are well known yet. However it is possible to define some **dietary guidelines and goals to achieve in terms of milk fatty acid composition:**

- Fewer saturated fatty acids (60 – 65%) especially less palmitic acid,
- More n-3 fatty acids with a well-balanced ω6/ω3 ratio (according to daily recommended intake for ω6 and ω3),
- Keep or decrease n-6 fatty acids,
- Increase concentration of rumenic acid.

The Swiss Society of Nutrition recommends the intake of **three portions of milk or dairy products a day**.
One portion equals: **2 dl of milk** or 150 – 200 g of yogurt/fresh cheese or 30 g of hard cheese or 60 g of soft cheese.

Human health and fatty acids

The effects of fatty acids on human health are well documented. An excessive consumption of fatty acids in one's daily diet can lead to fatty acids having a negative effect on human health.

The numerous fatty acids have different chemical compositions and can be divided into the following families.

Saturated fatty acids
- Short-chain fatty acids: no negative effects known on human health, anti-carcinogenic effect of butyric acid (C4:0)
- Long-chain and medium-chain fatty acids: palmitic acid (C16:0) is often mentioned and associated with a higher risk of cardiovascular diseases.

Unsaturated fatty acids
Some of them have been proven to have a positive effect on human health.
- Mono-unsaturated fatty acids: oleic acid (C18:1).
- Poly-unsaturated fatty acids: linoleic acid (n-6, ω6 family) and α-linolenic acid (C18:3 n-3, ω3 family). These are **essential fatty acids which cannot be synthesised by the human body. They have to be incorporated into the diet** by consumption of specific foods.
- Trans and conjugated fatty acids (CLA: conjugated linoleic acids): rumenic acid specific to ruminants (C18:2 cis-9 trans-11), vaccenic acid (C18:1 trans-11).

Trans fatty acids come mainly from two sources:
- Natural origin: the acids are produced through ruminal fermentation and can therefore be found in meat, milk and dairy products,
- Technological origin: the acids are produced through hydrogenation of vegetable oils (allowing fat to become solid for more stability and preservation) and/or during cooking processes with a very high temperature, in industrial processes.

Many studies show that an excessive intake of these trans fatty acids from a technological origin may lead to a higher risk of cardiovascular diseases by increasing "bad" cholesterol concentration (LDL) instead of "good" cholesterol concentration (HDL). This consequence has not been shown for trans fatty acids from a natural origin.

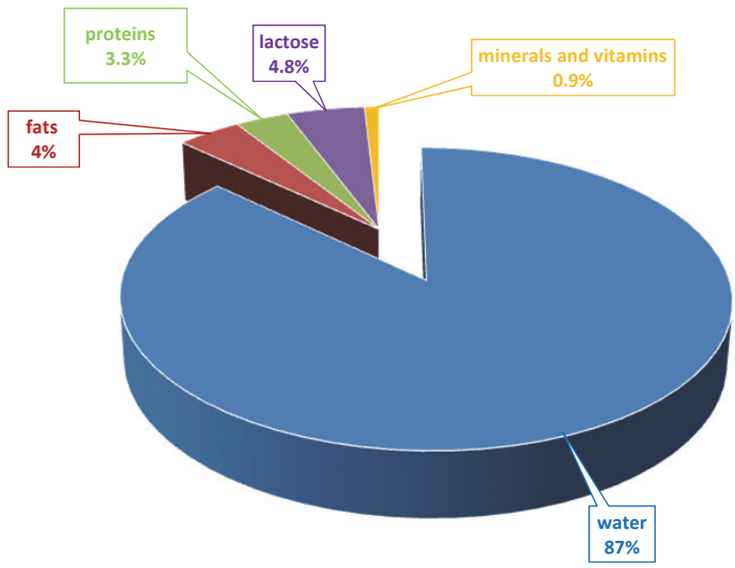
The content of trans-fat of technological origin is therefore limited by food regulations in several countries (eg. Switzerland and Denmark max. 2 g/100 g fat, intention to ban them in the USA over the next three years as in 2013 they were declared as not generally recognised as safe by the Food and Drug Administration).

n-3 family fatty acids
The n-3 family fatty acids are especially important in the development and functioning of the retina, the brain and the nervous system. Positive effects have also been proven in relation to cardiovascular disease prevention.

Rumenic acid (CLA) proved to be anti-carcinogenic. A wide range of other health benefits have been found, including anti-obesity-effects, cardiovascular health, improvement of glucose tolerance, bone density, immune system function and inflammation, and gut health. Vaccenic acid is synthesised by humans to rumenic acid.

Milk fatty acid composition

Cow milk composition

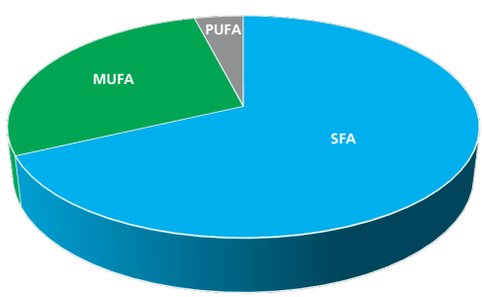


General information about milk fatty acids

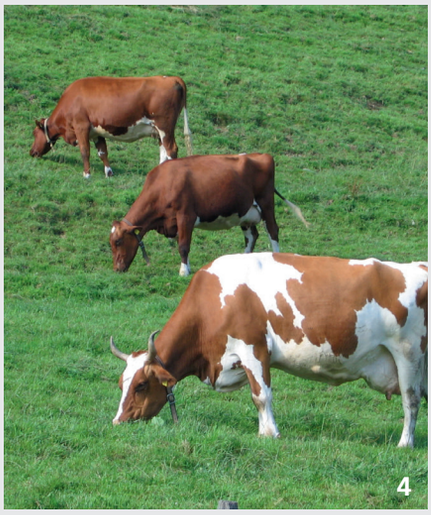
- Fatty acids are the major components of milk fat, about 97%.
- There are about 400 different fatty acids in milk, much more than in plant fats, and their concentration varies from one milk to another.
- Milk fatty acids origin from two sources: they are either synthesised by the cow in the mammary gland or are taken from the blood, therefore originating from the diet, from bio-hydrogenation in the rumen and from body reserves.
- Milk fatty acid composition can be affected by several factors. Nowadays, **animal nutrition is the most efficient way to change milk fatty acid composition quickly and in a reversible way.** Genetics has the potential to open new possibilities.

Distribution of milk fatty acids

Distribution of fatty acids in cows' milk, results from the Phénofinlait study (variation between cow breeds: Montbéliarde, Normandy and Prim-Holstein): **67–69% SFA, 27–29% MUFA, 3.6–4% PUFA.**



SFA: saturated fatty acids
MUFA: mono-unsaturated fatty acids
PUFA: poly-unsaturated fatty acids



4

5

How to improve milk fatty acid composition with animal nutrition

Effects of fodder

Every study shows the same conclusion: fodder does impact the milk fatty acids composition, with different consequences.

What we know

- **Milk from pasture-based diets gives the best answer** in terms of milk fatty acid composition: grazed grass is the best! The concentrations in rumenic, vaccenic and α-linolenic acids are higher.
- **Fresh grass is rich in n-3 fatty acids** whereas maize silage is rich in n-6 fatty acids: grass based diets have a better ratio n-6/n-3.
- The bigger the grass proportion in the diet, the higher is the proportion of "good" fatty acids (with a decrease in saturated fatty acids in parallel). Fresh grass fodder has a good concentration in PUFA.

Which factors play a big part

- **The season, related to the proportion of grazing in summer:** the concentration of unsaturated milk fatty acids is the largest in summer.
- **Vegetative stage of grass:** the n-3 fatty acid concentration is higher in spring and autumn grass.
- **Pasture botanical composition** (leguminous and non-leguminous), with a positive effect of fresh alfalfa on n-3 fatty acids.
- **The altitude** also has a positive effect on unsaturated fatty acids, **with higher concentration in mountains than in plains** (mobilisation of body reserves may be higher or some plant species rich in secondary metabolites may decrease fatty acid bio hydrogenation in the rumen).
- **Grazing system (rotational or continuous):** concentration in fatty acids can change more or less during the grazing season (in relationship with stocking density and quantity/quality of grass).

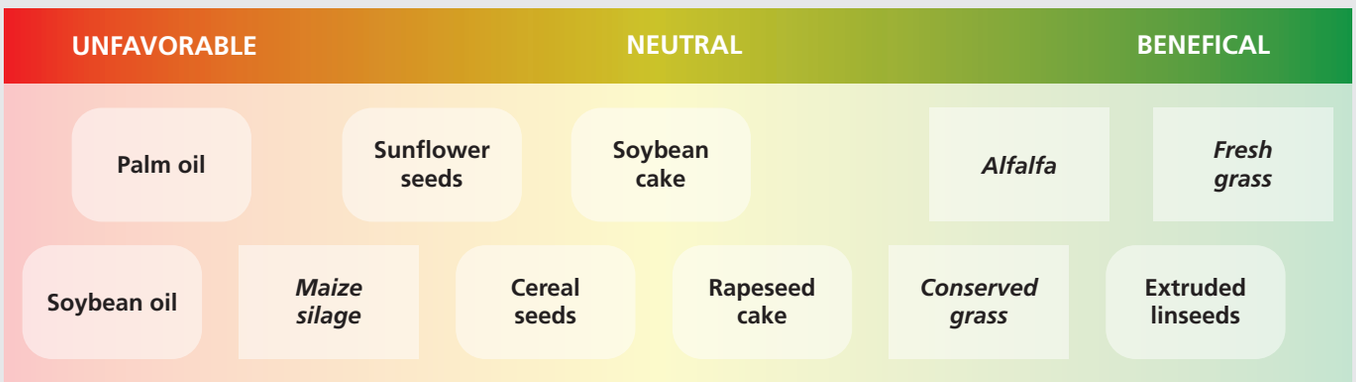
Practical advice

- Fatty acid composition starts to improve with a **minimum of 20% of grass in feeding.** This composition can therefore benefit from a few hours of grazing a day. Higher percentages of grass give better results: above 70% of grass (which is rather common in Switzerland), the CLA and n-3 fatty acids are still increasing.
- Conserved grass is also a good source: it is beneficial to replace maize silage as often as possible.
- **Fodder quality** is an important factor. The process of conservation (hay or silage) generally leads to a decreasing concentration in unsaturated fatty acids. However, if young grass is harvested in good conditions and dried in a hay dryer, the concentrations in n-3 fatty acids may be as high as in the fresh fodder.
- **Another benefit from grazed grass: it is the cheapest fodder!**
- It is difficult to lower the concentration of saturated fatty acids during the year in systems with little or zero grazing (feeding based on maize silage or maize silage and by-products).
- Fatty acids can be used as **bio-indicators to identify the origin or the production system of milk** (works for meat fatty acids as well).
- **Infrared analysis can be used as a quick and cheap method** to measure milk fatty acid composition.
- In the future, fatty acids may be used to **evaluate feeding efficiency, animal health or methane emissions.**

Effects of concentrates

In addition to forage or in limited grazing systems, fat containing concentrates can be another way to improve milk fatty acid composition.

- Some concentrates prove to be efficient, in replacement of soybean cake, to reduce the saturated fatty acids: linseed, concentrates with alfalfa, rapeseed cake, and sunflower seed.
- Linseed and rapeseed cake are fat-containing concentrates that supply a high level of n-3 fatty acids. The type of seed has to be chosen carefully: an extruded but no raw seed (that could cause anti-nutritional factors). The inconvenience of linseed is that its price is rather high.
- Sunflower seed is rich in linoleic acid (n-6) and has a positive effect on CLA.
- It is also interesting to replace soybean in the diet to support local crops and be more autonomous.
- Incorporation of fat in diet has to be limited. **Ideal proportion: 3.5%, 5% maximum** (4% if concentrates are oilseed). If the limit is exceeded, a ruminal dysfunction could occur. Diets based on forage are naturally less rich in fat than maize based diets.
- An excessive quantity of concentrates in the diet can lead to production of certain unwanted trans fatty acids.



Food sorted according to the increasing concentration in omega-3 fatty acids

How to improve milk fatty acid composition with genetics

Genetics was recently studied (Phénofinlait project conducted in France on over 1000 farms) and the results showed new possibilities of a changing fatty acid composition, other than animal feeding.

A few results of the study

- **Heritability of traits** (genetic shared performance which can be passed on to offspring) **is dependent on the origin of fatty acids:** it is a bit higher for saturated fatty acids which are synthesised in the mammary gland (unsaturated fatty acids being mainly from a diet origin).
- **Some parts of the genome** (QTL = Quantitative Trait Locus) **have been identified for having significant effects on fatty acids,** opening the way to genomic selection.

Genetics could be a new solution to change precisely milk fatty acid composition, by selecting specific traits.

Selling products with a high concentration of especially healthy fatty acids

Milk fatty acid composition can impact directly product quality. Saturated fatty acids tend to make milk fat "firmer" whereas unsaturated fatty acids make it "softer".

For example, Gruyère cheese from winter milk has a firmer texture that can easily break and butter from summer milk is more spreadable with a higher concentration of poly-unsaturated fatty acids (lower fusion point). A good milk fatty acid composition can have effects both on human health and on product quality.

The production of organic milk is based on at least 90% roughage in Switzerland and at least 50–60% in the EU. Especially with the Swiss regulations, as the roughage is mostly pasture and grass-based roughage, organic milk contains high amounts of both omega-3 fatty acids and CLA.

Some firms have developed specific brands to promote their milk based products on grazing or rich in n-3 fatty acids.

For example, the brand "Lait des prés" IP-Suisse sold under the label Terra Suisse encourages production and consumption of milk based on pasture and grass-based fodder, limits the proportion of concentrates in feeding and forbids the use of soybeans.
The brand "Tradilin" can assure a minimum concentration of n-3 fatty acids in its dairy products. The farmers have to feed their animals with specific concentrates (especially linseed), in addition to other fodder.

The health claims are rigorously defined in the "Ordonnance du DFI du 23 novembre 2005 sur l'étiquetage et la publicité des denrées alimentaires (OEDAI)" for Switzerland.
Any references to fatty acids in a product are strictly defined in legal texts and refer to clearly established limitations.

6


7

Photos

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