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# The nutritional benefits of organic milk - a review of the evidence

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More and more shoppers are choosing organic food – and for a whole range of reasons. Research has shown that people buy organic food because they believe it is healthier and tastier, as well as better for the environment and animal welfare (Green, 2004; Haward and Green, 2003). Consumers' beliefs are now supported by a growing body of scientific evidence which confirms that organic food is nutritionally superior than non-organic food.

## Organic milk – a glass of goodness

Several scientific studies have demonstrated the nutritional benefits of organic milk. They show that organic milk generally contains higher levels of beneficial nutrients and vitamins than milk from non-organic cows. The studies have found that organic milk contains higher levels of beneficial compounds in the milk fats, particularly short-chain omega-3 essential fatty acids, as well as vitamin E and the antioxidant beta-carotene (which the body converts to vitamin A). Higher levels of the antioxidants lutein and zeaxanthine have also been found in milk from cows that eat a grass-based diet typical of organic farming.

## Why is organic milk different?

The nutritional benefits of organic milk can be explained by the diets of organic cows. Organic cows eat a much more natural diet mostly consisting of fresh grass and clover (forage). In comparison, non-organic dairy farmers are allowed to use more grain-based (concentrate) feed containing cereals, maize and protein supplements. These diets increase milk yields but also effect the nutritional composition of the milk as well as the health of the cows. By increasing milk yields, concentrate feeds place greater pressure on the animal's physiology – leading to a shorter life, mastitis (udder infections) and other health problems.

Organic standards aim to ensure that organic cows and other livestock are reared for the quality of food they produce, rather than just maximising quantity. This is why at least 60% of their daily diet must consist of roughage for example fresh or preserved grass (EU, 1991; 4.7). In addition, to guarantee that their food is as fresh as possible at least 50% of their feed must be grown on the farm itself or on linked holdings (ibid; 4.3). This link between healthy soil, healthy animals and healthy people lies at the heart of organic farming.

It should be noted that these beneficial nutrients are contained in the fat component of milk. The research to date has analysed only full-fat cow's milk direct from the farm dairy (with the exception of the Italian study which looked at buffalo milk). Levels of these nutrients are higher in whole milk compared to skimmed milk, which is virtually fat-free.

## Vitamins and antioxidants in organic milk

The compounds found in organic milk have a range of nutritional benefits, including cancer and disease prevention.

The compound alpha-tocopherol is part of the **vitamin E** family. Vitamin E has **antioxidant** properties which means that it can prevent damage by free radicals that cause cancer.

Studies have shown that dietary intake of alpha-tocopherol “may be protective against cardiovascular disease, mutagenic alteration and cancer” (Bergamo *et al.*, 2003). According to the Expert Group on Vitamins and Minerals (2003), vitamin E is thought to play a role in the prevention of coronary artery disease (atherosclerosis), relieve menopausal symptoms and reduce chronic skin damage. Vitamin E is known to prolong the shelf life of milk since it acts as an antioxidant (Nielsen *et al.*, 2004). Other sources of vitamin E are plants and plant oils which tend to contain higher concentrations than animal tissues.

**Beta carotene, lutein and zeaxanthine** are members of the carotenoid family which are characterised by their antioxidant properties and appear to have cancer preventative properties (Van Poppel, 1993 cited in Bergamo *et al.*, 2003). Beta carotene is the compound that gives carrots their orange colour. It is important because it is a precursor to vitamin A which means that it is converted by the body into the vitamin. Studies in humans have shown that a high intake of beta-carotene in the diet is associated with a reduced risk of chronic diseases, such as coronary heart disease and cancer. However, it is unknown whether this is due to the properties of beta-carotene itself or other diet and lifestyle factors (Expert Group on Vitamins and Minerals, 2003). A Food Standards Agency study found that women with medium or high carotene intakes during childhood were less at risk of psychiatric disorder between the ages of 15-32 than those with lower intakes (Food Standards Agency, 2005). Other sources of beta carotene include green leafy vegetables and yellow fruits.

#### **What are omega-3 essential fatty acids?**

Omega-3 is a group of polyunsaturated fatty acids which are commonly found in milk, oily fish and some vegetables. Omega-3 and omega-6 are considered ‘essential’ to health because the human body cannot produce them and they must be obtained through a good diet (Robertson and Fanning, 2004). It is important that there is an adequate balance of omega-3 and omega-6 in the diet, the latter of which is mainly found in plant oils. However, most people are lacking in omega-3 and get too much omega-6. The balance in the average UK diet is around 1:10, while a ratio of 1:3 is recommended with a higher proportion of omega-3 (Simopolous, 2002 cited in Bergamo *et al.*, 2003).

There are two main groups of omega-3 which have different nutritional properties – short-chain omega-3 which are mainly found in milk and plants and long-chain omega-3 which are mainly found in oily fish like mackerel, salmon and herring. Milk can provide nutritionally important short-chain omega-3 (alpha-linolenic acid or ALA) but relatively little long chain omega-3 (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)). The latter are known to help maintain heart health as well as improving brain and vision development in fetuses and infants.

Some studies have shown that organic milk contains higher levels of short-chain omega-3 fatty acids (ALA). Research has also identified a higher content of the omega-6 fatty acids, conjugated linoleic acid (CLA) and linoleic acid, as well as a more beneficial (lower) ratio of omega-3:omega-6 in organic milk compared to non-organic milk.

The nutritional benefits of short-chain omega-3 fatty acids are less well understood than for long-chain omega-3. The Soil Association recommends that further research is needed to further understand the health impacts of the short-chain omega-3. The short-chain omega-3 are converted to long-chain omega-3 in humans, but this conversion is generally inefficient and occurs more in women, particularly younger women (Burdge and Calder, 2005). The Organic Milk Suppliers Cooperative (OMSCo) intends to commission a review of the health benefits of short-chain omega-3s and their conversion to the long-chain form in humans.

## **The findings on organic milk**

The findings of five key studies into the nutritional benefits of organic milk and dairy products are summarised below. (Studies 1, 3 and 5 have been published in peer-reviewed journals.)

### **1. University of Liverpool (Ellis *et al.* , 2006)**

#### **Results**

- Organic milk had higher levels of polyunsaturated fatty acids throughout the year, compared to non-organic milk. In particular, average levels of omega-3 fatty acids were 68% higher in organic milk.
- Organic milk also contains a much lower omega-6:omega-3 fatty acid ratio, which is considered beneficial, than non-organic milk: "The n-6:n-3 FA ratio each month in organic milk ranged from 1.27 to 1.90, and in conventional milk, ranged from 1.99 to 3.66." According to Simopoulos (2002), "a lower ratio of omega3/omega6 is more desirable in reducing the risk of many chronic diseases of high prevalence in Western societies."
- Organic milk also contains a higher proportion of polyunsaturated fatty acids to monounsaturated acids than non-organic milk.
- No significant differences were found in conjugated linoleic acid (CLA) or vaccenic acid content.
- Various individual factors beyond the farming system affected fatty acid content: month of the year, herd average milk yield, breed type, use of mixed rations and access to fresh grazing.
- Nevertheless, even after accounting for these other variables, a distinct 'organic' farming and a 'conventional' effect was seen for the level of some fatty acid groups.

#### **Methods**

- This study is particularly important, not only because it is published in a major journal, but also due to the robustness of the methodology: "This is the first study to consider a cross-section of UK farms over a 12-month production cycle, and supports the hypothesis that organic milk has a higher n-3 FA content compared with conventional milk."
- Milk was collected from bulk tanks at 17 organic and 19 non-organic farms in northwest England and in Wales. Monthly collections were made during a 12-month longitudinal study between May 2003 and April 2004.

#### **Conclusions**

- "Milk FA [fatty acid] composition is affected by farming system, with organic milk consistently having a higher proportion of PUFA [polyunsaturated fatty acid] and n-3 FA [omega 3 fatty acid], as well as a lower n-6:n-3 ratio. Additionally, there are several key seasonal, farm management, and cow nutrition factors that affect milk FA content. Despite accounting for management and feeding variables, an "organic" and a "conventional" effect was seen for some FA groups. This is important at the retail level, because "organic" or "conventional" labelling is one of the only differences that consumers can currently determine."

### **2. Danish Institute of Agricultural Sciences, Quality Low Input Food (QLIF) project (Nielsen *et al.* , 2004 and Nielsen and Lund-Nielsen, 2005)**

#### **Results**

- Organic milk in 7 out of 10 samples contained significantly higher levels of vitamin E (alpha-tocopherol) than non-organic milk (Figure 3). There was less synthetic vitamin E in organic milk which indicates less was added to the organic milk (Figure 4). Despite this, the vitamin E content of organic milk was higher than non-organic milk.
- The beta-carotene content was two to three times higher in organic milk than in non-organic milk.
- There was no difference in the fatty acid composition of the two milk types, including

CLA.

- Additional, unpublished data from this project showed that milk from experimental cows fed on grass silage contained significantly higher levels of the antioxidants lutein and zeaxanthine, as well as vitamin E (alpha-tocopherol) and beta-carotene (Table 1) compared to cows fed predominantly on maize (Soil Association, 2005a). These diets are typical of organic and conventional cows respectively in Denmark.

#### **Methods**

- Collected monthly samples from silo tanks at the Arla Foods dairy plant in Denmark, May 2003 to February 2004.
- The researchers are publishing additional data for milk in Denmark, the UK, Italy and Sweden.

#### **Conclusions**

- Differences are likely to be due to high levels of maize silage in conventional milk, compared to organic cows which are primarily feed on grass and leguminous plants.
- “The higher concentrations of vitamin E and carotenoids in organic milk area a result of feeding differences between the conventional and organic productions. The most important reason for the observed differences is presumably the large amounts of maize silage used in the conventional production, whereas a considerable amount of grass and leguminous plants are used in the organic production.”
- “If the organic farmers wish to produce milk with a high level of vitamin E and carotenoids in the future, the share of maize in the feed rations should not be increased.”

### **3. National Research Council and Regional Agency for Environmental Protection, Italy (Bergamo *et al.* , 2003)**

#### **Results**

- Significantly higher essential fatty acids, including CLA (conjugated linoleic acid), linolenic acid (LNA) as well as vitamin E (alpha-tocopherol) in organic buffalo milk and mozzarella cheese obtained from farm dairies.
- Also found significantly higher levels of polyunsaturated fatty acids, as well as fat-soluble vitamins and antioxidants: vitamin E and beta-carotene (turned into vitamin A in the body) in pasteurised and heat-treated organic cow's milk and dairy products purchased from supermarkets.
- Significantly lower concentrations of retinol (vitamin A) were found in organic buffalo milk and cheese, but there were no significant differences between samples of conventional cow's milk or dairy products.
- For instance, organic buffalo milk contained 33% and 31% higher levels of CLA and LNA respectively, and these results were even higher in buffalo mozzarella at 45% and 41% (Figure 1).
- Organic cow's milk contained 46% higher vitamin E, 60% beta-carotene and organic ricotta cheese contained 91% more CLA (Figure 2).

#### **Methods**

- Buffalo samples were obtained from farm dairies during April-June to minimise the impact of seasonal variations on milk-fat composition, cooled to 4°C.
- Two brands of both organic and non-organic cow's milk dairy products were purchased from supermarkets. The milk was industrially processed, either pasteurised or ultra-heat treated (UHT) and other products included butter and five types of cheese.

#### **Conclusions**

- “The finding of higher levels of alpha-tocopherol and beta-carotene in organic milk fat might have positive implications in human nutrition...”
- “It is noteworthy that the finding of higher CLA, TVA [*trans* -11 octadecenoic acid] and LNA amounts, in all organic samples analysed, strongly suggests a high nutritional value for organic milk.”
- “In particular, on account of the LNA importance for human nutrition and health and, on

the basis of the data reporting the cancer-preventative effect of TVA and CLA-rich foods, the nutritional quality of organic foods seems to be higher than that of conventional products.”

- “Animal diets have a major influence on milk CLA content... Fibre-rich organic diets may improve fat-soluble vitamin concentration in milk by decreasing yield.”

#### **4. University of Aberdeen (Robertson and Fanning, 2004)**

##### **Results**

- Examined ‘essential’ polyunsaturated fatty acids; found higher levels of omega-3 (C18:3n-3) in the summer months only and similar levels of omega-6 (C18:2n-6).
- Levels of omega-3 are highly variable between the five months studied.
- Organic milk contained significantly higher levels of omega-3 than conventional milk in June (>42%), July (71%) and August (62%) during summer grazing (59% higher overall for the three months).
- In April and May there were no significant differences on omega-3 content, due to winter feeding regimes (less grazing, more concentrate).
- No significant differences in omega-6 at any time, but there was an overall trend for organic to contain lower levels (87%).

##### **Methods**

- Milk samples collected between April and August 2004 from eight organic and eight non-organic farms in south west Scotland. Samples collected from bulk tanks and frozen on same day.
- Samples of milk purchased from retailers in Aberdeen during July 2004 showed that, on average, organic contained 37% more omega-3, similar levels of omega-6.

##### **Conclusions**

- Differences in omega-3 reflect feeding regimes, assuming that there is a higher proportion of grazing on clover pasture on organic farms.
- The study supports the hypothesis that legumes generally contain higher levels of polyunsaturated fatty acids than mixed grass swards, therefore producing higher polyunsaturated fatty acids concentrations in milk.
- “The work reported here demonstrates that organic milk does contain significantly higher levels of the beneficial polyunsaturated fatty acid ‘omega-3’, and a trend of lower levels of ‘omega-6’.”

#### **5. Institute of Grassland and Environmental Research, Aberystwyth (Dewhurst *et al.* , 2003)**

##### **Results**

- Feeding cows clover silages, particularly red clover, increased the levels of polyunsaturated fatty acids which are beneficial for human health, particularly alpha-linolenic acid, in milk.
- A three-fold increase in milk alpha-linolenic acid levels was observed between cows offered red clover silage compared with grass silage (both diets included a low level of concentrate at 4kg/d).
- “Alfalfa and red clover silage can lead to some improvement in the saturated fatty acid content of milk... There was... a significant reduction in palmitic acid which is known to increase plasma cholesterol in human.”
- The study looked at the effect of different feeding strategies on milk composition, particularly grass and legume silages. It did not look at certified organic cows but these feeds are common in organic farming.

##### **Methods**

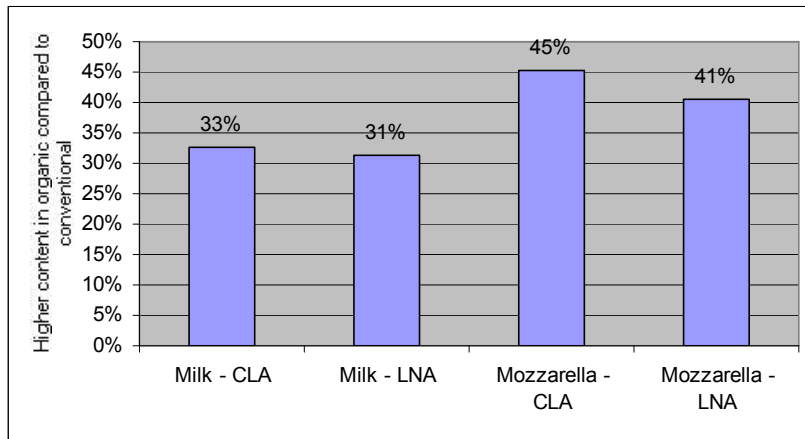
- Cows were fed a range of different dietary treatments based on concentrates and six different forages: grass silage, red clover silage, white clover silage, alfalfa silage and a 50:50 mixture of grass and red clover silage. The forages were grown in Aberystwyth and harvested over the 1998 and 1999 growing seasons.

- Cows had free access to forages through rough intake control feeders in a free-stall barn, or through individual stalls.
- The study also examined the effect of grass and legume silages in relation milk yields, nitrogen use efficiency.

**Conclusions**

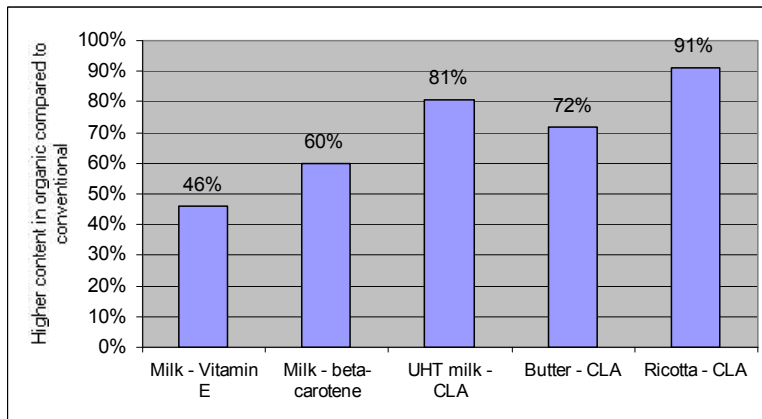
- “Milk from cows offered legume silages generally contains higher levels of polyunsaturated acids that are regarded as beneficial for human health (linolenic acid, conjugated linolenic acid and alpha-linolenic acid).”

**Figure 1 Fatty acid content in Italian organic buffalo milk and mozzarella**



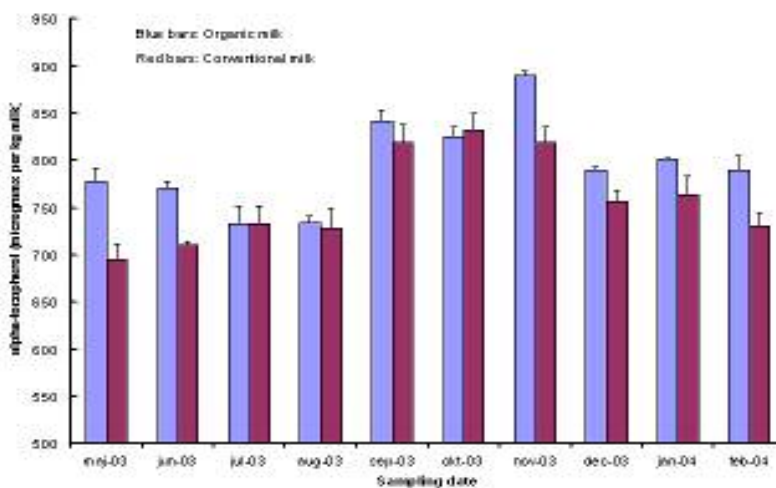
Source: Bergamo *et al.* , 2003

**Figure 2 Vitamin and CLA content in Italian organic cow's milk and dairy products**



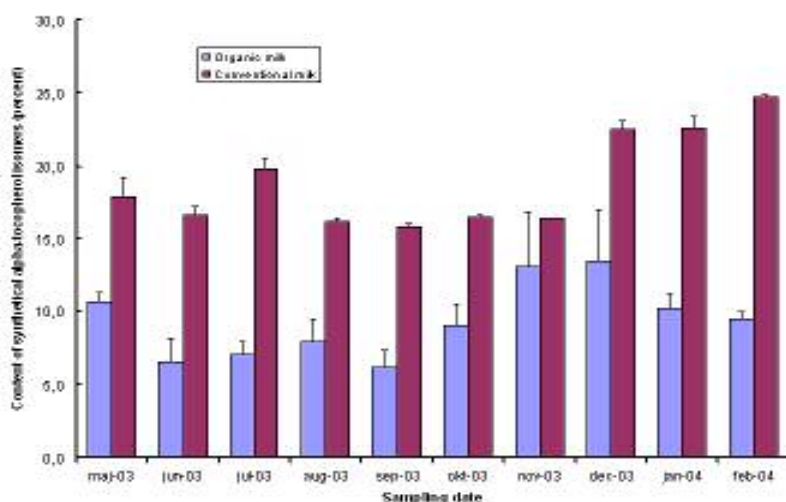
Source: Bergamo *et al.* , 2003

**Figure 3 Vitamin E content in organic and non-organic milk from Denmark**



Source: Nielsen *et al.* , 2004

**Figure 4 Synthetic Vitamin E content in organic and non-organic milk from Denmark**



Source: Nielsen *et al.* , 2004

**Table 1 Antioxidant content in experimental cows fed on grass and maize**

	Grass rich diet (i.e. organic)	Concentrate or maize rich diet (i.e. non-organic)	Higher content in milk from grass-fed cows (i.e. organic)
Alpha-tocopherol mg/l	1.0	0.44	127%
Beta-carotene µg/l	634.3	276.3	130%
Lutein µg/l	19.8	3.0	560%
Zeaxanthine µg/l	3.4	1.1	209%

Source: Unpublished data from QLIF project, cited in Soil Association (2005a).

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### Further Reading

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