# Health promoting effect of polyunsaturated fatty acids (omega-3 and omega-6) in milk and milk products (Short Review)

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**Abstract:** With the hopes of maintaining or enhancing quality of life; many health conscious individuals incorporate functional foods and beverages into their daily lives, as the costs of health care and prescription drugs increase, a growing trend towards self-medication with natural food-based ingredients occurs. The focus of this review is on the nutritional manipulation of omega- 3(n-3) and omega-6(n-6) and possible constraints to their enhancement in milk and its products. This review dealt with Milk Fat Bio-Synthesis, Pathways of Omega -3 & Omega -6 Metabolism, Beneficial Physiological Effect of Omega-3 & Omega -6 Polyunsaturated Fatty Acids (PUFA), Sources & Dietary Intakes, Factors Affecting the Content of Omega -3 & Omega -6 PUFA in Milk and Milk Products and Omega Families PUFA Contents in Milk and Its Products.

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## Introduction

Omega-3 (n-3) and omega-6 (n-6) based on the presence of the first double bond from the terminal methyl carbon.

Polyunsaturated fatty acids (PUFA) are fatty acids usually of 18 carbon atoms or more in length with 2 or more double bonds. PUFA can be divided into two main families, n-3 and n-6 depending on the position of the double bond relative to the methyl end of the fatty acid molecule, (Conner, 2000). Numerous studies have demonstrated that, n-3 PUFA are an important component of cellular structures and their inclusion in the diet provides a variety of health benefits including improved brain and retinal development and reduced risk of coronary heart disease (CHD) and type II diabetes (Conner, 2000).

The 1982 Nobel Prize was awarded for the discovery of omega-6 FA in the form of prostaglandins and related biologically active substances that are metabolites of arachidonic acid (AA), the 20-chain omega-6 FA that is a foundation of the inflammatory response (Ruxton *et al,* 2004). These omega-6 AA metabolites include prostaglandins, such as the thromboxanes and leukotrienes. Subsequent to that award, it has become appreciated that the proinflammatory 20-chain omega-6 arachidonic pathway is counterbalanced by an anti-inflammatory pathway based on the 20-chain omega-3 eicosa-pentaenoic acid (EPA). Omega-3 PUFAs, as well as omega-6 PUFAs, are classified as essential FA because the human body cannot synthesize them. The scientific literature is growing regarding the tremendous health benefits of omega-3 supplementation both for overall health and disease prevention and for the treatment of many inflammatory conditions (Moore, 2009).

The human body is capable of producing unsaturated fatty acids (PUFA) but it cannot produce FAs having double bonds below the ninth carbon atom, which includes omega-3 and omega-6 $FA_S$. Since the body cannot synthesize these essential FAs, they must be supplied via dietary intake or nutritional supplements. Many previous studies confirmed the beneficial and the consequences of omega -3 and omega- 6 fatty acid in human health (Simopoulos, 2009).

## Milk Fat Bio-Synthesis

Milk fat is a complex lipid containing more than 400 distinct fatty acids. Most of these fatty acids are esterified into glycerol as triacylglycerol which make up 97-98% of the milk lipid. The remainder is mainly comprised of much smaller amounts of phospholipids, cholesterol esters, diacylglycerols, monoacylglycerols, and free fatty acids, the predominant features of bovine milk fat include the presence of short chain fatty acids, the presence of odd and branch - chain fatty acids, a relatively high proportion of saturated fatty acids, a low proportion of polyunsaturated fatty acids (PUFA) and a relatively high proportion of trans fatty acids, including conjugated linoleic acid (CLA) (Kennelly and Bell, 2003).

Milk fat is synthesized in the mammary gland through the esterification of free fatty acids to glycerol. The fatty acids originate either through de-novo synthesis from acetate and β-hydroxybutyrate or from performed fatty acids, which come either from the diet or mobilization of body fat stores. De-novo synthesis of fatty acids produces most of the short and medium chain saturated fatty acids from 4:0 to 14:0 and approximately half 16:0, (Kennelly and Bell, 2003).

Milk fat consists of droplets of triglyceride (TG) that are coated with cell membrane. Thus 96-98% of milk fat is TG with the remainder mainly representing small amounts of phospholipids, cholesterol and cholesterol ester found in the milk fat globule membrane, (Guire and Bauman 2002). The triglyceride (TG) comprise over 400 FA, with a large portion of these produced as intermediates during lipid metabolism in the rumen, (Jensen, 2002).

However, most of these fatty acids (FAs) are present in trace amounts, and it is generally recognized that the major FAs in milk fat include saturated fatty acids (SFAs) from 4:0 to 18:0 plus palmetoliec, oleic, linoleic and trans-18:1 FAs. The FAs that compose milk TG are derived from two sources, de-novo synthesis and the uptake performed FA, (Guire and Bauman, 2002).

Substrates for de-novo synthesis are acetate and β-hydroxybutyrate derived from rumen fiber digestion (Lock and Bauman 2004).

### Pathways of Omega -3 and Omega -6 PUFA Metabolism

Linoleic acid (LA) is the precursor fatty acid of the bioactive omega-6 PUFA, arachidonic acid (AA); alpha linolenic acid (ALNA) is the precursor of the bioactive omega-3 PUFA eicosapentaenoic and docosahexaenoic acids. Both precursors are converted to their long chain metabolites by a series of desaturation & elongation steps and share common enzymes for these metabolic transformation, (Fig1) (Williams, 2000).

Conversion of ALNA to EPA and DHA is low in humans and may be further suppressed due to inhibition of the delta-6-desaturase enzyme, by high intakes of linoleic acid. AA and EPA/DHA are the substrates for the formation of two families of eicosanoids. The eicosanoids formed from AA have generally greater potency than those formed from EPA and as a consequence, their actions on vascular, immune and inflammatory systems differ markedly, (Williams, 2000).

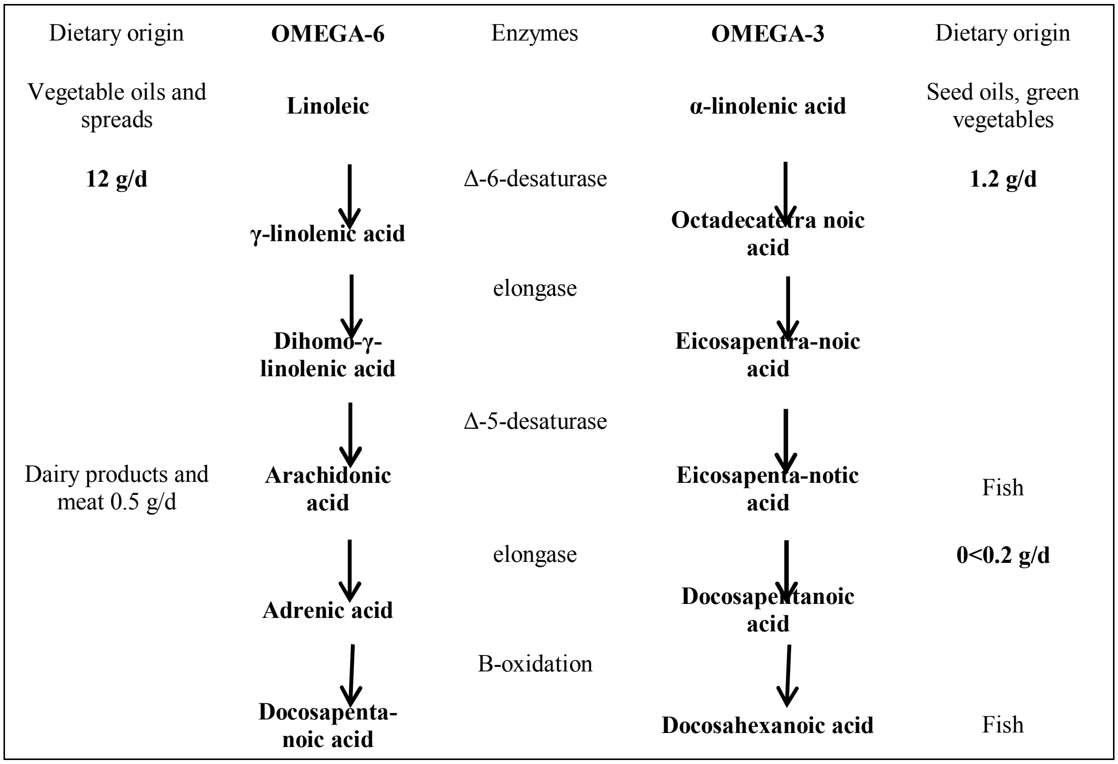

**Figure 1. Pathways of omega-6 and omega-3 metabolism showing chain elongation and desaturation steps which share common enzyme systems. Major sources of precursor and long chain omega-6 and omega-3 PUFAs in the diet are indicated. (Williams, 2000).**

### Beneficial Physiological Effect of n-3 and n-6 Polyunsaturated Fatty Acids (PUFA)

Historically, the goal of agricultural research has been to increase yield and productive efficiency with little focus given to improving the nutrient profile of food products. Mounting research evidence and consumer awareness of the potential health benefits of various micro components in foods has given rise to the concept of functional foods and helped create a demand for foods with improved nutrient profiles, (Lock and Bauman 2004).

Thus producers and scientists are in research and agricultural practices that may improve the nutrient profile of food products,(National Research Council, 2003).

The recommendations of consumption of long chain (LC) n-3 PUFA for cardiovascular health and additional evidence for the roles of LC n-3 PUFA in modulation of inflammatory disorders, (Calder,.2006), Conner and Conner 2007) in life,had resulted in sustained growth of consumer demand for LC n-3 PUFA ingredients over the last decade, (Bimbo,2009). It has been recognized for some time now, that this continuing increased consumer demand for LC n-3 PUFA may not be matched by the diminishing supply wild catch fish due to the deterioration of the marine ecosystems. The search for alternative complementary sources of LC n-3 PUFA through plant biotechnology has ensured in earnest and groups from Australia, (Robert, et al, 2005), USA, (Damude and Kinney, 2007) and Canada, (Truksa, et al ,2009) have reported on the feasibility of production of L C n-3 PUFA in substantive quantities in land plants . Alpha linolenic acid (ALA, C 18:3, n-3) which is abundantly found in linseed oil and stearidonic acid (SDA, C18:4 n-3) which constitutes 120-140 g/L of Echium oil , are on the same biosynthetic pathway as EPA and DHA and can act as precursors for the latter two acids, (Burdge and Colder 2006). Long chain omega -3 fatty acids (LCO-3 FA) eicosapentaenoic acid (EPA C20:5) and decosahexaenoic acid (DHA C22:6) have a large range of specific health benefits , (Kinsella, et al,(1990);Bucher et al ,(2002); Hooper, et al,(2004); Wang ,et al, (2006) and Cox, et al.,(2011) which will reviewed in another position.

In recent years, there has been considerable interest in the beneficial physiological effects of the long chain (LC) Omega -3 polyunsaturated fatty acids (PUFA), eicosapentaenoic acid (EPA) and docosahexaacid (DHA), these fatty acids are present in the diets of most developed countries in very small amounts due to low consumption of fish and its products. It has been suggested that , the typical western diet , may not supply the appropriate balance of omega -6 and omega -3 PUFA, (Simopoulos , 1991) , and this imbalance could contributed to a greater risk of coronary heart disease (CHD) via a more pro-thrombotic and pro – inflammatory state . Other chronic disorders which have been suggested to be linked with lack of omega-3 PUFA include hypertension, inflammatory and immune disorder, depression and neurological dysfunction. The recognition of the importance of DHA in neuronal development in the fetus and the new- born has also highlighted the vital role of this class of fatty acid in infant as well as adult nutrition, (Salem and Pawlosky, 1994).

The fatty acid composition of animal products (egg, milk and meat) is tbhe reflect of both the issue fatty acid biosynthesis and the fatty acid composition of ingested lipids. This relationship is stronger in monogastries than in the rumen. This relationship can be used to increase the human intake of fatty acids with health benefits( Kitessa *al* 2011).

It is now recognized that n-3 fatty acids (FAs) are essential for normal growth and important for brain development, vision, and immunity in infants, these FAs may also play a vital role in the prevention and treatment of cardiovascular diseases, (Williams, 2000).

The potential health benefits of omega-3 fatty acids have been widely reported for several conditions including cardiovascular disease, hypertension, atherosclerosis, brain development, diabetes, cancer, arthritis, inflammatory, autoimmune and neurological disorders (Gogus & Smith, 2010; Kadam & Prabhasankar, 2010). Moreover, Wang *et al.* (2006) stated that, Long chain omega-3 polyunsaturated fatty acids (LC PUFA n~3), specifically EPA and DHA have been found to reduce the risk of cardiovascular disease by reducing the total serum cholesterol and serum triglycerides. Intake of EPA and DHA were found to lower the risk of ischemic heart disease (Lemaitre *et al,* 2003) and cardiac arrest in humans (Bhatnagar & Durrington, 2003). The reduction of TAG by LC n-3 PUFA could be due to decreased hepatic synthesis of very low density lipoprotein (VLDL) by inhibition of various enzymes (Chan & Cho, 2009). Addition of EPA and DHA to cultured cardiomyocytes of neonatal rats inhibited the induction of tachyarrhythmia (Let *et al.,* 2003). DHA has been found to play a role in cognitive functions and also may protect against Alzheimer's disease (Van Gelder *et al.,* 2007). The consumption of LC n-3 PUFA, especially DHA is important during pregnancy in women since it is essential for the proper development of eyes, growth and function of brain and nerve tissue in infants (Cheatham *et al.,* 2006). Several studies have determined the protective effect of dietary EPA and DHA against cancers by animal experiments (Lafelice *et* al., 2008). Dietary supplementation of tumor bearing mice with LC n-3 PUFA have been found to slow down cancer of the colon, mammary gland and prostate (Hardman, 2004). A meta analysis study by Theodoratou *et al.* (2007) revealed the positive effect of LC n-3 PUFA on significant decrease in colorectal cancer. One of the mechanisms of cancer prevention by omega-3 PUFAs is by inhibition of production of various proteins that cause cell proliferation and tumor formation (Larsson *et al.,* 2004). Inflammatory diseases such as rheumatoid arthritis and Crohn's diseases could be treated with LC n-3 PUFAs because of their anti-inflammatory properties by inhibition of prostaglandins (PGE2), interleukin 1(IL -1) and tumor necrosis factor (TNF a) (Ferrucci *et al.,* 2006). The consumption of omega-3 fatty acids has been found to have beneficial effects in age related memory loss as supported by a study in rats (Dyall *et al,* 2010). Overall, omega-3 fatty acids have been found to play a protective role in the prevention of various diseases, especially cardiovascular disease**.**

**Sources and Dietary Intakes**

Dietary sources of the essential PUFAs differ by type. Omega-6 FA are found in rich supply in vegetable oils (Lafelice *et* al., 2008), such as corn and canola oils, and meat from animals fed on diets of cereal grains such as corn and rice. Omega-3 FA can be found in both plant and marine sources. Alpha linoleic acid (ALA) is found in plant sources and also in animals that eat the plant sources. ALA is most abundant in seeds, oils, and nuts, such as flax seeds/oil, hemp seeds/oil, pumpkin seeds/oil, olive oil, rapeseed oil, and walnuts. Flax has been found to contain the highest levels of ALA of the plant sources, while walnuts have been found to contain the highest concentration of ALA of any tree nut. Purslain, a common succulent wild plant, considered a weed in the USA but used as a food source in Europe and Asia, has been found to contain high levels of ALA (Simopoulos *et* al., 1992).

The primary dietary sources of omega-3 FA are marine sources, such as algae and cold water fatty fish, but they are also found in terrestrial sources such as seeds and nuts. Modern Western diets include low amounts of natural sources of omega-3 FA. Food products fortified with omega-3 FA provide a means of dietary supplementation that could increase the overall intake of omega-3 FA by individuals looking to supplement their dietary intake or by individuals who do not prefer natural sources (Moore, 2009).

Omega-3 fatty acids could be considered as the basic components of daily nutrition due to their beneficial effects. Dietary recommendations for omega-3 fatty acids have been made by health authorities in different countries (Gogus & Smith, 2010). Dietary guidelines of the UK recommends average daily intake of 0.2g/day of EPA and DHA (Ruxton & Derbyshire, 2009). Daily intake of 0.5 to 1.0 g of EPA and DHA has been recommended by American Heart Association (Lichtenstein *et at.,* 2006) and by The American Dietetic Association of Canada (Kris-Etherton & Innis, 2007). The International Society for the Study of Fatty acids and Lipids (ISSFAL, 2004) recommended 2.2 g/day of ALA and 650 mg of EPA plus DHA per day with a minimum of 220 mg of EPA and DHA per day. Recommendations have been made for the ratio of n-6: n-3 to be 2.5:1 to 5:1 based on the beneficial effect on disease conditions (Simopoulos, 2009). This ratio is important because high intake of omega-6 interferes with the metabolic pathway of conversion of ALA to EPA and DHA and results in production of more eicosanoids from arachidonic acid such as prostaglandins (PGE2), thrombaxanes and leukotrienes among others. These eicasanoids leads to formation of thrombus, allergic and inflammatory disorders.

Thus a diet rich in n-6 fatty acids increases the risk of bleeding disorders and decreases the benefits of ALA (Simopoulos, 2002). Although the precise daily requirements of n-3 FAs are still being debated, it is suggested that for adults an intake of 650 mg-per day is desirable, Simopoulos (1999).

Health studies suggest that a dietary n-6: n-3 PUFA ratio closer to 5 would be more favorable for cardiovascular well-being, (Simopoulos, 1999). Proportional levels of n-6 and n-3 fatty acids in the diet promote a balanced interaction between the often antagonistic physiological effects of n-6 and n-3 products.

**Factors Affecting the Content of n-3 and n-6 PUFA in Milk and Milk Products.**

Several factors influence both the quantity and the quality of lipids in animal products, especially milk and its products. Internal factors such as age (or weight), gender, genotype have mainly an influence role on the quantity of lipids in these products. Among these factors genetics which is very important. For example, breeding for leaner carcasses has led to decrease in total fat from 45 to 35% to less than 20% today for a commercial pig, (Nguyen, et al, (2004)). But selective breeding results not only in changes of total fat content, but also in changes in fat distribution between different depots, which allows to produce animals with lower subcutaneous fat without decreasing intramuscular fat which is very important for meat organoleptic qualities. External factors such as temperature, feeding has an influence on the fatty acid composition of lipids. Our focus will mainly be the diet effect on lipid composition of animal products.

However, the amount of these fatty acids that are present in ruminant derived foods in very low due to the biohydrogenation of dietary n-3 FAs (Linolenic, C18:3) in the rumen. Attempts had been made to enhance levels of n-3 FAs in milk and dairy products, by abomasal infusion, (Ashes, et al, (1997)) or incorporating n-3 fats into ruminant diets, (Cant, et al, (1997)); Chilliard, et al, (2000). Gulati, et al, (2002) found that a more efficient feeding system for ruminants by protecting different sources of n-3 fat.

When these protected fat supplements are fed to dairy cows on a pasture based system, they will deliver n-3 FAs postabomasally to the small intestine for absorption and incorporation into ruminant milk. The availability of milk, dairy products enriched in n-3 long chain fatty acid will provide consumers with a greater intake of these essential nutrients without making any substantial changes in their dietary habits.

Because vertebrates lack the n-3 fatty acid desaturase responsible for synthesizing n-3 PUFA, and because n-3 and n-6 PUFA are not interconvertible in mammals, n-3 PUFA must be obtained from dietary sources. As a result of the increased consumption of vegetable oils rich in n-3 fatty acids, and the reduced consumption of fish and other foods rich in n-3 fatty acids typical western diets contain n-6: n-3 PUFA ratios that are greater than 10, , (Simopoulos (2004)). Supplemental dietary fats are included in dairy cow rations to increase energy density of the diet to improve reproduction, (Staples, et al, 1998; Mattos, et al, 2000) and immune function (Lessared, et al, (2004)) and to increase the functional food value of dietary products, (Lock and Bauman, (2004)).

The main nutritional factors affecting milk fat composition especially omega families include the effect of forages, rumen modifiers and supplemental fats and oils. These factors can influence the milk fatty acid composition by providing dietary performed fatty acids by influencing the rumen production of precursor for de-novo synthesis by affecting rumen microbial fatty acid synthesis, and through the rumen production of specific fatty acids that either inhibit or stimulate de-novo synthesis, (Kennelly, 1996; Mansbridge and Blake, 1997; Kennelly, and Limm, (1998); Chilliard, et al, (2001); Jensen, (2002); Kennelly and Bell, (2003).

**Omega Families PUFA Contents in Milk and Milk Products**

Milk naturally contains low levels of omega-3 FA, at around 0.66% to 1.11% of the total FA that occur (Makhoul *et al.,* 2006). Due to the low levels of omega-3 FA naturally in milk, much research has been done to manipulate the FA composition of the milk that cows produce by altering their diet (Gorecki & Janusz,1997). While the amount of omega-3 FA, specifically ALA, and CLA in milk can be elevated by the cow's diet, there is low transfer efficiency of the omega-3 FA from the bovine diet into the milk fat.

Many of the omega-3 fortified foods on the market are dairy-based products. Dairy products, such as milk, naturally contain low levels of omega-3 FA. Omega-3 FA comprise approximately 1% of the total fats that occur naturally in these products, although evidence has shown that there are differences in these levels depending on whether the cow was from an organic or conventional farm (Makhoul *et* al., 2006; Marmesat *et* al., 2009).

Dairy products may be providing a good delivery system for omega-3 FA due to the nature in which they are stored and consumed. Investigators have concluded that the best products for omega-3 FA fortification are ones that are stored at low temperatures for short times, and in packages that prohibit the passage of air and light. Dairy products are usually consumed within short periods from the time of purchase and meet the aforementioned storage parameters, suggesting that they serve as good candidates for fortified delivery of omega-3 FA. (Marmesat *et* al., 2009).

Milk fat contents of EPA (20:5 n-3) and DHA (22:6 n-3) are of interest because of their potential benefits to human health. The effects of these omega -3 FA on reducing the risk of cardiovascular disease , type 2 diabetes , hypertension, cancer and certain disruptive neurological functions and their potential mechanism of action have been extensively reviewed, Conner, (2000), Williams ,(2000); Wijendran, and Hayes (2004)); Larrson, et. Al., (2004).. In human nutrition, there is an effort to increase consumption of these functional food components due to the low intake of Omega-3 and the relationship of the intake of omega-3/ omega-6 FA; Western diets typically have an omega-6 to omega-3 ratio of 20-30:1, whereas the ideal ratio is thought to be 4:1 or less, (Simopoulos, (1999)). As a consequence, opportunities to enhance omega-3 FA in many foods including dairy products are being explored (Lock and Bauman, (2004)).

Kolanowskia & Weixbrodt (2007) found that, dairy products such as fresh milk, yoghurts, soft and processed cheeses, cream and butter could be fortified at different levels with omega-3 . They stated that, fortification of dairy products with long-chain polyunsaturated fatty acid (PUFA) omega-3 by fish oil addition appeared possible; however, the level of fortification was limited. The highest level of fortification was obtained for solid, high-fat dairy products (spreadable fresh cheese, butter and processed cheeses), especially when flavorings were present. Such dairy products maintained a constant sensory quality during 4 weeks of storage. One portion of butter, processed and spreadable fresh cheeses fortified at levels established in the study, might provide 180-360 mg of long-chain omega-3 PUFA, significantly elevating their average level in the diet.

They also showed that semi-liquid dairy products (yoghurts, creams) were suitable for fortification with fish oil at very limited levels from 1 up to 5 g/kg. On the contrary, the highest level of fortification was achieved in the case of solid dairy products, including spreadable fresh cheeses

(Philadelphia type), butter and processed cheeses, at 20, 30 and 40-60 g/kg, respectively. But, overall sensory quality of higher levels of fortification decreased significantly. They showed that the upper fortification level, which did not change sensory quality, was higher in the case of samples with high fat content (butter, processed cheeses) compared to those with low fat content. Similarly, samples containing flavoring ingredients (spreadable soft cheese and processed cheese with garlic) could be fortified at higher levels than the unflavored ones. They evaluated butter, spreadable fresh cheeses (flavored and not flavored) and processed cheeses (flavored and not flavored) during storage periods. Samples were fortified at the upper level and evaluated sensorial during storage.

Bermudez-Aguirre & Barbosa-Canovas (2012) evaluated three stages of cheese making that fortified with omega-3 of animal and vegetable sources: after milk pasteurization, during curdling and salting. Better retention was observed with microencapsulated oil, after milk pasteurization (8.49 mg/g) in Queso Fresco (QF), during salting (8.69 mg/g) in cheddar (C) and during curdling (2.69 mg/g) in mozzarella (M). Non thermal approaches such as high hydrostatic pressure (HHP), pulsed electric fields (PEF) and ultrasound (US) were used to increase the retention of omega-3. In (QF), PEF and US achieved the highest retention (5.20-5.12 mg/g); whereas in (C) and (M), HHP was the best method (5.49 mg/g and 6.64 mg/g).

Sensory analysis indicated that oxidative aroma increased during storage for the antioxidant and omega-3 fatty acid fortified dairy-based beverage. Ascorbyl palmitate was determined to have a pro-oxidative effect on the formulated omega-3 fortified dairy-based beverages. Antioxidants present in the commercial grade fish oil used for fortification were effective in controlling oxidation in the formulated omega-3 fatty acid fortified dairy-based beverages (Bermudez-Aguirre & Barbosa-Canovas, 2012).

Milk produced through dietary modifications also is more prone to oxidation due to the higher content of PUFA (Kolanowski & Weibrodt, 2007). It is more economic and efficient to fortify the milk with omega-3 FA (EPA and DHA) through formulation and processing. Milk, or milk-based dairy products, that have been fortified with omega-3 FA may provide a means for supplementation of omega-3 into the diet. There are several aseptically packaged UHT processed milk products on the market in the U.K. that have been fortified with omega-3 FA. One product, produced by Dairy Crest, claims to provide 50% of the recommended daily intake of omega-3 FA with two glasses (Let *et aL,* 2003), although the source of the recommended daily intake and serving size are not stipulated.

The typical fatty acid composition of bovine milk consists of 5% PUFA, 70% saturated fatty acids and 25% monounsaturated fatty acid (MUFA) and contains little n-3 PUFA, (Grummer, (1991)).

Increasing the proportion of n-3 PUFA in milk fat would help to improve the nutritional composition of an important component of the North American diets. Milk is a particularly attractive target for n-3 PUFA augmentation because milk fat is dispersed in extremely small micelles, which improves the absorption and bioavailability of lipid soluble compounds including n-3 PUFA, Visioli, *et al,* (2000); Kao, et al, (2006)).

Milk fatty acid composition affects organoleptic qualities which has important roles in milk processing and may affect human health (Prentice, et al, (2006); Carriquiry, et al, (2009)). Milk fat compositions are affecting the flavor, nutritional properties and physical functionality of dairy products and consequently influence its suitability and applications. They include the reduction of the saturated to unsaturated fatty acids ratio and augmentation of some fatty acids levels with specific desirable human nutrition. Milk fat is responsible of the sensory, physical and manufacturing properties of all dairy products, (Naylegain and Lindsay, (1995)). However, milk fat is relatively more saturated than most plant oils and this had led to a negative consumer perception and a public health concern related to excessive intake of saturated fats. Milk fat content and fatty acids (FAs) composition can be significantly altered through nutrition of the dairy cow's offering the opportunity to respond to market forces and human health recommendations, (Lock and Shingfield, (2004)).

These FAs are particular interest because of their potential benefits to human health. However, modification of the FAs content of milk fat in dairy cows' is impacted significantly by the extensive metabolism of lipids that occurs in the rumen, (Williams, (2000)).

Fermented milk have gained wide consumer acceptance, supported not doubt by its image as a healthy food, as well as their taste and flavor.

Strategies for increasing the level of n-3 polyunsaturated fatty acids (PUFA) in milk have generally been based on incorporation of fish oil in the cows diet (Abu- Ghazaleh, et al, (2001); Chouinard, et al, (2001); Baer, et al, (2001); Abu- Ghazaleh, et al, (2003) and Pilar, et al, (2004)).

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