Eur. J. Lipid Sci. Technol. 2012, *114*, 369–371 DOI: 10.1002/ejlt.201200111

Cinzia Ballabio

Patrizia Restani

Editorial

Lipids in functional foods, nutraceuticals and supplements

In recent decades, there has been a growing interest in the concept of 'functional foods' within the food industry and from the consumers, but although many definitions exist for functional foods, an official, internationally accepted definition is still missing. The concept of functional foods derives from the awareness that specific components of the diet have beneficial effects on the health and well-being and have a potential role in reducing risks of disease.

Some foods which are commonly consumed in the daily diet, such as fruits, vegetables, grains, fish and dairy products, are widely studied for their many natural components that contribute benefits beyond those of basic nutrition. An important group of compounds within unsaturated fatty acids are the long-chain (C16–C20), PUFA (LC-PUFAs). Humans can synthesize certain fatty acids, but are unable to desaturate long-chain fatty acids at either C3 or C6 from the methyl end, making them essential. Examples of foods rich in ω-3 PUFA are anchovies, sardines, mackerels and other fatty fish.

Plant sterols (or phytosterols), the formulations and effects of which have been recently reviewed in EJLST [1], are naturally contained in vegetables oils, cereals, tree nuts and legumes, represent another important group of fat components widely studied for their capacity of lowering serum concentrations of cholesterol. This effect occurs because plant sterols, being structurally similar to cholesterol, reduce its absorption from the gut.

Functional foods can be traditional foods or foods in which one or several components have been modified, removed or reduced (e.g. a yoghurt with reduced fat), added (e.g. spread with added phytosterols), replaced or enhanced (e.g. a juice with enhanced antioxidant content) to improve the benefits. This can also be achieved through innovative technological approaches developed by the food industry.

Results from epidemiologic and clinical studies have indicated that the consumption of ω-3 PUFAs, namely eicosapentaenoic acid (EPA) and docosaesaenoic acid (DHA), and of phytosterols (mainly β-sitosterol, campesterol and stigmasterol) have positive effects in decreasing risk factors of cardiovascular diseases.

Several groups studied the incorporation of phytosterols in various foods rich in fats, such as margarine, salad dressing, cream-cheese, milk and yogurt [2–4]. In double-blind placebo-controlled randomized studies, it has been demonstrated that the consumption of phytosterol-enriched fermented milk was associated with a significant decrease in plasma concentrations of low-density-lipoprotein cholesterol as compared with the consumption of placebo [5–7].

The lipid-lowering effect of milk enriched with ω-3 PUFAs has also been investigated in various clinical trials [9]. Milk fat is considered an efficient vehicle to favour the adsorption of fat and lipid-soluble compounds (ω-3 PUFAs, oleic acid, vitamin E, etc.), because of its dispersion in very small micelles [7, 8]. The formulations, sources and effects of ω-3 PUFAs on human and animal health have been widely considered in studies published in EJLST [10–12].

This special issue on 'Lipids in Functional Foods' focuses on: (i) new sources for lipids with health beneficial properties to improve the value of low quality foods, and (ii) innovative technological approaches to enhance their analysis, extraction procedures or to enrich the nutritional profile of traditional foods.

Caramia and colleagues [p. 375–388] reviewed current studies on extra virgin olive oil as a traditional 'fat' functional food, providing components of great interest for the reduction of risk factors for several pathological conditions. The antioxidant activities of the constituents of vegetable oils have been investigated by Nakbi et al. [p. 469–478] in adult rats. Murine models have been exploited by Xiao and colleagues [p. 461–468] to study the beneficial effects of cold-pressed flaxseed oils, enriched with vitamin E, on lipid profile and antioxidant status. Triacylglycerols, the main components of edible oils, differ in the total length of acyl chains

and the degree of unsaturation. A review by Kalo and Kemppinen [p. 399–411] deals with analytical methods to separate the regioisomers, whose determination is important to understand the digestion, absorption and metabolism of TAGs, as well as their physical and technological properties.

The papers by Chemat and colleagues [p. 453–460] and Monfalouti and colleagues [p. 446–452] investigated potential innovative sources for healthy ingredients using sea buckthorn by-products to obtain carotenoids and argan fruits pulp as a novel source of polyphenols.

The organoleptic characteristics and nutritive profile of a soup enriched with microencapsulated linseed oil, which is a natural source of α-linolenic acid, have been investigated by Rubilar et al. [p. 423–433]. The microencapsulation is a new technological approach used by the food industry to prevent lipid peroxidation. Another way to prevent oxidation is by adding antioxidants – the potential of lipophilized phenolic compounds has been evaluated by Sørensen and colleagues [p. 434–445]. The health benefits of a fish meal diet enriched with ω-3 PUFAs have been studied by Ontsouka et al. [p. 412–422] in alleviating intestinal inflammatory activity in dogs affected by chronic enteropathies.

Gorissen et al. [p. 486–491] investigated the capacity of some bifidobacterium and lactobacillus strains to produce CLA and conjugated linolenic acid (CLNA) with the aim to enrich fermented milk and meat with these compounds; the effects of CLAs on human carcinoma cell lines were also studied in vitro by Zhong and colleagues [p. 479–485].

This special issue is the fruit of a joint effort by ourselves and the Journal, represented by Uwe Bornscheuer, Lucie Kalvodova and all the Associate Editors.

The topics covered in this issue should be valuable for those doing basic research as well as the food industry. We hope that you will find the articles on how lipids can contribute to the human health and well-being interesting.

Dr. Cinzia Ballabio
Dept. Pharmacological Sciences,
Universitá degli Studi di Milano, Italy

Patrizia Restani
Dept. Pharmacological Sciences,
Universitá degli Studi di Milano, Italy

References

[1] Mac Kay, D. S., Jones, P. J. H., Phytosterols in human nutrition: Type, formulation, delivery, and physiological function. *Eur. J. Lipid Sci. Technol.* 2011, *113*, 1427–1432.

[2] Law, M. R., Plant sterol, stanol margarines, health. *BMJ* 2000, *320*, 861–864.

[3] Cleghorn, C. L., Skeaff, C. M., Mann, J., Chisholm, A., Plant sterol-enriched spread enhances the colesterol-lowering potential of a fat-reduced diet. *Eur. J. Clin. Nutr.* 2003, *57*, 170–176.

[4] Korpela, R., Tuomilehto, J., Hogstrom, P., Seppo, L. et al., Safety aspects and cholesterol-lowering efficacy of low fat dairy products containing plant sterols. *Eur. J. Clin. Nutr.* 2006, *60*, 633–642.

[5] Hansel, B., Nicolle, C., Lalanne, F., Tondu, F. et al., Effect of low-fat, fermented milk enriched with plant sterols on serum lipid profile and oxidative stress in moderate hypercholesterolemia. *Am. J. Clin. Nutr.* 2007, *86*, 790–796.

[6] Plana, N., Nicolle, C., Ferre, R., Camps, J. et al., Plant sterol-enriched fermented milk enhances the attainment of LDL-cholesterol goal in hypercholesterolemic subjects. *Eur. J. Nutr.* 2008, *47*, 32–39.

[7] Mannarino, E., Pirro, M., Cortese, C., Lupattelli, G. et al., Effects of a phytosterol-enriched dairy product on lipids, sterols and 8-isoprostane in hypercholesterolemic patients: A multicenter Italian study. *Nutr., Metab. Cardiovasc. Dis.* 2009, *19*, 84–90.

[8] Visioli, F., Risè, P., Plasmati, E., Pazzucconi, F. et al., Very low intakes of N-3 fatty acids incorporated into bovine milk reduce plasma triacylglycerols and increase HDL-cholesterol concentrations in healthy subjects. *Pharmacol. Res.* 2000, *41*, 571–576.

[9] Carrero, J. J., Baró, L., Fonollá, J., Gonzáles-Santiago, M. et al., Cardiovascular effects of milk enriched with (-3 polyunsaturated fatty acids, oleic acid, folic acid, and vitamins E and B6 in volunteers with mild hyperlipidemia. *Nutrition* 2004, *20*, 521–527.

[10] Borhaug, H., Kristensen, M., Brudeli, B., Sontum, P. C. et al., Water-soluble omega-3: A concept for purification of fish oil and nutraceuticals? *Eur. J. Lipid Sci. Technol.* 2011, *113*, 1235–1242.

[11] Derosa, G., Cicero, A. F. G., Fogari, E., D'Angelo, A. et al., Effects of n-3 PUFA on insulin resistance after an oral fat load. *Eur. J. Lipid Sci. Technol.* 2011, *113*, 950–960.

[12] Haug, I. J., Sagmo, L. B., Zeiss, D., Olsen, I. C. et al., Bioavailability of EPA and DHA delivered by gelled emulsions and soft gel capsules. *Eur. J. Lipid Sci. Technol.* 2011, *113*, 137–145.

