

A designer oil for better health

Vijai K.S. Shukla

Tracing back to 1929 to the historic volume 82 of the *Journal of Biological Chemistry* clearly reveals two opposing views, developed by McAmis and co-workers and the husband-and-wife team of George and Mildred Burr, regarding the essentiality of n-6 and n-3 fatty acids. The high impact of linoleic acid, the so-called n-6 essential fatty acid (EFA), became a focus in the minds of scientists and technologists, leading to overconsumption of linoleic acid-containing products. Not much attention was paid to the findings of McAmis and co-workers.

For the last three decades, human nutrition research has concentrated on establishing the benefits of oils rich in essential polyunsaturated fatty acids (PUFA) and long-chain polyunsaturated fatty acids (LCPUFA) to human physiological functions. Research has shown that EFA are important to living systems and to the regulation of life processes. PUFA and LCPUFA in the n-3 and n-6 families are the precursors of prostanooids and eicosanoids that have a variety of biological activities. n-3 fatty acids are known to have a direct effect on the heart muscle itself: increasing blood flow, decreasing arrhythmias, improving arterial flexibility, and altering other cellular processes that are associated with heart functions.

Paleolithic man was a hunter-gatherer, eating lean meat, fish, green vegetables, fruits, nuts, and berries and exercising heavily and often. In modern Western society, the human diet is composed mainly of wheat, maize (corn), rice, and a variety of precooked or industrially fried food, leading to a relative deficiency of n-3 PUFA. The huge intake of hydrogenated oils through various sources, coupled with a lack of exercise, also contributes significantly to the deterioration of human health (Fig. 1).

This EFA imbalance is exacerbated by consumption of meat from animals fed a diet of grain relatively rich in n-6 PUFA rather than wild plants with a high n-3 content. Even farmed fish contain lower amounts of n-3 PUFA than those living in the wild. Overall, the ratio of n-6/n-3 PUFA in the modern diet is as high as 20–25:1 instead of the ideal ratio of 1:1. The n-6/n-3 ratio in the brain is 1:1, in fat tissues 5:1, and in other tissues 4:1.

The return of n-3 fatty acids into the food supply

n-3 fatty acids must be incorporated in foods rather than be used solely as a dietary supplement. Furthermore, the development of a variety of n-3-rich foodstuffs would allow increased dietary intakes with little change in dietary habits.

In the diet n-3 fatty acids can be increased by using oils rich in α -linolenic acid (18:3n-3) and the n-6/n-3 ratio reduced by avoiding vegetable oils rich in linoleic acid (18:2n-6). The use of vegetable oils rich in monounsaturated fatty acids (oleic acid, 18:1), e.g., rapeseed/canola oil, also improves the n-6/n-3 ratio in the diet.

The International Food Science Centre has recently developed a nutritional oil blend, Nutridan, from cold-pressed vegetable oils. The oil has a very high α -linolenic acid (18:3n-3) content and an n-6/n-3 ratio less than 1. This oil can be used in baked goods such as breads, croissants, buns, and cakes, yet it is also suitable for making table spreads, mayonnaise, and salad dressing. It can be encapsulated for various pharmaceutical applications as well. The unique property of Nutridan is that by continuous use of this

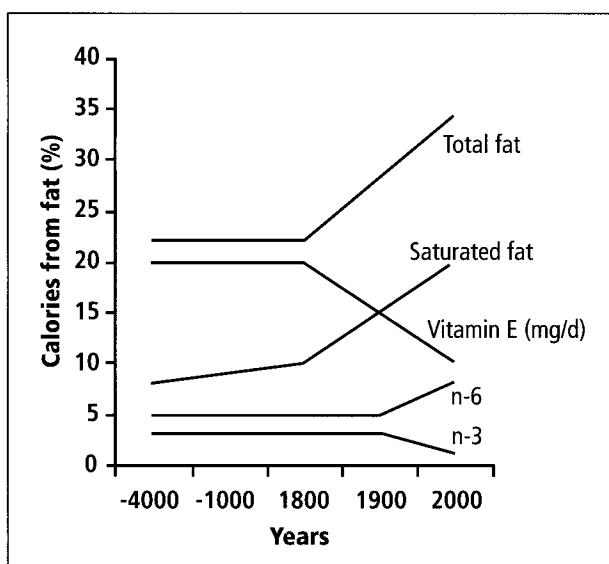


Figure 1. Change in our dietary intakes from ancient times.

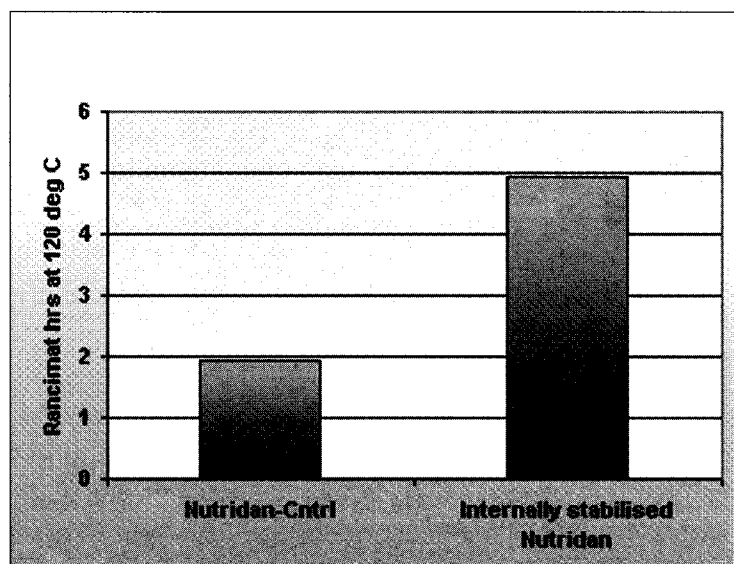


Figure 2. Increase in oxidative stability of Nutridan using natural antioxidants. The Rancimat instrument provides a measurement of the oxidative stability of edible oils and fats.

product one can reduce the n-6/n-3 ratio to half within a period of 12 weeks.

An important feature of Nutridan is its high oxidative stability. Oils rich in PUFA are highly sensitive to oxidation. Exposure of a polyunsaturated oil to air, heat, and light leads to a free radical chain reaction at the allylic carbon atom yielding a variety of oxidized products, the first of which is unstable hydroperoxides that readily furnish the short-chain volatile aldehydes responsible for the odors and flavors associated with rancid fat. Determination of the anisidine value, which measures the amount of aldehydes produced, is indicative of the extent of these oxidative effects. We faced enormous problems in stabilizing n-3 fatty acids because of their sensitivity toward oxidation. Numerous papers describe these problems in detail and also provide solutions to eradicate these in future production processes. Our work (e.g., *inform* 9:955-961, 1998) and that of others have shown that the anisidine value of many encapsulated EFA oils can be as high as 6.0, with a peroxide value of 6.9, whereas for fish oil capsules it varies from 14.3 to 34.0.

Stabilization of a nutritional PUFA oil with natural antioxidants

Nutridan has been internally stabilized with natural antioxidants from rosemary leaves (see Fig. 2), giving a Totox value ($2 \times$ peroxide value + anisidine value) of less than 3, ex-works.

Rosemary extracts are obtained from the herb *Rosmarinus officinalis*, which is native to the Mediterranean and North Africa. Rosemary is known for its seasoning, healing, antiseptic, and antibiotic properties. Research found that the antioxidant properties of rosemary extracts are due to the high content of diterpenes, namely, carnosic acid and carnosol (together they account for over 90% of the antioxidant activity), epirosmanol, isorosmanol, and others. The flavonoid luteolin, found in rosemary leaves, also has antioxidant properties. Antioxidants from rosemary leaves act as: (a) inhibitors of lipid peroxidation, (b) metal chelators, and (c) active scavengers for superoxide radicals. It is a proven fact that dietary lipids and antioxidant nutrients such as rosemary extract influence bone formation and cartilage biology.

To control the development of rancidity in the manufacture of top-quality PUFA oils, the following precautions must always be taken:

- Use high-quality, freshly produced raw materials.
- Store the stock in a cool, dark, and dry place under an inert atmosphere of nitrogen.
- Use stainless steel drums, containers, or tanks to avoid trace metal contamination.
- Use stringent quality control to avoid mixing any old oils in any part of the process.
- Prolong shelf life using the optimal level of antioxidants.
- Heat the oils to the minimum practical temperature required for processing. All forms of excess heating should be avoided.
- Avoid air leakage. Any microleakage allowing the influx of even trace amounts of air can induce the development of thermal polymers, oxidative polymers, and thermal oxidative polymers.

Future perspectives

In the past, the food industry focused on improving processing and increasing product shelf life. Now the product development focus is on nutritional quality. The definition of food safety needs

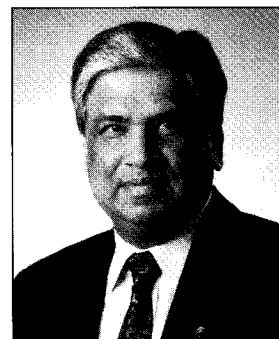
to expand in order to include nutrient structural changes and food composition. The scientific base for product development and collaboration among agricultural, nutritional, and medical scientists is expanding. This should result in greater involvement of nutritionists and dietitians in industrial research and development to respond to an ever-increasing consumer interest in the health attributes of food.

Background reading

Shukla, V.K.S., *The Role of Dietary Fats and Oils*, in *Fats, Oleochemicals and Surfactants: Challenges in the 21st Century*, edited by V.V.S. Mani and A.D. Shitole, Oxford & IBH Publishing Co., New Delhi, India, 1997, pp. 31-45.

Shahidi, F. (ed.), *Natural Antioxidants—Chemistry, Health Effects, and Applications*, AOCS Press, Champaign, 1997.

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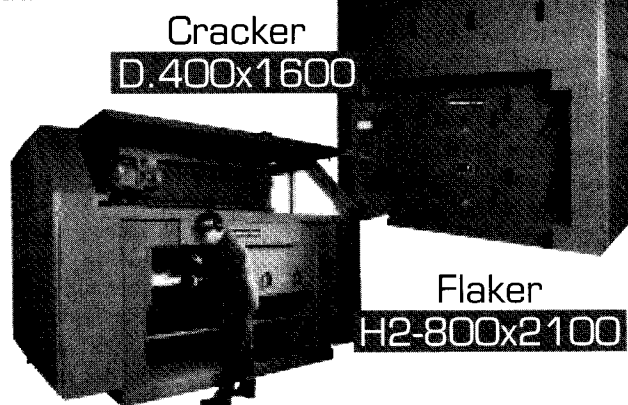


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