CHOLESTEROL OXIDES CONTENT IN ANIMAL ORIGIN FOODS AND SAFETY CONSUMPTION OF SOME PRODUCTS.

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Background

Lipids can undergo deterioration in various ways during processing, handling, and storage of food products. Lipid oxidation is one of the primary mechanisms of quality deterioration in foods. The changes in quality are manifested by adverse changes in flavour, colour, texture and nutritive value, and the possible production of toxic compounds (Gray et al., 1996). The mechanism of cholesterol oxidation is similar to that of unsaturated fatty acid oxidation, and the initiation process involves the formation of a cholesterol radical that then react with ground state oxygen. Cholesterol molecules function as an integral part of lipid bilayer of the cell membrane and are closely associated with membrane phospholipids. Thus, it has been postulated that hydrogen could be extracted from cholesterol by peroxy or alkoxy radicals of oxidized neighboring polyunsaturated fatty acids (Ahn et al., 2000). According to this hypothesis, the hydroperoxides of polynsaturated fatty acids formed during lipid oxidation would be necessary to initiate cholesterol oxidation and thus, the formation of COPs (Cholesterol Oxidation Products) (Chan et al., 1993). A variety of COPs have been detected in foods of animal origin as milk, eggs and meat (Ahn et al., 2000) and their amount vary according to the fatty acid composition and to the kind of processing (Paniangvait et al., 1995). In particular the exposure of food containing cholesterol to heat, air, or irradiation increases the production of COPs.
Some of COPs are reported to be implicated in a number of adverse biological effects including atherogenesis, cytotoxicity, carcinogenesis (Smith, 1996). Therefore, the presence of COPs in certain types of foods raises questions about the safety of these products..

Objectives

The objective of this work was to identify foods that could be significant sources of COPs and perform conservative estimates of their content in the diet of Italian teenagers.

Methods

The results of the INRAN-RM-2001 food survey were used to identify the main sources of cholesterol in the diet of a representative sample of Italian teenagers. This survey was conducted by the National Research Institute for Food and Nutrition (INRAN), within the framework of the European "Montecarlo" Project. 223 teenagers living in the country of Rome recorded all foods and beverages ingested during 4 consecutive days in 3 different periods of the school year 2000-01 (Leclercq et al., 2002). All subjects were instructed by standardized fieldworkers on how to fill the diaries. Standard household measures and standard portions were used to express quantities. The diaries were corrected, checking for food description and possible omissions. Consumption data were put in electronic form, codified and transformed in weight and nutrients of single raw foods using an ad hoc software.
Consumption data were analysed in order to identify the principal sources of cholesterol, literature was then searched to assess the range of COPs in these products taking into account processing (industrial processing, cooking procedures and storage). Besides, we considered milk powder and egg powder, studying their presence in manufactured foods. It is compulsory for manufacturers to report their presence among ingredients on the food label. For this reason the "INRAN food label data bank" was used to identify the products containing them.

Results and discussion

Results from INRAN-RM-2001 food survey indicate that the sample of teenagers obtained 39% of daily energy from fat, consuming on average 105 ± 31 g of fat/day. The intake of cholesterol was 300 ± 110 mg/day, with 18% of teenagers consuming more than 400 mg/day. The main sources of cholesterol were meat products (29%), eggs (28%) and milk and dairy products (18%).
COPs have been found in several foods including liquid eggs and dried egg products, meat and meat products and other processed foods. The literature search indicated that eight common COPs are usually found in foods including epimers of 7-hydroxycholesterol, epimers of epoxycholesterol, 7-ketocholesterol, 20-hydroxycholesterol, 25-hydroxycholesterol, and cholestanetriol. Eggs and egg-containing products have been studied extensively, essentially due to their high cholesterol content. An average egg contains 213 mg cholesterol, about twice the cholesterol content of butter and freeze-dried meat products and about 5-10 times more cholesterol than is found in most dairy products. Concentrations of total COPs in products ranged from trace amounts to 1320 ppm, in particular: fresh egg values ranged from trace to 46,3 ppm and eggs with treatments (fried, spray-dried) from trace to 1320 ppm. Several dairy products and milk powder were reported to contain oxidized COPs. The quantitative pattern of concentration of the 8 COPs in milk powder products was fairly similar to that observed in the analysis of dehydrated egg yolk and its mix products. Results showed that fresh milk and milk products contained from trace to 29 ppm of COPs and from trace to 1037 ppm for heated and dehydrated milk products. Concentrations of total COPs in fresh meat and meat products ranged from trace amounts to 8 ppm, whereas the fried or freeze dried meat ranged from trace to 495 ppm (Hwang et al., 1993; Pie et al., 1991). Only one author reported a very hign value (4878 ppm) for processed meat.
The combination of consumption data of meat and meat products (137 ± 59 g/day), milk and milk products (213 ± 112 g/day) and eggs (22 ± 16 g/day) in the sample of Italian teenagers with the range of COPs found in these products will allow us to perform conservative estimates of COPs intake and to identify food consumption patterns that may lead higher intakes.

Pertinent literature

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