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POLYUNSATURATED FATTY ACIDS (n-3 AND n-6) AND ANTIOXIDANTS IN AVERAGE DIET OF WARSAW ADULT INHABITANTS

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Key words: diet, polyunsaturated fatty acids (PUFA) n-3 and n-6, antioxidants

The study aimed at establishing the intake level of n-3 and n-6 polyunsaturated fatty acids and antioxidants in an average diet of Warsaw adult inhabitants. The research was carried out in 2001/2002 on the group 409 adults (227 women, 183 men) of Warsaw adult inhabitants using three--day dietary records and household budget expenditures. The intake of polyunsaturated fatty acids n-3 and n-6 was lower than the recommended by WHO/FAO. The intake of linolenic, DHA and EPA (n-3) was much lower than recommended, while the intake of PUFA n-6 linoleic acid was much higher than the recommended by ISSFAL. The ratio of polyunsaturated fatty acids n-6 to n-3 in Warsaw diet was 5:1. It was as proved that the intake of antioxidants – vitamin E and vitamin A was satisfactory, but the consumption of vitamin C was much lower than recommended.

INTRODUCTION

Polyunsaturated fatty acids n-3 are components with beneficial effect on health including immunnotherapy proved in a lot of researches. There are alpha-linolenic, docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids in n-3 acid group. The linoleic and arachidonic acids belong to n-6 acid group. The effects of the activity of n-3 polyunsaturated fatty acids depend on their level in the diet as well as their proportion to n-6 polyunsaturated fatty acids they compete with for enzymes in metabolism [Newton, 1996; Simopoulos, 1991; Spiller, 1996; Ziemlański, 1998]. Membrane phospholipids consist of fatty acids and these fatty acids are substratum to synthesis of a lot of biologically active compounds, therefore they play essential role in correct development and function of human body. The eicosanoids, produced from polyunsaturated fatty acids in the body, control the operation of the heart-vascular system, influence the blood pressure, triacyloglycerol concentrations in plasma, immunological response, inflammatory disorders and cell proliferation [Gertig & Przysławski, 1995; Spiller, 1996; Ziemlański, 1998]. It is affirmed that low consumption of n-3 polyunsaturated fatty acids and high intake of n-6 polyunsaturated fatty acids contribute to the increased risk of coronary heart disease, cancer and autoimmune and inflammatory disorders, such as rheumatoid arthritis, psoriasis, atopic dermatitis and asthma [Newton, 1996; Simopoulos, 1991, 1999; Spiller, 1996].

In the report WHO/FAO the intake of n-3 polyunsaturated fatty acids should be 1–2% of energy in the diet and n-6 polyunsaturated fatty acids – 5–8% of energy in the diet [WHO/FAO, 2003]. The International Society for the Study of Fatty Acids and Lipids recommended the following intake of particular polyunsaturated fatty acids for adults: alpha-linolenic acid – 1% energy (2.22 g/day), DHA and EPA – 0.3% energy (0.65 g/day), and linoleic acid – 2% energy (4.4 g/day). Docosahexaenoic and eicosapentaenoic acids should make up at least 0.2% of energy in the diet (0.44 g/day), while the upper limit for the intake of linoleic acid was established at 3% of energy (6.67 g/day) [Simopoulos *et al.*, 1999]. The physiological ratio of n-6/n-3 fatty acids is about 1:1 to 4:1 [Spiller, 1996].

AIM

The aim of the study was to establish the intake level of polyunsaturated fatty acids n-3 and n-6 and antioxidants (vit. A and beta-carotene, vit.C, vit. E) in an average diet of Warsaw adult inhabitants.

MATERIALS AND METHODS

The intake of examined ingredients was estimated based on research data gathered using three-day dietary records of 409 adult persons (227 women, 183 men) in 2001/2002. On the basis of the data, the intake of polyunsaturated fatty acids n-3 and n-6 and antioxidants in the diet was computed. Polyunsaturated fatty acids were n-3 were presented as a sum of linolenic, docosahexaenoic and eicosapentaenoic aids and n-6, as a sum of linoleic and arachidonic acids. The Polish food composition tables [Kunachowicz *et al.*, 1998] and literature data [Daniewski *et al.*, 1998] were used in calculations.

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The losses of nutrients in the diet connected with the influence of technological process were taken into consideration during calculation. Polyunsaturated fatty acids established 10% loss. However, as vitamins have greater sensitivity a higher reduction was applied, namely 55% for vitamin C and 20% for vitamins A and E. The results were compared with the recommended dietary allowances for Polish population by the Institute of Food and Nutrition [Ziemlański, 2001], the recommendations of the WHO/FAO of 2003 [WHO/FAO, 2003] and the recommendations of the world organization ISSFAL (International Society for the Study of Fatty Acids and Lipids) of 1999 [Simopoulos *et al.*, 1999].

RESULTS

The average intake of polyunsaturated fatty acids amounted to 14.0 g/day in Warsaw diet. The consumption of polyunsaturated fatty acids constituted 5.8% of energy, thus their consumption was higher than the minimum requirement announced in the dietary allowances for the Polish population, that is 3–4% of total energy [Ziemlański, 2001] and was close to recommendations of the world organization WHO/FAO, that is 6–10% of energy [WHO/FAO, 2003]. Polyunsaturated fatty acids came from fats (61%), mainly vegetable fats. A lower amount of these acids was found in meat and meat products (14%) and also bread and cereal products (12%). Other products, such as milk and milk products, fish and fish products, vegetable and vegetable products, fruit and fruit products, eggs products supplied 11–13% of polyunsaturated fatty acids (Figure 1).

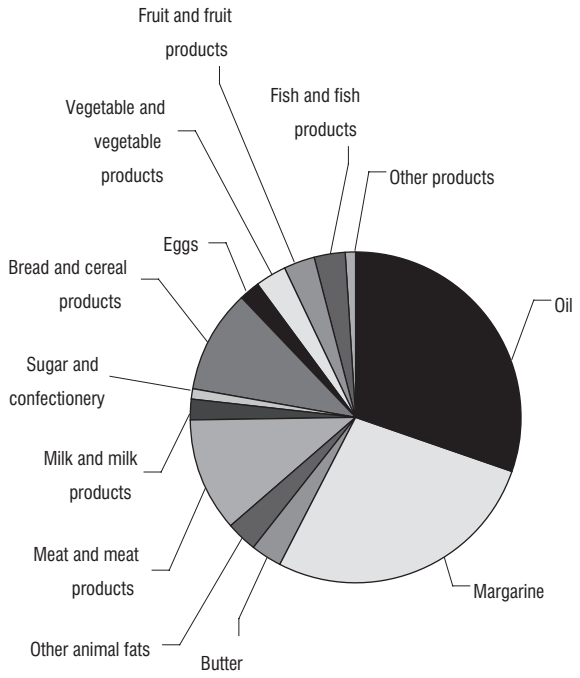

FIGURE 1. The sources of polyunsaturated fatty acids (n-3, n-6) in Warsaw adult inhabitants diet.

The consumption of polyunsaturated fatty acids n-3 was 2.14 g/day in Warsaw diet (0.9% of energy) (Figure 2), while the recommended level of polyunsaturated fatty acids from this group is 1–2% of energy in the diet [WHO/FAO, 2003].

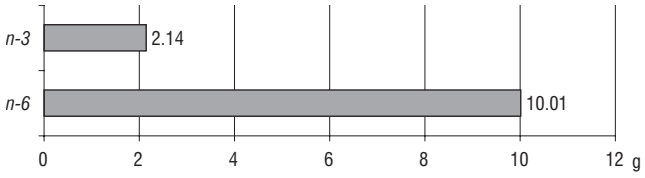

FIGURE 2. Daily intake of polyunsaturated fatty acids n-6 and n-3 in an average diet of Warsaw adult inhabitants.

The main source of polyunsaturated fatty acids n-3 in Warsaw diet were fatty products. They supplied 67% of these fatty acids (oil – 53%, margarine – 10%). The meat and meat products had lower participation (14%) in supplying polyunsaturated fatty acids n-3, the fish and fish products supplied 12% these fatty acids. Other products, such as bread and cereal products, milk and milk products, eggs supplied lower amount of these acids (7%) (Figure 3).

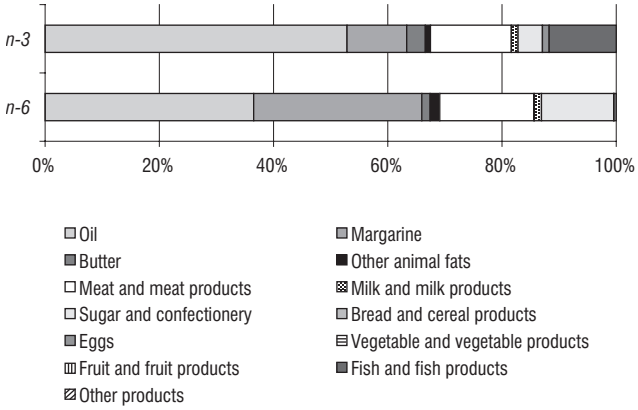

FIGURE 3. The sources of polyunsaturated fatty acids n-3 and n-6 in Warsaw adult inhabitants diet.

The intake of linolenic acid was 1.88 g/day (0.8% of energy) and was lower than ISSFAL recommendation (2.22 g/day – 1% of energy) [Simopoulos *et al.*, 1999] (Figure 4). Linolenic acid in Warsaw diet mainly came from fats, they supply 78% that acid (vegetable oils 61%, margarine 12%). Other products supply lower amounts of this acid: meat and meat products 15%, bread and cereal products 5%, milk and milk products 1%, fish and fish products 1% (Figure 5). The intake of DHA and EPA was much too low and was 0.25 g/day, 0.1% of energy in the diet, while the recommended intake level is 0.65 g/day (0.3% of energy in the diet) [Simopoulos *et al.*, 1999] (Figure 4). The main source of eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids in the diet was fish and fish products, they supplied 85% of these acids. Eggs supplied 9% of these acids, and meat and meat products 6% (Figure 5).

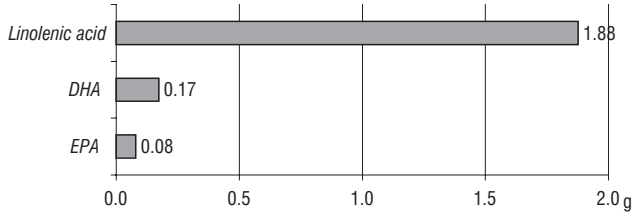

FIGURE 4. Daily intake of linolenic acid, DHA and EPA in an average diet of Warsaw adult inhabitants.

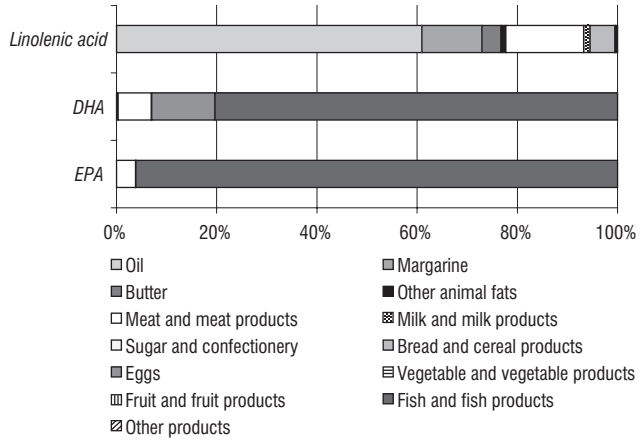

FIGURE 5. The sources of linolenic acid, DHA and EPA in Warsaw adult inhabitants diet.

In Warsaw diet the consumption of polyunsaturated fatty acids n-6 was 10.01 g/day (4.2% of energy) (Figure 2) and was lower than WHO/FAO recommendation that they constitute 5-8% of energy in the diet [WHO/FAO, 2003]. The main source of polyunsaturated fatty acids n-6 in the diet were fatty products. They supplied 69% of these fatty acids (oil – 37%, margarine – 29%). Meat and meat products supplied 17% of these fatty acids, bread and cereal products – 13% and other products – 2% (Figure 3).

The intake of linoleic acid was 9.86 g/day – about 4.1% of energy in the diet, that was much higher than recommended (4.44 g/day – 2% of energy) [Simopoulos *et al.*, 1999] (Figure 6). The main source of linoleic acid in the Warsaw diet were fats, they supply 70% of this acid (vegetable oil 37%, margarine 30%). Meat and meat products supply 16% of this acid and bread and cereal products supply – 13%. Insignificant amounts of this acid in the diet came from milk and milk products – 1% (Figure 7). The intake of arachidonic acid in Warsaw diet was 0.15 g/day (0.06% of energy), (Figure 6). Arachidonic acid from n-6 group in 75% came from meat and meat products, 14% of this acid supplied fish and fish products and 6% fats (mainly animal fats), and 4% – eggs (Figure 7).

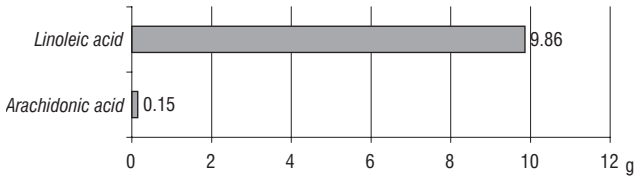

FIGURE 6. Daily intake of linoleic and arachidonic acid in an average diet of Warsaw adult inhabitants.

A ratio of n-6 to n-3 polyunsaturated fatty acids in Warsaw diet was about 5:1 and was close to the recommended dietary allowances for Polish population (4–6:1) [Ziemlański, 2001]. These proportions were significantly different from the proportion considered as physiologic (1–4:1) [Spiller, 1996].

The level of consumption of vitamin E (9.0–10.7 mg) was adequate, which is beneficial with the great intake of polyunsaturated fatty acids. The intake of vitamin C was 40.0 mg in Warsaw diet (Figure 8) and was significantly lower than recommended 60 mg [Ziemlański, 2001]. The

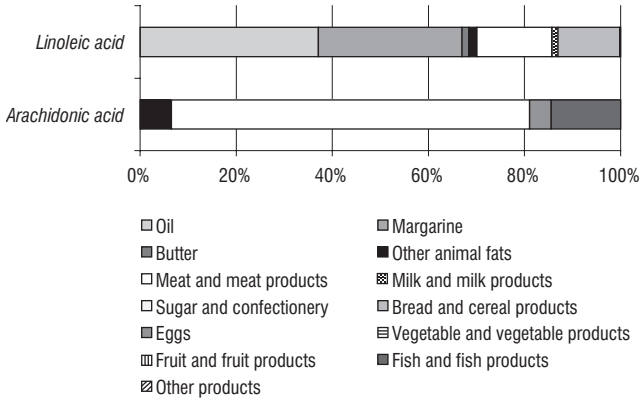

FIGURE 7. The sources of linoleic and arachidonic acid in Warsaw adult inhabitants diet.

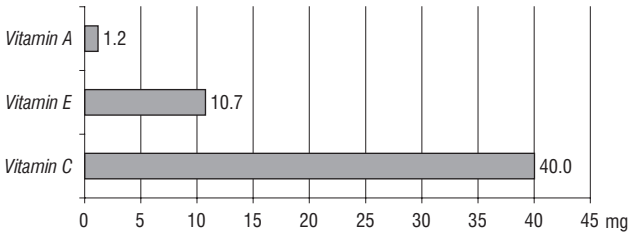

FIGURE 8. Daily intake of antioxidants in an average diet of Warsaw adult inhabitants.

consumption of vitamin A was 1200 μg in Warsaw diet, which is even above the recommended value for Polish population – 600–700 μg [Ziemlański, 2001].

The results of the research indicate that the consumption of polyunsaturated fatty acids n-3 in the diet should be increased by consumption oil rich in alpha-linolenic acid, *e.g.* rapeseed oil. It is recommended to consume more fish. In order to ensure proper vitamin C intake it is recommended to increase the intake of fruit and vegetables rich in this vitamin and their products.

The research of diet of Warsaw inhabitants in 1984-2001 show that the consumption of polyunsaturated fatty acids have been increasing for the last ten years: it was 12.4 g (5.4% of energy) in 1993 and 14.2 g (5.4% and 6.2% of energy) in 2001 [Waśkiewicz, 2001]. The estimation carried out by Daniewski *et al.* [1999] on the basis of data from the Central Statistical Office shows the higher consumption of polyunsaturated fatty acids in Poland (16.7 g/day) than in own research. In research in the Wielkopolska Province in 1997 polyunsaturated fatty acids constituted 5.8% of energy in the diet [Przysławski & Nowak, 2000], which was close to the results obtained in own research. The average intake of polyunsaturated fatty acids in Denmark and Great Britain was comparable to the consumption in Warsaw and constituted 14.09 g/day [Tjonneland *et al.*, 1993] and 14.75 g/day [Sanders, 2000]. In comparing the Norwegian and Danish diets with the Warsaw diet, the participation of linolenic acid and linoleic acid was similar and amounted to approximately 0.59% and 4.35% of the energy in the Norwegian diet [Johansson *et al.*, 1998], 0.83% and 5.60% of the energy in the Danish diet [Tjonneland *et al.*, 1993], 0.8% and 4.1% of energy in the Polish diet. An average Norwegian and Dane consumed high levels of EPA and DHA, which together amounted to 0.32% of energy in the Norwegian

diet [Johansson *et al.*, 1998], 0.24% of energy in the Danish diet and 0.1% of energy in the Warsaw diet. The ratio of polyunsaturated fatty acids n-6 to n-3 in Warsaw diet was close to the proportion of these fatty acids in the Norwegian and Danish diets – about 5:1 [Johansson *et al.*, 1998; Tjonneland *et al.*, 1993], in Polish diet the ratio was too high (7:1) [Dybkowska *et al.,* 2004], which was undesirable. Even higher proportion of n-6 to n-3 fatty acids (about 8:1) was confirmed in Wielkopolska [Przysławski & Nowak, 2000] and in Australian diet [Meyer *et al.*, 2003], but in the United States of America the ratio was almost 10:1 [Kris-Etherton *et al.*, 2000]. The lowest and most desired proportion polyunsaturated fatty acids n-6 to n-3 is characteristic to the Japanese diet, it amounted to 4:1 [Sugano & Hirahara, 2000]. The level of consumption of antioxidants assessed in own research was similar to Kunachowicz *et al.* [2003] research and it constitutes 747–754 μg of vitamin A, 7.71–8.05 mg of vitamin E and 42.3–42.6 mg of vitamin C.

CONCLUSIONS

1. The participation of polyunsaturated fatty acids n-3 and n-6 in total energy of Warsaw diet was lower than recommended.

2. The intake of linolenic acid, DHA and EPA (PUFA n-3) was much lower than recommended, however the intake of linoleic acid (PUFA n-6) was much higher then recommended, which unsettles the proportion of these acids in the diet (physiologically undesirable). The ratio of polyunsaturated fatty acids n-6 to n-3 in Warsaw diet was 5:1, and were significantly different from the proportion considered as physiologic (1–4:1).

3. Amongst antioxidants the intake of vitamin A and E was as recommended, while the intake of vitamin C was too low.

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