Assessment of meat products and saturated fatty acid intake in human diets

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Abstract. The World Health Organization (WHO) has released a guide to proper diet in which the food pyramid is presented. The food pyramid indicates graphically which types of food should be eaten daily. Changes in the diet of any population are slow and difficult to achieve. The aim of this study was to investigate: a) the fatty acid composition of processed meat products, and; b) the daily saturated fatty acid (SFA) content, as calculated by estimated consumption of processed meat products (meat pieces preserved in plastic casing by heat treatment) present in the Serbian market. Consumption of 100 g of preserved pork meat pieces per day equated to 4.64 g saturated fat or 23.20% of daily fat intake being saturated, while consumption of preserved poultry meat pieces would result in 1.73 g of saturated fat, or 8.65% of daily fat intake being saturated which is closer to the recommended daily intake of 10% of fats being saturated. Further research is needed to understand better the optimal combination of unsaturated fatty acids in these processed meat products and recommended daily intakes that should maintain and enhance the health status of consumers.

1. Introduction

When planning a diet, the first step is to calculate energy needs. The World Health Organization (WHO) has released a guide to proper diet in which the food pyramid is presented [1]. The food pyramid graphically illustrates which types of food should be eaten daily. A red colour denotes foods that should be consumed rarely. An orange colour indicates foods which should be moderately consumed. A green colour indicates foods that should be eaten most often. The base of the pyramid includes cereals and their products, which should account for 35-45% of the total daily energy intake (marked in green). The next step in the pyramid consists of fruits and vegetables, with fruit accounting for 15% and vegetables for 20% of the total daily energy intake (marked yellow-green). The third step consists of the milk and milk products and groups of meat, fish and eggs both with 10% of the daily energy intake (marked yellow-red). At the top of the pyramid are oils, fats, and sugars, which should account for only 5% of the daily energy intake (marked in red).

Changes in population diets are slow and difficult to achieve. Sudden and radical change in a population’s diet can cause distrust and rejection. However, the countries that have set intermediate dietary targets for their populations have experienced good acceptance, and satisfactory changes and health effects, and this approach is supported by the WHO [2]. WHO European Food and Nutrition Action Plan 2015-2020 aims to promote healthy diets by addressing priorities such as excessive intake...
of energy, saturated fats and trans fats, sugar and salt, and inadequate consumption of vegetables, fruits and whole grains [2].

The prime reason for such concern has been the growing epidemic of overweight resulting from our obesogenic environment with an abundance of cheap and high caloric foods available at any place, any time [3]. A substantial proportion of the population worldwide, including children and adolescents, is now overweight, with far-reaching consequences in terms of increased risk of chronic illness [4]. The overweight epidemic has spurred research into the health consequences of overeating and overweight, and information about this has found its way to the public that now tends to associate eating with health, especially in the United States [5]. WHO recommend that the daily energy intake of fat does not exceed 30%. Almost half of the required amount of fat should originate from monounsaturated fatty acids (MUFAs). It is known that fat combustion produces 9.3 kcal; excessive intake of fat (vegetable and animal sources) increases the energy intake, because high-fat foods with high energy density can lead to obesity and associated pathologies conditions and disorders.

Saturated fatty acids (SFAs) are found predominantly in fat of animal origin (pork, beef and mutton tallow, meat and meat products, milk and milk products), hydrogenated vegetable margarine (solid), and solid vegetable fat. They can increase the levels of harmful LDL and total serum cholesterol, and with that, increase the risk of thrombosis, even though there are proven beneficial effect of stearic fatty acid (C18:0) on human health [6]. Oleic acid (C18:1cis-9) is the most widely distributed MUFA and is predominantly found in olive oil, rapeseed oil, peanut oil and avocado. MUFA maintains the level of protective HDL cholesterol in the blood [6]. Polyunsaturated n-3 fatty acids (n-3 PUFAs) are found in fish oil (herring, mackerel, sardines, trout) [7]. Regular consumption of these fish twice a week reduces the risk of platelet aggregation during blood clot formation, and reduces the risk of thrombosis, cerebrovascular accident and myocardial infarction [8]. The n-3 PUFAs have a small but positive effect on reducing LDL cholesterol and they have a pronounced effect on the lowering of triglycerides in the blood [8]. The n-6 PUFAs are found in vegetable oils (sunflower, corn, soybean, safflower oil and cotton oil), and soft margarines. n-6 PUFA improves absorption of antioxidant vitamins (vitamins A and E) and other liposoluble vitamins and lower levels of LDL cholesterol. Their daily energy intake is limited to 7%, as increased intake can lead to accumulation of oxidation products [9]. Trans fatty acids are formed during hydrogenation of vegetable oils, a product of solid vegetable fats. It was reported that trans fatty acids and SFAs have a very similar effects on increasing LDL and decreasing HDL cholesterol levels in the blood [10].

Meat and meat products contain large amounts of SFAs. Pieces or cuts of very fat-rich meat (neck, ribs, sausages, kidneys, knees, paps) are typically cheaper than more expensive cuts and are sources of SFAs [11,12]. As social and economic factors strongly contribute to unhealthy diets and poor nutrition, population-wide strategies, policies and targeted interventions are required by governments [2]. In particular, beneficial effects of the Mediterranean diet have been reported [13,14]. The Mediterranean diet refers to a collection of eating habits traditionally followed by people in the countries bordering the Mediterranean Sea. Mediterranean diet typically consists of high consumption of fruits and vegetables, legumes and complex carbohydrates (whole grains), a moderate consumption of fish, low consumption of red meat, olive oil as the main source of fat, low-to-moderate consumption of red wine, and low-to-moderate consumption of milk and dairy products [13,14].

The aims of this study were to investigate: a) the fatty acid composition of processed meat products, and b) the daily SFA content, as calculated by estimated consumption of processed meat products (heat treated meat pieces) present on the Serbian market.

2. Materials and Methods

2.1. Samples

Twenty preserved meats were examined, 10 pork and 10 poultry. Heat treated meat products with net weights of 2 kg were purchased from meat companies from Serbia. The finished products were heat
treated in polyamide plastic casing, diameter of 90 mm. The colour, smell and taste of each was characteristic of boiled salted pork or poultry. Pasteurization was conducted until a temperature of 72 °C in the centre of the products was achieved. Ingredients were: category I pork or poultry meat pieces, ice, protein preparations, carbohydrates, spices and stabilizers.

2.2 Fatty acid analysis by capillary gas chromatography

The total fat content was determined according to ISO standard method 1443:1973. Total lipids for fatty acid determination were extracted from meat products by accelerated solvent extraction (ASE 200, Dionex, Sunnyvale, CA) according to the method of [15]. Fatty acid methyl esters (FAMEs) in the extracted lipids were prepared by transesterification using 0.25 M trimethylsulphonium hydroxide (TMSH) in methanol (EN ISO 5509:2000). FAMEs were determined by gas-liquid chromatography (GLC, Shimadzu 2010, Japan) equipped with flame ionization detector and capillary HP-88 column (length 100m, i.d. 0.25 mm, film thickness 0.20 µm). Injector and detector temperature were 250 °C and 280 °C, respectively. Nitrogen was used as the carrier gas at flow rate of 1.33 mL min⁻¹. The injector split ratio was set at 1:50. To achieve complete separation of the examined compounds, a programmed column oven temperature starting at 125 °C and ending at 230 °C was applied. Total analysis time was 50.5 min. The chromatographic peaks were identified by comparing relative retention times of FAME peaks with peaks in Supelco 37 Component FAME mix standard (Supelco, Bellefonte, USA). Each sample was analysed in duplicate. Results were expressed as weight of fatty acid (g) in 100 g of fatty acids.

2.3. Calculation of daily intake total fat and saturated fats

Percentages of saturated fat derived from preserved meat pieces were calculated in relation to the reference intake of 2,000 kcal. The rules on labelling and advertising in Serbia [16] and in the US [17] recommend an intake of saturated fats of 20 g d⁻¹. These values are informative for consumers in interpreting nutritional values of food products. Calculation of saturated fat intakes was performed by dividing saturated fat content expressed in 100 g of product by 20 g.

2.4. Statistical analysis

Data obtained for the fatty acid compositions were subjected to analysis of variance (ANOVA) with the Tukey-Kramer HSD test for the comparisons of means at the 5 % level of significance. Statistical analysis was performed using SAS Institute Inc. JMP 10 software.

3. Result and discussion

The fatty acid compositions of the studied preserved meat pieces are presented in Table 1.

Table 1. Fatty acid composition (g/100 g of total fatty acids) of preserved meat pieces

| Fatty acids | Preserved meat pieces (pork) (n = 10) | Preserved meat pieces (poultry) (n = 10) |
|-------------|---------------------------------------|----------------------------------------|
| C14:0       | 0.94±0.03                             | 0.63±0.28                              |
| C15:0       | 0.05±0.01b                            | 0.09±0.02a                             |
| C16:0       | 23.70±0.50a                           | 22.22±0.41b                            |
| C16:1       | 1.74±0.10b                            | 3.29±0.42a                             |
| C17:0       | 0.31±0.01a                            | 0.13±0.03b                             |
| C18:0       | 13.84±0.92a                           | 7.38±0.93b                             |
| C18:1n-9    | 38.58±1.68a                           | 31.03±1.62b                            |
C18:2n-6 17.15±0.76a 26.22±0.60a
C20:0 0.31±0.02a 0.10±0.05b
C18:3n-3 (ALA) 0.99±0.07b 1.80±0.18a
C20:1 0.92±0.04a 0.35±0.03b
C20:2 0.67±0.03 0.52±0.10
C20:3 n-6 0.10±0.02 0.17±0.02
C20:3n-3 0.14±0.02a 0.07±0.02b
C20:4 n-6 0.41±0.06b 2.22±0.08a
C20:5n-3 (EPA) nd 0.19±0.09
C22:5n-3 0.09±0.01b 0.48±0.03a
C22:6n-3 (DHA) 0.08±0.07b 0.42±0.03a
SFA 39.14±1.38a 31.56±2.21b
MUFA 41.25±1.74a 37.10±1.61b
PUFA 19.20±0.80b 30.09±0.75a
P/S 0.49±0.02b 0.98±0.06a
n-3 1.30±0.04b 2.35±0.72a
n-6 17.90±0.80b 26.28±2.32a
n-6/n-3 13.80±0.78a 10.22±1.04b

*a, number of samples; results are shown as mean±SD; nd = not detected. Values in the same row with the same letter are not significantly different (P≥0.05). SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; P/S = polyunsaturated/saturated fatty acids.

Generally, preserved poultry meat pieces were characterized by lower levels of SFAs. The MUFA content of the poultry meat pieces was significantly (P<0.05) lower than in the preserved meat pieces overall, with oleic acid (C18:1n-9) being the most common MUFA. The most common n-6 PUFA was linoleic acid (C18:2n-6). The most common n-3 PUFA was α-linolenic acid (ALA, C18:3n-3), which was more abundant in preserved poultry meat pieces (Table 1), while it occurred in lower amounts in preserved pork meat pieces. Generally, significantly higher contents of docosahexaenoic acid (DHA, C22:6n-3) (P<0.05) were found in preserved poultry meat pieces than in preserved meat pieces overall. However, meats and processed meats are also associated with nutrients and nutritional profiles that are often considered negative including high levels of SFAs, cholesterol, sodium and high fat and caloric contents [18]. However, the PUFA/SFA ratios (P/S), as one of the quality parameters of lipid foods, were far greater than 0.4 in the preserved meat pieces (0.49-0.98). The ratio of n-6/n-3 was 10.22 in preserved poultry meat pieces and 13.80 in preserved pork meat pieces, while the n-6/n-3 ratio should be between 1 and 4, respectively [19,20].

The estimated percentage of daily saturated fat intake for products is presented in Table 2. Consumption of 100 g of preserved pork meat pieces per day equated to 4.64 g saturated fat that would account for 23.20% of daily fat intake being saturated, while consumption of 100 g of preserved poultry meat pieces equated to 1.73 g of saturated fat, or 8.65% of daily fat intake being saturated, which is closer to the recommended daily intake of 10% of fats being saturated [16,17,21]. Researchers [22] showed that pork products could be modifying to provide a significant increase in functional lipids, which can have positive influences on health.
Table 2. Percentage of total fat and saturated fat derived from preserved meat pieces in relation to the reference intake of 2,000 kcal per day, and given 100 g of product is consumed per day

| Daily intake                              | Preserved meat pieces (pork) | Preserved meat pieces (poultry) |
|-------------------------------------------|------------------------------|--------------------------------|
| Saturated fat, g/100 g of product         | 4.64                         | 1.73                           |
| Saturated fat intake, %                   | 23.20                        | 8.65                           |

4. Conclusion
The increased awareness of the meat industry regarding the importance of the fat quality in processed meat products and its impact on health, optimization of the product specifications (replacement of SFAs with unsaturated fats), health promotion activities by public health authorities, as well as better education of consumers about beneficial nutrition habits (e.g. Mediterranean diet) should reduce the rate of coronary heart disease. Further research is needed to understand better the optimal combination of unsaturated fatty acids in processed meat products and recommended daily intakes that should maintain and enhance the health status of consumers. Studies have indicated that healthy diet has an important role in the prevention of hypertension.

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