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An update on processed foods: Relationship between salt, saturated and *trans* fatty acids contents

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ABSTRACT

To update the current situation on salt, fat and fatty acid composition of processed foods, a study including a wide range of different food categories was conducted in Portugal. Different validated analytical techniques were used, and a PCA and correlation analysis were conducted to establish a trend between the different components in each food category.

The highest salt content was found in snacks, fast-food, sauces and ready-to-eat meals, while the saturated fatty acids were higher ($p < .05$) in bakery products, cookies, biscuits and wafers, and snacks. The highest levels of *trans* fatty acids were found in the fast-food group, followed by the snacks, potato and potato-products and bakery products. A significant positive correlation ($p < .05$) was found between salt and fat content in ready-to-eat meals and in the potato and potato-products. The PCA analysis identified total fat, low *trans* fatty acids and high salt content as distinctive characteristics of some food categories.

1. Introduction

Processed foods are generally recognized as a source of salt, fat and sugar. An excessive intake of these nutrients is perceived as the leading reason for an increased risk in the development of several chronic diseases (obesity, diabetes, cancer and cardiovascular disease). Generally, food processing is associated with negative effects on the quality and safety of foodstuffs. However, food processing is extremely important to extend shelf-life or just to make them edible (EUFIC., 2010). In 2010, a review on the importance of food processing and processed foods was published by Floros et al. (2010). Briefly, this review describes the scientific and technological improvements that allow having nowadays a production-to-consumption food system that enables to feed the world population. Moreover, new tools of biotechnology were also addressed, focusing on the rapid growth of the world population and on obtaining an efficient and cost-effective production of foods in a sustainable manner (Floros et al., 2010). Some of the main topics focused in this review linked with the present research are: preservation of food supply, advantages/disadvantages of food processing and how to solve the diet/disease challenge (Floros et al., 2010). From a nutrition point of view, food processing arises several questions regarding the nutritional quality and safety of food. However, it has also been essential to solve some nutritional barriers, like gluten-free foods, crucial for the treatment of coeliac patients.

In the last thirty years, the processed food market has grown like never before and every day "new" processed foods with different features are available on the market (Stuckler, McKee, Ebrahim, & Basu, 2012). There is no consensus regarding the definition of processed foods. In 2010, the International Food Information Council Foundation defined processed food as "*a food where any deliberate change occurs before it's available for us to eat*". Moreover, different categories among processed foods were defined taking into account the extent of processing (International Food Information Council Foundation, 2010). According to the United States Department of Agriculture (USDA), processed food is defined as "*any raw agricultural commodity that has been subject to procedures that alter the food from its natural state*" (Dwyer, Fulgoni, Clemens, Schmidt, & Freedman, 2012). Recently, a new category of processed foods has arisen, the ultra-processed foods, which are formulations developed by the food industry with substances extracted from foods (Louzada et al., 2015).

Convenience is one of the main reasons to consume processed foods. However, it is not the only reason, since frequently processed foods are also more pleasant, with attractive sensory and palatability properties (van Langeveld et al., 2017).

In terms of public health, nutritional quality of foods, dietary intake and mortality are closely linked (Popkin, Adair, & Ng, 2012). Regarding

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the salt content, a high intake of foods rich in salt is related with an increased risk of developing hypertension, which contributes to the burden of heart disease, stroke and kidney failure, premature mortality and disability (World Health Organization., 2013). Therefore, for the prevention of cardiovascular disease, the World Health Organization recommends a population salt intake level of less than 5 g/day for adults and 2 g/day for children (World Health Organization, 2013). According to the European Union strategy for salt reduction, 12 food categories were identified, from which the countries have to select at least 5 to target through their national nutrition action plans and strategies (World Health Organization, 2013). The Portuguese HYpertension and SAlt (PHYSA) study, conducted in 2013, revealed that the Portuguese population has an average salt intake of 10.3 g/day, which is more than the double of WHO recommendations (Polonia, Martins, Pinto, & Nazare, 2014).

Another priority intervention area according to the European Strategy for Prevention and Control of Noncommunicable Diseases 2012–2016 was the "*elimination of trans fats in food (and their replacement with polyunsaturated fats)*" (World Health Organization., 2012). This is also part of the European Food and Nutrition Action Plan 2015–2020, whose general objective is to improve food system governance, the overall quality of the population's diet and nutritional status, and to promote health and well-being (World Health Organization., 2014).

Most of the European countries are still not limiting the content of *trans* fatty acids (TFA) in food, except Austria, Switzerland, Iceland, Norway, Denmark and Hungary, which have limited TFA content to less than 2% of total fat in foods (excluding ruminant TFA) (World Health Organization., 2015). Moreover, the indication of TFA content on nutritional declaration is not mandatory, according to Regulation (EU) n.° 1169/2011 (European Parliament/Council of the European Union, 2011). Regarding the recommended maximum intake, a report from Food and Agriculture Organization, stated that the intake of TFA should be as low as possible (< 1% of total energy intake), which for a 2000 kcal diet, represents around 2 g of TFA intake per day (FAO., 2010). The European Food Safety Authority (EFSA) has emitted in 2010, a Scientific Opinion on Dietary Reference Values for fats, including saturated, polyunsaturated, monounsaturated and *trans* fatty acids, and cholesterol. However, no Population Reference Intake, Average Requirement, or Adequate Intake was set, recommending that TFA intake should be as low as possible within the context of a nutritionally balanced diet (European Food Safety Authority, 2010). An excessive intake of TFA has been linked with an increase for coronary heart disease risk factors and coronary heart disease events, among other chronic diseases (Souza et al., 2015).

Based on the identified priority intervention areas, the aim of this study was to determine salt and total fat contents and fatty acids profile of a selection of processed foods, in order to get an update of the current situation. Also, a novel approach was performed by analysing possible correlations between the different components among the studied food categories, in order to establish a possible trend relative to the relationship between salt, saturated and *trans* fatty acids contents among processed foods.

2. Materials and methods

2.1. Reagents and standards

All chemicals and reagents used in this study were of analytical grade from different suppliers (Merck, Darmstadt, Germany; Panreac, Barcelona, Spain). Fatty acids methyl esters (FAMEs) standards were obtained from Supelco® (Supelco® 37 FAME Mix C4:0–C24:0, and Linoleic acid cis/*trans* isomers, Supelco, CA, USA) and GLC 674 from Nu-Chek-Prep (Elysian, MN, USA). For quality assurance of analytical data, the Standard Reference Material® 1548a and 1544 were used. Ultrapure water was prepared using a Milli-Q filter system (Millipore, Bedford, MA, USA).

2.2. Samples

2.2.1. Sample selection

Between 2014 and 2016, 260 composite samples of different categories of processed foods were collected from retail stores, supermarkets, food chains, restaurants and takeaway in Portugal. Whenever possible, different brands and different retailers for the same type of food were acquired, in order to achieve the best representativeness. The selected food samples were grouped as: cookies, biscuits and wafers (n = 61), potato and potato-products (n = 47), ready-to-eat meals (n = 41), bakery products (n = 32), nuts and oilseeds (n = 31), fast-food (n = 20), snacks (n = 13), cereal products (n = 11), and sauces (n = 4). More detailed information regarding the criteria used for the prioritisation and distribution by food categories is provided in Section 3.1. When the selected items arrived at the laboratory, an excel form was filled out with the following information: (1) identification; (2) description; (3) place, date and time of collection; (4) type of packaging; (5) nutritional declaration (energy, fat, saturated fatty acids, carbohydrates, sugars, fibre, protein and salt); (6) portion size; (7) list of ingredients; (8) expiring date; and (9) other relevant information.

2.2.2. Sample preparation

All the acquired items were stored in accordance with label instructions (when available) and were analysed before their expiry date. When it was necessary to apply cooking procedures, those items were prepared in accordance with manufacturer's instructions, using domestic cooking equipment. A composite sample of approximately 1 kg was prepared with at least three units of the same item. All the samples were homogenised in a blender (GM200, RETSCH, Germany) during 1 to 3 min at 5000 rpm, depending on the food matrix. Afterwards, samples were properly conditioned according to their perishability (e.g. high perishable foods were frozen at −20 °C) until analysis.

2.3. Total fat

Total fat was determined by an acid hydrolysis method (Albuquerque, Santos, et al., 2016). Briefly, 75 mL of ultrapure water and 45 mL of hydrochloric acid fuming 37% were added to 2–10 g of sample. Then, this solution was boiled for 20 min and left to cool down until room temperature. Afterwards, the solution was filtered with a filter paper (Whatman® n.° 40, Maidstone, United Kingdom). For the fat extraction, a Soxhlet apparatus (Soxtec™ 2050, Auto Fat Extraction System, FOSS Analytical, Hillerød, Denmark) and petroleum ether were used. The obtained residue was dried for 1 h 30 min at 101 °C ± 2 °C, until constant weight. The analytical procedure for the determination of total fat content was performed in triplicate. Results are expressed as g/100 g for all the analysed food products.

2.4. Fatty acids determination

2.4.1. Fat extraction

For fat extraction, approximately 10 g of sample were weighed and 120 mL petroleum ether was added (Albuquerque, Oliveira, Sanches-Silva, Bento, & Costa, 2016). The solution was stirred around 60 min, depending on matrices complexity, and a separation of phases was obtained. The upper phase (organic phase) was dried with sodium sulphate (Na_2SO_4) and filtered (Whatman® n.° 42, Maidstone, United Kingdom). Petroleum ether was evaporated using a rotary evaporator (Büchi R-210, Labortechnik AG Switzerland).

2.4.2. Preparation of fatty acid methyl esters (FAMEs)

To determine the fatty acids profile of the selected food samples a cold transesterification method was performed according to the ISO 5509:2000, with slight modifications. 0.2 g of the fat extract were weighed and 2.5 mL of *n*-heptane and 0.25 mL of methanolic KOH (2N) were added (European Committee for Standardization, 2000). After