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Study Review

Nutritional and functional components of non centrifugal cane sugar: A compilation of the data from the analytical literature

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ABSTRACT

Non-centrifugal cane sugar (NCS) (panela, jaggery, kokuto, etc.) is a traditional sweetener of increasingly economic importance after a long process of displacement by refined sugar. By searching the analytical literature with the different local names of NCS (jaggery, gur, kokuto, panela, chancaca, piloncillo, rapadura, muscovado, unrefined sugar, black sugar) as key-words, this review identified the published data on its content of 7 proximate, 14 minerals, and 13 vitamins so to calculate its average and median values, as well as list its contents of potentially relevant functional components like phenolics, amino acids, complex sugars and others. The forty-two publications on chemical content and properties found to show that NCS has nutritionally and functionally significant quantities of minerals, vitamins and phenolics, among other constituents, as well as antioxidant capacities. This justifies its inclusion in food composition databases and in reviews of antioxidant properties and phenolic contents of foods. Higher awareness of the nutritional and functional properties of NCS could increase scientific, nutritional and health interest in this food.

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1. Introduction

Non-centrifugal cane sugar (NCS), the technical denomination used by the Food and Agriculture Organization of the United Nations (FAO), is a solid unrefined product obtained by evaporating sugarcane juice (FAO, 1994). It has been traditionally consumed as a sweetener in most sugarcane growing regions of the world where it is known by many different names, the most common ones being jaggery and gur (South Asia), panela (Latin America), muscovado (Philippines), rapadura and azucar mascavo (Brazil) and kokuto (Japan) (Jaffé, 2012a). In 1961 NCS represented 16% of total per capita caloric sweetener consumption worldwide. This share has been falling reaching 3% in 2009. Today, it is a marginal food on the world market but still important in some of the producing countries. This is shown by its share in the daily consumption of caloric sweeteners (g/person/day) for 2007 of the following countries: Myanmar 46%; Bangladesh 20%; Colombia 19%; India 10%; Pakistan 10% (Own calculations based on Faostat data).

However, whilst production of NCS has been declining in Asia it has been rising, even if only slowly, in Latin America according to the International Sugar Organization (2013). There it reached an all-time high in 2011 surpassing the 2,000,000 metric ton level for the first time. There are growing efforts to increasingly market NCS alongside other types of niche market sugars overcoming the negative view that the traditional sugar industry has had of non-centrifugal sugar (International Sugar Organization, 2013).

But the growth of the international importance of NCS is hampered by the widespread confusion over its product identity caused by its many names. Many of the publications on chemical and food science aspects of NCS are in Japanese, Spanish or Portuguese and most use its local name. As a result of this dispersion and difficulty of access of the available information NCS is not recognized as an important food and therefore not included in most of the nutritional content of foods databases as, for example, in the US, France and Switzerland (ANSES, 2012; FFS and VOS, 2014; USDA, 2013). The "brown sugar" and "turbinado sugar" included in some of them are coated sugars, that is, refined crystallized saccharose mixed with some level of sugarcane molasses. Also, databases of antioxidant components in foods, like the Phenol Explorer (Neveu et al., 2010) and the U.S. databases on proanthocyanidins, isoflavones and flavonoids (USDA, 2004; Bhagwat et al., 2008, 2013;) do not include NCS, the same as reviews on antioxidant capacity and phenolic contents of foods, with one exception (Sreeramulu and Raghunath, 2011), as the following publications show (Blomhoff, 2005; Devasagayan et al., 2004; Dimitrios, 2006; Halvorsen et al., 2002; Petti and Scully, 2009; Shahidi and Naczk, 2006). This review purposes to identify and facilitate the use of the available analytical data of acceptable quality on the nutritional and functional properties of NCS, focusing on its content of minerals, vitamins, antioxidants and other potentially relevant components and its health effects. In this way the recognition of NCS as a promising functional food will be advanced, hopefully increasing research efforts to extend its use.

2. Methodology

Papers published in scientific journals, as well as food composition tables and databases recognized by INFOODS, the international network organized by the FAO, published before April 2015, have been the sources of the data. Posters or conference presentations have not been included. The Google search engine and Google Scholar have been the main tools used to identify relevant publications. Searches were done in English, Spanish and Portuguese covering 20 pages of search results. The keywords used have been "non centrifugal cane sugar" and the different local names of NCS (jaggery, gur, kokuto, panela, chancaca, piloncillo, rapadura, muscovado, unrefined sugar, black sugar) combined with keywords relevant to the purpose of the article such as "chemical composition", "nutrients", "antioxidants", "vitamins", etc. In the case of the food composition data the information provided by INFOODS for each country in the world has been examined to identify the data on NCS composition accessible through the Internet, in English, German, French, Spanish or Portuguese (INFOODS, 2014).

In all, forty-two publications containing relevant analytical data on NCS composition were obtained, fourteen on proximate, minerals and vitamins, sixteen on antioxidant properties and phenolics content and twelve on other potentially functional components. Additionally twelve publications on antioxidant capacity and content in parts of the sugarcane plant, sugarcane juice and sugarcane molasses were identified.

Each identified publication was abstracted and data points taken to be each reported analytical value, usually a mean of duplicate or triplicate values. Data points described as "non detected" were assigned a value of zero. Statistics were calculated using Microsoft Excel.

3. Nutritional content of NCS

NCS is essentially dried sugar cane juice. The juice is extracted from the cane, cleaned, clarified and then concentrated by evaporation of its water content. Depending on the manufacturing process it is either presented in solid form, known as lump sugar, or in granulated form. Given the high sucrose content of cane juice it is, therefore, crystals of sucrose mixed with molasses, the additional constituents of cane juice. The World Customs Organization (WCO) (2010) defines it as follows: "The product contains only natural anhedral microcrystals, of irregular shape, not visible to the naked eye, which are surrounded by residues of molasses and other constituents of sugar cane".

These additional constituents are reducing sugars (glucose and fructose), minerals, vitamins, organic acids, amino acids, complex or rare sugars, and other trace substances, many probably still unknown.

3.1. Proximate composition

The published proximate composition of NCS, presented in Table 1, is surprisingly scarce as only thirteen publications were identified. Six of these are research papers and seven are official national food composition tables (Bangladesh, Brazil, Central America, Colombia, Japan, Peru, and UK).

Sucrose is the most important component, between 76.55 and 89.48%, followed by reducing sugars (3.69–10.5%) and water (1.5–15.8%). The relatively large range of moisture content is caused by differences in the manufacturing process conditions of this mainly artisanal product. The mineral content (ashes) is relatively high (0.3–3.6%). Protein content ranges between