

INAA and AAS of different products from sugar cane industry in Pakistan: Toxic trace elements for nutritional safety

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Instrumental neutron activation analysis (INAA) have been used to determine As, Br, Hg, Sb and Se in combination with atomic absorption spectrometry (AAS) as a complementary technique for the quantification of Cd and Pb in jaggery, brown sugar, white sugar and molasses. All sugar cane products were collected from the local sugar cane industry of Pakistan. The highest concentration of these potentially toxic elements was quantified in molasses; however, molasses together with jaggery, brown sugar and white sugar contains trace amounts of all of these elements. Due to very low concentration of Cd it could only be detected in molasses. To evaluate the percentage contribution of these elements in the sugar cane products to the weekly recommended values, intakes on weekly consumption of 100 g of each item have also been calculated which follow the pattern Br>Se>Pb>Hg>As>Sb. The elevated Br contents may be attributed to the use of Br-containing chemicals for fumigation; however, these contents are well within the tolerance levels. The estimated weekly intake of all toxic elements is very low indicating that sugar cane products can be safely ingested as part of the diets.

Introduction

In Pakistan, the sugar industry is mainly dependent on sugarcane and a nominal percentage of sugar-beet production. Sugar cane crop is an important cash crop of Pakistan and is grown on area more than one million hectares. At the time of partition of India in 1947, the country only had two sugar mills with total production of 7.932 tons. By the end of 2006, the number increased to 75, producing 3.6 million tons of sugar.^{1,2} The main reason for the success and development of this industry can be attributed to the fact that almost all the products, by-products and waste can be sold or used, apart from the supporting climatic conditions of the country for harvesting, cheap labour and low transportation charges as most of the industries are located close to the sugarcane cultivation sites. Globally, Pakistan is ranked as fifth in terms of area, fifteenth by yield and twelfth by recovery among the sixteen major producers of sugar by sugarcane. Besides jaggery, brown sugar and white sugar as the main products of this industry, molasses is exported in large quantities to the international market. Since molasses is used to produce ethanol, Pakistan exported 234,000 metric tons of ethanol in the year 2007.³

Nevertheless, the sugar industry is also beset with many problems of environmental safety and pollution concerns. Pakistan though being lucky to have gained entry into international export markets also has to strictly satisfy the World Trade Organization (WTO) enforcement based on the quality and safety of all export commodities. Since a number of chemicals including lime, sulphur, phosphoric acid, bleaching powder,

polyelectrolyte, floatation aid, and decolorant are used in the sugar making process, the end products and by products have to be strictly monitored for any contaminants. The quality of these chemicals varies from mill to mill due to different type of processes, in addition the use of the fertilizers, insecticides and other chemicals also add to the inventory of the toxic pollutants in the sugar products. The area of concern is to ensure the quality of the sugar cane products and by-products for dietary and environmental safety.

Trace elements play a major role in human health and safety. Our daily dietary articles are the principal pathways for the ingestion of potentially toxic element. It is, therefore, important to monitor the level of these toxicants in major food articles for their possible safe intake. Therefore, a study was undertaken to characterize the toxic trace elements in different produce of the sugar cane industry of Pakistan to aid in stipulating the pro-active human health and environmental concerns. In addition the prospects of the study would also help in heeding domestic safety regulations and compliance for the sugar producers to improve the quality of their products to satisfy the eco-conscious international markets. Non destructive, highly sensitive technique of instrumental neutron activation analysis (INAA) with comparatively low detection limits was used in this work to quantify toxic trace elements in jaggery, brown sugar, white sugar and molasses. Due to the low sensitivity of INAA for the determination of Cd and Pb, atomic absorption spectrometry (AAS) has been utilized as a complementary technique.

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