A Feasible and Fast Method for the Determination of Bromine and Iodine in Rice Combining Microwave-induced Combustion and ICP-MS

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Abstract

Rice from different countries were digested by MIC, in order to quantify Br and I by ICP-MS.

Introduction

Rice is a cereal widely consumed around the world, present in the diet of more than half the world population.[1] Depending on the world region, several species of rice are cultivated. However, the main types of rice consumed are white, parboiled and brown. They are produced by different processes, and contain varying amounts of nutrients due to processing, the use of fertilizers and pesticides, and the nutrients in the soil where they are cultivated. Bromine and iodine are examples of these nutrients. Though they have important functions in the human body, these two nutrients may cause thyroid disorders when over-consumed.[2] Therefore, the determination of Br and I in food is a challenge and the development of analytical methods is necessary. Thus, in this study, microwave-induced combustion (MIC) was used for digestion of rice for Br and I determination by inductively coupled plasma mass spectrometry (ICP-MS).

Results and Discussion

Samples of rice (white, parboiled and brown) from Brazil, Chile, Germany and Uruguay were used in this study. After grinding, the samples were dried in an oven, at 60 ºC, for 4 h. For decomposition of samples by MIC method, was used a microwave oven (Multiwave 3000™, Anton Paar, Austria) equipped with up to 8 quartz vessels (80 mL, 280 °C and 80 bar). A portion of rice (1000 mg) was wrapped in polyethylene film and sealed by heating. The samples were placed in quartz holders containing a disk of filter paper with 50 µL of 6 mol L^{-1} NH_4NO_3, and the holders with samples were inserted into quartz vessels containing 6 mL of 50 mmol L^{-1} NH_4OH as absorbing solution. The vessels were closed, pressurized with 20 bar of O_2 and the samples were irradiated with microwaves (1400 W/5 min; 0 W/20 min)[3]. Bromine and I concentrations were determined by ICP-MS (Elan DRC II, PerkinElmer, Canada). For evaluating the accuracy, recovery tests were performed and a reference material (RM NIST 8435) was analyzed. Recoveries ranged from 98 to 108% for Br and I, respectively. Analysis of the RM showed agreement of 96% for Br and 105% for I, with relative standard deviation up to 6% for both elements. Afterward, this method was applied to 12 samples of rice from different countries. The results showed a large variation of Br concentration in white rice, from 0.304 to 23.71 µg g^{-1} and from 0.009 to 0.031 µg g^{-1} for I. For parboiled rice, the concentration of Br ranged from 0.259 to 0.808 µg g^{-1}, while for I, the concentration was up to 0.015 µg g^{-1}. The brown rice samples showed concentrations from 0.388 to 0.605 µg g^{-1} for Br and from 0.011 to 0.030 µg g^{-1} for I. For all samples, concentrations of Br were higher than I concentrations. Furthermore, in a daily portion of rice of 120 g, all samples contained less than 1% of the recommended daily allowance of Br (4 mg kg^{-1}), for a person weighing 75 kg. With respect to I concentrations, the samples present from 0.72 to 2.48% of that recommended for an adult ingestion (150 µg day^{-1}).

Based on the results, the proposed method, which combines MIC with ICP-MS, appears suitable for Br and I determination in a wide range of concentration in several types of rice. Moreover, using MIC method, which has never been applied to rice samples, it was possible to decompose up to 1000 mg of rice. This can be considered a high sample mass and contributed to obtaining very low limits of detection (0.009 µg g^{-1} for Br and 0.005 µg g^{-1} for I).

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