Asian Journal of Chemistry Vol. 14, Nos. 3–4 (2002), 1307–1310

Uranium Contents in Wheat Samples of Saudi Arabia

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Wheat is one of the most grown crops in most of the world countries. Radionuclides may be concentrated in environment in a manner that can pose risk to human health. Accurate knowledge of such radionuclides in human food is of great importance to avoid any risk. In this work, Inductively coupled plasma mass spectrometry (ICP-MS) and α-spectrometry techniques were applied to determination of uranium in wheat samples. Wheat samples were collected from ten regions through Saudi Arabia. Also bran and white flour samples were investigated.

Key Words: Uranium, Contents, Wheat, α-Spectrometry, Saudi Arabia.

INTRODUCTION

The study of elemental contents in food, environmental and biological samples have attracted worlwide interest. The determination of trace quantities of elements present in these types of matrices is of considerable importance, because of their essential and toxicological action of some of them in the human body. This has strengthened the need to use reliable analytical methods capable of analyzing food samples as well as other matrices[1–3].

Wheat grain contains several elements at minor or trace concentration. Several studies have been carried out to determine the elemental concentratin in wheat, flour and bran[1, 4–6]. Uranium is one of the heaviest naturally occurring radionuclides in the environment of man. This element enters the human body mainly through food and water, for which reason it requires its assessment in different foods for estimation of intake from foods by man. Its estimation in various foodstuffs has already attracted some laboratories[7–11].

EXPERIMENTAL

Sampling

In Saudi Arabia wheat is grown in ten regions throughout the country. The collection and distribution of wheat from the various regions is carried out by a government agency known as Grain Silos and Flour Mills Organization (GSFMO). It has 10 branches in the various regions of Saudi Arabia. Farmers

bring their wheat produce to GSFMO branch where it is mixed and kept before sales and distribution. Ten samples were collected from these branches under the assumption that each collected sample represents its region.

Generally wheat consists of about 22.5% bran, 2.5% wheat germ and 75% white flour (semolina)[12].

Digestion Procedures

15 g of the sample was put into a 100 mL beaker and placed in a furnace at 500°C for 48 h. The ash was digested on a hot plate by 6-mL HNO_3 and 2 mL H_2O_2.

Analysis of U by α-Spectrometry

The digested sample was transferred to a beaker and a known amount of ^{232}U tracer solution was added as internal standard. The beaker was placed on a hot plate to near dryness. 25 mL of 8 M HNO_3 was added. Approximately 250 mg of $NaNO_2$ crystals were added. The sample was heated to near boiling. Then the solution was transferred to anion exchange resin, 8 mm I.D. by 20.5 cm long: Dowex 1-X4 (50–100 mesh, chloride form). The sample was allowed to flow through the column at a rate of 2 mL per min. into a 100-mL beaker. The beaker containing the column effluent was placed on a hot plate and left to dryness. The residue was dissolved using 10 mL of 2.8 M $Al(NO_3)_3$ and transferred to an extractioh vial. 1.5 mL of ethyl acetate was added and the mixture was shaken for 10 min. The solution was centrifuged and the ethyl acetate layer was transferred into a new extraction vial. 5 mL 2.8 M $Al(NO_3)_3$ was added to the ethyl acetate and shaken by hand for 1 min to remove any iron that may have been extracted into the ethyl acetate. The vial was centrifuged and the ethyl acetate layer was transferred into a culture tube. The ethyl acetate extract was transferred onto a stainless steel disc placed on a hot plate set at 85°C. The disc was flamed to red heat and allowed to cool. TENNELEC TC 256 α-spectrometer was used to measure the α-activity.

The concentration of ^{234}U, ^{235}U or ^{238}U in the sample was calculated as follows:

$$BQ/L = (1000 \times C_a D)/ (60 \times C_b V)$$

where $C_a = {}^{234}U$, ^{235}U or ^{238}U net count rate, cpm,

$C_b = {}^{232}U$ net count rate, cpm,

D = ^{232}U disintegrations per minute, dpm,

V = Aliquot size, mL.

Analysis of U by ICP-MS

Inductively coupled plasma-mass spectroscopy (ICP-MS) is an alternative to other methods such as α-spectrometry and thermal ionization mass spectrometry (TIMS) for determination of total and isotopic uranium. The ICP-MS used in this work was a VG PlasmaQuad2 unit (Fisons Instruments, Elemental, Winsford, Cheshire, UK) equipped with necessary software for data acquisition in scanning, single/multiple ion monitoring (*i.e.*, peak hopping) and time-resolved acquisition

(TRA) modes. The instrument was equipped with a Meinhard Type A concentric nebulizer (Precision Glassblowing, Parker, CO) and a Scott-type double glass spray chamber. Operational parameters for the ICP-MS are provided in Table-1.

TABLE-1
OPERATIONAL PARAMETERS FOR THE ICP-MS

Parameters	Value
Radiofrequency power:	
Forward	1.35 kW
Reflected	< 5 kW
Gas flow rates:	
Coal gas	13.5 L /min
Auxiliary gas	0.7 L /min
Nebulizer gas	0.7 L /min
Nebulizer pressure	20 psi

TABLE-2
URANIUM CONCENTRATION BY α-SPECTROMETRY AND ICP-MS

Samples	Concentration of uranium in ppm	
	α-spectrometry	ICP-MS
Khamis	< DL	< DL
Riyadh	< DL	< DL
Hail	< DL	0.027
Wadi	< DL	0.011
Jouf	< DL	< DL
Kharj	< DL	0.034
Damman	< DL	0.030
Tabuk	< DL	0.047
Jeddah	< DL	0.027
Gasim-Wheat	< DL	0.026
Gasim-Bran	< DL	0.078
Gasim-white flour	< DL	0.015

RESULTS AND DISCUSSION

The concentration of uranium in the wheat samples under investigation measured by α-spectromery and ICP-MS are shown in Table-2.

Quantitative determination of uranium at low levels has attracted some laboratories. Uranium is one of the heaviest naturally occurring radionuclides in the environment of man. This element enters the human body mainly through food and water, for which reason it requires its assessment in different

foodstuffs[7-14]. In this work, inductively coupled plasma mass spectrometry (ICP-MS) and α-spectrometry techniques were applied to the determination of uranium in wheat samples. By examining the results of Table-2, it can be seen that even without chemical separation of uranium ICP-MS is able to give the level of uranium in the samples under investigation up to 0.011 ppm. The uranium concentration in Saudi wheat samples is very low and it is in the range of 0.011-0.047 ppm. The concentration of uranium in bran sample is higher than in wheat or white flour (semolina) samples. The concentrations were 0.078, o.026, and 0.015 ppm respectively. Elemental concentration in bran is usually higher than in white flour or wheat[15]

ACKNOWLEDGEMENTS

The author is grateful to the Grain Silos and Flour Mills Organization (GSFMO), Riyadh plant, particularly Mr. K.I. Al-Abdulathim, for helping in samples arrangement and collection; to Mr. N.A. Teasley and Mr. J. Giaquinto from Oak Ridge National Laboratory, USA, for their assistant during this work; and King Abdulaziz City for Science and Technology for financially supporting this project.

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(*Received:* 21 February 2002; *Accepted:* 6 May 2002) AJC-2687