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TRACE ELEMENTS ANALYSIS IN RICE

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Various rice species, marketed in Austria, were analyzed for their Se, Cr, Ni, Rb, Fe, Co, Cs, Ag and Hg contents by neutron activation analysis. The concentration values found for Se ranged between 0.023 and 0.265 ppm, for Cr 0.540-1.875 ppm, for Ni 0.359-0.965 ppm, for Rb 1.604-6.400 ppm, for Fe 24.3-139.8 ppm, for Co 0.026-0.055 ppm, for Cs 0.016-0.032 ppm, for Ag 0.0006-0.0034 ppm, for Hg 0.003-0.023 ppm. Statistical analysis showed in the majority of cases that there is a significant difference in Se, Cr, Ni, Rb, Fe, Co, Hg contents but not in Cs. Highest values of Se and Fe were found in rice from Belgium /long seed, super patna/, whereas the Cr concentration was the highest in rice from Thailand /siam patna/. Ni was highest in rice from Uncle Ben's, Rb in Kresto from USA.

INTRODUCTION

In general, the elemental composition of a plant reflects the composition of the soil or other nutrient medium. The ratios of the elements in the plant is not

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necessarily the same as those in the soil or even in the nutrient solution. In other words, plants are to some degree selective in their absorption of elements. The seasonal variation in the chemical composition of plants has been reported by many workers[1,2].

The uptake of the elements from the soil is determined by many factors.

The abundance in the lithosphere,
the form of element,
the pH of the soil,
the physical condition of the soil /tilth, temperature, moisture content/,
the genetic constitution of the plant species.
Sometimes, under severe deficiency conditions, it is possible that the decrease of the concentration of an element results in a small increase in growth. This phenomenon is known as the Steenbjerg effect[3].
The uptake of elements by plant roots consists of two phases: absorption and accumulation.
The interaction between ions can result in competition or competitive inhibition or in the stimulation of uptake[4].

Many workers have also shown that comparable concentrations of elements take place from fresh water[5]. In a recent study, concentrations of metals /Mn, Zn, Fe, Co, Cu/ in plants in Lake Maggiore were determined by activation analysis[6]. It was found that macrophytes revealed a certain pattern in their metal content: completely submerged or partially submerged plants had much higher quantities of the element than surface plants.

Since many plants serve as the principal food for many species of animals including fish, their ability to concentrate metals to a high degree may constitute a hazard for the food chain in the case of polluted waters.

Much less extensive data are reported for the uptake of elements from soils by higher plants. Certain plant species have the ability to accumulate high concentrations of a particular element. Several species growing on strontium-rich soils in England were shown to contain strontium concentrations as high as 26000 ppm compared with 100-200 ppm in other species from similar soils[7].

Several trace elements are considered essential, non-essential or toxic for animal life. However, all elements in high concentrations may become detrimental to organisms[8]. The nutritional role and the essentiality of trace elements as well as their biochemical and pathological significance to man and animals have been recently reviewed by several investigators[9,10].

It is important, therefore, to measure the trace element content of foodstuffs in an attempt to increase our understanding on the distribution of elements both geographically and throughout the food chain[11].

Therefore this report is concerned with trace elements in various rice species, which are solid in Austria.

MATERIAL AND METHODS

Samples

Rice cultivars studied in this report:

No.	Variety and country
1	Siam patna Thailand
2	Surinam patna Holland
3	Uncle Ben's long seedamer. parboiled
4	Splendor rice Italy
5	Surinam rice Rotterdam Holland
6	Super patna long seed Belgium
7	Kresto long seed-rice USA

Non-destructive neutron activation analysis

Rice samples weighing from 0.2 to 0.3 g, chemical standards evaporated onto filter paper, were sealed in quartz ampoules and irradiated for 24 h at a thermal neutron flux of 9×10^{13} $n.cm^{-2}.s^{-1}$ in the core of ASTRA-REAKTOR. After 4 weeks the samples and standards were counted /^{75}Se, ^{51}Cr, ^{58}Co for Ni, ^{86}Rb, ^{59}Fe, ^{60}Co, ^{134}Cs, ^{110m}Ag, ^{203}Hg/.

Samples were measured on a Canberra 4000-channel analyzer connected to a 80-cm^3 Ge/Li/-detector of 5% efficiency and of 1.7 keV resolution at 1332.4 keV.

RESULTS AND DISCUSSION

The mean values and standard deviations of trace element content in different rice samples can by found in Table 1 showing selenium, chromium, nickel,

TABLE 1

Concentration /µg/g, $\bar{x}\pm s$/ of Se, Cr, Ni, Rb, Co, Cs, Ag and Hg, found in various rice samples

Rice-species	Nr.		Se	Cr	Ni	Rb	Fe	Co	Cs	Ag	Hg
			µg/g								
"Siam panta"		$\bar{x}$	0.029	1.875	0.696	2.446	24.3	0.026	0.032	0.0020	0.008
Thailand	1	s	0.003	0.840	0.315	0.617	3.1	0.014	0.012	0.0016	0.003
		n	8	8	8	8	8	8	8	8	8
"Surinam panta"		$\bar{x}$	0.032	1.349	0.698	2.939	64.9	0.044	0.027	0.0006	0.003
Holland	2	s	0.012	0.560	0.592	0.977	18.6	0.021	0.022	0.0005	0.002
		n	9	9	9	9	9	9	9	9	9
"Uncle Ben's"		$\bar{x}$	0.048	1.440	0.965	2.039	64.4	0.027	0.028	0.0018	0.011
amer.parboiled	3	s	0.006	0.841	0.393	0.264	6.8	0.007	0.020	0.0013	0.003
long seed		n	10	1	10	10	10	10	10	10	10
"Splendor rice"		$\bar{x}$	0.023	0.816	0.671	1.604	41.7	0.026	0.023	0.0018	0.004
Italy	4	s	0.003	0.673	0.397	0.380	3.4	0.008	0.019	0.0012	0.002
		n	10	10	10	10	10	10	10	10	10
"Surinam rice"		$\bar{x}$	0.031	0.540	0.359	2.832	32.4	0.026	0.016	0.0013	0.004
Rotterdam	5	s	0.007	0.332	0.210	0.663	4.6	0.009	0.017	0.0012	0.002
Holland		n	8		8	8	8	8	8	8	8
"Super patna"		$\bar{x}$	0.253	0.655	0.670	3.200	139.8	0.031	0.022	0.0034	0.023
Belgium	6	s	0.030	0.405	0.355	0.404	6.1	0.016	0.015	0.0015	0.017
long seed		n	9	9	9	9	9	9	9	9	9
"Kresto"		$\bar{x}$	0.265	1.143	0.531	6.400	130.0	0.055	0.032	0.0014	0.021
long seed-rice	7	s	0.036	0.710	0.259	1.040	10.4	0.019	0.020	0.0008	0.009
USA		n	8		8	8	8	8	8	8	8

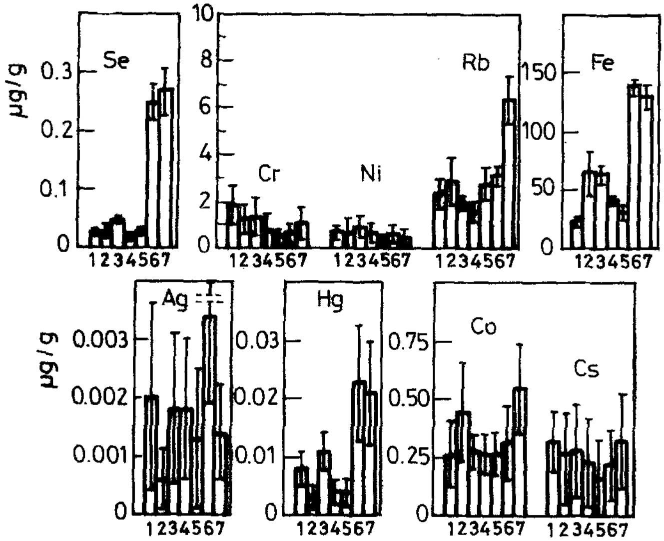

Fig. 1. Comparison of Se, Cr, Ni, Rb, Fe, Co, Cs, Ag and Hg concentration in rice samples

rubidium, iron, cobalt, cesium, silver and mercury content of rice samples which are sold in Austria.

Statistical analysis of significant differences between rice sorts /Figs 1, 2/ was performed using the t-test /t = 0.05/ /Ref. 12/.

Highest values of Se and Fe were found in rice from Belgium /long seed, super patna/, whereas rice from Thailand /siam patna/ contained the most Cr.

Elemental selenium is practically non-toxic, howevery, hydrogen selenide and other selenium compounds are extremely toxic and resemble those of arsenic in their physiological reactions. Selenium is not essential to plants but has been reported to stimulate growth in certain species. Some land /0.2 ppm/ and marine plants /0.8 ppm/ contain selenium[13,14]. We have found 0.023 ppm in splendor rice from Italy and 0.265 ppm Se in rice from USA /Kresto/.

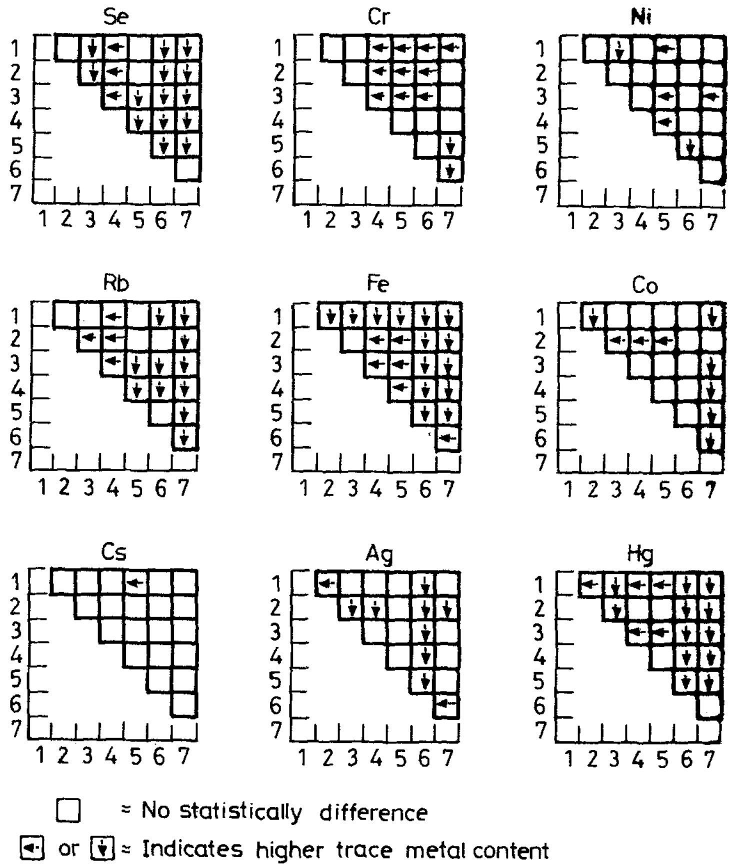

Fig. 2. Differences in Se, Cr, Ni, Rb, Fe, Co, Cs, Ag and Hg content of rice samples by "t-test"

Rice samples investigated by us contained 0.540-1.875 ppm Cr.

Loveridge et al.[15] and Yamamoto et al.[16] found 1 ppm chromium in marine plants and Saint Rat[17] Lounamaa[18], Schroeder et al.[19], 0.23 ppm Cr in land plants.

Most plants contain less than 1 ppm, but the leaves of wheat may have levels of 4-6 ppm. There are no reports of beneficial of Cr on plants, but there are numerous reports of toxic effects. Chromium deficiency is characterized by disturbances in glucose, lipid and protein metabolism. It seems that chromium is involved in glucose tolerance in man. Hexavalent chromium is much more toxic than trivalent. Chronic exposure to high chromium levels has been correlated with lung cancer in man and liver and kidney damage in animals[20].

Ni concentration was high in rice from Uncle Ben's /0.965 ppm/, Rb in Kresto /6.4 ppm/ from USA. Yamamoto[16] found 3 ppm Ni and Borovik-Romanova[21] 7.4 ppm in plant materials. Rb might act to some extent as a nutritional substitute for potassium in some simple organisms. There is no evidence that rubidium has any significant effect on human health.

The concentration of Fe in various rices, which we investigated was 24.3 - 139.8 ppm; marine plants contain 700 ppm and land plants 140 ppm Fe /Ref. 22/.

Most of iron is present in hem-proteins such as hemoglobin myoglobin, in non-hem proteins as ferritin, transferrin and hemosiderin, as well as in a number of enzymes which are mainly involved in respiration and oxygen transport.

Iron toxicity inhibits the cellular-type defense of the organism by blocking the reticulo-endothelial system. As can be seen, the Co /0.026-0.055 ppm/, Cs /0.016-0.032 ppm/, Ag /0.0006-0.0034 ppm/, Hg /0.003-0.023 ppm/ concentration was much lower than that of other trace metals.

Co may vary from 0.5 ppm in a non-accumulator to as high as 1.8% dry weight in an accumulator species such as Crotolaria cobalticola[23].

Cobalt has proved to be an essential element for blue-green algae, it it also essential for some bacteria, fungi and green algae. There is no evidence of essentiality to higher plants, although some workers have reported growth and yield responses. Values exceeding 1 ppm in plants are rare[20].

Vitamin B_{12} contains 4% by weight of cobalt. Cobalt deficiency has been known to occur in different animals. No cases of dietary deficiency of cobalt in man have been reported.

Smales and Salmon[24] found 0.07 ppm and Yamagata et al.[25] 0.2 ppm Cs in plant.

Terrestrial plants contain approximately 0.015 ppm and marine plants approximately 0.030 ppm mercury[20]. We have found 0.003-0.023 ppm Hg.

Although few data are available it appears that plants reflect fairly well the mercury content of their environment. There is no need for a systematically designed effort to obtain up-to-date and accurate data on the trace element content of foods, which will be useful in designing therapeutic diets and carrying out investigations in laboratories and in hospitals in connection to trace element deficiencies.

Information on the trace element content of foods will also be useful in food consumption studies to assess the overall availability of trace elements to certain population and age groups and also in nutrition planning for analysis of national food supplies, particularly for regions and countries known to be prone to deficiencies of trace elements[26].

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