Determination of Mineral Contents in Unpolished Rice and Bean Samples by Neutron Activation Analysis.

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1. Introduction

As scientists have focused their researches on the health impacts caused by mineral nutrient deficiencies and hazardous elements [1, 2], public concern regarding mineral intake from dietary food is rising. In this reason, the dietary habits of Koreans have been shifted from white rice to more nutrient rice like unpolished rice and rice mixed with beans. It is known that unpolished rice and beans contain more protein, vitamin and mineral contents than white rice and are more beneficial to human health, even though they sometimes cause indigestion or allergy.

The objectives of this study were to determine the mineral contents in unpolished rice and bean samples by a neutron activation analysis (NAA) and to compare the level of mineral contents between the samples.

2. Experiments

2.1 Sampling and Sample Preparation

Four kinds of unpolished rice such as unpolished glutinous rice, germinated unpolished rice, typical unpolished rice and unpolished rice by organic farming, and three kinds of beans such as black soybean, kidney bean and small black soybean, were chosen as target samples for this study. Samples which have two different producer, were purchased from big markets. 200 gram of analytical sample was made by mixing 100 gram of a sample from each producer. The prepared grains were cleaned with de-ionized water and then dried in an oven. And then, the sample was ground using a blender with a titanium blade. Finally, samples of 100 to 400 mg were prepared for an instrumental neuton activation analysis (INAA).

2.2 Neutron Activation Analysis

NAA #1 irradiation holes with a Pneumatic Transfer System (PTS) of the HANARO research reactor were used for the activation of the prepared samples. In a typical INAA manner, samples were activated by short (sample weight: 100 mg) and long (sample weight: 300 mg) irradiation to detect short-, median- and long-lived nuclides. The analytical conditions are summarized in Table 1. In order to detect the gamma-rays emitted from the irradiated samples, HPGe detectors coupled to a multichannel analyzer were used. Mineral contents were determined by an absolute method using nuclear data, detection efficiency, thermal neutron flux and so on. NIST SRM 1568a-Rice Flour for analytical quality control was analyzed under the same analytical condition as the samples.

Table 1. Analytical conditions of NAA for this study

Division	Irradiation time	Decay time	Counting time	Nuclides detected
Short	30s	3 min & 50min	500 sec & 1200 sec	^{28}Al, ^{49}Ca, ^{38}Cl, ^{66}Cu, ^{27}Mg, ^{56}Mn
Long-1st Detection	2hrs	3～7 days	5000 sec	^{76}As, ^{82}Br, ^{42}K, ^{24}Na,
Long-2nd Detection	2hrs	longer than 1 month	30000 sec	^{60}Co, ^{51}Cr, ^{134}Cs, ^{59}Fe, ^{86}Rb, ^{75}Se, ^{65}Zn

3. Results and Discussion

3.1 Mineral contents of unpolished Rice and Bean Samples

Seventeen elements, Al, As, Br, Ca, Cl, Co, Cr, Cs, Cu, Fe, K, Mg, Mn, Na, Rb, Se and Zn were determined and the results are summarized in Table 2. With respect to analytical quality control, analytical results in terms of relative error (%) are shown in Fig. 1. Analytical results of most elements are within 20% of the relative error when compared to certified or reference values of the NIST SRM 1568a-Rice Flour.

Table 2. Analytical results of unpolished rice and bean samples (unit: mg/kg)

Element	Unpolished Glutinous Rice	Germinated Unpolished Rice	Unpolished Rice	Unpolished Rice by Organic Farming	Black Soybean	Kidney Bean	Small Black Soybean
Al	0.82	0.90	2.02	2.45	8.97	2.90	15.69
As	0.186	0.226	0.218	0.191	< 0.027	< 0.022	< 0.031
Br	0.22	0.33	0.24	0.31	0.94	0.33	0.67
Ca	108	235	124	125	1556	867	2732
Cl	228	193	227	228	58	179	50
Co	0.019	0.011	0.022	0.007	0.121	0.274	0.153
Cr	0.065	0.24	0.89	0.056	0.32	0.93	1.46
Cs	0.030	0.027	0.029	0.032	0.054	0.033	0.056
Cu	3.92	2.30	1.81	3.17	10.87	6.12	11.66
Fe	11.6	12.7	17.0	11.4	81.0	79.8	117.2
K	2675	2053	2655	2938	20255	17282	21603
Mg	1316	1457	1078	1730	2605	1995	2988
Mn	27.8	34.6	27.2	39.8	33.5	18.5	34.7
Na	7.59	25.4	10.3	11.0	5.19	1.29	4.59
Rb	6.68	5.51	4.60	6.14	16.46	7.51	8.68
Se	0.103	0.036	0.022	0.024	0.027	0.020	0.035
Zn	29.2	25.2	24.0	22.5	52.7	35.5	60.1

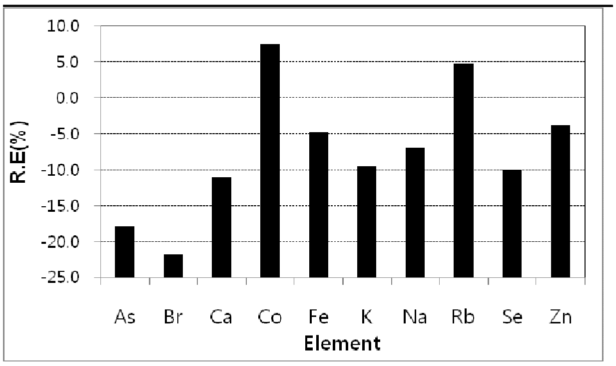

Fig. 1. Relative error of NIST SRM-Rice Flour by NAA

In Table 2, K shows the highest values in the analyzed elements from unpolished rice and bean samples. Only As in the unpolished rice samples shows higher contents than that in the bean samples. Ca, Cu, Fe and K in the unpolished rice are 8 times higher than those in the bean. Mg and Zn in the unpolished rice are slightly higher than those in the bean.

3.2 Comparison with Mineral Contents in White Rice

Table 3 shows the summary of level of mineral contents in unpolished rice and beans for the comparison with mineral contents in white rice [3]. In Table 3, mineral contents increase by an order of bean, unpolished rice, white rice. This result demonstrates that unpolished rice and beans contain more mineral contents than white rice and are more beneficial to human health.

Table 3. Comparison of mineral contents between unpolished rice, bean and white rice(unit: mg/kg)

Element	Unpolished Rice	Bean	White Rice
Al	0.82 ~ 2.45	2.90 ~ 15.69	1.13
As	0.186 ~ 0.226	< 0.031	0.13
Br	0.22 ~ 0.33	0.33 ~ 0.94	0.19
Ca	108 ~ 235	867 ~ 2732	53.9
Cl	193 ~ 228	50 ~ 179	193
Co	0.007 ~ 0.022	0.153 ~ 0.274	0.0053
Cr	0.056 ~ 0.89	0.32 ~ 1.46	<0.01
Cs	0.027 ~ 0.032	0.033 ~ 0.056	0.0086
Fe	11.4 ~ 17.0	79.8 ~ 117.2	1.5
K	2053 ~ 2938	17282 ~ 21603	660
Mg	1078 ~ 1730	1995 ~ 2988	241
Mn	27.2 ~ 39.8	18.5 ~ 34.7	9.06
Na	7.59 ~ 25.4	1.29 ~ 5.19	4.1
Rb	4.60 ~ 6.68	7.51 ~ 16.46	1.39
Zn	22.5 ~ 29.2	35.5 ~ 60.1	15.3

4. Conclusions

Seventeen elements from unpolished rice and bean samples were determined based on INAA. The level of mineral contents was compared between the samples. NAA is very useful technique for evaluating the nutritional status in terms of mineral intake through the analysis of a variety of food samples.

REFERENCES

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