Analysis of Cl, Mn, Na, Zn in Food Samples by a Neutron Activation Analysis

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1. Introduction

Due to their westernized dietary habit, Korean children are still threatened by the increasing risks of chronic disease such as obesity, hypertension, low immunity, etc. In addition, they are often exposed to a deficiency of Ca, Mg, Fe and micro-minerals which are necessary for their growth, immunity, and prevention of anemia. Nonetheless, the nutritional adequacy of mineral intakes for children is difficult to assess because of a lack of related studies and a nutritional database with respect to Korean children's foods [1].

In this study, ninety kinds of foods consisting of lunch meals from an elementary and a middle school and children's favorite snacks were collected and prepared for an analysis. INAA which has an advantage of a non-destructive technique was employed to determine the elements like Cl, Mn, Na, Cl in the pretreated food samples. Quality control was carried out by using certified reference materials. From the analytical results, elemental concentration range in the collected samples according to the food groups was summarized

2. Experimental

2.1 Sampling and Sample Preparation

Three day's lunch meals supplied for students of an elementary school and a middle school located in Yongin city, Korea, were collected in the summer and winter seasons. Therefore, they were cooked and heat-treated foods. It was intended to collect fifteen food samples from each school in a season and sixty samples were assembled. However, forty seven kinds of lunch meal samples excluding duplicate foods were collected. The lunch samples can be divided into four groups which are main dishes(7samples), soups and stews(9samples), side dishes(21samples) and desserts(10samples).

Meanwhile, referring to the results of previous studies for Korea children's preference snacks[2, 3], forty three kinds of children's favorite snacks like fast foods, breads, ice cream, etc., were selected and purchased from big shopping mall and food store in the vicinity of a school. The snack samples can be divided into three groups that are fast foods(14samples), flour foods(11samples) and others(18samples).

The collected food samples, except for the liquid samples, were homogenized by using a blender with a titanium blade. The homogenized samples were put into a pre-weighed plastic tube and freeze-dried for 48 hrs ~ 96 hrs at -60^{o}C. The moisture contents for each sample were recorded. For the neutron activation analysis, the pretreated samples were powdered by an agate mortar and put into polyethylene vials.

2.2 Neutron Activation Analysis

The NAA #1 and #2 irradiation holes with a Pneumatic Transfer System (PTS) of the HANARO research reactor were used for the neutron activation of the prepared samples. For the analyses using short or medium-lived nuclides of Cl-38, Mn-56, Na-24 and long-lived nuclides Zn-65, the samples were irradiated for 5 s at the NAA #1 irradiation hole and 4 hrs at the NAA#2 irradiation hole, respectively. Al-01%Au and Fe wire were co-irradiated with the samples to monitor the thermal neutron flux. Gamma-rays emitted from irradiated samples were measured by using a HPGe detector(EG & G ORTEC) coupled to a 16K-Multichannel Analyzer. For the quality control, certified reference materials(NIST SRM 1572-Citrus Leaves, 1573a-Tomato Leaves, 8436-Durum Wheat Flour and GBW09101 Hair) were assayed under the same conditions as the samples and the results are shown in Table 1.

Table 1. Analytical results of CRMs(unit : mg/kg)

Element	Mean	±	SD (1s)	Certi.	±	Unc. (2s)	R.E(%)	Name of CRM
Cl	373	±	11	(414)			9.78	SRM 1572
Mn	19.9	±	0.2	23	±	2	13.1	SRM 1572
Na	259	±	12	266	±	12	2.76	GBW09101
	158	±	6	160	±	20	1.08	SRM 1572
Zn	29.6	±	1.1	30.9	±	0.7	4.08	SRM 1573a
	22.5	±	0.7	22.2	±	1.7	1.4	SRM 8436

3. Results and Discussion

Cl, Mn, Na and Zn can be detected from all the prepared samples and the analytical results are summarized in terms of the food types in Table 2 ~ Table 5.

Table 2. Summary of Cl analysis with food types

Food type	Range			Mean	SD
Main dish	80	~	3639	670	1313
Soup and stew	943	~	27154	7014	7705
Side dish	2943	~	12018	7059	2485
Dessert	4.4	~	7471	1322	2427
Fast food	4621	~	16447	7944	3099
Flour food	1689	~	8848	4761	2057
Others	14	~	21182	3652	5219

Table 3. Summary of Mn analysis with food types

Food type	Range			Mean	SD
Main dish	0.82	~	4.00	2.61	1.03
Soup and stew	0.22	~	7.15	2.39	2.27
Side dish	1.06	~	19.27	3.85	4.31
Dessert	0.03	~	11.9	3.18	3.87
Fast food	0.38	~	8.77	2.34	2.12
Flour food	1.57	~	22.71	5.54	5.87
Others	0.16	~	25.41	3.34	6.02

Table 4. Summary of Na analysis with food types

Food type	Range			Mean	SD
Main dish	5.8	~	2015	309	753
Soup and stew	560	~	13801	3754	3861
Side dish	1708	~	7052	4219	1441
Dessert	3.1	~	4021	853	1419
Fast food	2200	~	9233	4574	1915
Flour food	1273	~	6193	3357	1661
Others	4.6	~	12100	2197	3147

Table5. Summary of Zn analysis with food types

Food type	Range			Mean	SD
Main dish	4.04	~	7.74	6.02	1.46
Soup and stew	1.10	~	9.28	4.46	3.13
Side dish	2.47	~	35.60	9.99	8.23
Dessert	1.61	~	16.45	6.10	4.68
Fast food	1.09	~	21.5	8.09	6.00
Flour food	2.38	~	12.24	7.11	2.80
Others	1.24	~	59.8	7.86	13.67

The mean values of Cl and Na have the highest values in the fast food and the lowest values in the main dishes. In the case of Mn, flour foods and fast foods showed the highest and lowest mean values, respectively. As for Zn, Side dish has the highest value. However the variation of the mean values according to the food types was not so large.

3. Conclusions

Ninety food samples were analyzed by INAA. This work will be used to accumulate basic data in a variety of Korean foods and to evaluate the nutritional status of Korean children.

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