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Original Article

Mineral Intake from Sum of Standard Food Composition Table and That from Our Analytical Data

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Daily intakes of some mineral nutrients were calculated from the data in the standard table of food composition in Japan (2000) on trial menus of our students. On the other hand, all of the cooked foods prepared for each trial menu by the students were well mixed and ground down into uniform sludge. The contents of some mineral elements were determined by the atomic absorption spectrophotometry by use of acid sample solutions dissolving ashes of each of the sludgy food samples. Students' menus were of four different styles; Japanese food which was westernized and fatty at present; convenience store food which was composed of daily box lunches, boiled rice-balls, prepared dishes and side dishes from a convenience store; precooked food which was composed mainly of instant noodles or prepared food; and high zinc food which was cooked including a considerable number of high zinc foods except oysters, because they has a long off-season in Japan. Except for zinc and sodium (chloride), our analysis showed results which were a little lower results than the sum provided by the standard food composition table. The high zinc food provided much zinc, especially in the summed data. The precooked food showed a low zinc level, however, the zinc intake displayed by the analysis of the convenience store food showed a level of the zinc intake second to the analytical result of high zinc food. Eventually, the analytical zinc intake of the convenience store food, 9.1 mg/day, was within the recommended daily zinc intake of Japanese young women from 18 to 29 years old. On the other hand, the precooked food showed a low level of zinc intake, 3.1 and 3.9 mg/day, in the summed intake from the food composition table and our analytical result, respectively. In the present study, renewing the standard table of food composition in Japan, we attempted to clarify the difference between the old and the new standard food composition tables by use of nearly the same menus. Although intakes of calcium, phosphorus and iron seemed to decrease, those of magnesium, zinc and manganese looked like to increase in the summed data from the new table. However, this difference between the new and old tables was indistinct and not consistent but partially unavoidable, because insufficient data of the old standard food table had inevitably induced us to use a local food composition table.

Key Words: Ca, K, Mg, Zn

Introduction

In the past study, we had suggested that the intake of zinc for Japanese adults was insufficient [5, 8, 9] to the former nutrient requirement which was just the same to

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the American requirement level. Prior to the 21 st century, the standard table of food composition in Japan was expanded and revised [7]. At nearly the same time, the nutrient requirements in Japan had been revised as applicable to every age group or both sexes [1]. In this study, we have reinvestigated the intake of several minerals by two means; the sum of mineral data in the students' four menus based on the data of the new standard table of food composition [7], and the analytical data of the sludgy cooked food from nearly the same menus.

At present, potassium, calcium, magnesium, zinc and sodium were analyzed. Adding to these minerals, phosphorus, iron, copper and manganese were also compared based on the old [6, 10] and the new [7] food composition tables. From the above list of minerals, zinc is thought to be difficult to make sure their personal adequacy, since zinc deficiency symptoms have many variations, and the symptoms are different with each type of case. Such conditions together with its homeostasis in body fluid [2] make it difficult to diagnose deficiencies. This suggests that enough intake of zinc like the recommended daily level is essential to experience the useful effects of zinc for the promotion of health.

Materials and methods

The daily intake of sodium, potassium, calcium, magnesium and zinc were determined by the atomic absorption spectrophotometry. The sample was a dilute hydrochloric acid solution which was prepared after an overnight ignition at 480 °C in an automatic temperature regulated electric furnace. This ignition temperature was decided by that of rice samples, where the samples could oxidize to get nearly white ash without cadmium loss [3, 4]. In the case of rice samples, at a temperature of less than 500 °C, substantial cadmium loss did not occur [3, 4]. In the past experiment, the recovery during the drying or ashing procedure had been checked by an automatic temperature regulation system of the electric oven or the electric furnace with a continuous temperature recording system in the furnace and in the ashing samples [3].

The melting temperature and the boiling temperature of metallic cadmium are 320.9 °C and 767 °C respectively. In the case of zinc, the melting and boiling temperatures are 419.5 °C and 907 °C respectively. Therefore, the physically supported dominance can be assured in the ashing course of zinc as like that of cadmium case. At any rate, our present ignition condition seems to be practically enough for zinc, even though several mineral losses have been reported in the course of drying or ashing [2].

In addition to the seven minerals mentioned, some other minerals such as phosphorus, iron, copper and manganese have been studied in regard to the daily sum according to the data in the old [6, 10] or the current standard food composition table [7]. The sums of newly enriched minerals into the new composition table [7] is naturally compared on the daily intake level to those of the old table [6] including another food composition table [10] consisting of magnesium and micronutrients those were excluded in the old food composition table [6] on the daily intake level.

Table 1 indicates the students' menus for used in this investigation. First, the typical Japanese food menu is given. This was cooked mainly by western manner, however, some strange food materials, hardly understandable to western people, seem to be present. Total foodstuffs used were 55. Next, the convenience store food menu is shown. Items that can be easily bought at a convenience store an original box lunch and some specially prepared daily dishes from the store are included. Food materials used were thought to be 32. The third menu is of processed food which includes instant food or precooked food, for example, instant noodles, beefburger, fried potatoes and potato chips. Easily separable food items were 12. The fourth menu is of high zinc food which is composed by several zinc rich food items; although each one is eaten by our students' own choice. Therefore, crude cereals, food having a long off-season like oysters, and expensive foods are excluded. Total food items used were 39 exactly.

Results and Discussion

Data based on students' menu have been obtained through the daily sum of respective minerals according to the content of each in the current standard table of food composition in Japan [7]. The other kind of data is prepared by the analysis of mixing sludge of the cooked food for each menu. They are the Japanese food in Table 1; the convenience store food which consists of the box lunch, the rice-balls, the prepared dishes and the side dishes from the store; the processed food, consisted of instant foods; and the high zinc food which is composed of many high zinc food items with the exception of oysters which are the highest zinc food. Oysters are not an all

Table 1 Four types of students' menu

1. Japanese food (composed of 55 different food items)
   Breakfast: Cooked rice (well polished), Seasoned and toasted laver (seaweed, *Porphyra yezoensis*), Omelet, Grated radish, Lotus rhizome slices, okra and flesh of Japanese plums salad, Fermented salty soy bean paste soup with *sake* lees.
   Lunch: Spaghetti Napolitan, Potage soup of squash, Fruit and yogurt salad.
   Supper: Steamed waxy rice with chicken and vegetables locally flavored at *Hiruzen* area, Fermented salty soy bean paste soup with *tofu* and seaweed (*Undaria pinnatifida*), Spinach, sesame salad with soy sauce dressing, Silver pomfret slices broiled with *yuzu* sauce, Sliced lotus rhizome pickles in vinegar.
2. Convenience store food (composed of about 32 items)
   Breakfast: Melon bun, Aloe yogurt.
   Lunch: Cooked rice balls (with *katsuo,* with *konbu*), Salad of Japanese radish.
   Supper: A special box lunch for an interval at a theater, Green tea.
   Snack: Baked pudding.
3. Precooked food (composed of about 12 items)
   Breakfast: Instant noodles.
   Lunch: Beef-burger sandwich, Soda.
   Supper: Instant noodles.
   Snack: Potato chips, Soda.
4. High zinc food (composed of net 39 items)
   Breakfast: Saute of ground meat and mushroom, Fermented salty soy bean paste soup with corbs (a small fresh water shellfish), Salad of immature corn and potato, Grean tea.
   Lunch: Pasta with broccoli and shrimp, Rolled spinach and beaf flavored with tomato, Black tea.
   Supper: Western style cooked rice with mushrooms, Fermented salty soy bean paste soup with *wakame* (seaweed, *Undaria pinnatifida*), Corn sauce gratin with scallopes and broccoli, Herbal roasted *shiitake* mushroom (*Lentinus edodes*), Grean tea.

*Italicized word, *e.g., P. yezoensis or sake* is a scientific or a Japanese name.

Table 2 Intake of several minerals from sum or analysis, and their rates of adequacy

	Recommended intake*1→	K, 2000 mg		Ca, 600 mg		Mg, 250 mg		Zn, 9 mg		NaCl, 10 g	
	Data source ↓	Intake	Ade.	Intake	Ade.	Intake	Ade.	Intake	Ade.	Intake	Ade.
Japanese food*4	Sum*2	3,888	194	512	85	393	157	8.4	93	11.4	114
	Analysis*3	2,169	108	406	68	277	111	8.3	92	10.7	107
Convenience store food*5	Sum*2	3,362	168	475	79	241	96	7.8	87	11.5	115
	Analysis*3	1,260	63	395	66	153	61	9.1	101	15.4	154
Precooked food*6	Sum*2	2,218	111	473	79	187	75	3.1	34	27.3	273
	Analysis*3	1,208	60	356	59	125	50	3.9	43	13.7	137
High zinc food*7	Sum*2	3,682	184	400	67	494	198	11.9	132	13.3	133
	Analysis*3	2,135	107	197	33	258	103	8.7	97	13.5	135

*1 In Japan, the above recommended intakes are available to young adult women from 18 to 29 years. Those are used for the calculation of adequacy, percentage of each intake to the upper recommendation.
*2 Sum shows total intake during a day of each mineral counted from the standard table of food composition in Japan (2,000).
*3 Analysis shows each intake per day based on our analysis using an atomic absorption spectrophotometer.
*4 Japanese food contains breakfast, lunch and supper those are eaten by our students' own accord as shown in Table 1.
*5 Convenience food means that the menu is mainly composed by merchandises in a convenient store.
*6 Precooked food mean the case of save time to prepare meals. Precooked or instant food is used.
*7 High zinc food show the case of menu which is composed mainly by high zinc food which is eaten by our students' own accord.

season food. All people do not always like oysters. After all, people who eats oysters can easily get enough zinc during the winter, but not during warm seasons (from April to the end of October in western Japan). Excluding oysters, there are no food that includes a sufficient amount of zinc to meet the daily requirement easily.

Table 1 includes the daily taken foodstuff numbers composed of each menu, respectively. The foodstuff numbers are as follows: 55 in Japanese food, 32 in convenience store food, 12 in precooked food and 39 in high zinc food. It is common sense that consuming a variety of foods in a day results in a good balanced mineral intake. The relationship between the number of different foodstuffs consumed and adequate mineral intake is clear in the case of Japanese food, convenience store food and precooked food although some exceptions are present as in the case of sodium and in high zinc foods (Table 1 and Table 2).

Table 2 shows two kinds of intake and adequacy. The upper one is calculated from the sum of intake of potassium, calcium, magnesium, zinc and sodium based on the standard table of food composition in Japan [7]. The lower one is calculated from the analytical data. The concentration of each mineral of the final sample solution was determined by the comparison between the sample and the standard output of the atomic absorption spectrophotometer. The checked weight before the drying of the sludgy sample and the weight of the whole sludgy sample were used as the base for the calculation.

Low intake of calcium and high intake of sodium were characterized in table 2. Those seemed to be peculiar to Japanese food. Too many restrictions, such as limited protein intake, about 55 g per day, the necessity of animal protein to maintain a certain zinc intake level, control of fat or energy to prevent adult diseases and so on are existent as the problems to solve at once. Such complexity might caused a reduction of a cup of milk per day in the diet.

In table 2, it is likely that the analytical data is lower than the sum of the food table data, except two cases of zinc and sodium. There is no comment on the lower values provided from the analysis, because we have no data on the recovery of related minerals from this analytical procedure, and there are many mineral losses during the dryness or ignition process [2].

About zinc, we think there is no problem in the recovery, because we had had the recovery data of cadmium [3] which was similar but somewhat unreliable in physical properties to zinc. Although the method of final analysis was different from the present atomic

Table 3 Mineral intake from an improved menu for much zinc intake per day (by old table).

Food	K (mg)	Ca (mg)	Mg (mg)	P (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Mn (mg)
Breakfast								
Whole wheat bread	299	26	68	334	3.3	2.3	0.36	2.99
Vegetable salad	170	22	14	78	0.9	0.6	0.05	0.11
Milk tea	166	102	10	93	0.1	0.4	0.02	0.18
Lunch								
Cooked brown rice with *Hijikia**1	513	112	133	286	4.7	1.8	0.23	1.93
Poak and vegetable soup	442	32	24	79	1.1	0.7	0.14	0.18
*Brassica**2-sesami-soy sauce salad.	322	227	29	65	2.5	0.5	0.10	0.26
Supper								
Whole wheat bread	299	26	68	334	3.3	2.3	0.36	2.99
Humberger	473	37	28	120	2.2	2.0	0.19	0.18
Pumpkin-carrot soup	670	67	28	83	1.8	0.6	0.11	0.41
Snack between meals								
Fruits yogurt	193	62	14	59	0.2	0.2	0.05	0.23
Sum of intake per day	3,548	712	416	1,529	20.1	11.4	1.59	9.47*3
Recommended mineral intake*4	2,000	600	250	700	12.0	9.0	1.60	3.00
Adequacy (%)	177	119	166	218	168	127	99	316

*1 *Hijikia fujiforme,* called "Hijiki" in Japan, is a seaweed, brown algae, including much K, Ca, Mg, Fe and dietary fiber, although availability of each mineral is low.

*2 *Brassica campestris,* called "Komatsuna" in Japan, is a leafy vegetable, containinng as much vitamins as spinach.

*3 Mn intake is much, it is nearly 10 mg/day, the upper limit intake.

*4 Recommended mineral intakes are for women from 18~29 years old. They are used for adequacy calculation.

Table 4 Mineral intake from an improved menu for much zinc intake per day (by new table).

Food	K (mg)	Ca (mg)	Mg (mg)	P (mg)	Fe (mg)	Zn (mg)	Cu (mg)	Mn (mg)
Breakfast								
Whole wheat bread	289	22	121	272	2.3	2.6	0.37	3.50
Vegetable salad	149	20	10	71	0.7	0.5	0.13	0.10
Milk tea	158	110	11	95	0.0	0.4	0.01	0.22
Lunch								
Cooked brown rice with *Hijikia**1	496	112	131	276	5.4	1.8	0.25	1.81
Poak and vegetable soup	465	26	26	99	0.9	0.8	0.12	0.20
*Brassica**2-sesami-soy sauce salad.	373	151	25	60	2.3	0.4	0.09	0.23
Supper								
Whole wheat bread	289	22	121	272	2.3	2.6	0.37	3.50
Humberger	460	38	29	183	1.8	2.8	0.14	0.18
Pumpkin-carrot soup	650	57	31	76	1.2	0.5	0.10	0.27
Snack between meals								
Fruits yogurt	213	66	16	60	0.1	0.3	0.05	0.17
Sum of intake per day	3,541	624	521	1,464	16.9	12.7	1.63	10.19*3
Recommended mineral intake*4	2,000	600	250	700	12.0	9.0	1.60	3.00
Adequacy (%)	177	104	208	209	141	141	102	340

*3 Mn intake is too much, it exceeds 10 mg/day, the upper intake limit. The other * marks are the same to the cases in Table 3.

absorption spectrophotometry, it seems that the present results are sure, even though, a considerable loss seems to be found during drying or ignition in many mineral elements [2]. In any event, when the ignition temperature was lower than 500 ℃ [3], we have no uncertainty about zinc loss during the drying and ashing processes.

Although the zinc case shows a low adequacy rates compared with the other minerals except calcium, the analytical data are not always lower than the summed data. One reason for this is caused by a negligible loss of zinc compounds during the analytical process; that is lucky for us.

In order to know well the new standard table of food composition [7], we had tried to clarify the difference in quality between the new and the old tables. The menu which was composed of 37 different food items was analyzed by use of both food composition tables. In the old table [6], there were no data about zinc, copper or magnesium basically. Therefore, we used, due to need, another local food composition table [10] which includes magnesium and many other micronutrients. The results are given in Table 3 and 4, respectively. From standpoint of mineral nutrition, it seems that the difference between these tables is insignificant, although certain differences are present in the case of each mineral. A common significant point was high intake of manganese. The countermeasures to manganese excess seem to be important, because the low insulin diet depending on food requiring a low blood insulin level is fashionable at the present time.

The commercially prepared box lunches and daily dishes have been analyzed and their low zinc content has been pointed out [11]. This experiment showed the same tendency in regard to processed food which was composed by not many foodstuffs. Conversely, the study of convenience store food indicated that sufficient amounts of zinc were found, particularly in our analytical data, while the summed data from the current food composition table [7] did not show so much zinc. This result suggest some interesting problems to us. For example, the food menu including boxed lunches points to a low zinc content but in our data shows enough zinc is present, while processed foods exhibit a low level of zinc.

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