

**Original****Analysis of Fiber Intake and Its Sources in a Year School Lunches at a School in Japan**

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**ABSTRACT** *Background:* Deficiency of dietary fiber is the most important health-related nutrition problem at present in Japan. It is also true for school lunch. In Japan almost all the elementary school students have school lunch throughout the year and the recommendation of fiber for the upper grade students is 6g/lunch. However, they have not been successful. *Objective:* To analyze the contribution of fiber sources in school lunch and to find the new method(s) to increase fiber intake to more than 6g. *Method:* Fiber intake by all the school lunches in a year (197 days) at a public school was calculated by using the Japanese Standard Food Composition Table. All the 197 menus were grouped into 3 categories of fiber as more than 6g, 5 - 5.9g and lower than 4.9g. Furthermore, the contribution of various food groups (cereals, vegetables, potatoes, fruits, beans, soy products, nuts and seeds, seaweed, mushrooms, etc.) were calculated. More detail analysis was conducted for the vegetable (root vegetables, stalk vegetable, leafy vegetables, fruit- vegetables, flower vegetable). *Result:* Staples foods of 197 menus were 141 for rice and 56 for wheat, being about 75 % was rice. However, among the 18 menus with more than 6g fiber intake, as the staple foods, 9 and 9 used rice and bread, respectively. When the rice was the staple food, a lot of burdocks, konnyaku and soybean were used. There were 27 menus with a fiber of 5 -5.9g and only 6 of them used rice as a staple food. Fiber supplied by commonly used rice (85g) was only 0.4g. The average intake of fiber from vegetables was 1.9g. The use of rice as a staple food for more than 3.5 times a week (5 days) is recommended by the Japanese government to sustain and to activate the local products. Under such a situation, we have to consider the use of brown rice. *Conclusion:* To meet the fiber requirement by vegetables is difficult and fiber-rich foods such as brown rice may be recommended for Japanese school lunch.

**Key words:** school lunch, vegetable, fiber, rice

**INTRODUCTION**

The School Lunch Law was established in 1954 in Japan, and the current school lunch is implemented based on the School Lunch Practice Standards (1). Among dietary intake criteria, dietary fiber is determined as a nutrient to set a target amount for primary prevention of lifestyle-related diseases. A target amount per day of 18 years or older for the male is 19 g or more and for female is 17 g (2). However, the data related to the dietary fiber requirements of children were limited. It is difficult to determine the relationship between dietary fiber intake and the incidence rate of lifestyle-related diseases. According to annual nutrition survey of school children, the fiber intake of fifth-grade children in elementary school was 10-15g (3). It has been shown that fiber intake of children may be lower than the requirement. Generally, vegetables are considered as an important source of dietary fiber.

In addition, the Ministry of Agriculture, Forestry and Fisheries' proposal to consume 350 g of vegetables per adult per day seems to strongly support the opinion that it is necessary to eat vegetables(4). Definition of vegetable is different not only from country to country but also from ministry to ministry within Japan. However, some students say that they are not good at vegetables because of taste. So far, nutrition teachers and school nutrition staffs have made many reports on leftovers of vegetables in school lunches (5) but have yet to find clear improvement. In this study, we analyze the menu of past school lunch to clarify what kind of menu can meet the standard

amount of fiber, and the fiber intake standard of elementary school-aged 10 to 11 years. Thereby we suggested a viable solution to improve the amount of fiber intake by children in school meals.

**METHODS**

In this study, we used 197 menus for school meals in a year at an elementary school. The local government offers a complete school lunch, with 3.5 times a week for rice. The usage of milled rice for the upper grades of elementary school is 85g. In addition, the bread implemented by the city is a bread containing rice flour in which the percentage of flour used is 90% wheat flour and 10% rice flour produced in the prefecture. In the upper grades, rice flour bread is mainly provided with 63 g wheat flour and 7 g of rice flour.

Fiber intake in 197 menus in a year was calculated using the Japanese Food Composition Table (6). Specifically, dietary fiber was classified into three groups: 6g or more, from 5 to 6g and less than 5g. The staple food was classified into cooked rice and bread, and the tendency of fiber intake per serving by staple food was analyzed. We also estimated the amount of dietary fiber contained in the staple food. Furthermore, the ratio of fiber intake was calculated by the food group as follows cereals, vegetables, potatoes, fruits, beans, soybean products, seeds and fruits, seaweed, mushrooms, etc. In particular, vegetables were divided into five types; root vegetables, stem vegetables, leaf vegetables, fruits and vegetables (Photo 1) and their characteristics were analyzed. Fruits, mushrooms, seaweeds, beans, seeds and potatoes are not vegetable by the Japanese definition (6)

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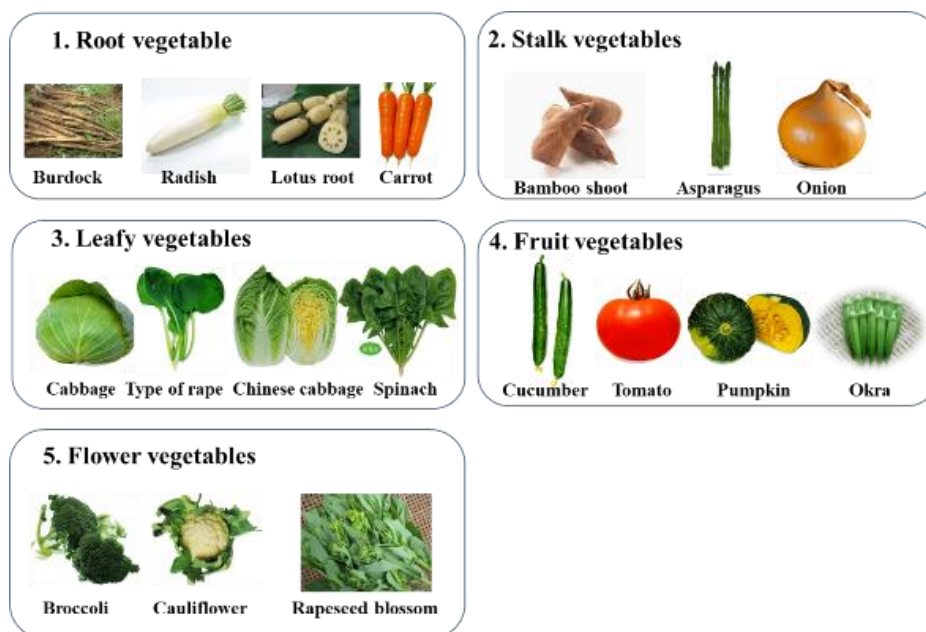


Photo 1. Classification of Japanese vegetables

**RESULT**

The distribution of staple food in 197 days is 141 days as rice and 56 days as bread, so 3/4 of the school meals using rice were staple food. After sorting the menus according to the amount of fiber, the result was 18 menus providing 6 g or more of fiber, 27 menus providing 5g to 5.9g and 152 menus providing 4.9 g or less. The average vegetable intake was 103 g, 105 g and 82 g when the fiber intake was 6 g or more, 5 to 5.9 g and 1.9 g or less, respectively. The average amount of plant-based fiber is 2.9 g, 2.1 g and 1.7 g for menus provided from 6 g or more, 5 to 5.9 g and 4.9 g. or less, respectively. The average amount of plant-based fiber in 193 meals is 1.9g.

Table 1 shows menus that provide 6g or more of fiber (18 menus). The average amount of fiber provided from this menu group was 6.9 ± 0.9 g. Staple food of 18 menus with fiber content of 6 g or more was the fact that the number of regular meals is 9 for rice and 9 for bread.

**Table 1. Menu provided more than 6g of fiber per serving**

No	Amount of fiber (g)	Staple food	Menu
1	8.5	Bread	apple jam, milk , pork beans, seaweed salad, yuzu dressing
2	8.4	Bread	apple jam, milk, pork beans, corn
3	8.4	Bread	sugar-reduced jam, milk, pork beans, boiled vegetables, mayonnaise
4	7.9	Rice	milk, soybean kinbira burdock, croquette, boiled cabbage, worcester sauce
5	7.3	Bread	milk, stewed hamburger, broccoli, pumpkin botage
6	7.3	Rice	milk, chicken and konjac miso stew , croquette, broccoli, worcester sauce
7	6.8	Rice	milk, pork and burdock stew, seaweed salad, green soybean dressing, mixed nuts
8	6.8	Rice	milk, Japanese style hamburger, soybean chopped burdock
9	6.3	Bread	small bread with rice flour, milk, spaghetti napolitan, boiled vegetables sesame dressing, frozen mandarin orange
10	6.2	Bread	small bread with rice flour, margarine, milk, fried soba noodle, fried beans
11	6.2	Bread	plain bread with rice flour, apple jam, milk, fried vegetable, university potato
12	6.2	Bread	apple bread with rice flour, milk, seaweed udon noodle, fried beans, mandarin orange
13	6.2	Bread	soybean flour fried bread with rice flour, milk, pumpkin potage, omelette ketchup
14	6.2	Rice	milk, soybean chopped burdock, thick roasted egg, yukari pickled
15	6.2	Rice	milk, soybean chopped burdock, crab egg roll, instant pickles
16	6.2	Rice	milk, sudachi vinegar, small fish nut
17	6.1	Rice	milk, soybean chopped burdock, grilled saury, sudachi
18	6.1	Rice	milk , simmer sour pork with burdock, thick omelet containing vegetables , yukari pickled , mixed nuts

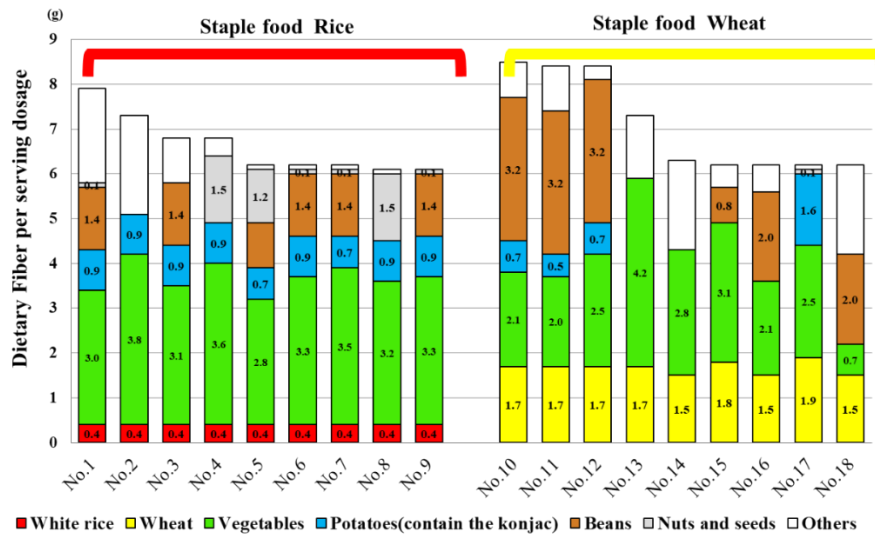


Figure 1. Origin of dietary fiber when the staple food was rice (left) or bread (right)

Figure 1 shows the origin of dietary fiber by staple food. When rice was staple food, only 0.4 g of fiber from rice, 2.9 g of fiber from vegetables, about 0.9 g of fiber from tubers (mostly konnyaku) and beans is about 0.9 g (mostly soy) and 0.5 g of fiber from nuts (mostly sesame and mixed nuts) were consumed. In the case of staple food was bread, the amount of fiber from bread was 1.7 g, 2.4 g from vegetables, about 0.4 g from tubers (mainly potatoes), about 1.6 g from

beans (mainly soy and beans), seeds and fruits (mostly mixed nuts that consume 0.1 g of fiber).

Figure 2 shows contribution of dietary fiber from 5 types of vegetable by stable foods. When staple food was rice, 2.4g of total 3.3g was from root vegetables and when staple food was bread, total intake was 2.4 g and similar intakes from 5 types of vegetables.

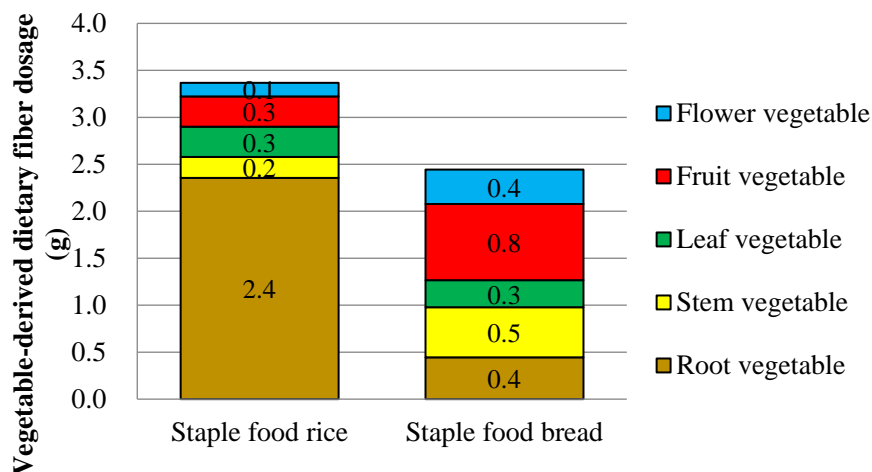
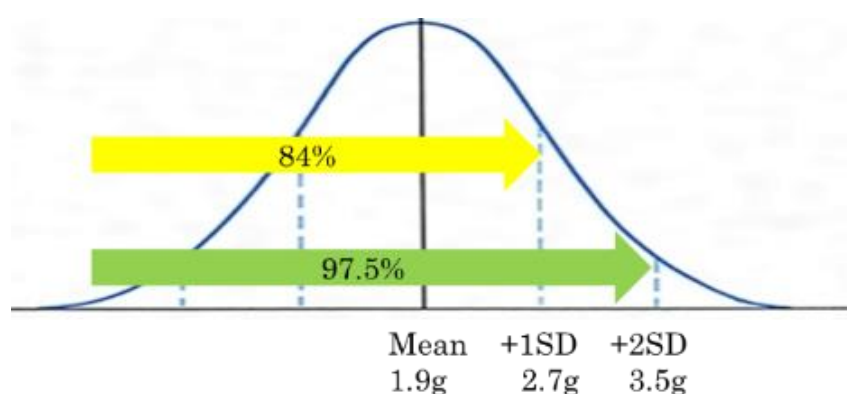


Figure 2. Contribution of dietary fiber from 5 types of vegetable by rice or bread as staple foods (n=9 in each staple food)

Table 2 shows 27 menus that provide between 5 and 5.9g per meal. This menu group provides an average of  $5.4 \pm 0.3$  g of fiber. There were only 5 menus using rice as a staple food. In addition, this group often served stewed dishes using root vegetables as side dishes.

**Table 2. Menu provided 5 - 5.9 g of fiber per serving**

No	Amount of fiber (g)	Staple food	Menu
1	5.9	Bread	reduced sugar jam, milk, chicken and cabbage curry sauteed, abe river mochi
2	5.9	Bread	milk, boiled vegetable in cream, omelette ketchup, kiwi fruit
3	5.8	Bread	,milk, wiener chili sauce, boiled vegetable mayonnaise
4	5.8	Rice	red rice, milk, shrimp fry, boiled cabbage, tartar sauce, kinju juice, honey peanut
5	5.7	Bread	chocolate paste, milk, grilled rice noodle, boiled vegetable, mayonnaise
6	5.7	Bread	milk, Western-style boiled fruit cocktail
7	5.6	Bread	chocolate pate, milk, stewed hamburger, corn soup
8	5.6	Bread	soybean paste, milk, seaweed udon noodle, yukari pickle, corn
9	5.5	Bread	brown sugar bread with rice flour, milk, scotch egg, boiled vegetable, corn bottage soup
10	5.5	Bread	cocoa bread with rice flour, milk, borsch, Japanese style salad, Japanese dressing.
11	5.5	Rice	milk, chikuzenni, narutokintoki croquette
12	5.3	Bread	plain bread with rice flour, soybean paste, milk, spaghetti napolitan, French salad, French dressing
13	5.3	Bread	half-calorie margarine, milk, stir-fried vegetable, abe river mochi
14	5.3	Bread	milk, stewed hamburger, corn potage soup, moonlit jelly
15	5.3	Bread	spaghetti with soybean flour, seaweed salad, sesame dressing
16	5.2	Bread	self-edd sandwich, milk, corn potage soup
17	5.2	Bread	sugar jam, spaghetti with meat sauce, French salad, French dressing
18	5.2	Bread	small butter bread with rice flour, milk, spaghetti with meat sauce, French salad, French dressing
19	5.2	Bread	milk, clam of chowder meat dumpling, boiled cabbage
20	5.2	Rice	Milk, Braised foods, Boiled cabbage, komatsuna, mixed nuts
21	5.2	Rice	milk, yuzumossi oden, yuzumiso oden miso, mandarin orange, Nozawa-ha pickled with rice flour
22	5.1	Bread	milk, spaghetti soup, seaweed salad, blue jiso dressing
23	5.1	Bread	milk, mushroom spaghetti, Japanese salad, citrus fruit dressing
24	5.1	Bread	milk, spaghetti Napolitan, French salad, French dressing
25	5	Bread	sandwich, milk, corn potage soup
26	5	Bread	pumpkin bread, milk, gome udon, small sardine tempura, ponkan orange, setubun festival menus
27	5	Rice	Hayashi rice, milk, seaweed salad, green joso dressing



**Figure 3. Mean intake of fiber from vegetable and the values of mean+1SD and +2SD**

Figure 3 shows that the mean value of vegetable-derived fiber is 1.9g and the mean + 1SD is 2.7g that cover 84% of the participants (yellow arrow). The mean + 2SD is 3.5g that includes 97.5% of participants (green arrow). These results indicate that it is very difficult to take more than 3g from vegetable.

Figure 4 shows the distribution of various vegetable intakes of 197 lunches in a year. Intakes from root vegetable was 36%, stem vegetable 21%, leafy vegetable 22%, fruit vegetable 15% and flower vegetable 6%.

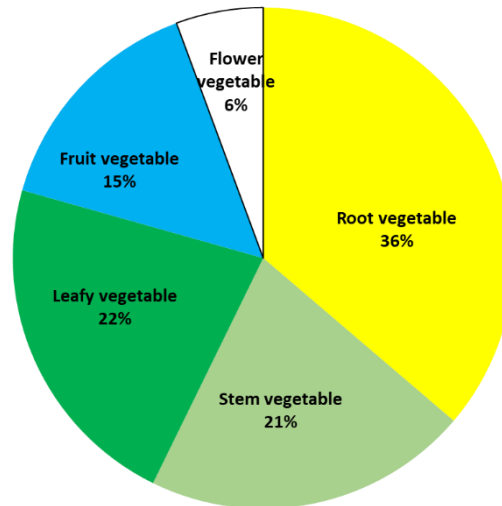


Figure 4. Distribution of various vegetable intakes

#### DISCUSSION

In this study, the distribution of staple food in 197 days was 141 days as rice and 56 days as bread, in other words 3/4 of the school meals using rice as stapled food. It was found that when the staple food was white rice, the menu from which vegetables can be satisfied with fiber requirement was extremely limited. Staple food of 18 menus with fiber content of 6g or more in 197 days were 9 menus using rice and 9 menus using bread. The menu used rice characterized by burdock, konjac, soybeans used in large amounts.

In the school lunch standard for every child or student, effective April 1, 2013, the standard value of fiber was set at 6g for elementary children 10 to 11 years old. Among the menus that provide 6g of fiber, 9 menus use rice as staple food, the dietary fiber is 0.4g from rice, 0.9g from konjac, 0.9g from soybeans and 0.9g from nuts and 2.9g from vegetables. Similarly, if staple food was bread, then the fiber is 1.4 g from bread, 0.4g is from tubers, 1.6g was from beans, 0.1g was from the grain and 0.1g and 2.5g were derived from vegetables. As a result, the amount of vegetable-derived fiber provided at a school meal was approximately 3g, which makes it very difficult to increase vegetable-derived fiber to 3.5g or more. A menu with fiber of vegetable origin of 3.5g or more is used mainly with burdock, legume and konjac. When leafy vegetables like cabbage and cardamom were used, the amount of dietary fiber was usually 2g or less.

Eating insufficient fiber is often thought to be due to insufficient intake of vegetables. According to FAOSTAT (Food Balance Sheet) based on FAO (7) guideline, the results of annual vegetable consumption per capita in 2009 in major countries around the world show that Japanese vegetable consumption is 278g, in the United States is 337g, Canada is 308g. Thus, the consumption of Japanese vegetables compared to other countries is not large. However, there is no unified definition of vegetables and fruits in the world due to the culinary culture of each country and the way of thinking of each country.

In comparison on FAO (7), Japanese and American definitions of vegetables, in Japan, "vegetables" are edible herbaceous plants that refer to edible plants with a high water content (6). They mainly eat leaves, roots, stems (including rhizomes), flowers, buds, and fruits as side dishes. In contrast, the United States classifies vegetables into five subgroups: dark green vegetables, red and yellow vegetables, legumes, starchy vegetables, and others (8). Among them are potatoes, sweet potatoes and other potatoes, as well as seasonings such as tomato ketchup. If we compare the definition of Japanese vegetables with the definitions of each country, it seems that vegetable consumption in Japan is not small. In a school lunch this study, the average dietary fiber intake from vegetables was 1.9g. The current target intake of vegetables is set for green-yellow vegetables and light-colored vegetables. For example, referring to the Japanese definition, if vegetables are classified into five types: root vegetables, stem vegetables, leaf vegetables, fruit vegetables, and flower vegetables (6), the dietary fiber content differs, and root vegetables contain many dietary fibers. Isn't a standard for target intake necessary? If we are trying to fill our dietary fiber with vegetables, we will need to think more about the scientific rationale that "let's meet the 350g per day regardless of whether it's leafy or root vegetables." It is also important to taste various dishes from the viewpoint of expanding the food experience. Couldn't it be better to eat vegetables more freely? We guess 100-200g for leafy vegetables and 100-200g for root vegetables.

According to a report from the Survey and Research Cooperation Council on the Development of Standards for Eating Children's Meals for School Lunch (March 1991), "It is not enough to simply fill 8 g of dietary fiber per 1,000 kcal of energy. Efforts to promote the use of brown rice (including germinated brown rice), potatoes, beans, seeds, nuts, vegetables, mushrooms, algae, etc. to increase intake while maintaining the desired Japanese food culture should be encouraged through school lunches to help children

stay in their daily diet

Increasing fiber intake from vegetables is not easy. We want to suggest the use of sprouted brown rice to increase dietary fiber intake. The reason for this is that new cookware is required to use brown rice, but germinated brown rice can be cooked with the same equipment as white rice. Already, some municipalities use germinated brown rice for school meals. The amount of germinated brown rice used is 5 to 10% of that of polished rice, and it is used about once or twice a month. However, in order to take advantage of the fact that brown rice is easy to ingest dietary fiber, it is preferable to use 50-100% germinated brown rice. The use of germinated brown rice will also be significant in maintaining the food culture that has been cultivated on rice by Japanese people. In addition, cultivating the eating habits of eating germinated brown rice during school age may contribute to future health.

The use of rice as a staple food for more than 3.5 times a week (5 days) is recommended by the Japanese government to sustain and to activate the local products. Under such a situation, perhaps the only way to increase the fiber intake to more than 6 g is the use of brown rice. Brown rice needs special cooking pan, therefore, pre-germinated brown rice may be recommended.

In conclusion to meet the fiber requirement by vegetables is difficult and fiber-rich staple foods such as brown rice or pre-germinated brown rice must be recommended.

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