ORIGINAL

Acceptability of Fish Meat with Okara as School Lunch

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ABSTRACT ***Background*:** At present in Japan, fish consumption is decreasing. It is desirable that through their school lunch children will learn that fish is tasty. Deficiency of fiber intake is also a problem in Japanese people. Supplying enough fiber is a difficult task in school lunch. Okara is a byproduct created during the process of tofu production. It is mainly fiber and has the potential for beneficial uses. Since in the past there has been little study on supplying fiber from main dishes, we were challenged to address this topic. *Purpose.* To develop tasty main dishes from fish meat with Okara. ***Methods and results*:** As a preliminary study, we conducted various trials to make a tasty base of "fish and Okara" that looked like hamburger shaped, that has one portion (80g) of the final base could supply 2.2g fiber. We named it "hamburger style of fish and Okara". It was served to all the 349 children from the first to 6th grade in a school lunch at a Japanese school and evaluated by the comparison with ordinary Japanese-style meat hamburger (ordinary hamburger). Their evaluation about ordinary hamburger and "hamburger style of fish and Okara" were respectively; Overall taste is good 94 and 85%, good for easy to eat 90 and 77%, basic taste is good 93% and 83%, aroma is good 82 and 68%, appearance is good 89 and 76%. Although the results of ordinary hamburger were more favorable than those of "hamburger style of fish and Okara", the evaluation of "hamburger style of fish and Okara" was high. Waste of them was only 2.2 and 4.6% by weight, respectively. ***Conclusion*:** "Hamburger style of fish and Okara" was highly evaluated by school students and these dishes helped to meet the fiber requirement from school lunch.
Keywords: Okara, fish, hamburger, fiber, school lunch.

INTRODUCTION

As a problem of the current Japanese dietary habits, there is a lack of dietary fiber intake. In the Japanese Dietary Reference Intake reported in 2015 by the Ministry of Health, Labor and Welfare, the target amount of dietary fiber was 20 g/day or more for men and 18 g/day or more for women aged 18 to 69 years (1), however, according to the National Health and Nutrition Survey in 2017, the average intake was as low as 14.6 g/day for men and 14.3 g/day for women, and it did not meet the target amount(2). There is a similar problem even in the young generation. The reference value of dietary fiber for school lunch is 4 g or more at 6-7 years old, 5 g or more at 8-9 years old, 5 g or more at 10-11 years old, and 6.5 g or more at 12-14 years old(3). However, the actual intake was only 4.6 g at elementary school (6-11 years old), 5.9 g at junior high school (12-14 years old)(4). Dietary fiber is one of the nutrients that are difficult to meet the requirement. In school meals, opportunities to provide children with root dishes and legumes to increase fiber intake. The ingredients used for these side dishes are often foods which children dislike. This leads to an increase in waste of vegetables(5). "Okara" is generated as a by-product in the production of tofu(6). Okara is a food containing a lot of dietary fiber (11.5 g/100 g)(7), and its value to use as a source of dietary fiber is very high. However, in Japan, less than 1 % of Okara is being used for edible(8).

Another problem is the decreased intake of fish in

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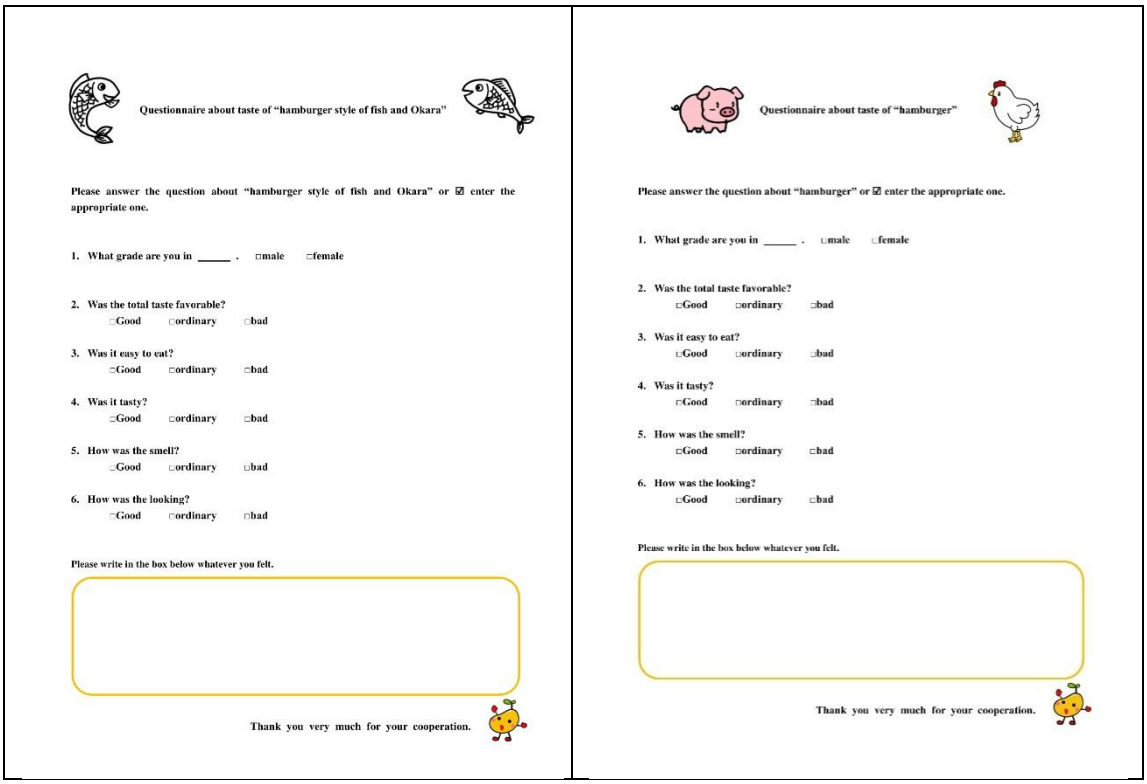
Japan. Consumption of fish that has been eaten as a protein source has been decreasing for a long time(9), and meat intake exceeds that of fishes and shellfishes in 2010.

METHODS

Development of "hamburger style of fish and Okara" We tried to develop a mixture of Okara and fish meat as a hamburger-style main dish. However, fishy smell and rough mouth feeling of Okara's texture became a problem, so we examined whether it can be eliminated by cooking method. First of all, we examined the fish odor reduction about Surimi (paste) of Lizard fish, Surimi of Scabbard fish, Surimi of Alaska pollack and Otoshimi (fragment) of Alaska pollack which are easily available as materials. Five methods were compared, namely immersed in sake, immersed in mirin, dipped in milk, dipped in ginger root juice, and covered with salt. As the results we found that dipping in milk is the best for fish odor reduction. Next, for the reduction of roughness of texture, we tried three methods (weight reduction of Okara, increase of tofu, increase of milk) and found that the increase of milk was best. By the above studies, we concluded to use Alaska pollack paste as a main source, dipping the fish paste in milk for odor reduction and increasing milk for making the product smooth mouth feeling. In order to adjust the solidness of the dough, we decided to add rice flour. In order to chew up and improve the coloring, carrots, edamame, burdocks were carved into about 7 mm.

In this way, we made the basic fabric and developed the "hamburger style of fish and Okara" as the main dish.

Preference test Subjects were the first to sixth grade (total of 349 people) elementary school children at a school near Tokyo. As a main dish school lunch, "hamburger style of fish and Okara", and the tastes of ordinary hamburgers made from pork and chicken ordinary used were compared. Questionnaire 1 is about the taste of "hamburger style of fish and Okara" and Questionnaire 2 is about the taste of ordinary hamburger (Fig 1). The recovery rates were 95.7 % and 97.3 %, respectively. In order to make it easy for elementary school children to understand, questions items and their expression methods were examined. Evaluation was made in three levels about overall taste, easy to eat, basic taste, aroma and appearance. Three levels are: good, ordinary and bad.



Questionnaire 1. Taste of hamburger style of fish and Okara

Questionnaire 2. Taste of ordinary hamburger

Fig 1. Questionnaire

Table 1 shows the food material weight of "hamburger style of fish and Okara". For one person is about 80 g. Table 2 shows the food material weight of ordinary hamburger. For one person is about 45 g.

Table 3 shows energy and nutrient concentrations. Calculated in Standard Tables of Food Composition in Japan (2015)(7).

Table 1. Food sources and their weights in 1 portion (80g) of "hamburger style of fish and Okara"

Food material	Weight (g)
Alaska pollack Surimi	22.7
Okara (law)	13.6
Tofu (Momen)	9.1
Bread crumb	3.0
Rice powder	2.0
Milk	6.3
Egg	3.8
Onion	12.1
Carrot	2.3
Burdock	2.3
Green soybean	2.3
Nutmeg	0.05
Salt	0.5
Pepper	0.05

Table 2. Food sources and their weights in 1 portion (45g) of ordinary hamburger

Food material	Weight (g)
Pork (thigh)	0.8
Chicken (thigh)	18.0
Onion	12.0
Ginger	0.8
Egg	6.0
Bread crumb	3.2
Miso (red)	2.4
Sugar	0.8
Sesame	0.8

Table 3. Energy and nutrient concentrations of "hamburger style of fish and Okara" and ordinary hamburger

	Energy kcal	Protein g	Lipids g	Ca mg	Fe mg	Fiber g	Salt g
Hamburger style of fish and Okara	81	7.0	1.8	37	0.4	2.2	0.8
Ordinary hamburger	157	11.7	9.3	23	0.6	0.6	0.4

Statistical analysis Statistical analysis was conducted by Chi-square test using Excel Statistics.

Ethical considerations We explained to the school the purpose and methods of the research and that would make every effort so that nobody can identify the school and individuals. We used only common foods. The school explained the above information to the teachers and parents and obtained their agreement.

RESULTS

Their evaluation about ordinary hamburger and "hamburger style of fish and Okara" were respectively; Overall taste is good 94 and 85 %, good for easy to eat 90 and 77 %, basic taste is good 93 and 83 %, aroma is good 82 and 68 %, appearance is good 89 and 76 %. Fig 2 shows the comparison of taste between ordinary hamburger and "hamburger style of fish and Okara". Although the results of ordinary hamburger were more favorable than those of "hamburger style of fish and Okara", the evaluation of "hamburger style of fish and Okara" was also high.

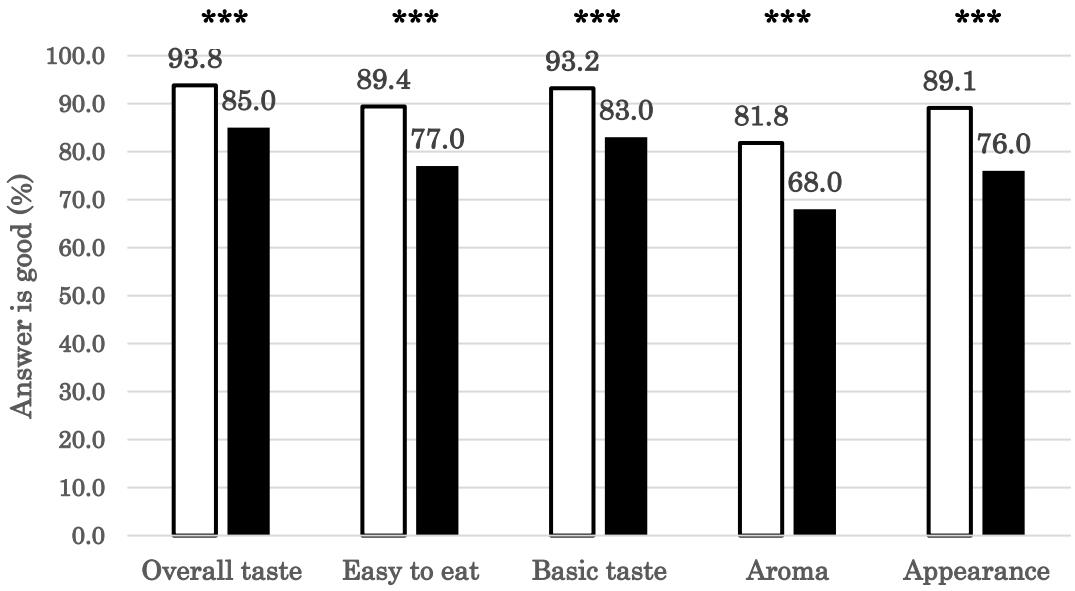


Fig 2. Comparison of taste between ordinary hamburger (□) and "hamburger style of fish and Okara" (■)
*** Significantly different by *Chi*-square test at $p<0.001$

Out of 43.49 kg of the total amount of "hamburger style of fish and Okara", the amount of waste was 2.01 kg and the waste rate was 4.6 %. On the other hand, out of the total volume of ordinary hamburger 26.7 kg, the amount of waste was 0.6 kg and the waste rate was 2.2 %. From Table 3, it was found that 2.2 g of dietary fiber is contained in 80 g of "hamburger style of fish and Okara". This indicates that it contains dietary fiber about 4 times more than ordinary hamburger.

DISCUSSION

"Hamburger style of fish and Okara" developed by us was able to obtain high evaluation as a result of providing it as school meal to elementary school students. Fish and Okara contain nutrients that are likely to be deficient in modern society, and various advantages can be considered, but their utilization is insufficient. Especially Okara is discarded in making tofu, but it is a food containing a lot of dietary fiber. In order to use fish and Okara as school lunch, it was an issue how to deliciously cook the odor of fish and the texture of Okara.

Dietary fiber is one of the nutrients deficient in school lunch(4,5). Root crops and legumes have many dietary fiber, but it is difficult to ingest dietary fiber sufficiently from these vegetables because there are many children left behind. It is possible to use staple food such as brown rice, but it is not realistic because it requires a special rice cooker. Pregerminated brown rice can be cooked with ordinary rice cooker, but the price becomes somewhat higher. For these reasons, it is desired that intake of dietary fiber is taken from the main dish.

In this research, "fish and Okara" was main dishes and we examined how to make delicious dishes with them. Surimi (paste) of Alaska pollack had a considerable fish odor. We examined using sake, mirin, milk, salt and ginger. Alcohol contained in sake has the function of evaporating trimethylamine which is a component of the fish odor. Mirin also has a similar function(10). Colloidal particles of milk protein and fat tend to adsorb odor components(11). Salt exerts moisture rich in trimethylamine out of fish body due to osmotic pressure effect. Strong fragrance ginger component cineol becomes a component without smell when mixed with trimethylamine. For these reasons, we tried five methods. As a result, we were able to confirm that milk is a food ingredient that eliminates of the fish odor. It was considered that the evaluation of "aroma" is high because it was able to suppress the fish odor.

We studied the use of Okara to increase dietary fiber. Okara has three types: 1) Okala obtained by traditional production method and contains 81.1 g / 100 g of water(12), 2) Okala obtained by the new manufacturing method and contains 75.5 g / 100 g of water(7,12), and 3) Okara obtained by drying and contains 7.1 g / 100 g of water(7).

In this study, Okara number 2) was used. This Okara has a characteristic that the fiber is long, and I expected a role as a "tether" such as croquette and hamburger. In order to reduce roughness due to Okara, the blending ratio of Okara, tofu and milk was examined. As a result, milk was most effective. It is thought to be an effect by lipid contained in milk.

In the cooking process, we were aware of adding salt to surimi. The fish meat has the property that when it is well kneaded by adding salt, the binding property increases(13). As a result, I was able to alleviate more roughness.

In order to regulate the firmness of the dough, the ingredients and its blending amount were examined. As a result, 3 g / 80 g of bread crumbs and 2 g / 80 g of rice flour gave the soft texture of the dough. It seems that the characteristics of the rice flour were also related. The rice flour used this time is made in Japan, sucks water well and thinks it was connected to a soft texture(14).

We examined the addition of vegetables to add texture, crunchy, coloring to this fabric. A combination of carrots, burdocks, and green soybeans was evaluated with good texture and color. As a result of examining the composition of the seasoning, it was the best evaluation with salt 0.5 g / 80 g, nutmeg and pepper 0.05 g / 80 g of the dough.

We conducted a preference study of “hamburger style of fish and Okara”. The target school is a medium-sized elementary school with 349 children (1st to 6th grade children), the ratio of men and women is almost the same. Even in comparison with the results such as surveys of family situations and students' tastes, physique of height/weight, lifestyle surveys such as sleeping hours and absence of breakfast(15), national physical fitness · exercise ability · exercise habit survey(16) etc. that school was the average school in the area.

In this research, we aimed to be able to ingest “fish” and “dietary fiber” lacking in the eating habits of present children at the same time, and to be able to offer development of “delicious main dish” especially for lunch. The evaluation about ordinary hamburger and “hamburger style of fish and Okara” were respectively; Overall taste is good 94 and 85 %, good for easy to eat 90 and 77 %, basic taste is good 93 and 83 %, aroma is good 82 and 68 %, appearance is good 89 and 76 %. Although the results of ordinary hamburger were more favorable than those of “hamburger style of fish and Okara”, the evaluation of “hamburger style of fish and Okara” was high. The lowest evaluation among Okara hamburger is aroma (68%). However, the evaluation means that 68 % of the children answered that they smelled good. It can not be said that “hamburger style of fish and Okara” is not tasty. In addition, “hamburger style of fish and Okara” contains 2.2 g of dietary fiber per 80 g. This suggests that “hamburger style of fish and Okara” may meet the requirement of dietary fiber. However, I think that whether Surimi of Alaska pollack can obtain the necessary amount at a price that can be used for school lunches throughout the year is a major task and a limit to incorporate into the menu as new meal.

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