



## Survey on the Intake of Food Additives by College Students over a Week

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### Authors' contributions

This work was carried out in collaboration between both authors. Author MT designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author RS managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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### ABSTRACT

**Aims:** We conducted the survey to identify the amount of food additives consumed by college students within a week. Most college students are not even aware of the food additives used in foods part of their daily intake. The contamination by food additives is one of the adverse effects of the consuming convenience foods.

**Study Design:** Students recorded all the foods consumed by them over either seven consecutive or non-consecutive days and submitted as reports.

**Location and Duration of Study:** The survey was conducted at the Toyama Prefectural University. Data were collected from October 2015 to March 2016.

**Methodology:** Students took pictures of the food labels they consumed for a week and submitted reports. We classified the students based on whether they lived alone or with their family and analyzed the total amount of food additives consumed, frequency of eating out, and frequency of having breakfast. We also analyzed the data based on gender.

**Results:** There was no significant difference between the students who lived alone or with their family regarding the amount of food additives consumed and frequency of eating out. Further, students who lived with their family showed a higher frequency of having breakfast than those who

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lived alone.

**Conclusion:** We found no significant differences in the consumption of food additives based on the students' gender or living situation. The students in this study became aware of the amount of food additives consumed by them as a part of their daily diet, which may help them pay more attention to the meals they consume daily and improve their dietary pattern.

*Keywords: Food additives; college students; living alone; living with family; breakfast.*

## 1. INTRODUCTION

Life in Japan is probably very convenient and comfortable, especially for people in urban areas, because they are able to obtain what they want instantly, without any difficulties because all convenience store are open 24-hour a day and located in almost all residence areas. Especially, a large quantity and variety of foods from multiple cuisines are available at all times and at affordable prices, less than 500 yen or approximately 5 USD, in Japan.

Currently, Japan imports approximately 6,000 tons of food annually and disposes about 2,000 tons, that is, one third of the imported amount [1]. On the other hand, food safety in Japan has been declining.

Recent studies have discussed food and food additive intolerance [2-5]. The relationship between the consumption of food additives and disorders in children were discussed in a study [6]. Pollock et al. [7] mentioned the types of food additives consumed by children. No clear evidence was found between the consumption of food additives and childhood hyperactivity [8]. The relationship between consumed food additives and children with atopic syndrome has also been discussed [9]. Concerning increase of phosphorus intake from food additives was discussed by Takeda et al. [10] and Moore et al. [11]. Food additives and those side effects such as cardiovascular disease, allergies, hyperactivity, headaches, depression, and so on were summarized by Haas [12]. Recently, Weiner discussed about the pitfalls and the proper parameters for food additive study [13].

The concern regarding food additives in the Japanese society has increased after Abe [14-16] wrote books on the topic. However, it seems that the majority of the Japanese people do not really care about their food because foods that are the richest sources of artificial food additives [6] flourish in Japan because they are convenient.

Ready-to-eat meals sold at convenience stores in Japan usually contain large quantities of food

additives [14]. Further, college students heavily depend on these meals for their daily diet.

The purpose of this study was to investigate the dietary pattern of college students and to know the amount of artificial food additives college students consume in their daily lives. Through this survey, the students realized how much artificial food additives they consume and inject into their bodies based on their dairy dietary pattern. We considered gender differences, students' living situation (alone or with their family), and their habit of having breakfast.

## 2. MATERIALS AND METHODS

### 2.1 Targeted College Students

We selected five junior students and 40 sophomore students from the classes named "Special Topics" offered in 2015 and "Exercise of Environmental Physico-Chemical Issues" offered in 2016, respectively. The survey was conducted for the 45 participants. All students who took those classes participated in this survey but two students were not included because of their reports did not have enough data for analysis. We lectured the students on food additives and explained about the survey. All students had informed consents for this survey.

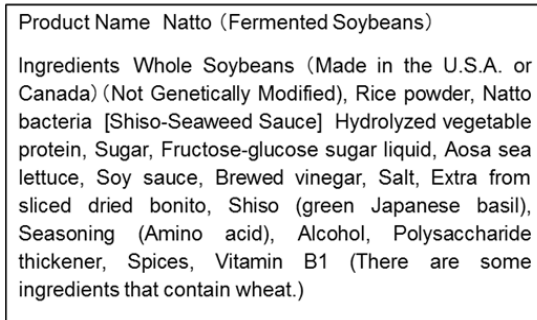
### 2.2 Duration of Data Collection

Students were instructed to record all their meals (breakfast, lunch, and dinner) for seven consecutive or non-consecutive days. The reports of junior and sophomore students were collected in 2015 and 2016, respectively. We also asked the students whether they were living alone or with their family.

### 2.3 Data Collection Methods

The students took pictures of the labels of foods they consumed, which were usually on somewhere of food containers (bags, trays, or plastic containers), using their smartphones and counted the food additives consumed in every

meal. The judgement on the food additives was made on the study by Abe [14]. The students was explained in the classes about food additives so they could tell which was food additives and count the number of those. Fig. 1 shows the label on the package of Natto or Fermented Soybeans, which is a typical Japanese food.



**Fig. 1. Ingredients in Natto**

Fermented Soybeans are eaten by mixing a special sauce, the Shiso-Seaweed sauce in this case, which usually comes with Natto. According to Fig. 1, it contained nine kinds of food additives, i.e., hydrolyzed vegetable protein, fructose-glucose sugar liquid, brewed vinegar, extra from sliced dried bonito, seasoning (amino acid), alcohol, polysaccharide thickener, spices, and vitamin B1. Food additives that were already present in the ingredients were not considered.

In the case of soy sauce, for example, two types exist, i.e., a real soy sauce and a fake one that contained food additives [14]. Real soy sauce comprises of only soybeans, wheat, and salt; on the other hand, the fake one (soy sauce produced by a new brewing method) contains food additives, such as defatted soybeans, amino acid liquid, fructose-glucose sugar liquid, monosodium glutamate, disodium 5 ribonucleotide, glycine, licorice, stevia, saccharin sodium, polysaccharide thickener, caramel color, lactic acid, sodium succinate, and butyl benzoate. In the label, it just says “soy sauce” and the consumers are not told which soy sauce is used. Therefore, food additives in the ingredients were ignored in this study.

In this study, we counted the number of time each food additives was consumed. For example, if a student consumed the food additive A at breakfast and again at lunch, then the number was reported as two. When students are at a cafeteria of the university or restaurants in the town, they were not able to know what kinds of food additives were present in their meals; therefore, it was reported as zero. Eating out was counted based on the do or die method; therefore eating out only for lunch, dinner, or all three meals was counted as one.

### 3. RESULTS AND DISCUSSION

The summary of the results is shown in Table 1.

**Table 1. Summary of the students’ Diet Habit**

		Entire			Students living alone			Students living with family		
		Total	M	F	Total	M	F	Total	M	F
Sampling Size (persons)	n	45	36	9	30	24	6	15	12	3
	Mean	19	20	19	19	19	20	20	21	16
Intake of Food Additives per Capita per Day (number)	Median	17	17	20	17	16	21	22	23	17
	Mode	13	13	22	11,13, 16,30	13,16, 30	-	8,22	8	-
	Minimum	5	5	9	5	5	11	8	8	9
	Maximum	39	39	27	34	34	27	39	39	22
Times of Eating Out in 7 days (days)		4.3	4.6	3.9	4.4	4.8	3.7	4.2	4.2	4.3
Breakfast Taken Habit: Yes (%)		63	53	89	52	46	83	73	67	100

Note: M: Male, F: Female

### 3.1 Analysis of Entire Data

#### 3.1.1 Total (entire- total)

We collected data from 45 students in this study. The number of female students was very low compared to male students, since the university only offers engineering courses.

In Japan, number of women in engineering department is usually low. Therefore, the trends of the amount of intake food additives were strongly influenced by the trends of male students.

The average amount of food additives that a student consumed in one day was 19. The median and mode were 17 and 13 respectively. The lowest and highest amounts consumed in one day were 5 and 39 respectively. The student who had the lowest consumption of food additives was a male student who lived alone. Since he was good at cooking, he usually cooked at his apartment, which is why he consumed the lowest number of food additives. He ate out only three of the seven days reported. Since the number of food additives consumed was not counted when the students ate out, it appeared that the lesser the quantity of food additives consumed, the larger the number of the days spent eating- out was. The relationship between the number of days spent eating- out and sum of food additives consumed in a week is shown in Fig. 2. According to the figure, the number of food additives consumed was not influenced by the number of days spent eating-

out. Although some students ate out every day, they showed a high total consumption of food additives.

#### 3.1.2. Analysis based on gender

Based on the entire observation, according to the median and mode values, the female students showed more fluctuation in terms of the amount of food additives consumed. In terms of times spent eating- out times over a week, male students ate out more than female students did. Regarding breakfast habit, female students had a higher tendency to have breakfast compared to male students.

### 3.2 Analysis Based on Living Alone

#### 3.2.1 Total (total- living alone)

Since the students who lived alone consisted of nearly 70% of the total students (Entire-Total), all the values except the habit of having breakfast, were close to values of Entire-Total. Only the habit of having breakfast was smaller than Entire-Total for this group.

#### 3.2.2 Analysis based on gender

For male students, in terms of the amounts of food additives consumed, the mean and median were almost the same, but male students' median was smaller than the mean, so it can be concluded that some male students consumed fewer quantities of food additives. Fig. 3 shows the relationship between the sum of food

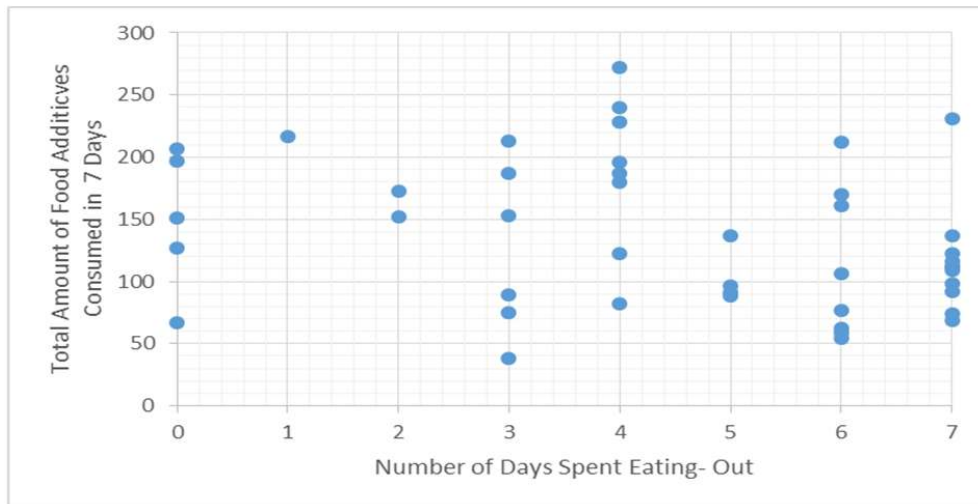
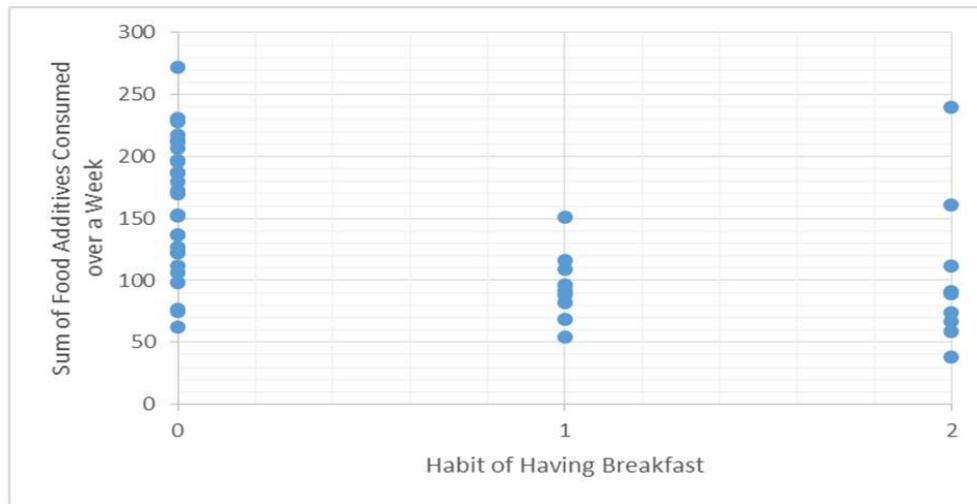


Fig. 2. Pattern of eating-out and amount of food additives consumed



**Fig. 3. Breakfast and amount of food additives**

additives consumed over the week and the habit of having breakfast. The students who always ate breakfast, never are breakfast, and had breakfast sometimes were reported as 0, 1, and 2 respectively. According to the figure, students who did not have breakfast showed a low intake of food additives. Therefore, male students, previously mentioned, consumed fewer food additives because they have breakfast. Male students reported eating- out more than female students. More than 80% of the female students reported having breakfast; on the other hand, one half of the male students reported the same.

### 3.3 Analysis on Living with Family

#### 3.3.1 Total (total- living with their family)

The student who consumed the highest amount of food additives belonged in this group. Therefore, the median was bigger compared to Entire- Total. The number of times spent eating-out in the week was nearly the same as Entire-Total. A higher frequency of having breakfast taken habit was reported compared to Entire-Total.

#### 3.3.2 Analysis based on gender

Although the sample consisted of fewer female students, it was clear that they consumed less food additives than male students did. All the female students ate breakfast and nearly 70% of the male students reported having breakfast.

### 3.4 Comparison of Students Living Alone and with Their Family

Of the students, 30 lived alone and 15 lived with their family. The average number of food additives consumed by students in one day was 19 and 20 for students living alone and with their family respectively, and there was no significant difference between the two groups.

In terms of number times the students ate out in the week, there were no significant differences between male and female students living with their family; on the other hand, the male students living alone reported a higher frequency compared to students living with their family. Regarding the habit of having breakfast, the result showed that more students living with their family possessed this habit compared to the students who lived alone. However, a clear relationship between the amount of food additives consumed and the frequency of eating out or having breakfast could not be found.

It was found that foods that contain many foods additives were convenient, such as ready to eat, instant, and frozen foods. Typical examples of each of these convenient foods containing food additives shown in Table 2.

The students who consumed very high amounts of food additives on a daily basis had consumed such food often. The amount of consumption exceeded the mean value of 19 (Table 1) when the students took any two kinds of foods or the

**Table 2. Food additives in convenient foods**

Convenient foods	Typical examples	Names of foods additives	Number of food additives
Ready to Eat Foods	Meal Boxes (Bento)	Seasoning (Amino acid), Acidifier, pH regulator, Glycine, Sodium acetate, Starch adhesive (Processed starch), Starch adhesive (Polysaccharide thickener), Starch adhesive (Agar), Caramel color, Carotenoid pigment, Essence, Enzyme, and Trehalose.	13
Instant Foods	Instant Noodles	Vegetable protein, Extracts from fish, Extracts from Seaweed, Processed starch, Seasoning (Amino acid), Thickener (Gum Arabic), Phosphate (Sodium), Calcium carbonate, Caramel color, pH regulator, Emulsifier, Antioxidant (Vitamin E), Essence, Extracts from seasoning spices, Paprika pigment, Gardenia pigment, Vitamin B2, Monascus pigment, and Vitamin B1.	19
Frozen Foods	Shrimp and rice casseroles	Dextrin, Extracts from fish, Extracts from vegetables, Cheese seasoning, Fermented seasoning, Thickener (Processed starch powder), Thickener (Xanthan), Cellulose, Seasoning (Amino acid), Xylose, Emulsifier, Essence, sodium hydrogen carbonate, carotenoid pigment, and Extracts from spice seasoning	15

same foods twice (Table 2). Even when the students had no breakfast, ate less, or often ate out, in which case the food additives consumed was not counted, the number of food additives drastically increased if the students consumed many convenient foods. Remarkably, it was found that seasonings contain many food additives, which is also described by Abe [14]. For example, as seen in Fig. 1, the sauce that comes with the main food contained a significant number of food additives. The main food, i.e., soybeans, does not contain any food additives, however, the sauce contains nine. Therefore, it can be concluded that people must be careful about consuming seasoning while being concerned about food additives.

The students who consumed fewer numbers of food additives, i.e., less than 14 per day, were classified into two groups: self-cooking group and simple meal group. The simple meals group consisted of people who just consumed a piece of bread and snack, one instant noodle, functional foods, and so on. Most students who did not have breakfast often indulge in a simple meal.

In terms of the relationship between the habit of having breakfast and the students' living situation,

the students living with their family had a higher frequency of having breakfast than the students living alone. All the female students living with their family had breakfast and all the students were in the habit of having breakfast.

#### 4. CONCLUSIONS

From the results, the following conclusions were made:

- The mean number of consuming food additives was 19, which was not significantly different between male and female students. The same trend was seen between students in different living situations. There was no significant difference between students living alone and those living with their family.
- The students who consumed low amounts of food additives (less than 14 per day) were either the students who cooked by themselves or those who consumed simple meals.
- Convenient foods should be consumed very careful because these foods contained high amounts of food additives. Seasoning accompanying the main foods, such as sauce, should be consumed

- carefully it always contains a high amount of food additives.
- There was no significant relationship between the amount of foods additives consumed and the habits of eating- out or having breakfast.
  - Students living with their family showed a higher frequency of having breakfast. The same trend could be seen for female students compared to male students.

The students who participated in this research realized that they consumed a high amount of food additives without being aware of it, and this was a chance for them to reconsider their dietary habits. Food additives are used extensively in meals consumed not only in Japan, but in other developed societies as well. People must remember that food is an essential part of the human body and that it will influence our body in future. This is the time for people to reconsider their daily food habits.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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