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Replacement of Sea Salt with Aizuyamajio may Reduce Salt Consumption in Japan

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ABSTRACT *Background and purpose*. Excessive salt intake is a global health concern. In the Aizu region of Fukushima Prefecture in Japan, Aizuyamajio is made from hot spring water and has a lower salt content than sea salt. In this study conducted a sensory evaluation of Aizuyamajio and sea salt, and compared the differences. *Methods*. Fourteen students from different prefectures consented to participate in this study. For the sensory evaluation method, participants rated sea salt and Aizuyamajio on their sweetness, saltiness, bitterness, sourness, and umami which were further evaluated using the four-point method. Additionally, respondents freely answered questions regarding the use of Aizuyamajio for cooking. *Results*. On comparing the sweet, salty, bitter, sour, and umami tastes between Aizuyamajio and sea salt, a significant difference was noted in the saltiness, however, no other significant differences were observed. Thirty-five methods have been suggested for using Aizuyamajio for cooking. *Conclusion*. The results of this study suggest that sea salt and Aizuyamajio have different tastes and lower salt equivalents. Furthermore, Aizuyamajio has a different taste from sea salt and may be used as a low-salt seasoning.
Keywords: Aizuyamajio, sea salt, low-salt, salty, tastes

INTRODUCTION

Excessive salt intake is associated with lifestyle-related diseases, such as hypertension (1). Hypertension, in turn, is associated with cerebrovascular diseases including arteriosclerosis (1). World Health Organization (2) recommends a sodium intake of less than 2000 mg/day (equivalent to less than 5 g/day of salt) for adults to maintain good health. However, the global average sodium intake for adults is reported to be 4310 mg/day (equivalent to 10.78 g/day of salt) (3).

In Japan, Dietary Reference Intakes for Japanese (2020) has set the daily salt intake for men and women (for those 18 years of age or older) at less than 7.5 g and less than 6.5 g, respectively (4). However, according to the 2019 Japanese National Health and Nutrition Survey, the average salt intake was 10.1g and 9.3 g for men and women, respectively (5). Hence, efforts to reduce salt consumption are required, which may serve as a role model and contribute significantly to improving health worldwide.

When the body ingests excessive amounts of salt, it increases the salt concentration in the plasma volume, resulting in an increase in water content in the blood and a subsequent increase in plasma volume (6). As a result, contribute to the cause of hypertension develops when the pressure on the plasma volume vessels increases to circulate more plasma (6).

In Japan, sea salt is commonly consumed and is mainly prepared from seawater. There is salt made from hot spring water in the Aizu region of Fukushima Prefecture (7). That salt termed Aizuyamajio (7). The Aizuyamajio content in hot spring water in the Aizu region is 16.5 g/L, lower than the 23 g/L of seawater, the source of sea salt (7). The nutritional value of sea salt (A co. anonymised for commercial purposes) per 100 g is 0 kcal of energy, 0 g of protein, 0 g of fat, 0 g of carbohydrates, 95.0 g of salt equivalent, 350 mg of potassium, 200 mg of calcium, and 570 mg of magnesium. The nutritional value of Aizuyamajio per 100 g is 0 kcal of energy, 0 g of protein, 0 g of fat, 0 g of carbohydrates, 77.8 g of salt equivalent, 400 mg of potassium, 2200 mg of calcium, and 400 mg of magnesium. Therefore, Aizuyamajio has less salt content compared to sea salt of the same amount. Using Aizuyamajio instead of sea salt as a seasoning may help reduce excessive salt intake. However, very few studies have between Aizuyamajio and sea salt and their preparation methods. In this study conducted a sensory evaluation of Aizuyamajio and sea salt, compared differences in taste, and examined cooking methods using Aizuyamajio to improve the use of Aizuyamajio in cooking.

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MATERIALS AND METHODS

Participants and methods

All study participants provided informed consent, and this study was approved by the University of Aizu Research Ethics Committee (2023 University of Aizu Plan No. 77). In this study verbally explained to the participants that their privacy would be protected and that there would be no disadvantages based on whether they responded. Also, participants were given an explanation of the study design and aim of the experiment. Those subject to ethical considerations were informed and consented to participate by signing a consent form. A prepaid card worth 1,500 JPY (approximately $9.9) was provided to the respondents after survey completion as compensation for their time. Those who were unwell were excluded from the study participant. This study was conducted on 14 students from A junior college in A prefecture who consented to be the research participants of this study. The study was performed in only one day. Study participants conducted a sensory evaluation of Aizuyamajio and cooking methods by eating Aizuyamajio.

The sensory evaluation method was as follows. First, 1 cup (approximately 0.1 g) of sea salt (A co.

anonymised for commercial purposes) was placed on a cocktail steer (Muddler Spoon Ivory 100 Pieces Artnap). Participants drank one glass of water to get rid of the sea salt left in them mouth. Subsequently, they consumed one cup (approximately 0.1 g) of Aizuyamajio (Purchased from: AizuYamajio Kigyo Kumiai, All Rights Reserved Aizu Yamajio Kigyo Kumiai) different from the one that they had consumed earlier. Then filled out a self-administered questionnaire (Questionnaire) about the five tastes of sweetness, saltiness, bitterness, sourness, and umami as well as how to use Aizuyamajio. The study design is shown in Fig 1. The sweet, salty, bitter, sour, and umami tastes of Aizuyamajio and sea salts were evaluated using the four-point scale, and the appropriate answers were marked with a circle.

Statistical analyses

The Student's t-test was performed on the results using Excel statistical software to compare Aizuyamajio and sea salt. In all cases, a p-value of <0.05 was considered statistically significant. Additionally, respondents were free to answer questions regarding the use of Aizuyamajio for cooking.

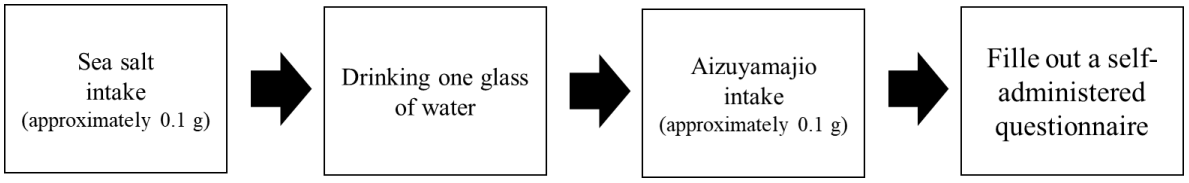

Fig 1. Study design

Questionnaire: Sex Age

Please circle the one you think is most appropriate for each category of sea salt and Aizuyamajio.

	Sea salt	**Aizuyamajio**
Sweetness	Sweet・Somewhat sweet ・ Somewhat not sweet・Not sweet	Sweet・Somewhat sweet ・ Somewhat not sweet・Not sweet
Salty	Salty・Somewhat salty・ Somewhat not salty・Not salty	Salty・Somewhat salty・ Somewhat not salty・Not salty
Bitter taste	Bitter・Somewhat bitter・ Somewhat not bitter・Not bitter	Bitter・Somewhat bitter・ Somewhat not bitter・Not bitter
Acidity	Sour・Somewhat sour・ Somewhat not sour・Not sour	Sour・Somewhat sour・ Somewhat not sour・Not sour
Umami	Has umami・Somewhat umami・ Somewhat no umami・No umami	Has umami・Somewhat umami・ Somewhat no umami・No umami

*If you use Aizuyamajio, please describe what kind of dishes you would use it for.

RESULTS

All the 14 participants were females aged 19.07±1.64 years (mean±SD). The results of comparing Aizuyamajio and sea salt in sweetness, saltiness, bitterness, sourness, and umami are presented in Table 1. A significant difference was observed in the 'saltiness' of the taste, however, no other significant differences were noted.

Thirty-five methods have been proposed for the use of Aizuyamajio in cooking which are listed in Table 2. As a result, dishes that are used with sea salt in Japan were proposed.

Table 1 Comparison of the taste of sea salt and Aizuyamajio (same respondents, n=14)
*There is a significant difference between sea salt and Aizuyamajio ($p<0.05$).

	Sea salt					**Aizuyamajio**			
	Number of respondents n=14				*p-value*	Number of respondents n=14			
Sweetness	Sweet	Somewhat sweet	Somewhat not sweet	Not sweet		Sweet	Somewhat sweet	Somewhat not sweet	Not sweet
	0	4	2	8	0.15	2	4	4	4
Salty	Salty	Somewhat salty	Somewhat not salty	Not salty		Salty	Somewhat salty	Somewhat not salty	Not salty
	9	5	0	0	<0.01*	1	9	2	2
Bitter taste	Bitter	Somewhat bitter	Somewhat not bitter	Not bitter		Bitter	Somewhat bitter	Somewhat not bitter	Not bitter
	0	4	0	10	0.15	3	3	2	6
Acidity	Sour	Somewhat sour	Somewhat Not sour	Not sour		Sour	Somewhat sour	Somewhat Not sour	Not sour
	1	5	1	7	0.24	0	3	1	10
Umami	Has umami	Somewhat umami	Somewhat no umami	No umami		Has umami	Somewhat umami	Somewhat no umami	No umami
	1	9	0	4	0.18	4	7	2	1

Table 2 Suggestion on how to cook Aizuyamajio

Suggested dishes	Number of responses
Ramen	3
Salt rice ball	2
Nigiri meshi	1
Salt soft serve ice cream	1
Sweets (Ice cream, etc.)	1
Ice cream	1
Salted chocolate pie	1
Daifuku (Japanese sweets)	1
Clear soup	1
Soup	1
Miso soup	1
Put on tempura	1
Sprinkle over tempura	1
Tempura	1
Sprinkle on grilled foods (such as shiitake mushrooms)	1
Grilled fish	1
Fish (cooked with plenty of salt)	1
Salt-grilled fish	1
Yakitori salty	1
Sashimi	1
Fried vegetables	1
Cucumber	1
Pickles	1
Ajillo	1
Boiled	1
Boiled dishes	1
Japanese food	1
Chinese cuisine	1
The true taste of Aizuyamajio	1
Put on meat	1
Tamagoyaki	1
Egg dishes	1

Unless the answers were identical, they were written exactly as they were.

DISCUSSION AND CONCLUSION

In this study observed that the salty taste was perceived to be significantly different among the survey participants at Junior College A in Prefecture A on sensory evaluation of Aizuyamajio and sea salt, and usage of Aizuyamajio in cooking. Additionally, many foods that use sea salt are listed and can be substituted with Aizuyamajio for cooking purposes. The difference in the amount of salt equivalents is considered to be the main reason for the difference in saltiness. The salt equivalent amount of Aizuyamajio used in this study was 77.8 g per 100 g, while that of sea salt was 95.0 g per 100 g. As a result, the ratio of salt equivalent to Aizuyamajio/sea salt was 18% lower at 77.8/95.0; therefore, many participants felt that Aizuyamajio was saltier, whereas others felt that Aizuyamajio was less saltier than sea salt.

For example, in a previous study, sensory tests showed that healthy tasters, who were young Japanese women in their late teens and 20s, were unable to distinguish between salty tastes (sodium chloride concentrations of 0.3%, 1.25%, 5%, 10%, and 20%). Therefore, a difference in the salt equivalent amounting to 18% in this study was recognized (8). These results suggest that on consuming an identical amount of Aizuyamajio as sea salt, one may find it less salty.

Based on the results of the sensory evaluations other than salty taste, there were no significant differences; however, the results for sweetness, bitterness, sourness, and umami, and taste perception differed. This is attributed to the fact that the amount of mineral components is generally different in Aizuyamajio than in sea salt. For example, studies involving mineral water revealed that taste sensations differed depending on the mineral (9). Therefore, although there was no significant difference between the Aizuyamajio and sea salt, the results were not the same.

Many dishes that use sea salt as a seasoning or dishes that are already made using Aizuyamajio have been cited (10,11). Regarding cooking methods for Aizuyamajio, most of the foods mentioned include those that use sea salt as a seasoning in Japan or those that are already prepared using Aizuyamajio. For example, sea salt is used in Japanese food culture (12,13). Furthermore, sea salt is used in products including ice cream. Aizuyamajio is used in cheese, rice balls, and ice cream, and has already been commercialised. Similar foods were proposed in this study, suggesting the possibility of using Aizuyamajio in foods that already use sea salt.

The limitation of this study is that, although Aizuyamajio use is popular in one region of Japan, it is unclear whether they are widespread throughout

Japan. Additionally, the number of participants was small and the results were limited to one area. If salt is reduced by using Aizuyamajio, there is no known data regarding its effect on the blood pressure of individuals, creating a need for further investigation of the effects of intake of Aizuyamajio.

In Japan, efforts are being made to reduce salt content by adding glutamic acid, monosodium glutamate, calcium diglutamate, inosinic acid, and guanylic acid to umami substances which has been commercialised (14). The equivalent amount of salt in Aizuyamajio is low, and it is thought that wild salt with a different flavour may be added to the low-salt seasonings used in Japan and used as low-salt foods. However, though Aizuyamajio consumption is practised, is not with the intent of salt reduction. Patients with mild essential hypertension had lower blood pressure when they changed their diet from sea salt to mineral-rich salt (15). Therefore, Aizuyamajio may have the potential to improve hypertension. Furthermore, Aizuyamajio may also be possible to use it as a low-salt food with a different taste than sea salt.

In conclusion, the results of this study revealed that Aizuyamajio can be used as a low-salt food with a different taste from sea salt.

ACKNOWLEDGMENTS

Author would like to thank the research participants. This study was supported by an internal competitive research funding from the University of Aizu. The author declared no conflicts of interest.

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