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Dietary Salt and Health: UMAMI Seasoning as an Attempt to Reduce Salt Intake

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Abstract

Sodium in salt is a major factor in various non-communicable diseases. These include high blood pressure, stroke, stomach cancer and others. In Japan before the 1970's, salt intake was about 15 g/day/person and the leading cause of death was stroke, especially brain hemorrhage. Through various types of nutrition education designed to reduce salt intake, the prevalence of stroke has been decreasing dramatically; however, it is still one of the leading causes of death. The highest number of patients are those with illnesses related to high salt intake and the medical cost of these illnesses may be greater than 50% of all medical costs. Many other countries may have similar problems. To reduce salt intake, UMAMI is commonly recommended in Japan and this actually has favorable effects; however, this has not yet been fully supported by scientific evidence. Among UMAMI seasonings, glutamate from kelp, (a kind of seaweed) is common in Japan. Since the UMAMI in kelp was found to be monosodium glutamate, artificial production of it was developed and is now used world-wide. In this article, we would like to review the role of salt in the body, its effects on health and sickness, attempts to reduce salt intake, and effective reduction methods, especially those using monosodium glutamate.

Keywords: Sodium; Na; Salt; NaCl; Role; Intake; Health; Monosodium glutamate; MSG; UMAMI

Salt Intake World-wide

Sodium cation (Na^+) is the most abundant ion in extracellular fluid. The normal Na concentration is 3,128-3,404 mg/L. Na plays a role in fluid and electrolyte balance. The flow of Na through voltage-gated channels in the plasma membrane is also necessary for the generation and conduction of action potentials in neurons and muscle fibers. The Na level in the blood is controlled by aldosterone, antidiuretic hormone and Atrial Natriuretic Peptide (ANP). Aldosterone increases renal reabsorption of Na and ANP increase Na excretion by the kidneys when the Na level is above normal [1]. Most of the excess Na is excreted in urine and in small amounts in feces and sweat, which maintains the salt (NaCl) homeostasis of the body.

In the ancient world, NaCl was a valuable seasoning used to preserve foods, especially meat, and it was also used to make seasonings such as garum [2]. In industrialized societies, NaCl has been using to preserve and flavor foods, to reduce the bitterness of certain foods or to improve yeast fermentation in dough [3-6]. Since NaCl is used for many purposes, the intake of Na is greater than is necessary for homeostasis [7]. In the International Study of Electrolyte Excretion and Blood Pressure (INTERSALT) Na intake was estimated from urinary excretion in 10,079 men and women from 32 countries in 1985-1987 [8]. The results showed that the Yanomamo Indians, a non-acculturated tribe inhabiting northern Brazil and southern Venezuela, have a low Na diet. The Na excreted in the 24-hour urine was as low as 2 mg [8,9]. The highest Na excretion was found in Tianjin (China), with 5,957 mg/day for men and 5,359 mg/day for women. The highest mean urinary Na excretion in Japan was found in Toyama prefecture with 5,152 mg/day. Another epidemiological study, the International Population Study on Macronutrients and Blood Pressure (INTERMAP study) [10] measured urinary Na excretion from 17 populations in 4 countries: the United States (US), United Kingdom (UK), Japan and China from 1996 to 1999. The highest mean values of urinary excretion were found in Beijing, where the values were 6,877 mg/day in men and 5,819 mg/day in women.

NaCl Intake and Health

High consumption of Na has been an issue of concern for public health worldwide. It has been found that Na intake has a direct correlation with blood pressure [11], and reduction of Na intake is considered a non-pharmacological approach to the prevention and treatment of hypertension [12-15], stroke, cardiovascular diseases and renal diseases [16,17]. Moreover, gastric cancer has also been associated with high intakes of NaCl [18]. Figure 1 shows the trends in age-adjusted death rates for leading causes of death in Japan [19]. Stroke was the outstanding cause of death until the mid-1970s; it has been

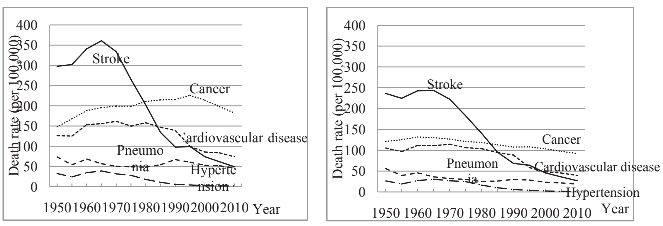

Figure 1: Trends in age-adjusted death rates of male (left) and female (right) for leading causes of death in Japan per 100,000 population.

Sources: Ministry of Health, Labour and Welfare (2011). Annual Report of the Vital statistics in 2010. Tokyo [19].

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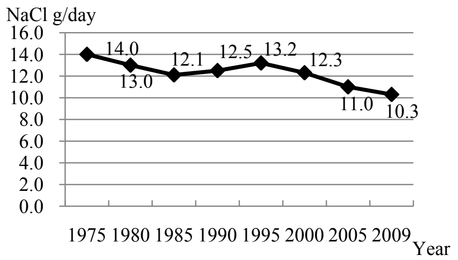

Figure 2: Reduction of NaCl intake in Japanese from 1975 to 2010.

Sources: Ministry of Health, Labour and Welfare (2011). Annual Report of the National Health and Nutrition Survey in 2009. Tokyo. (in Japanese) [20].

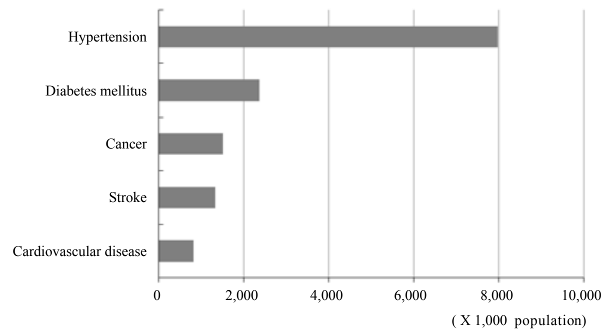

Figure 3: Number of patients by leading causes of death in Japan.

Sources: Annual report of the patient survey by the Japanese Ministry of Health, Labour and Welfare 2008 [20].

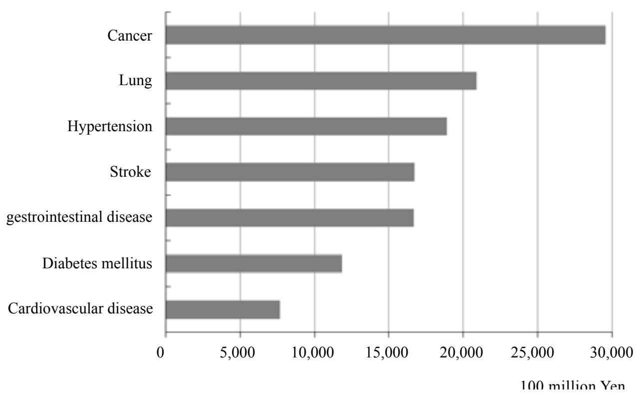

Figure 4: Medical cost by major diseases in Japan.

Sources: Annual report of the national medical care expenditure in by the Japanese Ministry of Health, Labour and Welfare (2009) [21].

decreasing parallel with the decrease in NaCl intake as shown in figure 2 [20]. Although the death rate from stroke has decreased dramatically, stroke patients are still the largest number of patients in Japan (Figure 3) [21]. Figure 4 shows the medical cost of major diseases in Japan [22]. Cancer is No. 1 but this includes stomach cancer, which is caused mainly by high NaCl intake. High NaCl intake is also a major factor for cardiovascular disease [22].

In 2007, WHO concluded that reduction in dietary NaCl intake is highly cost-effective and, together with the FAO, recommended consumption of less than 5 g NaCl/day (or 2000 mg of Na). This recommendation stressed that the dietary intake of Na from all sources influences blood pressure levels in a population [23].

Even though different programs have been established in various countries to decrease Na consumption, most of these programs have failed. Many countries have developed national policies to reduce Na intake [24,25]. Canada, Ireland, Netherlands, the UK and the US have targeted a reduction in NaCl intake to 6 g/day among adults [6]. To reach this goal, Finland has used media campaigns, worked with the food industry, and created labeling legislation for high-NaCl food [16]. It is estimated that the industry has reduced NaCl content between 20-25% [26]. The UK uses three main programs to reduce NaCl intake to 6 g per day: a public health campaign, working with the food industry to reduce NaCl levels in processed food, and front-of-pack labeling systems to provide information on NaCl content [16]. The NaCl intake was reduced from 9.5 g/day in 2000-2001 to 8.6 g/day in 2008 [27]. Although Japanese Na intake is far from the WHO goal, data from the National Nutritional and Health Survey [20] show that NaCl intake has been dropping, from 14.0 g in 1975 to 10.3 g in 2009, approaching the recommendation of the dietary reference intake 2010 for Japanese: 9 g for men and 7.5 g for women [28]. However, the Japanese Heart Foundation has recommended 6 g/day of NaCl for a healthy lifestyle [29]. A national program by the Japan Health Promotion and Fitness Foundation [30] has conducted local activities in different prefectures to promote a healthy life style by reducing Na intake and increasing vegetable consumption.

Various Attempts to Reduce NaCl Intake

One of the strategies recommended for reducing NaCl intake [31] is the gradual reduction of Na in food so that consumers do not realize that NaCl has been reduced. Girgis et al. [32] reported that a one-quarter reduction of the Na in white bread could be achieved without being noticed by reducing the Na through a cumulative series of small decreases over 6 weeks. To go unnoticed by general consumers, the reduction in Na should be done in all the breads in the market. Otherwise, the change will be noticed.

Potassium Chloride (KCl), calcium chloride, and magnesium sulfate have been used as substitutes for table NaCl; however, their bitter taste has limited their use [33]. Citric acid in tomato soup [34] and lactic acid in bread [35] could enhance saltiness and be useful in reducing NaCl intake.

Trial to Reduce Salt Intake with Monosodium Glutamate

Glutamate, a non-essential amino acid, has been used to enhance the taste and palatability of food. Ikeda [36] was the first person to isolate glutamate in crystalline form from kelp in 1908. Kelp has been used commonly as a UMAMI seasoning in Japan for many years. Glutamate combined with Na forms the flavor agent monosodium glutamate (MSG), giving the taste termed UMAMI. Today, MSG is produced from sugar cane, beets and tapioca starch. UMAMI is considered as one of the five basic tastes, along with sweet, salty, sour, and bitter. This was clearly confirmed when special receptors in the mouth that detect UMAMI taste was identified [37-39]. To reduce salt intake, UMAMI is commonly recommended in Japan. It is easy to think that MSG increases total NaCl intake, because it contains Na (12.3%). However, commonly used 1-2 g MSG which contains only about 0.1-0.2 g Na may reduce the use of several grams NaCl. We know it from our daily experiences, especially by dietitians, but we need enough scientific evidences.

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On the other hand, Bartoshuk et al. [40] observed that MSG increased NaCl intake. The subjects were given tomato juice and two bottles of seasoning which contained NaCl 2.5 M or MSG 2.5 M. They were then allowed to use either NaCl or MSG freely to make the juice as tasty as possible. The final Na concentration was higher in the juice with MSG than in that with NaCl, suggesting that MSG increases Na intake.

Bellisle et al. [41-43] showed by two studies that the effect of MSG on Na intake is not clear. The first study was conducted in young french men and women [41]. The subjects tasted foods with 0.6% of MSG. They had more food intake when MSG was added to the food than when they tried food without MSG. Similar results were also observed in 65 institutionalized elderly [42]. In both studies, increased intake of food with MSG could raise the intake of Na. However, from these studies we cannot tell whether the increase was directly caused by MSG or indirectly by the increased intake of foods due to the taste enhanced by MSG.

We can also see other reports which show the usefulness of MSG in NaCl reduction. In one study, the effect of MSG and calcium glutamate was studied. The palatability of sausages with low NaCl became similar to that of conventional sausages by the addition of MSG and calcium glutamate [44]. Similar results were reported with low-Na soup [45]. It has been shown that 85 mM NaCl soup with the addition of 50 mM of glutamate was preferred to the reference soup, which had 150 mM NaCl and no glutamate. A study involving different menus showed that the addition of MSG could reduce Na intake by 30% while maintaining palatability and satisfaction [46,47]. A Turkish study reported that the Na content of ready-made lentil soup could be reduced as much as 40% by use of MSG [48,49]. In this experiment, different NaCl levels were compared at various MSG concentrations in lentil soup and lentil soup with noodles to investigate the effect of MSG in NaCl reduced soup on preferences. The panelists preferred NaCl-reduced soup, especially at higher level of MSG. Further, Roininen et al. [47] studied the effects of UMAMI substances (MSG and inosinic acid) on the intakes of low- and high-NaCl soups. The subjects felt that the high-NaCl soup was palatable regardless of the presence of UMAMI substances. They liked low-NaCl soup with UMAMI but not one without UMAMI. In this study, the low-NaCl dishes with UMAMI had almost the same acceptability as the standard dishes. The results suggest that people can enjoy foods with UMAMI in a reduced NaCl food, since it maintains the taste balance. One explanation could be that the Na in the NaCl and UMAMI may play the main role to this balance because it was reported that Na could decrease the bitter taste of foods and increase their sweetness [50]. Further, in some foods, UMAMI substances could enhance the perception of different flavor characteristics, which may improve overall palatability in certain foods [51,52]. Yamaguchi [47] has formulated an equation about the palatability resulting from various combinations of NaCl and MSG in clear soups. The equation shows that for soup with a low-NaCl concentration MSG is useful in increasing palatability, but not for soup with a high-NaCl concentration [53].

Above examples indicate that if we simply used MSG in food, it increases Na intake from MSG, however if MSG is used for the purpose to reduce the NaCl intake without changing the taste of foods, it is helpful.

After analyzing the previous reports, we concluded that the use of MSG could reduce the salt added as the Institute of Medicine (US) suggested in the published a book entitled ‘Strategies to reduce sodium intake in the United States” [31].

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