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Scientific paper

Characterization of flavor component in Japanese instant soup stocks 'dashi'

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ABSTRACT

In Japan, many flavors of instant soup stock (dashi) are available and are often chosen on the basis of preference, the type of dish being prepared, and dietary habits of individuals. However, the complete characterization of all flavor components in Japanese instant dashi is unknown. Therefore, in the present study, we characterized the flavor components (free amino acids and 5′-ribonucleotides) of instant dashi and compared these with those of homemade dashi. Moreover, we used sensory evaluation to compare the effects of glutamate (Glu) content on the flavors of both instant and homemade dashi. Instant dashi was prepared using eight powders, seven bags, and one cube in accordance with the manufacturers' directions (generally, 0.67–1.90 g instant dashi/100 mL distilled water). Three homemade types of dashi [bonito, kelp (konbu), and a combination of the two] were conventionally prepared. Free amino acids and 5′-ribonucleotides in these three types were determined with ultra-high-performance liquid chromatography. In dashi containing seasoning (amino acids, etc.), Glu levels were higher ($P < 0.05$) and aspartate (Asp) and 5′-guanylate levels were lower ($P < 0.05$) than they were in instant dashi without seasoning. Glu, Asp, serine, threonine, and 5′-inosinate were all found in instant dashi, which contained lower levels of amino acids compared with the bonito-containing homemade dashi. Subsequently, we performed a sensory evaluation of the flavor of high-Glu instant dashi, low-Glu instant dashi, and two low-Glu homemade dashi. We then determined whether Glu levels were related to dashi flavor. The intensities and preferences (saltiness, after taste, and overall flavor) did not differ between high- and low-Glu dashi, suggesting that elevated Glu levels have little impact on flavor in dashi. To add flavor (e.g., saltiness or umami), lower levels of added Glu might be preferable in instant dashi combined with other flavor components.

Introduction

Soup stock is an extract of certain foodstuffs, such as fish, meats, vegetables, and seaweed, and it is often used to add flavor to cooked dishes. Globally, beef and chicken stocks are the most popular. In Japan, soup stocks are commonly made from certain fish (e.g., dried bonito flakes, boiled and dried Japanese anchovy, and flying fish), algae [e.g., dried kelp (konbu)], and fungi [e.g., dried mushroom (shiitake)]; these soup stocks are called "dashi." Dashi is used to add flavor not only to soup but also to Japanese salad and simmered dishes in Japan. Common recipes for Japanese dashi are as follows: to make bonito dashi, dried bonito flakes are added to boiling water and cooked for a few minutes; to make konbu dashi, konbu is soaked in water and heated to 100 °C before removing the konbu. These recipes are less time consuming than either western or Chinese soup stocks, which require longer cooking times.

Some flavor components of dashi are known. For example, the main umami components of dashi derived from ingredients such as konbu, bonito, and shiitake are glutamate (Glu) (Ikeda, 2002; Maekawa et al., 2007; Ninomiya, 2015), 5′-inosinate (IMP) (Kodama, 1913), and 5′-guanylate (GMP) (Kuninaka, 1960), respectively. Histidine (His), methionine (Met), arginine (Arg), phenylalanine (Phe), tyrosine (Tyr), and the branch chain amino acids [valine (Val), isoleucine (Ile), leucine (Leu)] have a bitter flavor, whereas serine (Ser), glycine (Gly), threonine (Thr), and alanine (Ala) have a sweet flavor (Kumakura and Fushiki, 2012; Kawai et al., 2002). 5′-ribonucleotides (e.g., uridine 5′-monophosphate and cytidine 5′-monophosphate) have an umami flavor, and organic acids (e.g., acetate, citrate, lactate, and

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malate) have a sour flavor (Kumakura and Fushiki, 2012). It has been suggested that dashi flavor and taste are affected by multiple flavor components. Only certain amino acids, such as Glu and aspartate (Asp), are included in dashi made from konbu (Ikeda, 2002; Maekawa et al., 2007; Ninomiya, 2015). In contrast, a variety of free amino acids are found in chicken bouillon, derived from chicken and vegetables (Ikeda, 2002; Ninomiya et al., 2010). Thus, the flavor components of dashi differ based on the type of added ingredients.

In Japan, many forms of instant dashi are widely available, which are based on dietary habits and are chosen based on preferences and types of dishes being prepared. Dashi is commonly used for daily dishes (such as miso and clear soups), salads, simmered dishes, and fried foods. Instant dashi is made from seasonings (e.g., free amino acids, salt, sugar, and dextrin), food extracts, and natural ingredients (e.g., dried bonito, konbu, and shiitake). Instant dashi is often classified based on whether it occurs as a powder or in a bag. The form and appearance of the powder type is similar to that of a powdered medicine. The bag type is comparable to a tea bag, with some ingredients included in the bag. Two other classifications of instant dashi include the seasoning-free and the foodstuff-mix types. Seasoning-free dashi only contains foodstuffs and not seasonings. The foodstuff-mix type contains some foodstuffs (e.g., dried bonito flakes, dried konbu, shiitake, vegetables, and chicken). In Japan, instant dashi is often used for cooking, as it is easier than preparing homemade dashi.

Koda et al. (2008) suggested that the differences in the flavors of instant and homemade boiled and dried Japanese anchovy dashi are related to the specific components added; many amino acids are present in homemade dashi, whereas instant dashi contains mostly Glu. However, the characterization of the flavor components in instant dashi is incomplete. Therefore, in the present study, we characterized the flavor components (free amino acids and 5′-ribonucleotides) of instant dashi and compared these with those of homemade dashi. Moreover, we used a sensory evaluation to compare the effects of Glu content on the flavors of instant and homemade dashi.

Materials and methods

Sample preparation

Instant dashi was prepared from eight powders, seven bags, and one cube (Table 1). The powders were bonito, seasoning-free bonito, low-salt bonito, konbu, seasoning-free konbu, boiled and dried Japanese anchovy, shiitake, or chicken bones. The bags contained bonito, konbu, flying fish, grilled flying fish, fish mix, vegetable mix, or Chinese soup stock. The cube was a consommé. Instant dashi was diluted with distilled water, following the manufacturers' directions on package (generally, 0.67–1.90 g instant dashi/100 mL distilled water). The diluted instant dashi was heated to 100 °C, filtered, and collected.

Three types of homemade dashi were made from bonito, konbu, and a combination of both. To prepare bonito dashi, 1.00 g dried bonito flakes were added to 100 mL boiling distilled water, cooked for 90 s, and filtered. To prepare konbu dashi, 1.00 g konbu was soaked in 100 mL distilled water for 30 min, heated to 100 °C, and filtered. The bonito/konbu dashi was made by combining both methods described above. All samples were stored at −30 °C until use.

Measurement of free amino acids and 5′-ribonucleotides

Free amino acids were measured with an ultra high-performance liquid chromatography (UHPLC)system (Shimadzu Co., Ltd., Kyoto, Japan) using Inertsil ODS-3 (4.6 mm I.D. × 150 mm, 3 μm.) (GL Sciences Inc., Tokyo, Japan). Detection of free amino acids was performed as follows: Asp, Glu, Ser, Gly, His, Arg, Thr, Ala, proline (Pro), Tyr, Val, Met, cysteine (Cys), Ile, Leu, Phe, and lysine(Lys) were derivatized to PTC-amino acids using phenyl isothiocyanate, as described previously (Glevarec et al., 2004). Derivatized samples were prefiltered through a 0.45-μm microfilter (GL Sciences Inc., Tokyo, Japan), using the following conditions: solvent A mobile phase: 60 mmol/L acetate buffer solution (pH 6.6): acetonitrile (94:4); solvent B mobile phase: 60 mmol/L acetate buffer solution (pH 6.6): acetonitrile (40:60); gradient: 0–55% solvent B (0–20 min), 55–100% solvent B (20–25 min), 100–0% solvent B (25–45 min); flow rate: 0.6 mL/min; reaction temperature: 40 °C; injection volume: 10 μL; and eluent monitoring at 250 nm.

The 5′-ribonucleotides (5′-IMP and 5′-GMP) were measured by a UHPLC system (Shimadzu Co., Ltd., Kyoto, Japan) using Shim-pack WAX-1 (4.0 mm I.D. × 5.0 mm, 3 μm) (Shimadzu Co., Ltd., Kyoto, Japan) (Adachi et al., 2002). Samples were prefiltered through a 0.45-μm microfilter (GL Sciences Inc., Tokyo, Japan), using the following conditions: mobile phase: 50 mmol/L phosphate buffer (pH 3.1); flow rate: 1.0 mL/min; reaction temperature: 40 °C, injection volume: 10 μL; eluent monitoring at 260 nm.

Sensory evaluation of flavor in dashi

The following samples were evaluated for flavor: high-Glu instant dashi (bonito powder), low-Glu instant dashi (seasoning-free bonito powder), homemade bonito dashi, and homemade combination of bonito and konbu. These samples were prepared using the methods described above, and the salt equivalents was adjusted to 0.8% by the addition of salt and the same volume of soy sauce. Salt equivalents was determined using salinometer (Pocket Salt Meter PAL-SALT) (Atago Co., Ltd., Tokyo, Japan). Intensities (fishy smell, saltiness, and aftertaste), preferences (sweetness, saltiness, and aftertaste), and overall flavor were examined. The scale for the intensities, preferences, and overall flavor were −3 (weak) to +3 (strong), −3 (dislike) to +3 (like), and −3 (dislike) to +3 (like), respectively. The subjects performing the evaluation were 30 females between 20 and 50 years of age.

Statistical analysis

Data are shown in units of μg/mL (free amino acid and 5′-ribonucleotide content), the mean ± SD (comparing the umami flavor component in different samples), and the mean (sensory evaluation). Statistical analysis was performed using Excel 2010 (Microsoft Japan Co., Ltd., Tokyo, Japan) and Statcell 3 (OMS Publishing, Inc., Saitama, Japan). The differences were compared using the Student's *t*-test. A P value < 0.05 was considered significant.

Results

Characterization of flavor components in instant dashi

Table 2 shows the free amino acid and 5′-ribonucleotide content in dashi. All instant dashi contained Asp, Glu, Ser, Thr, and 5′-IMP, whereas other amino acids and 5′-GMP were not found in all instant dashi formulations. The most characteristic pattern was a high Glu level in six dashi powders (bonito, low-salt bonito, konbu, boiled and dried Japanese anchovy, shiitake, and chicken bones), four dashi bags (bonito, konbu, flying fish, and Chinese soup stock), and cubed dashi. The instant dashi preparations that contained high Glu levels all included seasonings (e.g., amino acids) in the list of ingredients.

To clarify differences in flavor, the instant dashi preparations were categorized by form (powder vs. bag) and presence or absence of seasoning (amino acids, etc.). Differences in umami flavor components (Glu, Asp, 5′-IMP, and 5′-GMP) were then examined (Figs. 1 and 2). In powdered formulations, 5′-IMP levels were consistently higher than in bagged formulations (Fig. 1). In formulations containing seasonings (amino acids, etc.) (Fig. 2), Glu level was markedly higher ($P < 0.05$) and Asp and 5′-GMP levels were lower than in seasoning-free formulations ($P < 0.05$).