Study on the Flavor in Meat Soup Stock

(畜肉だしの風味に関する研究)

Summary

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Meat soup stocks of chicken, pork, and beef, which are called “soup stock”, “bouillon”, “fond” in Western countries, and “shàngtāng”, “báitāng”, “máotāng” in China, are highly appreciated as a base for savory dishes all over the world due to its desirable meaty flavor profile.

Chicken soup stock is commonly prepared by boiling whole chickens for four hours at low heat though flavoring ingredient is different in individual countries.

On the other hand, there are two types of pork soup stock: the white type (prepared without removing the marrow from the thighbone, followed by boiling at medium to high heat to gradually produce white turbidity), and the clear type (prepared by removing the marrow from the thighbone and boiling at low heat to avoid turbidity). The white type of pork stock is widely used in China and Japan, whereas the clear type of pork stock is widely used in Southeast Asia.

Beef soup stock, which grew on a European rootstock, is appreciated as a base for soup, stew, and sauce. And it became common in the terms of beef extract and is highly appreciated as a base for many commercial food products all over the world. Beef extract is commercially manufactured from beef broth that is produced by boiling meat at approximately 100 °C, followed by removal of fat from the broth, sterilization at approximately 120 °C–140 °C, and concentration processing, which enriches the savory meaty flavor.

Taste compounds of meat soup stock have already been investigated according to the type of meat, and it is known that amino acids, peptides, nucleic acids, organic acids, saccharide, and minerals are the major taste compounds of meat soup stock. However, there has only been limited research on the aroma-active compounds of meat soup stock.

Whereas the aroma compounds from white pork soup stock have been investigated and ranked according to their aroma intensity and possible contribution to the flavor of the stock, there is a lack of research on the aroma-active compounds of clear pork stock, chicken soup stock, and beef extract though they are commonly used as a base for savory dishes all over the world.

Therefore, the aim of this present study was to identify the most aroma-active compounds in chicken soup stock, clear pork stock, and beef extract, and to examine sensory interactions between aroma compounds and taste compounds in meat soup stock.

1. Characterization of the Key Aroma Compounds in Chicken Soup Stock

Aroma extract dilution analysis (AEDA) was performed on an extract prepared from chicken soup stock and 9 aroma-active compounds were selected. On the basis of high flavor dilution (FD) factors in combination with the results of the identification experiments, methylpyrazine, 2-ethyl-4-methylthiazole, 3-(methylthio)propanal, and (*E,E*)-2,4-decadienal were suggested as primary aroma compounds of chicken soup stock. Recombination and omission experiments of the identified aroma-active compounds in taste-reconstituted chicken soup stock showed that each compound had an individual aroma profile. A comparison of the overall flavor of the recombined mixture and the chicken soup stock revealed a high similarity, suggesting that these four compounds are important contributors to the aroma of chicken soup stock.

Omission experiments which were performed to study sensory profiling of the individual identified compounds showed that methylpyrazine and 2-ethyl-4-methylthiazole contribute to “roast”, whereas

2-ethyl-4-methylthiazole contributes to “roast meaty” in addition to “roast” flavors. 3-(Methylthio)propanal and (*E,E*)-2,4-decadienal have similar flavor profiles of “boiled meaty” but (*E,E*)-2,4-decadienal exhibits “fatty” and “animalic” flavor in addition to “boiled meaty” flavor. Additionally, they are important contributors to each characteristic flavor of chicken soup stock.

2. Characterization of the Key Aroma Compounds in Pork Soup Stock

The aroma extract dilution analysis (AEDA) of an extract prepared from pork stock and subsequent experiments led to the identification of 15 aroma-active compounds in the flavor dilution (FD) factor range of 64–2048. Omission experiments to select the most aroma-active compounds from the 15 odor compounds suggested acetol, octanoic acid, δ-decalactone, and decanoic acid as the main active compounds contributing to the aroma of pork stock. Aroma recombination, addition, and omission experiments of these four aroma compounds in taste-reconstituted pork stock showed that each compound had an individual aroma profile. A comparison of the overall aroma between this recombined mixture and pork stock showed strong similarity, suggesting that the key aroma compounds had been successfully identified.

Addition and omission experiments which were performed to study sensory profiling of the individual identified compounds showed that acetol, octanoic acid, and decanoic acid contributed to the mouthfulness flavor. Acetol also had a flavor profile of continuity, whereas octanoic acid had roundness flavor. Decanoic acid had a full body flavor profile, in addition to a mouthfulness flavor, whereas δ-decalactone had a specialized flavor profile of roundness flavor. These compounds were therefore important contributors to each characteristic flavor of pork soup stock.

3. Characterization of the Key Aroma Compounds in Beef Extract

Aroma extract dilution analysis (AEDA) of an ether extract prepared from beef extract (BE) and subsequent identification experiments led to the determination of seven aroma-active compounds in the flavor dilution (FD) factor range of 32–128. Omission experiments to select the most aroma-active compounds from the seven aroma compounds suggested that 2,3,5-trimethyl pyrazine, 1-octen-3-ol, 3-methylbutanoic acid, and 4-hydroxy-2,5-dimethyl-3(*2H*)-furanone were the main active compounds contributing to the aroma of BE. Aroma recombination, addition, and omission experiments of the four aroma compounds in taste-reconstituted BE showed that each compound had an individual aroma profile. A comparison of the overall aroma between this recombination mixture and BE showed a high similarity, suggesting that the key aroma compounds had been identified successfully.

Addition and omission experiments which were performed to study sensory profiling of the individual identified compounds showed that 1-octen-3-ol and 3-methylbutanoic acid contribute to the “boiled meaty flavor.” 3-Methylbutanoic acid also contributes to the “sweet meaty flavor,” in addition to a “boiled meaty flavor.” 2, 3, 5-Trimethyl pyrazine has a specialized “roasted flavor,” whereas 4-hydroxy-2,5-dimethyl-3(*2H*)-furanone has a specialized “sweet meaty flavor.” Therefore, these compounds are important contributors to each characteristic flavor of BE.

4. Sensory interaction between aroma compounds and taste compounds in meat soup stock

Sensory comparison between a complete mixture of aroma and taste compounds of chicken soup stock (CM28), which was prepared by adding 28 taste compounds to chicken soup stock aroma solution (SA), and chicken soup stock was performed to study interactions of taste compounds with aroma compounds in chicken soup stock. Whereas SA and CM28 have same concentrations of chicken soup stock aroma, sensory retronasal aroma intensities of CM28 (4.3) were found to be strongly increased compared to SA (1.0), and almost reached an intensity of 5.0 which was that for chicken soup stock. This indicated that chicken soup stock aroma was enhanced by taste compounds of chicken soup stock. Moreover, following omission and addition experiment of 28 taste compounds showed that chicken soup stock aroma could significantly be enhanced by the addition of Glu (Glutamic acid) and IMP (Disodium 5'-inosinate).

This is the first study to confirm the key aroma compounds of meat soup stock using aroma recombination and omission experiments and to investigate the roles of each aroma compound in meat soup stock. And we showed that a limited number of volatile compounds actually contribute to the overall aroma of meat soup stock whereas there are hundreds of aroma compounds in meat soup stock. We also found that chicken soup stock aroma could significantly be enhanced by the addition of Glu and IMP. It is already known that Glu has flavor (multiple oral sensation including taste) enhancing effect. However, to our knowledge, no study published in the available literature focused on aroma enhancement by Glu and IMP. In this study, we could achieve aroma intensity sensory evaluation by trained panelists, and found that soup stock aroma can be enhanced by taste compounds at the first time.

These findings of key aroma compounds and aroma enhancing taste compounds will greatly contribute to the scientific research for “deliciousness” of meat soup stock.

In recent years, there are many scientific studies for the cooking technique of professional chefs. And this study could be the part of the answer to the studies.