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Identifying and controlling formation of compounds that affect metallic flavor of beer

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INTRODUCTION

Traditional Japanese food, known as 'Washoku', has recently come to the forefront of the culinary world. In Washoku, the pairing of food—particularly seafood and alcoholic beverages—is of great importance. However, a metallic flavor is often detected when enjoying beer with seafood. Therefore, in this study, we investigated the origin of this metallic flavor and how to reduce it. Several examples of compounds that have been reported to induce a metallic flavor in alcoholic beverages are shown below:

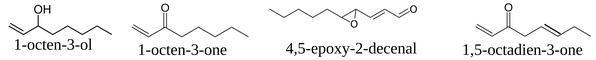

Fig. 1 Compounds reported to induce metallic flavor in alcoholic beverages

At the last ASBC annual meeting, we presented following:

- An analytical method for 1-octen-3-one, 1,5-octadien-3-one and 4,5-epoxy-2-decenal, which are very difficult to detect because of their low concentrations in beer.
- When beer is enjoyed on its own, 1-octen-3-one is the only compound that exists at concentrations above the threshold concentration.
- When beer is paired with seafood, 1,5-octadien-3-one has highest Odor Activity Value (OAV), which indicates that 1,5-octadien-3-one is the primary compound responsible for metallic flavor.
- The precursor compounds of 1,5-octadien-3-one are ω-3 fatty acids. Seafood is thought to be a major source of ω-3 fatty acids.

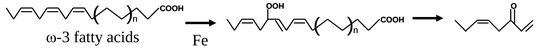

Fig. 2 Pathway of 1,5-octadien-3-one formation

In this study, to make the pairing of beer and seafood more enjoyable, we studied the factors affecting 1,5-octadien-3-one formation and how to decrease its formation when beer is consumed with seafood.

METHODS

＜Odor test＞

The intensity of metallic flavor was assessed by drinking beer with dried calamari. The metallic score was evaluated as 0 (very weak) to 7 (very strong).

Fig. 3 Dried calamari

＜Analysis of iron concentration＞

Iron concentration in beer was analyzed using ICP/MS.

＜Analysis of metallic flavor＞

Metallic compounds were analyzed as follows:

Beer sample + dried calamari
↓ Ultrasonication for 30 min
Filtration
↓
C18 solid phase extraction

(1-octen-3-one/1,5-octadien-3-one) PFBOA derivatization & GC/NCI-MSMS

(4,5-epoxy-2-decenal) SPME-GC/NCI-MS

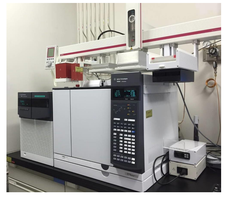

Fig. 4 Highly sensitive GC/MSMS

RESULTS

What is the main compound that induces metallic flavor when beer is enjoyed with seafood?

In our previous study, we identified three compounds that impart metallic flavor. We then compared the OAV of these three compounds in two situations: beer on its own, and after incubation with dried calamari. In the former case, 1-octen-3-one had the highest OAV, which suggests that 1-octen-3-one is the main compound responsible for metallic flavor. In the latter case, 1,5-octadien-3-one had the highest OAV, which suggests that 1,5-octadien-3-one is the main compound responsible for metallic flavor when beer is enjoyed with seafood. The precursor compounds of 1,5-octadien-3-one are ω-3 fatty acids, which are abundantly present in seafood; thus, the metallic flavor may be the result of a reaction involving ω-3 fatty acids and beer in the mouth.

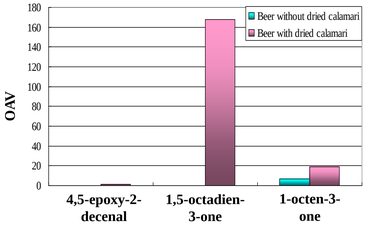

Fig. 5 Comparison of OAV of metallic-flavor inducing compound with/without dried calamari

Relationship between metallic score and concentration of 1,5-octadiene-3-one

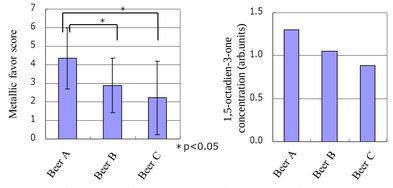

Fig. 6 Relationship between metallic score and concentration of 1,5-octadiene-3-one

We performed odor test and 1,5-octadien-3-one analysis of the 3 beers (Beer A, Beer B, Beer C). We then found that the concentration of 1,5-octadien-3-one increases with metallic intensity. This suggests that the concentration of 1,5-octadien-3-one is a good indicator of metallic intensity.

Correlation between iron concentration in beer and 1,5-octadien-3-one concentration

We also analyzed the relationship between iron concentration and 1,5-octadien-3-one concentration in several beers (n=9) that have different metallic flavor intensities. We found that there was a strong correlation (R^2=0.88) between iron concentration in beer and 1,5-octadien-3-one concentration. This indicates that the iron in beer promotes 1,5-octadien-3-one formation when we drink beer with seafood, and that we can suppress 1,5-octadien-3-one formation by reducing the iron concentration in beer.

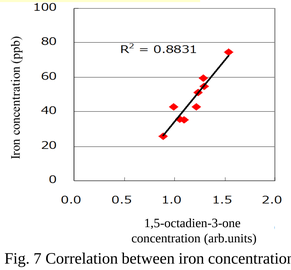

Fig. 7 Correlation between iron concentration in beer and 1,5-octadien-3-one concentration

RESULTS

Metallic flavor is affected by the type of kieselguhr

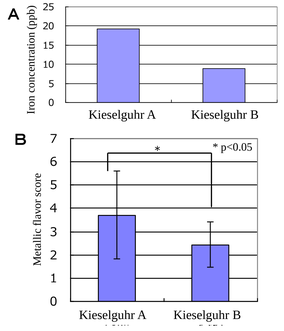

Fig. 8 Iron concentration (A) and metallic intensity (B) after filtration through different types of kieselguhr

We next attempted to reduce the iron concentration in beer, as this was found to suppress 1,5-octadien-3-one formation and thus the metallic flavor. We filtered beer using two types of kieselguhr with different potentials for iron elution into beer, and obtained two beers with different iron concentrations. We then performed the odor test and found that the metallic score was lower for the low iron content beer. This suggests that we can ultimately suppress metallic intensity by changing the type of kieselguhr or reducing the amount of kieselguhr used.

CONCLUSION

In this study, we investigated the reason for the presence of metallic flavor when beer is consumed with seafood and how to reduce it. We found the following:

1. Reaction between ω-3 fatty acids from seafood and iron from beer induce the formation of 1,5-octadien-3-one, which is responsible for the metallic flavor.
2. There is a strong correlation between 1,5-octadien-3-one concentration after incubation of beer with dried calamari and iron concentration in beer, and metallic intensity increases with iron concentration.
3. We were able to suppress the metallic intensity by filtering beer through different types of kieselguhr to reduce the iron concentration.

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