177

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Mechanism for fishy aftertaste formation in beer and seafood pairing

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Abstract

An unpleasant fishy aftertaste is sometimes perceptible when beer is co-consumed with seafood, as may occur with wine. To demonstrate that the mechanisms involved in this process are the same for beer and wine, we investigated the relationship between the ferrous ion concentration in beer and the degree of fishy aftertaste. Our results indicate that the ferrous ion concentration in beer is related to the intensity of fishy aftertaste as a result of (E,Z)-2,4-heptadienal formation (Fig. 1). These findings demonstrate that the mechanism for fishy aftertaste formation is common for wine and beer.

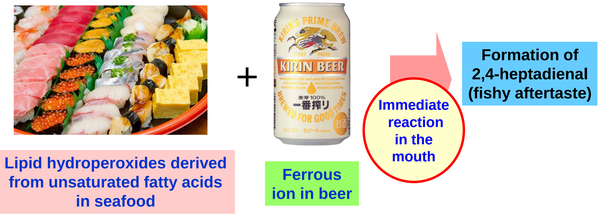


Fig. 1. Proposed mechanism for fishy aftertaste formation when beer is co-consumed with seafood

Introduction

Alcoholic beverages are frequently paired with food for their full enjoyment. In the case of wine, such pairings are referred to as “marriage”. However, an unpleasant fishy aftertaste is sometimes perceived when wine is co-consumed with seafood. This aftertaste is one of the reasons that people tend to avoid drinking wine and eating seafood together. To resolve this issue, we previously attempted to identify the component of wine that reacts with seafood and understand the mechanism that gives rise to the fishy aftertaste[1]. The results showed that ferrous ions contained in wine can instantaneously promote the formation of (E,Z)-2,4-heptadienal, which is one of the components of the unpleasant fishy aftertaste, via the breakdown of preformed lipid hydroperoxides derived from unsaturated fatty acids in seafood (Fig. 2).

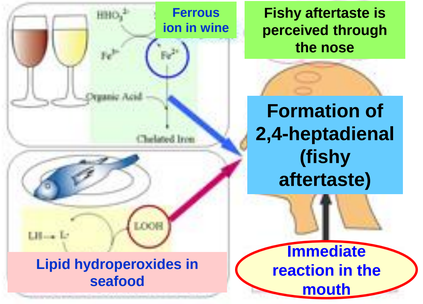


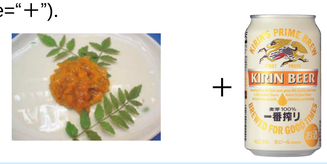
Fig. 2. Mechanism of fishy aftertaste formation in wine and seafood pairing

Materials and Methods

1. Sensory analysis

Perceived unpleasant fishy aftertaste intensity was rated on an unstructured three-point category scale of none (score=“-”), weak (score=“±”), or strong (score=“＋”).

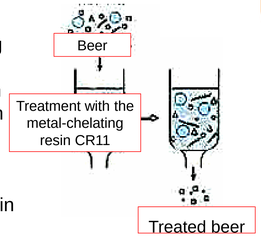
1. Eat a sample of seafood.
2. Drink a mouthful of beer.
3. Evaluate fishy aftertaste.



Intensity of fishy aftertaste + > ± > -

2. Treatment of beer

Ferrous ions in beer were removed through treatment with a metal-chelating resin. Beer samples with various concentrations of ferrous ions were then prepared by mixing the treated beer with untreated beer. The intensity of fishy aftertaste during the co-consumption of beer and seafood was then rated using sensory analysis. (E,Z)-2,4-heptadienal in the samples was measured by GC-MS.



Results and Discussion

1. Effect of ferrous ion in beer on fishy aftertaste formation

To investigate the relationship between the ferrous ion concentration in beer and the perception of fishy aftertaste, the intensity of the fishy aftertaste during the co-consumption of seafood and beer samples with various concentrations of ferrous ions was rated using sensory analysis. We first confirmed that the beer treated with the metal-chelating agent contained a markedly lower ferrous ion concentration than that of control beer (Table 1). In the sensory analysis, the unpleasant fishy aftertaste was not perceived with the treated beer samples. The organic acid concentration was nearly identical in the control and treated beer.

Table 1. Fishy aftertaste intensity and 2,4-heptadienal concentration in treated beer with a low ferrous ion concentration.

Beer sample	Ferrous ion concentration (mg/L)	Organic acids concentration (mg/L)	Fishy aftertaste*	2,4-Heptadienal concentration
Beer (untreated control)	0.065	736	+	2.92
Treated beer	0.003	737	-	N.D.

*Intensity of fishy aftertaste + > ± > -

The intensity of the fishy aftertaste was next evaluated during the co-consumption of seafood and beer samples containing various concentrations of ferrous ions. The fishy aftertaste intensity was found to decrease with decreasing ferrous ion concentration in the beer (Table 2). The fishy aftertaste was not perceived in beer with less than 0.028 mg ferrous ions per liter. These results indicate that a relationship exists between the ferrous ion concentration in beer, (E,Z)-2,4-heptadienal concentration, and the intensity of the unpleasant fishy aftertaste.

Table 2. Fishy aftertaste in treated beer containing various concentrations of ferrous ion.

Beer: Treated beer	100:0	80:20	60:40	40:60	20:80	0:100
Ferrous ion concentration (mg/L)	0.065	0.053	0.040	0.028	0.015	0.003
Fishy aftertaste*	+	+	±	-	-	-
2,4-Heptadienal concentration (mg/L)	2.92	2.40	N.D.	N.D.	N.D.	N.D.

*Intensity of fishy aftertaste + > ± > -

2. Effect of fitin, succinate and EDTA on fishy aftertaste formation

As fitin, succinate, and EDTA are also able to chelate ferrous ions, we also investigated the effects of fitin, succinate, and EDTA on the fishy aftertaste in beer treated with various concentration of these components. Sensory analysis revealed that the unpleasant fishy aftertaste in nearly all the treated beer samples (>25 mg/L fitin [Table 3A], >50 mg/L succinate [Table 3B], and >0.001 mM EDTA [Table 3C]) could not be perceived.
These results demonstrate that chelation treatment of beer with fitin, succinate, and EDTA is effective for reducing fishy aftertaste during the co-consumption of beer and seafood.

Table 3. Effect of fitin, succinate, and EDTA on the fishy aftertaste* in beer.

A.

Concentration (mg/L)	500	250	125	25	5	0
Fitin	-	-	-	±	+	+

B.

Concentration (mg/L)	1000	500	250	50	10	0
Succinate	-	-	-	±	+	+

C.

Concentration (mM)	0.1	0.05	0.01	0.001	0.0001	0
EDTA	-	-	-	±	+	+

*Intensity of fishy aftertaste + > ± > -

Conclusions

Our results demonstrate that ferrous ions in beer contribute to the fishy aftertaste that is often perceived during the co-consumption of wine/beer and seafood, and that the mechanism for the formation of 2,4-heptadienal is common between wine and beer.

Reference

1) Tamura *et al*. Iron is an essential cause of fishy aftertaste formation in wine and seafood pairing. J. Agric. Food Chem. 57: 8550-8556 (2009).