Effect of aroma on *kire* of beer

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What flavors are desirable in beer?

Full-body, *kire*, pleasant flavor, refreshing, strong bitterness, easy to drink, light taste, clear aftertaste...

“Body” and “*kire*” are important characteristics for evaluating beer flavors.

Ideal flavor

Kire

Strong

Weak

Body

Weak

Strong

Low carbohydrate

Happoshu
New genre

Premium Beer

Beer
✓ No. 1 beer in the Japanese market
✓ Major characteristic is “kire”
Definitions of body and *kire* for this study

**Retronasal aroma**

**Body**
- Total volume of taste and aroma

**Kire (Crispness)**
- Difference in flavor between the maximum and final mouthfeel
Our recent research into *kire*

- Compositional profile of beer flavor (2016 WBC)
- Bitterness depends on iso-alpha acid (2017 EBC)
- Residual sugar content of beer (2017 EBC)
Our recent research into *kire*

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### Comparison of $R^2$ values of the PLS models

<table>
<thead>
<tr>
<th></th>
<th>Explanatory variables</th>
<th>Data set for taste compounds</th>
<th>Data sets for taste and aromatic compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body</strong></td>
<td></td>
<td><strong>$R^2=0.97$</strong></td>
<td><strong>$R^2=0.97$</strong></td>
</tr>
<tr>
<td></td>
<td>Observed body score</td>
<td>Predicted body score</td>
<td></td>
</tr>
<tr>
<td><strong>KIRE</strong></td>
<td>$R^2=0.61$</td>
<td>$R^2=0.95$</td>
<td></td>
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<td>Observed KIRE score</td>
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Miyashita, S. et al., WBC (2016).
Elucidation of the identity of aromatic compounds that affect *kire* of beer, to find a way of improving *kire*

Aromatic compounds involved in *kire* affect retronasal aroma
Reason why we focused on retronasal aroma

Retronasal aroma has a strong influence on the perceived quality and flavor of food.

Scheme of this study

Sensory analyses of 14 brands of beer produced by major breweries in Japan

Retronasal aroma analyses of beer samples using Retronasal Flavor Impression Screening System

Identification of retronasal aromatic (RA) compounds characteristic of beer samples with significantly weaker *kire* scores

Confirmation that the characteristic RA compounds affect the *kire* of beer
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Results of sensory evaluation

- Beer
- Happoshu/New genre
- Low carbohydrate
Results of sensory evaluation

Kire vs Body scatter plot with categories:
- Beer
- Happoshu/New genre
- Low carbohydrate
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Retronasal Flavor Impression Screening System

1) Swallowing beer sample (30 mL)
2) Trapping the odorants from the nasal cavity (10 breaths) in Tenax TA

3) Addition of internal standard substance (2-octanol, 25 ng)
4) Nitrogen purge (100 mL/min, 30 min)

5) Separation of aromatic compounds by GC

Beers with weaker *kire* had significantly higher levels of medium chain (e.g., C8) fatty acid ethyl esters, acetates, and linalool retronasal aroma (“characteristic RA compounds”)

**Results of retronasal aroma analyses**

- **C8 Fatty acid ethyl ester**
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppm)
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppm)

- **Isoamyl acetate**
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppm)
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppm)

- **Linalool**
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppb)
  - Relative quantitative value of retronasal aroma
  - Concentration in sample (ppb)

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- Green: Relative quantitative value of retronasal aroma (left axis)
- Red: Concentration in sample (right axis)
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## Sensory evaluation

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<tr>
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### Control (Beer A)
### Sensory evaluation

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**Control (Beer A)**  
**Test 1**
### Sensory evaluation

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**Control (Beer A)**

**Test 2**

![no addition]
### Sensory Evaluation

#### Panels:
Trained panel (n=5~7)

#### Attributes:
Body, *kire* (1: weak ↔ 9: strong)

#### Method:
Blind tasting using a cup with a plastic lid

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<th>Sample</th>
<th>Added compounds</th>
<th>Amount added</th>
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<td>Control (Beer A)</td>
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<td>–</td>
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<td><strong>Characteristic RA compounds</strong></td>
<td>Difference between the control and Beer B ( \times 1, \times 2 )</td>
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<td>Test 2</td>
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<td>Difference between the control and Beer C ( \times 1, \times 2 )</td>
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Effect of characteristic RA compounds on *kire*

Acetates such as isoamyl acetate appear to negatively contribute to *kire*
Test 2: Effect of characteristic RA compounds on *kire*

Compounds such as medium chain fatty acid ethyl esters and linalool appear to negatively contribute to *kire*.

![Graphs showing the effect of compounds on kire](image)
Distinctive *kire* “SUPER DRY EXTRA COLD”

- Strong *kire*
- Clear aftertaste
- Refreshing
- Sharpness
- So good!
Effect of drinking temperature on retronasal aroma

Drinking temperature of the beer had a small effect on retronasal aroma of fusel alcohols.

For Isoamyl alcohol:
- At 25°C, the relative quantitative value was around 1.0.
- At 8°C, the value increased slightly to around 1.1.
- At -2°C, the value decreased to around 0.9.

For 2-Methyl-1-butanol:
- At 25°C, the relative quantitative value was around 1.0.
- At 8°C, the value remained around 1.0.
- At -2°C, the value decreased to around 0.8.
These results suggest that lowering the temperature improves *kire*.
Conclusions

✓ Beers with weaker *kire* have significantly higher levels of medium chain fatty acid ethyl esters, acetates, and linalool retronasal aroma

✓ These compounds contribute to retronasal aroma and significantly suppress sensory evaluations of *kire*

✓ Sensory evaluations suggest that lowering the serving temperature is an effective means of improving *kire*
Future work

Elucidation of compounds that contribute to kire (2016 WBC)

- Elucidation of the identity of aromatic compounds affecting to kire (2017 ASBC)
- Control of bitter after taste and residual sugar (2017 EBC)

<Visualization of kire>
Evaluation of kire by Time Intensity method

- Elucidation of the identity of aromatic compounds affecting to kire (2017 ASBC)
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Elucidation of compounds that contribute to kire (2016 WBC)