

ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Effect of aroma on *kire* of beer

Research Laboratories for Alcohol Beverages

ASAHI BREWERIES, Ltd.

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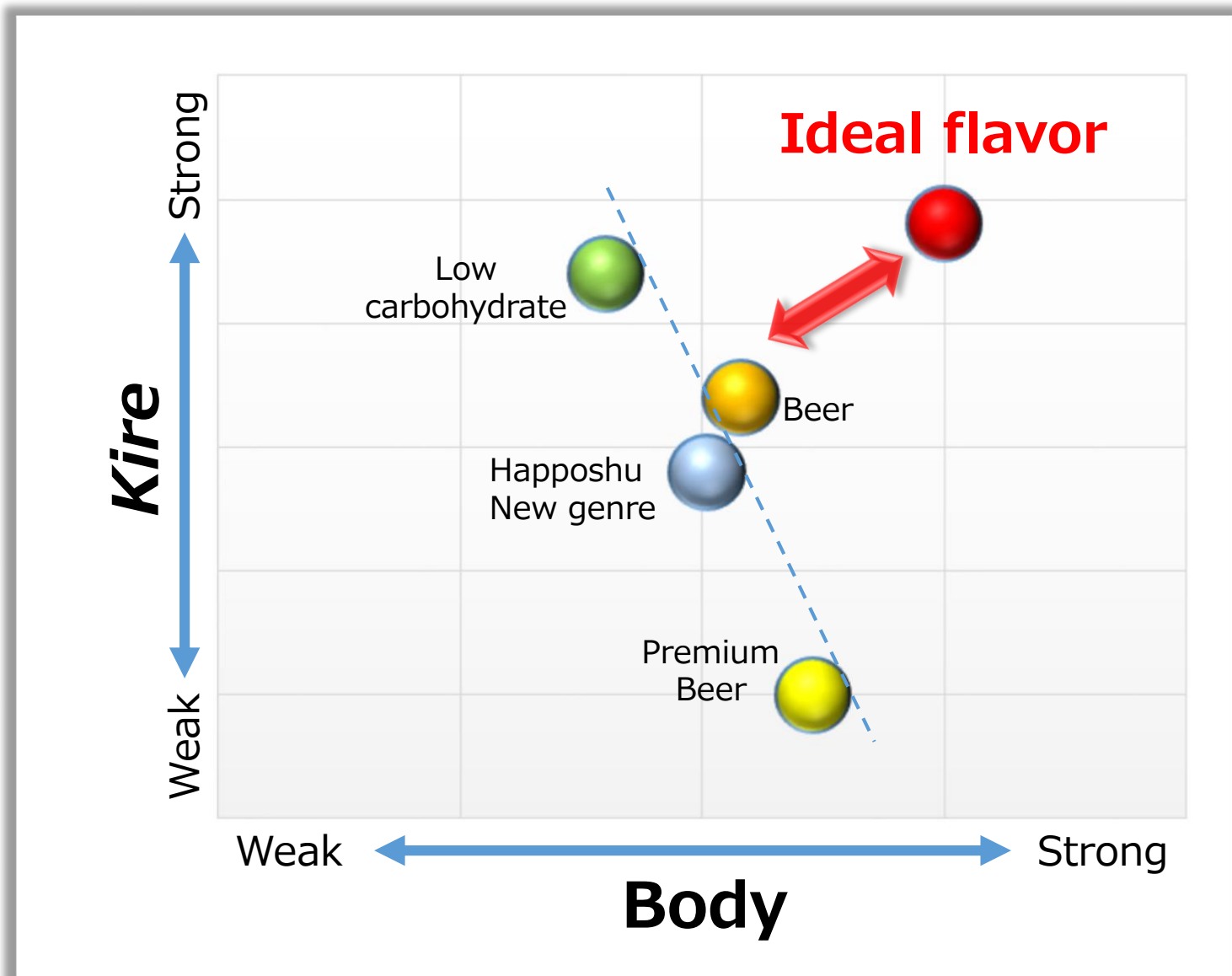
The Asahi logo, featuring the word 'Asahi' in a stylized, blue, italicized font.

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

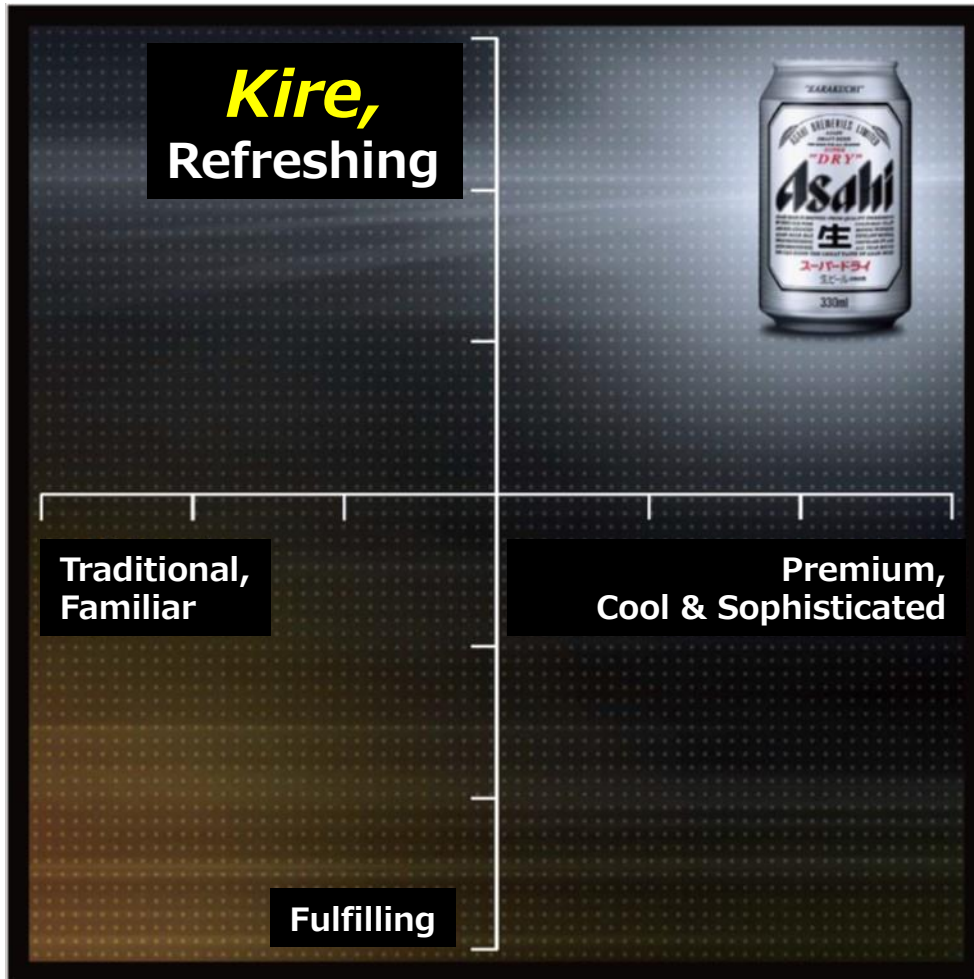
**“Body” and “*kire*” are
important characteristics for
evaluating beer flavors**



Preference survey by Japanese consumers (2015)



- ✓ No. 1 beer in the Japanese market
- ✓ Major characteristic is "*kire*"

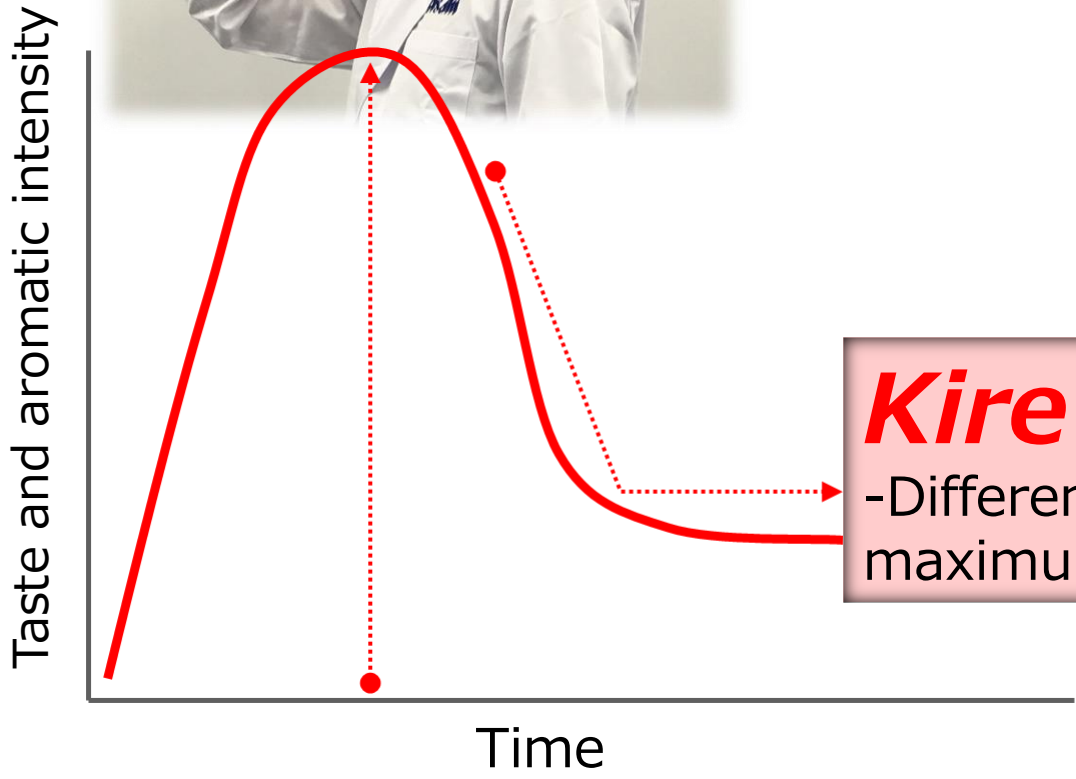


Retronasal
aroma



Body

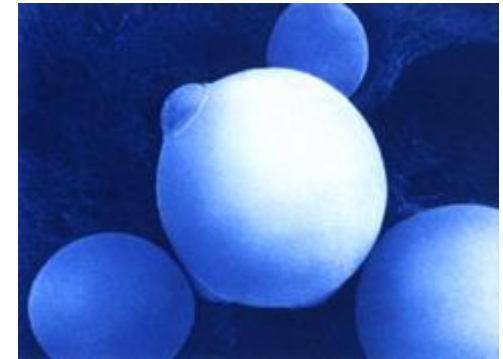
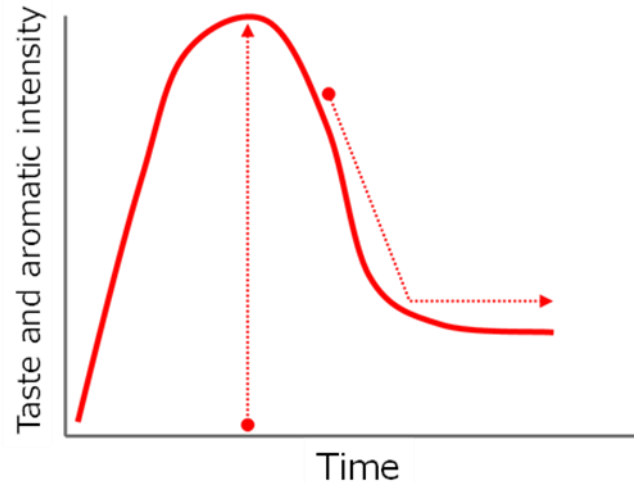
-Total volume of taste and aroma



Kire (Crispness)
-Difference in flavor between the maximum and final mouthfeel

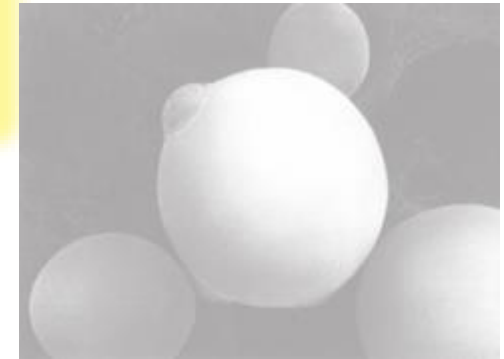
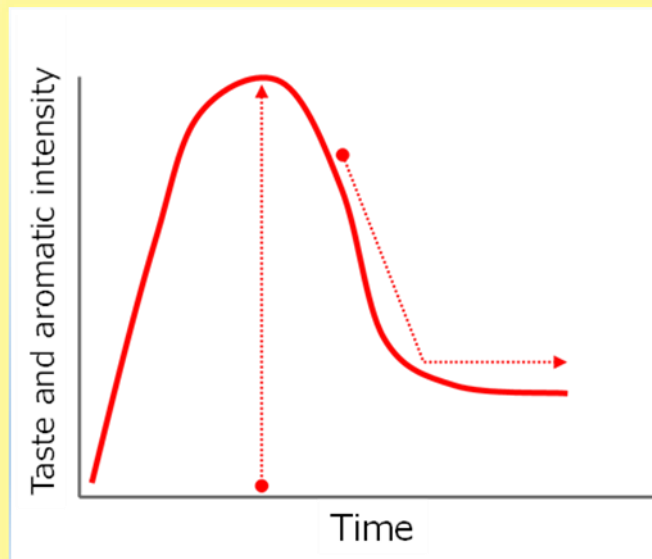
Our recent research into *kire*

- ✓ **Compositional profile of beer flavor (2016 WBC)**
- ✓ **Bitterness depends on iso-alpha acid (2017 EBC)**
- ✓ **Residual sugar content of beer (2017 EBC)**



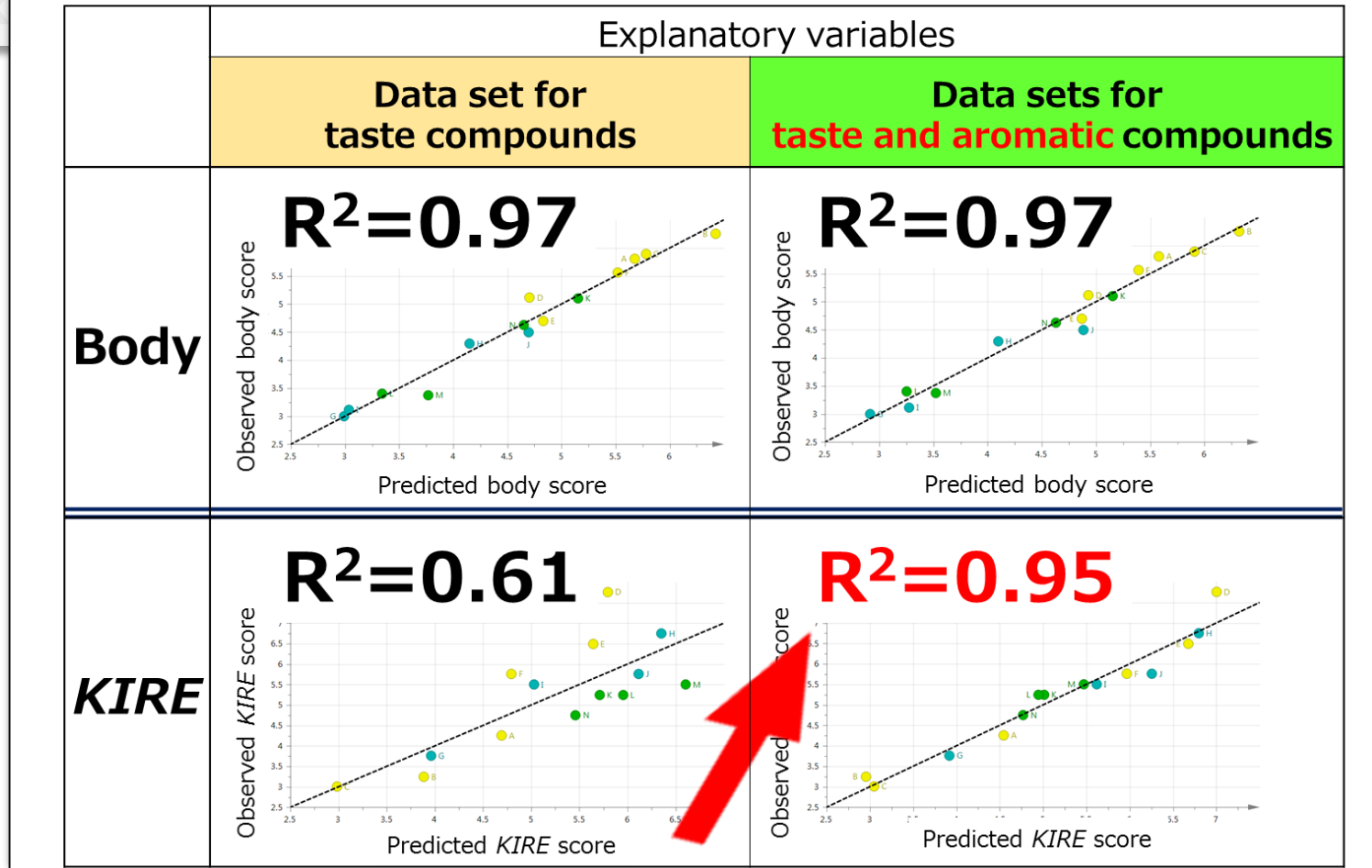
Our recent research into *kire*

- ✓ **Compositional profile of beer flavor (2016 WBC)**
- ✓ Bitterness depends on iso-alpha acid (2017 EBC)
- ✓ Residual sugar content of beer (2017 EBC)



✓ Compositional profile of beer flavor (2016 WBC)

Comparison of R² values of the PLS models



Elucidation of the identity of aromatic compounds that affect *kire* of beer, to find a way of improving *kire*

Hypothesis



Aromatic compounds involved in *kire* affect **retronasal aroma**

**Retronasal
aroma**



**Orthonasal
aroma**

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

Murphy, C., Cain, W.S., and Bartoshuk, L.M., *Sens. Processes* 1, 204-211 (1977).

Rozin, P., *Percept. Psychophys.* 31, 397-401 (1982).

**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**

**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

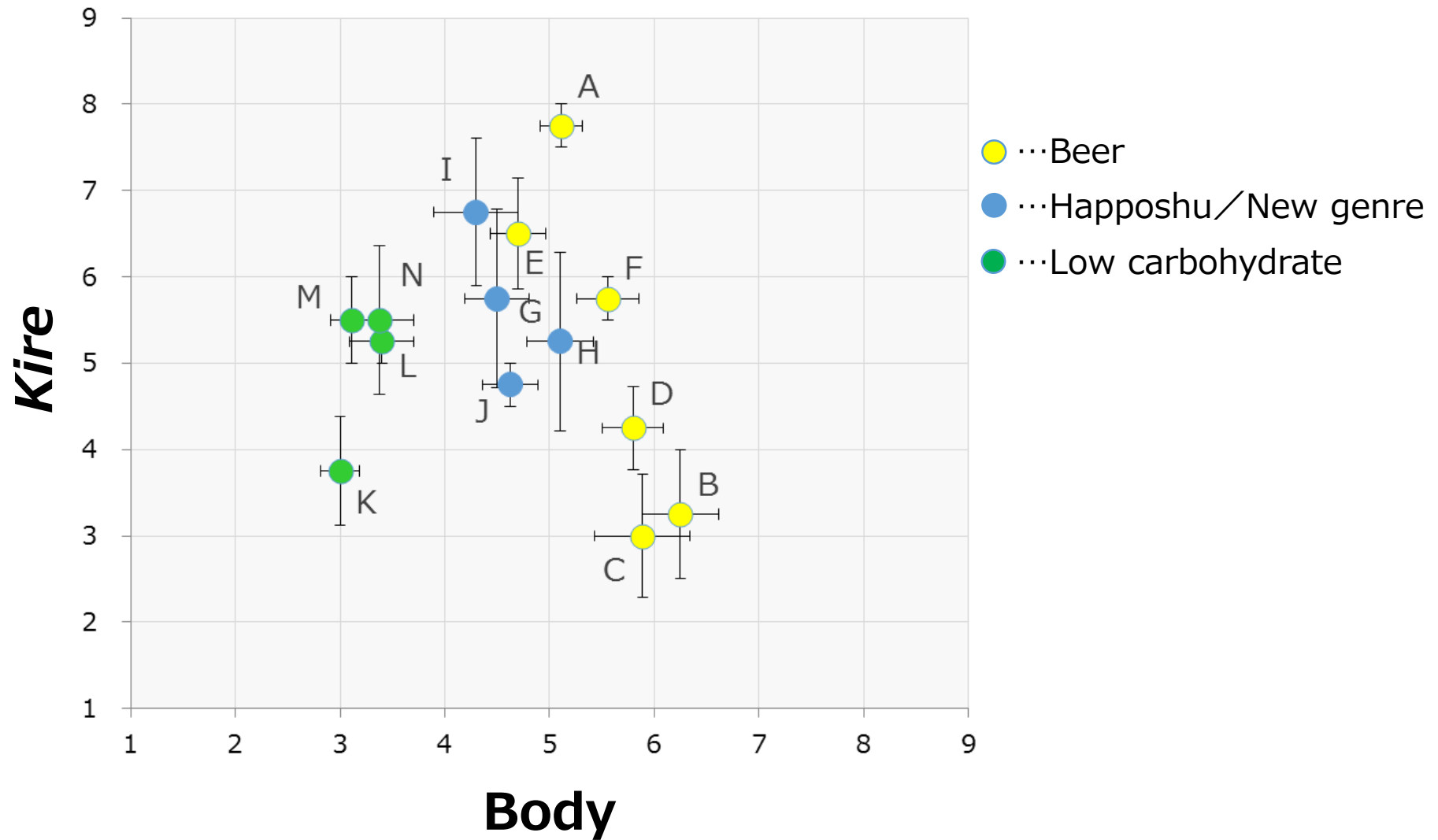


Identification of retronasal aromatic (RA)
compounds characteristic of beer samples
with significantly weaker *kire* scores

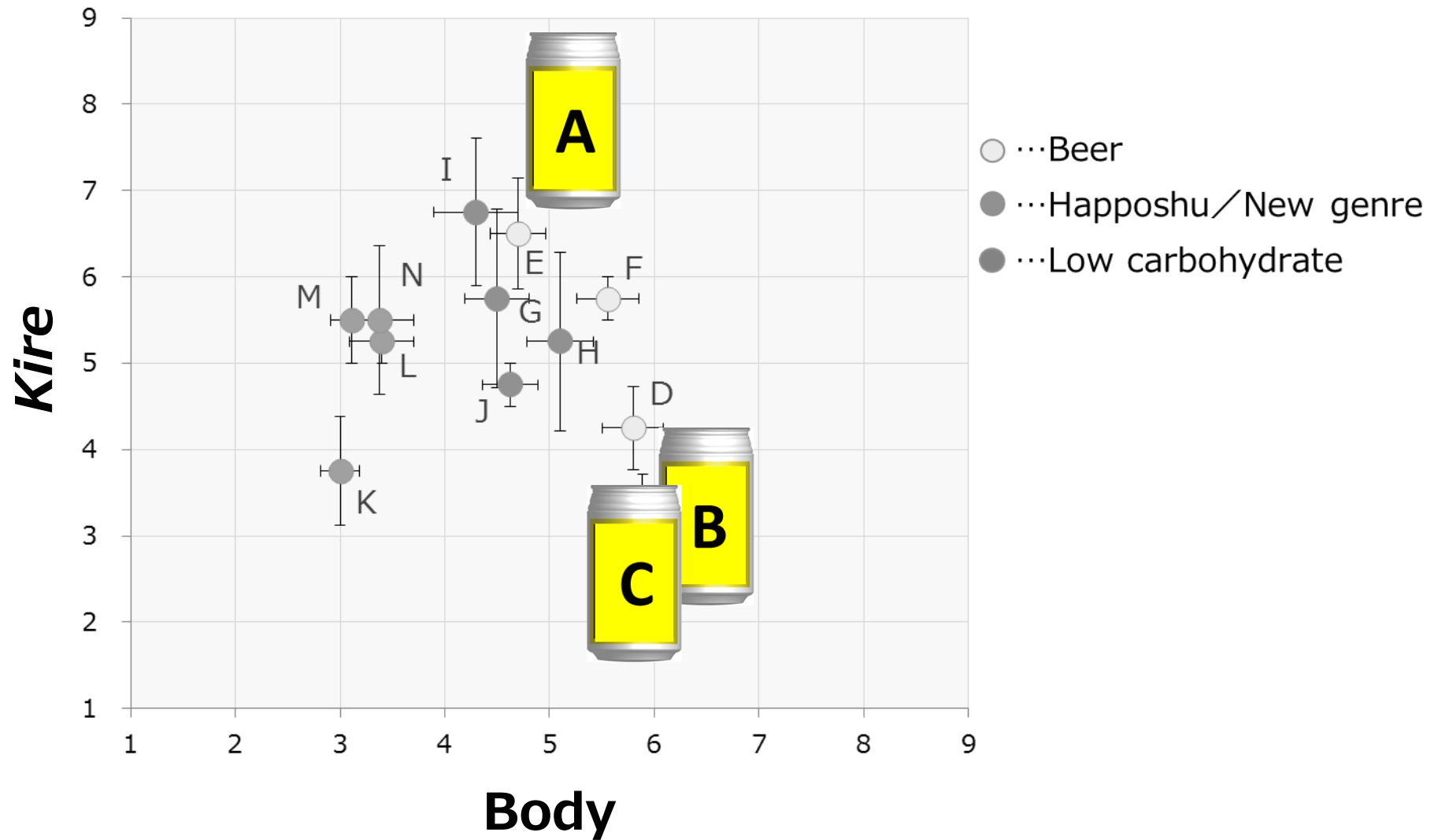


Confirmation that the characteristic RA compounds
affect the *kire* of beer

Results of sensory evaluation



Results of sensory evaluation



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

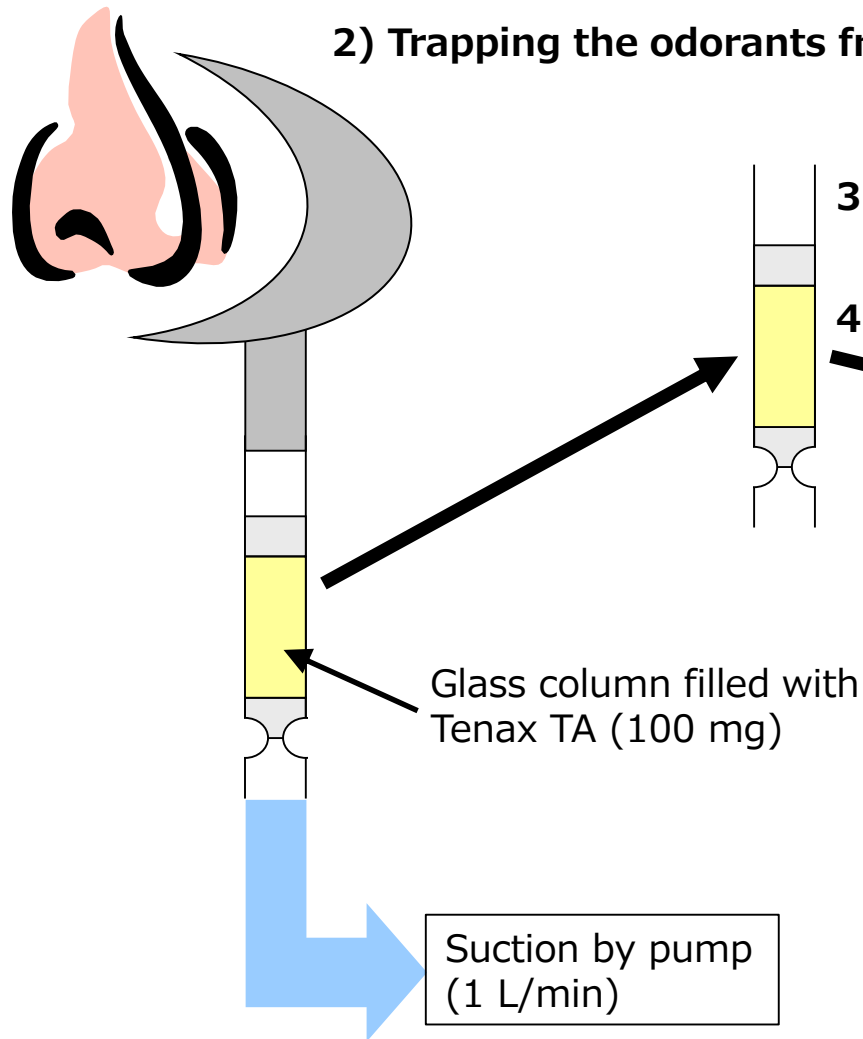


Confirmation that the characteristic RA compounds affect the *kire* of beer

Retronasal Flavor Impression Screening System

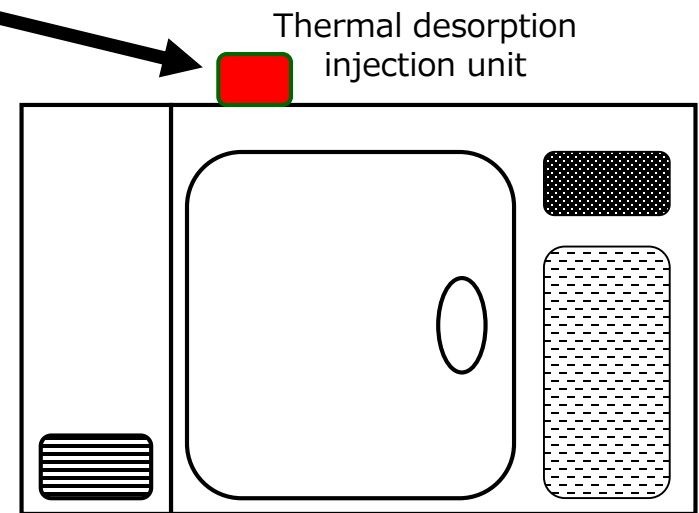
1) Swallowing beer sample (30 mL)

2) Trapping the odorants from the nasal cavity (10 breaths) in Tenax TA



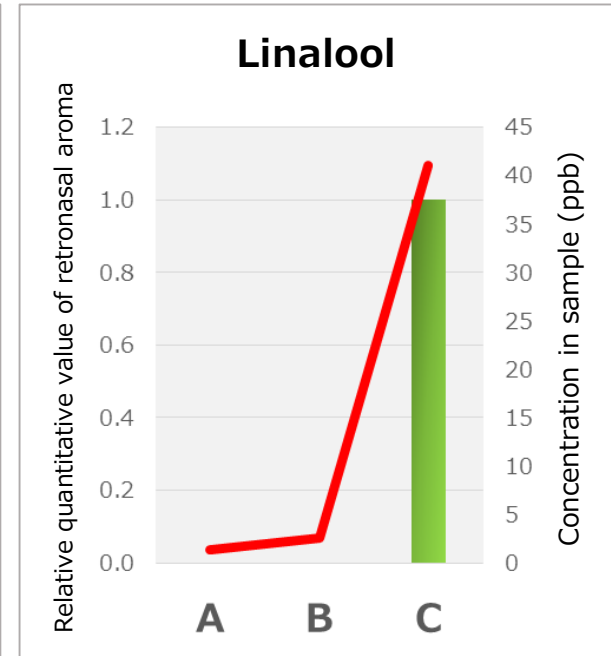
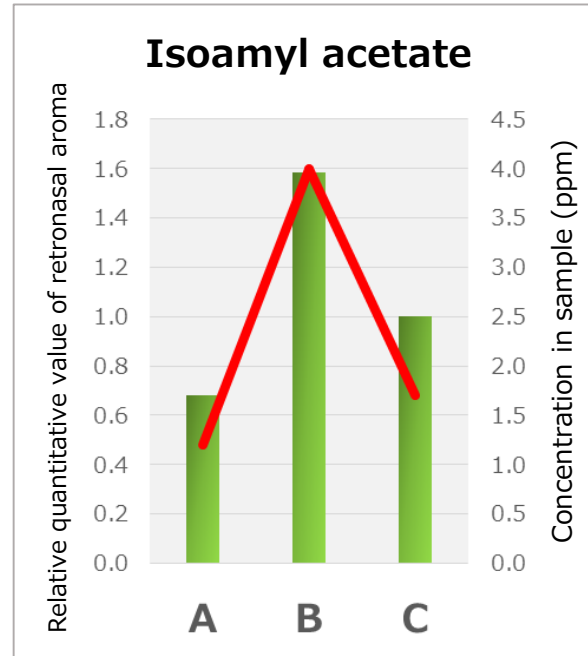
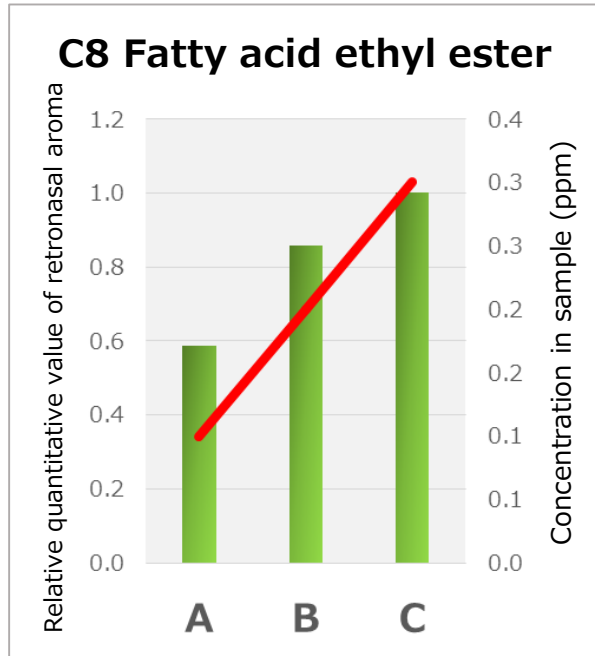
3) Addition of internal standard substance (2-octanol, 25 ng)

4) Nitrogen purge (100 mL/min, 30 min)



5) Separation of aromatic compounds by GC

Results of retronasal aroma analyses



■ Relative quantitative value of retronasal aroma (left axis)
— Concentration in sample (right axis)

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”)

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

Sensory evaluation

Characteristic RA compounds	Relative quantitative value of retronasal aroma			Concentration in sample (ppm)			Difference in concentration between Beer A and others (ppm)	
	A	B	C	A	B	C	B-A	C-A
C8 Fatty acid ethyl ester	0.6	0.9	1.0	0.1	0.2	0.3	0.1	0.2
C10 Fatty acid ethyl ester	ND	0.4	1.0	0.016	0.098	0.093	0.082	0.077
Ethyl acetate	0.9	1.8	1.0	13	35	18	21	4
2-Methyl-butyl acetate	0.8	1.3	1.0	1.3	3.0	1.8	1.6	0.5
Isoamyl acetate	0.7	1.6	1.0	1.2	4.0	1.7	2.8	0.5
Hexyl acetate	ND	1.0	1.0	ND	0.01	0.01	0.01	0.01
Octyl acetate	ND	2.0	1.0	0.003	0.005	0.006	0.002	0.003
2-Phenylethyl acetate	0.6	2.3	1.0	0.3	1.1	0.5	0.8	0.2
Linalool	ND	ND	1.0	0.0013	0.0026	0.0410	0.0013	0.040
2-Phenylethyl alcohol	1.1	1.5	1.0	24	29	26	5	2

no addition



Control (Beer A)

Sensory evaluation

Characteristic RA compounds	Relative quantitative value of retronasal aroma			Concentration in sample (ppm)			Difference in concentration between Beer A and others (ppm)	
	A	B	C	A	B	C	B-A	C-A
C8 Fatty acid ethyl ester	0.6	0.9	1.0	0.1	0.2	0.3	0.1	0.2
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2-Methyl-butyl acetate	0.8	1.3	1.0	1.3	3.0	1.8	1.6	0.5
Isoamyl acetate	0.7	1.6	1.0	1.2	4.0	1.7	2.8	0.5
Hexyl acetate	ND	1.0	1.0	ND	0.01	0.01	0.01	0.01
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2-Phenylethyl alcohol	1.1	1.5	1.0	24	29	26	5	2

no addition



Control (Beer A)



×1, ×2



Test 1

Sensory evaluation

Characteristic RA compounds	Relative quantitative value of retronasal aroma			Concentration in sample (ppm)			Difference in concentration between Beer A and others (ppm)	
	A	B	C	A	B	C	B-A	C-A
C8 Fatty acid ethyl ester	0.6	0.9	1.0	0.1	0.2	0.3	0.1	0.2
C10 Fatty acid ethyl ester	ND	0.4	1.0	0.016	0.098	0.093	0.082	0.077
Ethyl acetate	0.9	1.8	1.0	13	35	18	21	4
2-Methyl-butyl acetate	0.8	1.3	1.0	1.3	3.0	1.8	1.6	0.5
Isoamyl acetate	0.7	1.6	1.0	1.2	4.0	1.7	2.8	0.5
Hexyl acetate	ND	1.0	1.0	ND	0.01	0.01	0.01	0.01
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Linalool	ND	ND	1.0	0.0013	0.0026	0.0410	0.0013	0.040
2-Phenylethyl alcohol	1.1	1.5	1.0	24	29	26	5	2

no addition



Control (Beer A)



×1, ×2



Test 2

Sensory evaluation

Sample	Added compounds	Amount added
Control (Beer A)	–	–
Test 1	Characteristic RA compounds	Difference between the control and Beer B ×1, ×2
Test 2	Characteristic RA compounds	Difference between the control and Beer C ×1, ×2

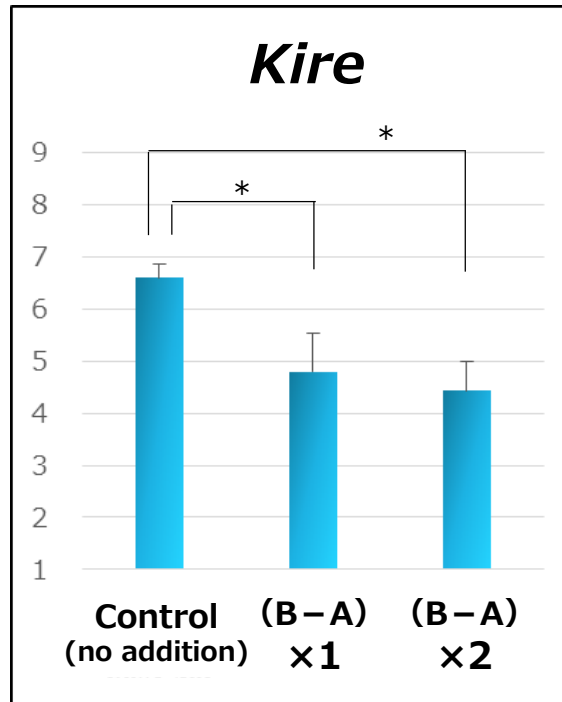
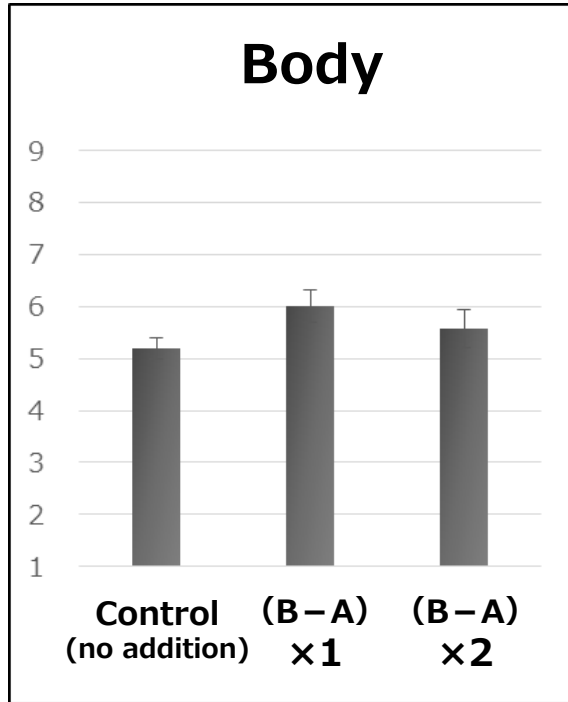
Panels: Trained panel (n=5~7)

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

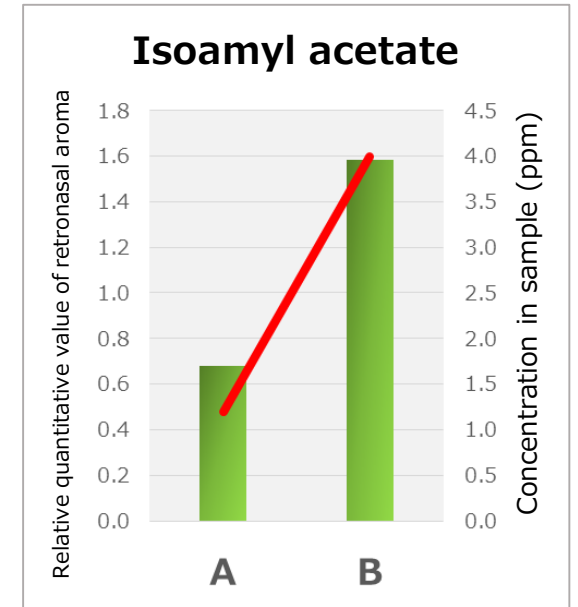
Method: Blind tasting using a cup with a plastic lid



<Test 1> Effect of characteristic RA compounds on *kire*



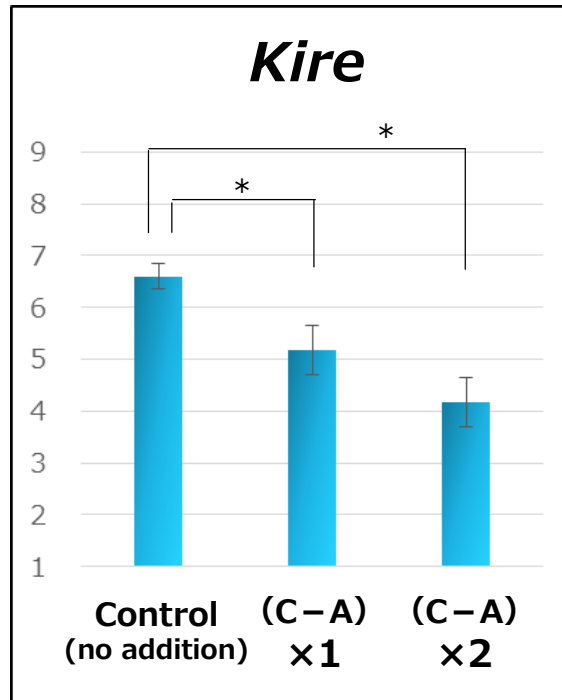
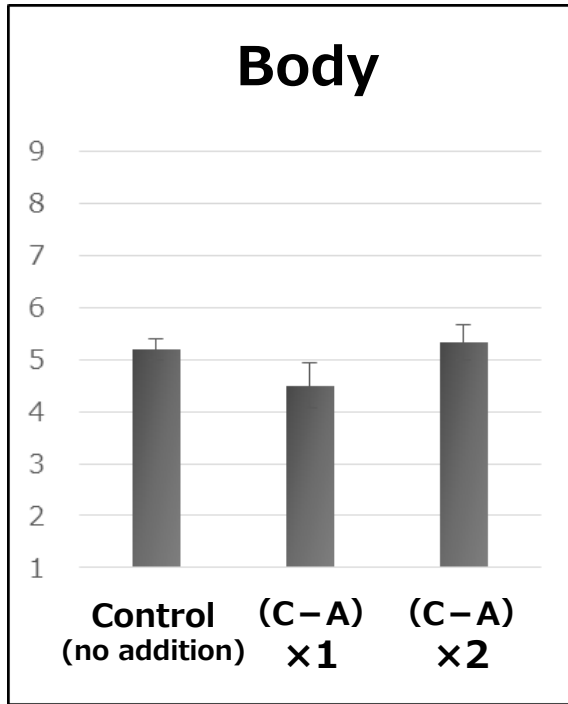
(*) $p < 0.05$



■ Relative quantitative value of retronasal aroma
— Concentration in sample

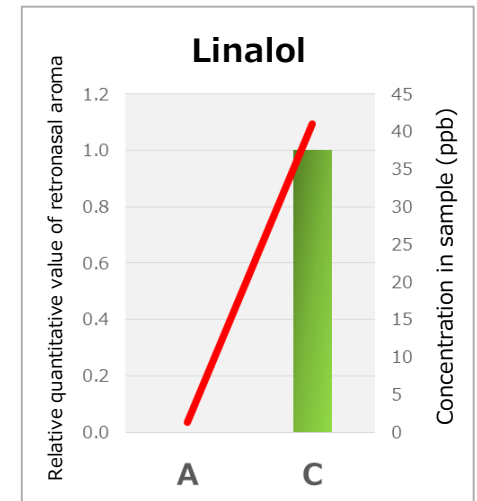
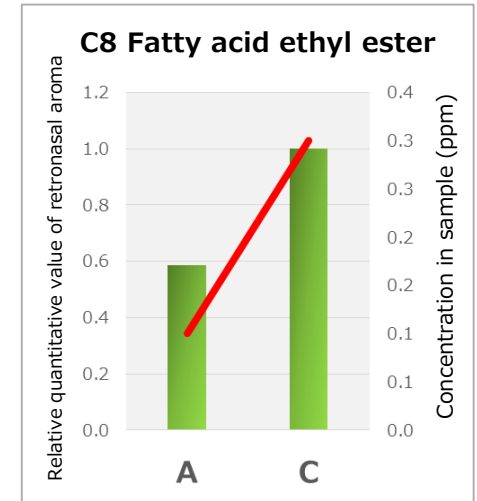
Acetates such as isoamyl acetate appear to negatively contribute to *kire*

<Test 2> Effect of characteristic RA compounds on *kire*



(*) $p < 0.05$

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



■ Relative quantitative value of retronasal aroma
— Concentration in sample

Distinctive *kire* "SUPER DRY EXTRA COLD"



Strong *kire*

**Clear
aftertaste**

Refreshing

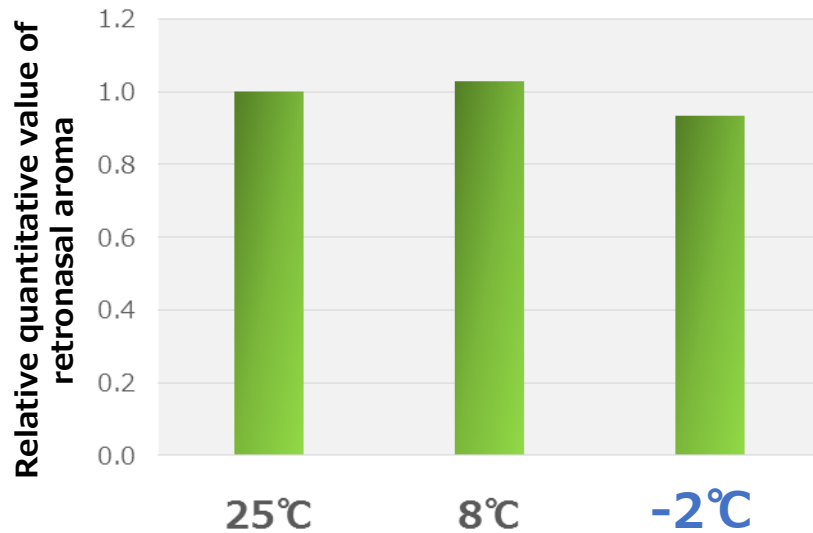
Sharpness

So good!

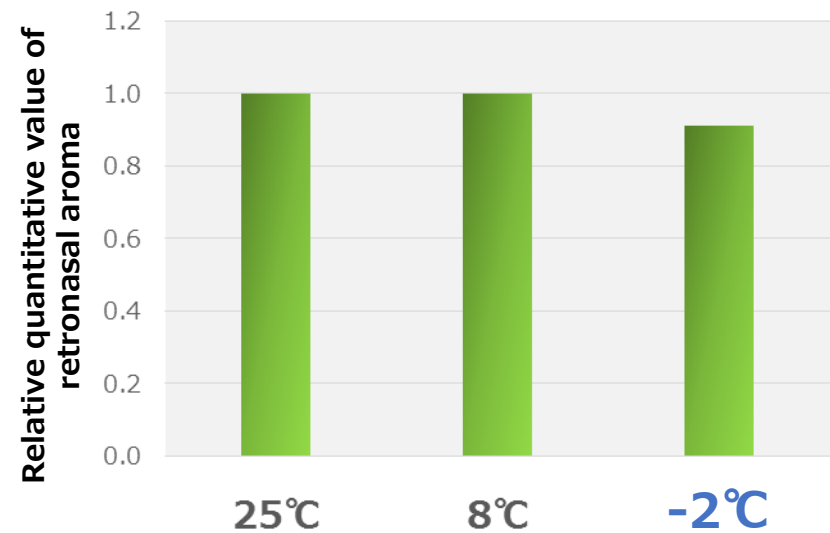


Effect of drinking temperature on retronasal aroma

Isoamyl alcohol



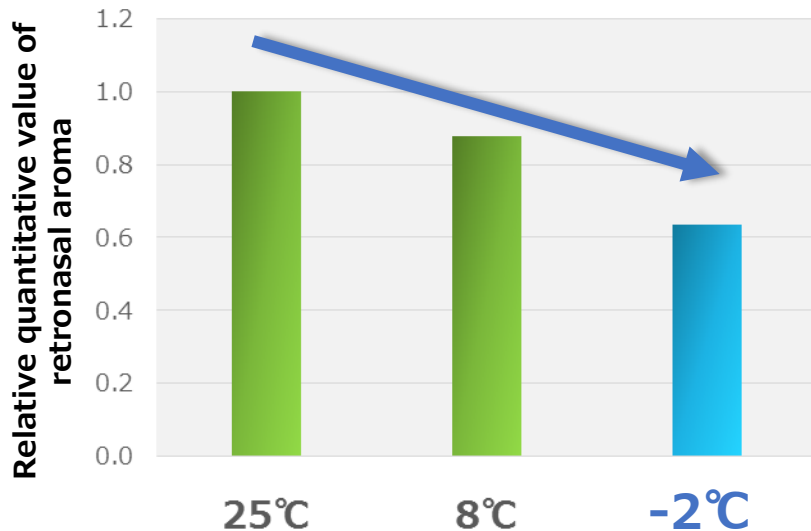
2-Methyl-1-butanol



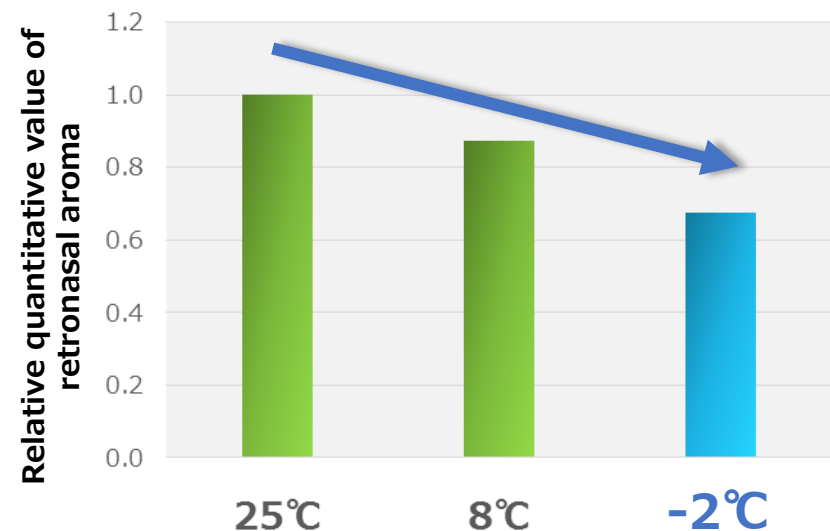
Drinking temperature of the beer had a small effect on retronasal aroma of fusel alcohols

Effect of drinking temperature on retronasal aroma

C8 Fatty acid ethyl ester

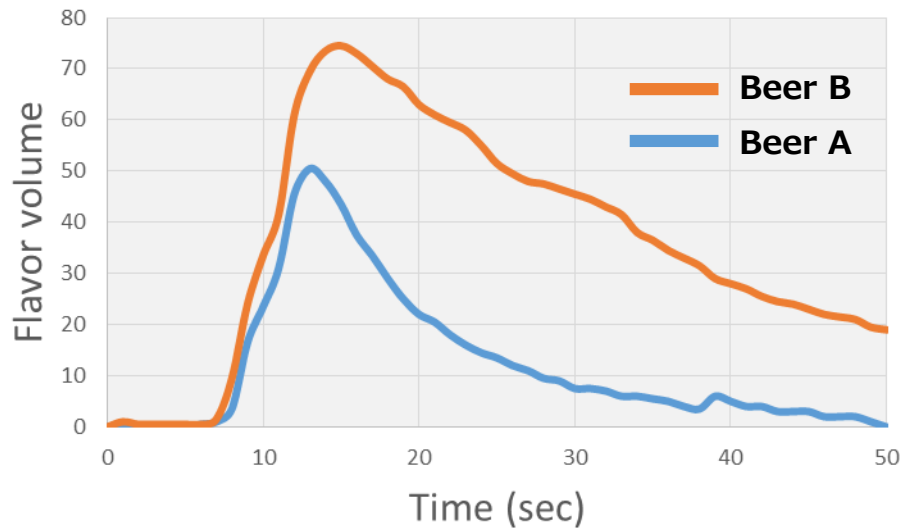


Isoamyl acetate



These results suggest that lowering the temperature improves *kire*

- ✓ **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***



Improvement
of *kire*

<Visualization of *kire*>

Evaluation of *kire* by Time Intensity method

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

Elucidation of compounds that contribute to *kire*
(2016 WBC)