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Application News

No. G317A

Gas Chromatography

Analysis of Aroma Components in Beer Using HS-20 and Nexis™ GC-2030

Beer contains an extremely large number of aromatic compounds, or aroma components. In this article, nine aroma components, which have a large influence on the flavor of beer, including alcohols and esters, were analyzed in five types of commercial beer. A multivariate analysis (principal component analysis, hierarchical clustering analysis) of those analysis results was also conducted, and the beers were compared.

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Analysis Method

A standard solution for the calibration curve was prepared by diluting a mixed stock solution of aroma components with 4% ethanol. 10 g of this solution was introduced into a headspace vial, an internal standard was added, and the vial was sealed, after which a headspace analysis was conducted and the calibration curve was prepared. Real samples were prepared in the same manner as described above using 10 g of non-deaerated beer and the internal standard and then sealed in a headspace vial. A headspace analysis was conducted, and quantitation was done using the prepared calibration curve.

Appearance of Nexis™ GC-2030 + HS-20

Analysis Conditions

Table 1 shows the device composition and analysis conditions.

Table 1 Device Composition and Analysis Conditions

Headspace sampler (HS-20)		Gas chromatograph (Nexis GC-2030 / FID-2030)	
Mode	: Loop	Injection Mode	: Split
Oven Temperature	: 40 °C	Split Ratio	: 1 : 5
Sample Line Temperature	: 70 °C	Carrier Gas	: He
Transfer Line Temperature	: 80 °C	Carrier Gas Control	: Column flowrate (5 mL/min)
Vial Pressure	: 150 kPa	Column	: SH-Wax (30 m×0.53 mm I.D., 1 µm) *1
Vial Heat-retention Time	: 45 min	Column Temp	: 40 °C (5 min) - 10 °C /min – 190 °C (5 min)
Vial Pressurization Time	: 1 min	Detector Temp	: 200 °C
Vial Pressurization Equilibrating Time	: 0.1 min	Detector Gas	: H_2 32 mL/min
Loading Time	: 0.5 min		Make-up (He) 24 mL/min
Loading Pressurization Time	: 0.1 min		Air 200 mL/min
Injection Time	: 0.5 min		
Needle Flush Time	: 5 min		

*1 P/N: 221-75899-30

Analysis Results of 5 Commercial Beers

Fig. 1 shows a representative chromatogram, and Table 2 shows the quantitation results (average of n=3) of the aroma components of the five commercial beer samples.

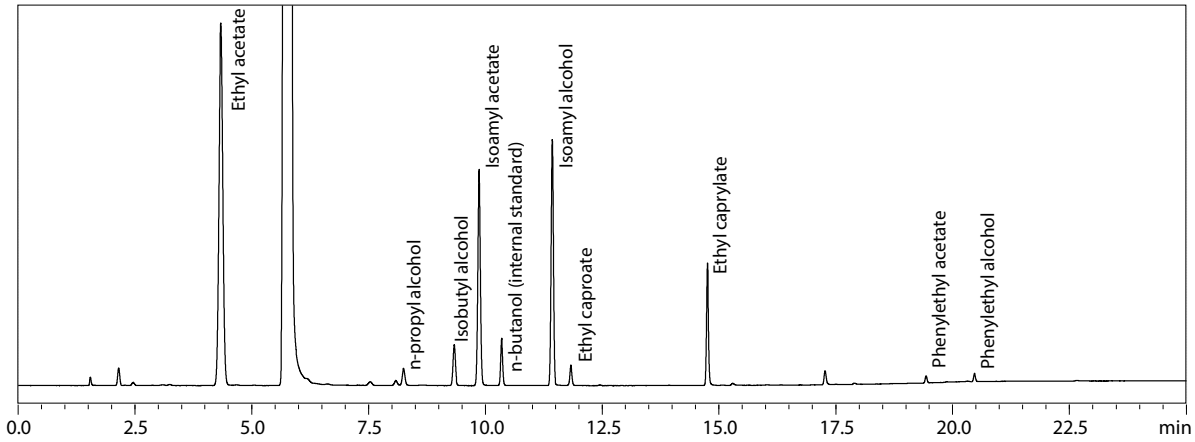

Fig. 1 Chromatogram of Beer

Table 2 Quantitation Results for Aroma Components (Unit: mg/L)

Compound	Beer A	Beer B	Beer C	Beer D	Beer E
Ethyl acetate	21.065	32.552	12.584	30.386	13.825
n-propyl alcohol	11.342	11.217	11.985	23.662	9.360
Isobutyl alcohol	10.490	10.941	14.126	0.190	9.198
Isoamyl acetate	2.188	2.725	0.936	0.459	1.120
Isoamyl alcohol	62.552	52.284	59.169	59.692	54.575
Ethyl caproate	0.067	0.091	0.052	0.088	0.094
Ethyl caprylate	0.114	0.159	0.067	0.124	0.137
Phenylethyl acetate	0.350	0.808	0.125	Not detected	0.231
Phenylethyl alcohol	16.891	21.655	17.025	13.420	16.583

Multivariate Analysis Results and Study

Using eight components (excluding phenylethyl acetate) that were detected in all the beers in this analysis (n=3), a principal component analysis and hierarchical clustering analysis were carried out with the multivariate analysis software SIMCA® 15 (Infocom Corporation). Fig. 2 shows a score plot of the results. The five beer samples were clearly separated on the score plot, and the differences among the beers could be visualized. Fig. 3 shows a dendrogram. The degree of similarity could be visualized from the dendrogram.

The score plot and dendrogram show that Beer D differs greatly from the other four beers, suggesting that the concentration ratio of the eight components is different in Beer D from the other beers. Moreover, only Beer D was a top fermentation ale beer, and the other beers were bottom fermentation lager beers.

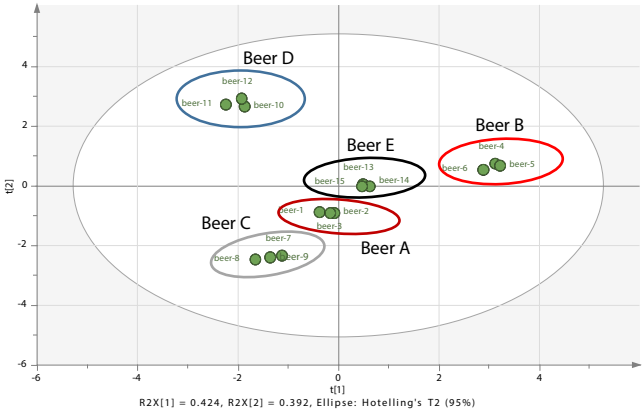

Fig. 2 Score Plot

Fig. 3 Dendrogram

Conclusion

Nine aroma components in beer could be analyzed with high sensitivity, and differences in the component concentrations among the beers could be recognized. Simple visualization of the comparison of the beers was possible by a multivariate analysis of those analysis results.

<Reference>
Brewers Association of Japan, BCOJ Beer Analysis Methods (2013)

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