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Aroma Components of Chicory (*Cichorium intybus* L.) Tea and Its Model System

Sung-Hee Choi

Department of Food Science and Nutrition, Dong-eui University, Pusan 614-714, Korea

Abstract

Aroma components of tea processed from Korean chicory roots were isolated and identified. The model system of amino-carbonyl reaction was carrid out to study the formation mechanism of aroma compounds of chicory tea during manufacturing process. The concentrated extracts from chicory tea and model system were analyzed and identified by gas chromatography (GC) and GC-mass spectrometry. Twenty-nine compounds, including pyrazines, furans, acids, alcohols, pyrroles and lactones were isolated and identified in chicory tea. The main compounds were pyrazines including methyl pyrazine, 2,5-dimethyl pyrazine, 2,6-dimethyl pyrazine, 2-ethyl-6-methyl pyrazine, 2-ethyl-3-methyl pyrazine, trimethyl pyrazine, 3-ethyl-2,5-dimethyl pyrazine, 5-ethyl-2,3-dimethyl pyrazine, and 2-acetyl-3-methyl pyrazine and pyrroles including acetyl pyrrole and formyl pyrrole ; and furans including furfural, acetyl furan, 5-methyl furan, 5-methyl furfural, and furfuryl alcohol. These pyrazine compounds of a roasted and nutty aroma may be important contributors to the flavor of chicory tea. The aroma concentrate of model system also had a roasted and nutty aroma and the main compounds were methyl pyrazine, 2,5-dimethyl pyrazine, 2,6-dimethyl pyrazine and trimethyl pyrazine.

Key words: chicory (*cichorium intybus* L.) flavor, pyrazines, lactones

INTRODUCTION

Chicory (*Cichorium intybus* L.) is an important agricultural product in Europe and Asia. The chicory roots are known for theirs organoleptic and pharmacological properties. In Europe, it is used as a substitute for coffee or blended with it (1,2), and it is used as a traditional medicine in Asia. It is also produced at Mt. Sorak of the Kangwon province in Korea, where it is processed for consumption as tea beverage. The manufacturing process for chicory tea is similar to that of other teas made from roots by parching, drying and cutting as usual steps. The taste of chicory tea is slightly bitter, while its aroma is roasty and aromatic. Maybe, the aroma is formed during the parching and drying processes. The consumption of chicory tea increases continuously in Korea.

A lot of researches on the chicory components have been carried out by many scientists, but most of researches on the chicory components were focussed on bitter components (3-5), nonvolatile compounds and their pharmacological effect (6). However, the studies on the aroma compounds has been little (7). And the formation mechanism of chicory aroma formed during the parching process also has not been investigated. Therefore, the aroma compounds of chicory tea made from its roots were isolated and identified. And also the amino-carbonyl model system reaction was carried out to confirm the formation mechanism of aroma compounds of chicory tea during the parching process in manufacturing processes. The concentrated extracts from chicory tea and model system were analyzed and identified by GC and GC-MS. Free amino acids of chicory tea, precursers of amino-carbonyl reactions were analyzed by amino acid analyzer.

MATERIALS AND METHODS

Chicory sample

Chicory tea produced at Mt. Sorak of the Kangwon province in Korea in 1997 was used.

Preparation of aroma concentrate

The aroma concentrate from 100 g chicory tea was isolated by a modified method from Likens and Nickerson, using a simultaneous distillation and extraction apparatus. The steam distillation and extraction (water-diethylether=1000:100 ml) was continued for 3 hours. The extract was dried over anhydrous sodium sulfate and the solvent was removed by the distillation of diethyl ether.

Analysis of free amino acids of chicory tea

Free amino acids of chicory tea were analyzed by automatic amino acid analyzer (Biochrom 20, Pharmacia Biotech., U.K.).

Amino-carbonyl reaction model system

The amino-carbonyl (0.075 mol glucose and 0.075 mol arginine) reaction model experiment was carried out by the same method as the preparation of aroma concentrate of chicory tea. The steam distillation and extraction (water-diethylether= 1000:50 ml)was continued for 4 hours. The extract was dried over anhydrous sodium sulfate and the solvent was removed by distillation of the diethyl ether.

Instrumental methods of aroma concentrates

Gas chromatography (shimadzu model 9A) equipped with

E-mail: choish@hyomin.dongeui.ac.kr
Phone: 82-51-890-1590, Fax: 82-51-890-1786

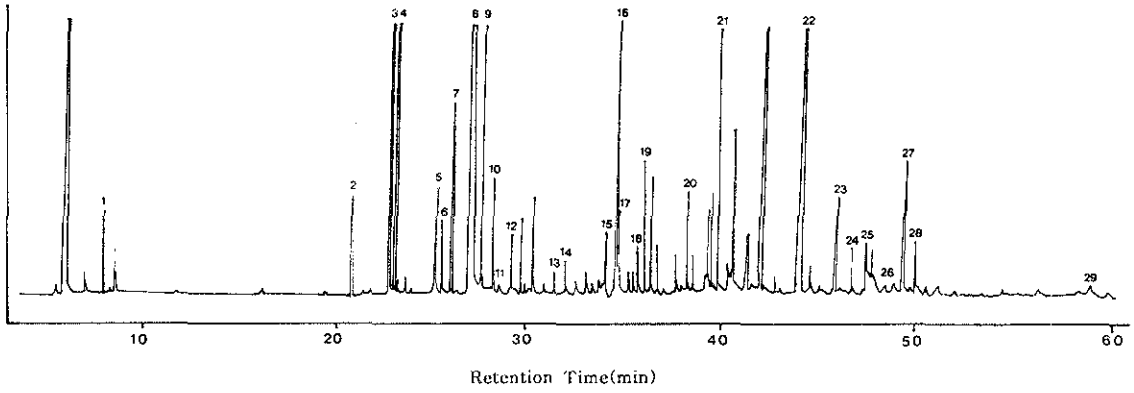

Fig. 1. Gas chromatogram of aroma concentrate from chicory tea.

FID and a 50 m × 0.25 mm Carbowax 20 M fused silica capillary column was used. The oven temperature was held at 60°C for 8 minutes and then programmed to 190°C for 4 minutes. Nitrogen was used as a carrier gas and the flow rate was 1 ml/min.

GC-MS system consisted of a Hewlett-Packard 5890 GC/5988 MS (ionization voltage : 70eV). The GC conditions were the same as those for the corresponding GC analysis, except that Helium was used as a carrier gas.

RESULTS AND DISCUSSION

The aroma concentrate of the processed chicory tea had a roasted and nutty note. The gas chromatogram of the aroma concentrate are shown in Fig. 1 and the identified components are shown in Table 1. Twenty-nine compounds including pyrazines, furans, acids, alcohols, pyrroles and lactones were isolated and identified from the chicory tea. About half of identified compounds were newly found (7) in this study. The main compounds were pyrazines including methyl pyrazine, 2,5-dimethyl pyrazine, 2,6-dimethyl pyrazine, 2-ethyl-6-methyl pyrazine, 2-ethyl-3-methyl pyrazine, trimethyl pyrazine, 3-ethyl-2,5-dimethyl pyrazine, 5-ethyl-2,3-dimethyl pyrazine, 2-acethyl-3-methyl pyrazine and pyrroles including acetyl pyrrole, formyl pyrrole and furans including furfural, acetyl furan, 5-methyl furan, 5-methyl furfural and furfuryl alcohol.

Even though the manufacturing processes of chicory tea were different among companies, in general, processes consist of parching, drying and cutting.

The aroma of chicory tea is roasty and nutty. Maybe, the roasty and nutty aroma is formed during the parching and drying processes. Pyrazines with a roasted and nutty aroma may be important contributors to the flavor of chicory tea. Pyrazines identified from chicory tea almostly corresponded to roasted bran rices (8). Most pyrazines identified in this study were found also in the previous study (7). 2-Acetyl-3-methyl pyrazine and 3-isopropyl-2,4,5-trimethyl pyrazine identified newly. 2-Acetyl-3-methyl pyrazine was not found from roasted bran rice (8) but was found from roasted products including filbert (9) and almond (10) etc. These pyrazines are believed to form mainly from amino-carbonyl reaction. The aroma of some lactones is very pleasant. Some of the pleasant roasted aroma was identified in roasted coffee. But γ-Butyrolactone [dihydro-2(3H)-furanone] and δ-valerolactone (tetrahydro-2H-pyranone) identified in chicory tea was not found from roasted coffee (11). γ-Butyrolactone[dihydro-2(3H)-furanone] was found also in the previous study (7) and δ-valerolactone was (tetrahydro-2H-pyranone) newly identified in this study. 4-Hydroxy-5-methyl-3(2H)-furanone and 4-hydroxy-2,5-

Table 1. The aroma compounds identified from *Cichorium intybus* L.

Peak No.	Compounds	RT[1)]	Peak area (%)	Evidence
1	Ethyl acetate	8.51	0.55	GC,MS
2	Methyl pyrazine	20.95	1.01	GC,MS
3	2,5-Dimethyl pyrazine	23.21	4.35	GC,MS
4	2,6-Dimethyl pyrazine	23.45	4.02	GC,MS
5	2-Ethyl-6-methyl pyrazine	25.63	0.83	GC,MS
6	2-Ethyl-3-methyl pyrazine	25.87	4.83	GC,MS
7	Trimethyl pyrazine	26.35	1.62	GC,MS
8	3-Ethyl-2,5-dimethyl pyrazine	27.16	13.82	GC,MS
9	5-Ethyl-2,3-dimethyl pyrazine	27.79	2.46	GC,MS
10	Furfural	28.38	1.04	GC,MS
11	Acetic acid	28.84	0.13	GC,MS
12	Acetyl furan	29.35	0.56	GC,MS
13	5-Methyl furfural	31.48	0.03	GC,MS
14	2-Methyl propanoic acid	32.14	0.33	MS
15	Dihydro-2(3H)-furanone	34.07	0.65	MS
16	3-Methyl butanoic acid	34.59	7.93	MS
17	Furfuryl alcohol	34.72	2.33	GC,MS
18	2-Acetyl-3-methyl pyrazine	35.72	0.49	MS
19	2-Furoic acid	36.02	1.10	GC,MS
20	Tetrahydro-2H-pyran-2-one	38.36	0.78	MS
21	Hexanoic acid	39.82	2.82	GC,MS
22	Acetyl pyrrole	44.21	10.33	GC,MS
23	1H-Pyrrole-2-carboxaldehyde	46.20	1.68	MS
24	3-Phenyl-2-propenal	47.10	0.55	MS
25	2-Formyl-1-methyl pyrrole	47.74	1.24	GC,MS
26	1,4-Cyclohexanediol	49.00	0.61	GC,MS
27	2-Methyl-2-piperazine	49.43	2.00	MS
28	Dimethylhydrazone propanal	50.34	0.91	MS
29	3-Isopropyl-2,4,5-trimethyl pyrazine	54.41	0.15	MS

[1)]RT: retention time

Table 2. Free amino acid composition of chicory tea

Compounds	Peak area (%)	Compounds	Peak area (%)
Aspartic acid	4.4	Isoleucine	1.5
Threonine	1.2	Leucine	0.4
Serine	6.5	Tyrosine	1.3
Glutamic acid	2.3	Phenylalanine	3.2
Proline	19.3	Histidine	0.5
Alanine	2.8	Lysine	0.9
Cystine	0.7	Arginine	53.9
Valine	1.3		

Table 3. The model system of Maillard reaction

PH	Temp. (Time)	Glucose	Arginine	Water
9.0	100°C (4 hrs)	13.50 g (0.075 mol)	13.07 g (0.075 mol)	1000 ml

pH was adjusted with saturated Na_2CO_3 solution.

The amino-carbonyl model reaction was carrid out, in order to confirm the formation the mechanism of aroma compounds of chicory tea during processing. The model system was done with diluting solutions of glucose and arginine (Table 3).

The volatile aroma concentrate of model system was obtained by simultaneous distillation and extraction with Likens and Nickerson's apparatus by the same method as preparation of aroma concentrate of chicory tea.

The aroma concentrate of model system had a roasted and nutty aroma. The gas chromatogram of the aroma concentrate from model system is shown in Fig. 2 and the identified components are shown in Table 4. The pyrazines identified from model system were methyl pyrazine, 2,6-dimethyl pyrazine, trimethyl pyrazine, 3-ethyl-2,5-dimethyl pyrazine.

The main volatile aroma compounds identified from chicory tea corresponded to the aroma compounds formed by the model experiment of maillard reaction.

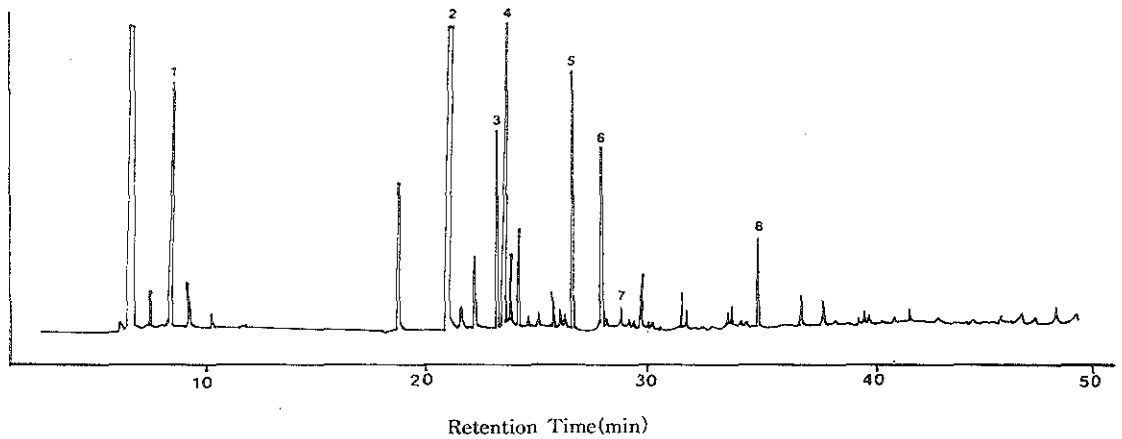

Fig. 2. Gas chromatogram of volatile concentrate from model system.

Table 4. The volatile compounds identified from concentrate of model system

Peak No.	Compounds	RT[1)]	Peak area (%)	Evidence
1	Ethyl acetate	8.47	3.21	GC,MS
2	Methyl pyrazine	20.96	35.03	GC,MS
3	2,5-Dimethyl pyrazine	23.14	2.56	GC,MS
4	2,6-Dimethyl pyrazine	23.42	11.65	GC,MS
5	Trimethyl pyrazine	26.27	3.33	GC,MS
6	3-Ethyl-2,5-dimethyl pyrazine	27.47	2.63	GC,MS
7	Acetic acid	28.81	0.27	GC,MS
8	Furfuryl alcohol	34.54	1.26	GC,MS

[1)]RT : retention time

dimethyl-3(2H)-furanone were isolated from beef broth (12). The former from beef broth was characterized as a roasted chicory root odor. The latter was proved as caramel-like odor.

Free amino acids of chicory tea were analyzed to confirm the role of amino acids as important precursors of aroma of chicory tea (Table 2). The main amino acid of chicory tea was arginine, which was most abundant (53.9%) among all amino acids.

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