Pr-P-16

Production

TRACING AROMA CHARACTERISTICS CHANGES DURING PROCESSING OF THE FAMOUS FORMOSA OOLONG TEA "ORIENTAL BEAUTY"

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Summary

Oriental Beauty (Pom-Fong tea), which has a pronounced honey aroma and a rich flavor with spicy note, is a high-grade tea produced *via* a higher degree of the fermentation process from tea leaves infested by the tea green leafhoppers (*Jacobiasca formosana* Paoli) in Taiwan. We have carried out aroma analyses of tea samples obtained during the processing to know the molecular basis of the characteristic aroma formation of the tea. The volatile components of samples were obtained by solvent extraction, and analyzed by using GC and GC/MS. 2,6-Dimethyl-3,7-octadien-2,6-diol was mainly contained at an early stage of the manufacturing process. Linalool, linalool oxides, 3,7-dimethyl-1,5,7-octatrien-3-ol, 2-phenylethanol and geraniol increased as the fermentation progress. Jasmine lactone and indole, which were mainly contained in Pouchong tea, were minor components.

Key words

Oolong tea, Oriental beauty, Leafhopper, Aroma analysis, Volatile components, Chiral analysis

Introduction

Oriental Beauty (Pom-Fong tea) is a famous oolong tea in Taiwan, which is produced *via* a higher degree of the fermentation process from tea leaves infested by the tea green leafhoppers (*J. formosana*). The oolong tea has a characteristic aroma. The aroma components of the oolong tea have been reported by several reserchers.[1-4)] Many volatile components have been identified by Gas Chromatography (GC) and Gas Chromatography/Mass Spectrometry (GC/MS). The major compounds contributed to the aroma of Pom-Fong tea were 2-phenylethanol, benzyl alcohol, linalool oxides, 2,6-dimethyl-3,7-octadiene-2,6-diol, 3,7-dimethyl-1,5,7-octatrien-3-ol and so on. These aroma compounds were different from the aroma components of Pouchong tea made *via* low degree of fermentation from non-infested leaves. The difference of aroma between Pom-Fong tea and Pouchong tea was probably due to degree of the fermentation process and the infestation by the leaf hoppers.

In this study we have investigated in detail changes of tea aroma formation throughout the tea processing as well as differences of volatile components between the teas prepared in the same manner from healthy material leaves and those infested by the insect.

Materials

Two types of material leaves (with/without the insect infestation) were used for the tea sample production: leaves of cv. Chinshin Dahpan cultivated under the best quality control and those of the same variety plucked from tea plants intentionally to be infested by the leafhoppers in June, 2004. The non-infested tea samples were prepared from autumn leaves of the same cultivar. The oolong tea samples were obtained at 7 series of the manufacturing process from no fermentation process to the final process as shown in Table 1.

Authentic materials for analysis were mainly purchased from Sigma-Aldrich, and some were prepared by ourselves.

Table 1. Tea samples

run	solar withering	indoor withering	turning over	panning	Wetting and softening	rolling	drying	tea leves: infested	tea leves: non infested
1				→	→	→	→	A1	B1
2	→			→	→	→	→	A2	B2
3	→	→	1 time	→	→	→	→	A3	B3
4	→	→	2 times	→	→	→	→	A4	B4
5	→	→	3 times	→	→	→	→	A5	B5
6	→	→	4 times	→	→	→	→	A6	B6
7	→	→	5 times	→	→	→	→	A7	B7

Methods

Each tea sample (5.0 g) was brewed with 75 g of deionized boiling water for 10 min. After filtration, the filtrate was filled up to 50 ml, and added with 50 μl of ethanol solution containing 0.01% 3-nonanone as an internal standard. The solution was saturated with sodium chloride and was extracted with 20 ml of dichloromethane. The extract was dried over anhydrous sodium sulfate for 12 hr. After sodium sulfate was filtrated off, the solvent was carefully removed with a Kuderna-Danish evaporative concentrator.

Instrumental methods

GC analysis was performed on a HP6890 (Agilent Technologies), equipped with FID and a HP-20M fused silica capillary column (25 m x 0.2 mm x 0.1 μ m df, Agilent Technologies). The oven temperature was held at 55 ℃ and programmed to 215 ℃ at 4 ℃/min. Helium was used as a carrier gas and the flow rate was 18 cm/sec. GC/MS analysis was performed on a GCMS-QP-2010 (Shimadzu), equipped with a BC-WAX fused silica capillary column (50 m x 0.2 mm x 0.15 μm df, GL sciences). The oven temperature was held at 70 ℃ and programmed to 220 ℃ at 4 ℃/min. Helium was used as a carrier gas and the flow rate was 18 cm/sec. Mass spectra were obtained at 70 eV with an ion source temperature of 200 ℃. Multidimensional gas chromatograph analysis was performed with a MDGC-2010 (Shimadzu). The precolumn was identical with the column of the GC/MS system described above. The oven temperature was held at 70 ℃ and programmed to 220 ℃ at 9 ℃/min. Helium was used as a carrier gas and the flow rate was 15 ml/min. The main column used was a Beta-DEX™ 225 (25 m x 0.25 mm x 0.25μm df, SUPELCO). The oven temperature was held at 70 ℃ and programmed to 100 ℃ at 1 ℃/min.

Results and Discussion

1. Volatile components

Main volatile components were benzyl alcohol (1), 2-phenylethanol (2), 2,6-dimethyl-3,7-octadien-2,6-diol (DOD) (3), linalool oxides (4), geraniol (5), caproic acid (6) and 3,7-dimethyl-1,5,7-octatrien-3-ol (hotrienol) (7). These aroma components increased as the fermentation progressed. The increasing ratios of the compounds in the infested tea leaves were higher than those of the non-infested tea leaves. The DOD existed at early stage of the manufacturing process (A1), which suggests that DOD is mainly contained even in the fresh material tea leaves. The infestation would be deeply concerned with the production of DOD.

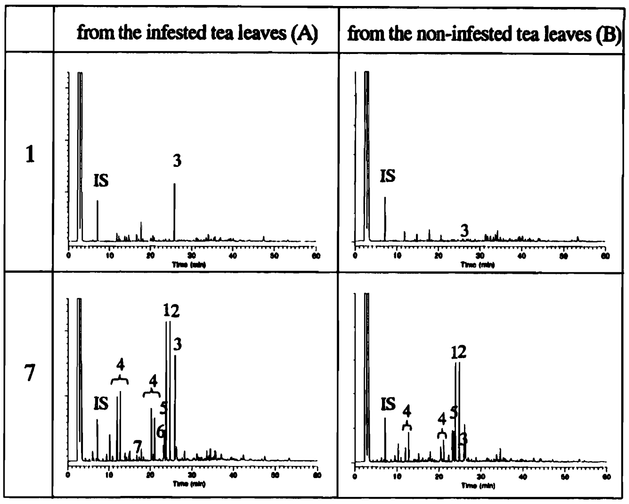

Fig. 1. Gas chromatograms of the tea extracts

2. Chiral analysis

DOD was a characteristic compound in the infested tea leaves. The chiral purity of DOD and related compounds, linalool and hotrienol, were analyzed by chiral column using a multidimensional GC. The DOD and hotrienol were high enantio purity both the infested tea samples and the non-infested tea samples, while linalool was low optical purity as shown in Table 2. The absolute configuration of DOD and hotrienol were reported the R form by Kawakami et al. The biosynthesis pathways of DOD have not been confirmed yet, considering that the DOD was the oxidant of linalool.

Table 2. Enantiomeric ratio of alcohols

Sample	Linalool		Hotrienol (7)[1)]		DOD (3)[1)]	
	R	*S*	*R*	*S*	*R*	*S*
A1	22.4	77.6	>99.9	ND[2)]	99.1	0.9
A7	17.5	82.5	95.5	4.5	98.7	1.3
B1	19.3	80.7	>99.9	ND	>99.9	ND
B7	5.7	94.3	94.1	5.9	98.0	2.0

1) The absolute configuration of each compound was determined based on the literature.[4)]

2) ND=not detected

References

1. Sakata, K. and Mizutani, M., *Food & Food Ingred. J. Jpn.*, **208**, 991-1003, 2003.
2. Ogura, M., *The TAKASAGO times*, **149**, 6-11, 2004.
3. Yamanishi, T., *Koryo*, **211**, 129-136, 2001.
4. Kawakami, M., Ganguly, S.N., Banerjee, J., and Kobayashi, A., *J. Agric. Food Chem.*, **43**, 200-207, 1995.