Bamboo vinegar solutions had pHs of 2.5 to 2.8, and the amounts of organic constituents were estimated to be 2.3 to 4.6% (w/w). Volatile organic compounds (28 components) were detected by GC–MS, and among of these, 11 compounds were common to three samples of bamboo vinegar. Perhaps acetic acid, 3-methyl-1,2-cyclohexadione, guaiacol, p-cresol, and syringol contributed to the characteristic odors (sour, smoky, and medicinal note) in bamboo vinegar.

Key words: volatile organic compound; bamboo vinegar; carboxylic acid; phenol

Bamboo (Phyllostachys pubescens) charcoal is manufactured by introducing dried bamboo into a kiln with a flame tunnel, heating the bamboo slowly to 600–900 °C, holding for 4 d, sealing the tunnel, holding for 4 d, cooling to room temperature, and withdrawing the charcoal. In this process of carbonization, the vapor is cooled and the resulting solution is recovered. After it is allowed to stand for at least 6 months, the solution is decanted to remove tar. The supernatant is distilled under reduced pressure to obtain it as a bamboo vinegar solution. The characteristic odors in bamboo vinegar are sour, smoky, and medicinal note. It is believed that bamboo vinegar can act as an insecticide, a bactericide, a deodorant for treating malodor from pets, and also as a folk medicine, but there are few reports concerning the components of volatile compounds in bamboo vinegar.1,2) Understanding of the chemical constituents in bamboo vinegar is important for their utilization and for quality standards. The aim of this study was to identify the volatile organic compounds with characteristic odors in bamboo vinegar.

Three samples of commercially available bamboo vinegar solution were tested with a pH meter, replicated three times for each sample. The pH of these bamboo vinegars remained consistently low, and the acidity being 2.5 to 2.8.

To investigate the characteristics of volatile organic compounds in bamboo vinegar, these samples were mixed with saturated NaCl and then extracted with diethyl ether. The amounts of organic constituents in bamboo vinegar were estimated to be 2.3 to 4.6% (w/w), and these extracts were identified using a Shimadzu QP-5050 GC–MS (Kyoto, Japan) equipped with a capillary column of DB-WAX (0.25 mm i.d. × 60 m, 0.25 μm film thickness). The oven temperature was programmed from 80 to 230 °C at a rate of 2 °C/min. The injection port and ionizing source were kept at 240 °C and 230 °C respectively. It was found that roughly 28 volatile organic compounds were contained in bamboo vinegar (Table 1). These compounds were identified by comparing retention times and mass spectra with authentic standards and co-injecting them with the standards. The organic compounds in bamboo vinegar were classified into carboxylic acids, phenols, ketones, and aldehydes. Among these, acetic acid comprised about 80% of total organic compounds and was the major organic constituent in bamboo vinegar.

To investigate the characteristic odor components in bamboo vinegar, these samples were extracted with diethyl ether and then washed with 5% NaHCO3. The ethereal extracts were identified by GC–MS. After treatment with 5% NaHCO3, all carboxylic acids (acetic, butyric, formic, and propionic acids) in bamboo vinegar were removed from the extracts. The extracts had a medicinal and a smoky note, but the sharply sour odor was absent. The extracts were washed with 5% NaOH and analyzed by GC–MS. As a result, all phenol compounds were removed from the extracts. The extracts had a medicinal and a smoky note, but the sharply sour odor was absent. The extracts were washed with 5% NaOH and analyzed by GC–MS. As a result, all phenol compounds were removed from the extracts. Comparing the extracts, carboxylic acids and phenol compounds contributed to the sour and medicinal and the smoky notes respectively.

On the other hand, cellulose and lignin are degraded into volatile low molecular compounds and tar by pyrolysis.3,4) It is thought that these carboxylic acids and phenol compounds were derived from cellulose and lignin.
These results indicate that the volatile organic compounds such as carboxylic acids and phenol compounds were formed by pyrolysis in the process of carbonization.

In conclusion, this study provides qualitative information about the volatile organic compounds of commercially available bamboo vinegars not previously reported. A total of 28 volatile organic compounds were detected, and among these, 11 compounds (2-cyclopenten-1-one, acetic acid, furfural, propionic acid, 2,3-dimethyl-2-cyclopenten-1-one, butyric acid, 3-methyl-1,2-cyclohexadione, guaiacol, phenol, \( \text{p-cresol} \), and syringol) were common to three samples of bamboo vinegar. These common compounds possessed characteristic odors, and the most odor-active included acetic acid (sour), 3-methyl-1,2-cyclohexadione (sweet and medicinal), guaiacol (smoky and medicinal), \( \text{p-cresol} \) (smoky and medicinal), and syringol (smoky and medicinal). These volatile organic compounds might contribute to the characteristic odor of bamboo vinegar.

Although there were many similarities between the components of bamboo vinegars and those of wood vinegars, 3-methyl-1,2-cyclopentadione (sweet, medicinal) occurred in bamboo vinegars but were absent from wood vinegars. It is clear that the differences in composition are unlikely to be sufficient to give rise to significant odor differences, because the amounts of the compounds were very low. There would thus appear to be no individual component that might contribute to differences in overall odor quality between bamboo and wood vinegars.

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References
