Characterization of Some Volatile Potato Components

Steam volatile oils obtained from potatoes both under vacuum and at atmospheric pressure have been analyzed by gas chromatographic and mass and infrared spectral methods. Major components characterized in the oil obtained under vacuum included 1-octen-3-ol, *trans*-2-octenal, *trans*-2-octenol, and geraniol. Major components characterized in the oil obtained at atmospheric pressure included 2-pentylfuran, phenylacetaldehyde, *trans*-2-nonenal, furfural, hexanal, and pyridine. The identities of 32 compounds were confirmed by direct comparison of their mass spectra and gas chromatography retention data with that of authentic samples.

A number of studies have been made on the characterization of the volatile components of potatoes. Those made before 1965 have been thoroughly reviewed and discussed by Self (1967). Some additional work since this time has been reported by Ryder (1966). Most of the earlier studies were concerned with components more volatile than hexanal. The present work was aimed at the characterization of higher boiling components.

EXPERIMENTAL

Oregon Russet Burbank potatoes were cut into strips (*ca.* 1 × 1 × 6 cm) and treated in a steam-distillation-continuous-extraction apparatus of the type described previously (Buttery *et al.*, 1969). Generally 4.5 kg batches of potatoes with 2 l. of odor-free triple-distilled water were used. Two types of oils were isolated. The first was obtained by carrying out the steam-distillation-continuous-extraction for 3 hr under vacuum (80 to 100 mm Hg) with the potatoes at 45 to 50° C and using hexane as the extracting solvent. The second type of oil was obtained by carrying out the procedure at atmospheric pressure for 3 hr with the potatoes at 100° C and using diethyl ether as the extracting solvent. Removal of the solvents through low holdup distillation columns gave the oils used for the study.

The oils were resolved into their components on a 1000 foot × 0.03 in. i.d. stainless steel capillary gas chromatography (glc) column coated with Silicone SF 96-100 containing 5% Igepal CO-880. The column was programmed at ½° per min from 70 to 170° C and held. For mass spectral analyses, components leaving the end of the capillary were introduced directly into a modified Consolidated 21-620 mass spectrometer as described previously (Buttery *et al.*, 1969).

For infrared absorption (IR) spectra, components were collected from the end of the capillary or from conventional packed columns in glass tubes. The IR spectra were generally recorded in CCl_4 or CS_2 solution using ultra-micro cavity cells and a reflecting beam condenser.

Authentic samples of components were obtained from reliable commercial sources or synthesized by well established methods. They were purified by glc before use.

RESULTS AND DISCUSSION

The volatile potato oil obtained by steam-distillation-continuous-extraction under vacuum (*ca.* 0.1 ppm of the original potato) had an aroma somewhat similar to that of the original raw potato. Table I lists the identities found for the constituents of this oil, together with the type of evidence used. The major component was 1-octen-3-ol. Other major components were *trans*-2-octenal, *trans*-2-octenol, and gernaniol.

The volatile potato oil obtained at atmospheric pressure (*ca.* 1 ppm of the potato) had an aroma somewhat similar to that of cooked potatoes. Table I lists the additional components characterized in this oil. The major component was 2-pentylfuran. Other prominent components included phenylacetaldehyde, hexanal, *trans*-2-nonenal, furfural, and pyridine.

The most unusual compound characterized was the 3,5-dimethyl-1,2,4-trithiolane which has been reported as a component of boiled beef (Chang *et al.*, 1968).

Table I. Volatile Potato Components Characterized

Components Characterized in Vacuum Isolated Oil[a,b]	Additional Components Characterized in Atmospheric Isolated Oil[a,b]
Hexanal (MS, IR, RT)	2-Methylbutanol (MS, RT)
Heptanal (MS, RT)	3-Methylbutanol (MS, RT)
Benzaldehyde (MS, RT)	Pentanol (MS, RT)[c]
2-Pentylfuran (MS, IR, RT)	Pyridine (MS, IR, RT)
1-Octen-3-ol (MS, IR, RT)	Furfural (MS, IR, RT)[c]
1-Octen-3-one (MS, RT)	2-Heptanone (MS, RT)
trans-2-Octenal (MS, IR, RT)	*trans*-2-Heptenal (MS, RT)
trans 2-Octenol (MS, IR, RT)	Methional (MS, RT)[c]
Naphthalene (MS, RT)	Phenylacetaldehyde (MS, IR, RT)
α-Terpineol (MS, RT)	Linalool (MS, RT)
Nerol (MS, RT)	*trans*-2-Nonen-4-one (MS, RT)
Geraniol (MS, RT)	Benzyl alcohol (MS, RT)[c]
2-Methylnaphthalene (MS, RT)	3,5-Dimethyl-1,2,4-trithiolane (MS, RT)
trans,trans-2,4-Decadienal (MS, RT)	*trans*-2-Nonenal (MS, IR, RT)
Biphenyl (MS, IR, RT)	2-Decanone (MS, RT)
	Methyl salicylate (MS, RT)
	Benzothiazole (MS, RT)

[a] MS, IR, RT = mass, infrared absorption spectra, and glc retention evidence, respectively. [b] Evidence cited consistent with that of authentic compound. [c] Also reported by Ryder (1966).

Deck and Chang (1965) had reported 2,5-dimethylpyrazine, which they isolated from potato chips, as possessing the odor of potatoes. Similar alkylpyrazines had also been reported in potato fusel oils some years earlier (Shorigin *et al.*, 1933). However, we were unable to detect any of these pyrazines in the present work. It seems likely that such pyrazines result from the interaction of potato carbohydrate and amino acid materials under the more severe heating generally employed in making potato chips and the commercial fusel oil. Such an origin has been suggested by Hodge (1967). In the present work, however, we did find some tentative evidence for the presence of the potent odorant 2-methoxy-3-ethylpyrazine (Seifert *et al.*, 1970) which, in the authors' opinion, has an odor very much like raw potatoes.

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