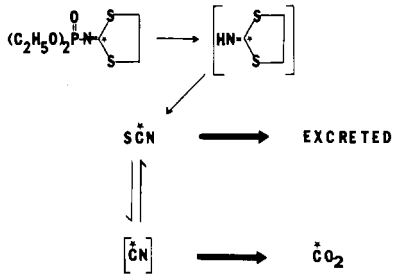

Figure 4. Pathways of metabolism of [^{14}C]phosfolan in the rat.

shown by cochromatography to be thiocyanate ion; it constituted greater than 99% of the extractable tissue radioactivity. Confirmation of this finding was provided by precipitation as silver thiocyanate which gave values of 98, 98, 97, and 96% for liver, kidney, muscle, and fat extracts, respectively.

Thin-layer chromatography of methanol extracts of rat carcass also showed only one metabolite which was identified as thiocyanate ion.

CONCLUSION

The excretory pattern and residue behavior of [^{14}C]-phosfolan administered orally to rats at 1 and 2 mg/kg have been studied. The compound is highly degradable and is excreted from the body as carbon dioxide in the respiration gases and as highly polar ionic metabolites in the urine. The only urinary and tissue metabolite that occurred in significant amounts has been identified as thiocyanate ion. Formation of 2-imino-1,3-dithiolanes as an intermediate step in the formation of thiocyanate has been postulated by Siegel and Rosenblatt (1958), although no salts were actually isolated or identified. Addor (1970) has reported isolation of 2-imino-1,3-dithietane hydrochloride from acid hydrolysis of the related imidocarbonic acid, (diethoxyphosphinyl)dithio-, cyclic methylene ester, which on titration with base yielded thiocyanate and thioformaldehyde polymer. A metabolic pathway of phosfolan in the rat is proposed in Figure 4. The metabolic fate of thiocyanate and cyanide has already been established (Williams, 1959).

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COMMUNICATIONS

Varietal Differences in Aroma Essence from Maize Kernels (*Zea mays* L.)

Aroma essences of reproducible composition were isolated from maize kernels (*Zea mays* L.) by steam distillation, extraction of the distillate, and slow evaporation of the extract. Gas chromatography revealed 91 components in the aroma essences. The quantitative composition of the essences differed significantly among five varieties of maize investigated.

The composition of the volatile aroma materials of some vegetable foodstuffs has been shown to be dependent upon plant variety or geographical location, or both, as reported for cranberries (Anjou and von Sydow, 1967), onions (Chua et al., 1968), cocoa beans (Bailey et al., 1962), tea (Bondarovich et al., 1967), coffee, bananas, oranges, tomatoes, potatoes, peppermint oils, spearmint oils, and peanuts (reviewed by Pattee and Singleton, 1972). More recently, cereal grains have been investigated, with identification of aroma compounds from corn (Goeckner, 1958), rice (Yasumatsu et al., 1966), wheat (McWilliams and Mackey, 1969), and triticale (Lorenz and Maga, 1972). Corn samples of "good" and "bad" (musty, sour, "insect") odor have been distinguished by gas chromatography (Dravnieks and Watson, 1973).

We have earlier reported varietal differences in the composition of headspace vapor from maize and wheat (Hougen et al., 1971). The present report similarly indicates that varietal differences can be observed in the composition of aroma essences prepared by steam distillation of maize. The work was part of a study on the quality of maize for use in the alcoholic fermentation industry. Steam distillation was used to simulate the industrial cooking process.

EXPERIMENTAL SECTION

Aroma essences were prepared from maize, essentially as described by Heinz et al. (1966), by steam distillation of ground kernels followed by extraction of the distillate with methylene chloride and slow evaporation of the solvent. About 15 μl of aroma essence was obtained from samples of 1250 g of maize. An internal standard (2,2,-4-trimethylpentane) was added to the essence preparations to ensure that subsequent chromatographic analyses would be independent of the volume of residual solvent in the essence and of the sample volume injected for analysis.

Samples were analyzed with a Varian gas chromatograph Series 1800, with a flame ionization detector and a stainless steel column (4.57 m × 1.8 mm i.d., packed with OV 225 on Chromosorb W AW DMCS, 80–100 mesh, 1:20 by weight). The column oven was held at 60 °C for 20 min, increased 2 °C/min for 10 min, held at 80 °C for 15 min,

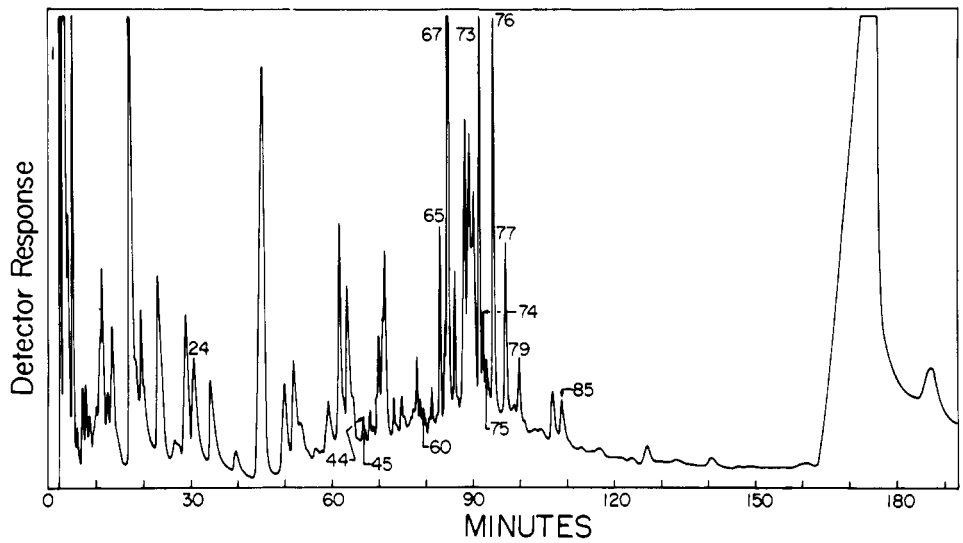

Figure 1. Typical gas chromatogram of aroma essence from maize kernels.

Table I. Peaks Distinguishing Any One Variety from the Other Four

Variety	Produced	Peak number
Minnesota 13	1963	24, 65, 67, 74, 75, 77, 79, 85
CM17 x CM7	1966	73
CO103 x ND203	1966	(44 + 45)
CM36 x CM46	1967	76
Rainbow Flint	1967	60

increased 2 °C/min for 50 min, and held at 180 °C. The injection port was held at 246 °C and the detector at 251 °C. The flow of nitrogen carrier gas was 19.6 ml/min. An Infotronics CRS 100 electronic integrator was used.

For statistical analysis, peak areas were divided by that of the internal standard (peak 1, Figure 1), and compared among samples by a nested analysis of variance. Where two peaks were not sufficiently resolved, their combined area was used in the computations.

RESULTS AND DISCUSSION

Gas chromatographic analysis of aroma essences revealed 91 components (Figure 1). These were not identified. The earlier analysis of maize headspace vapor yielded only 39 components (Hougen et al., 1971), presumably because the higher boiling components were retained in the Porapak column.

A quantitative comparison was made of five maize varieties, grown at Morden, Manitoba, not all in the same year (Table I). None of the earlier examined varieties was included. Aroma essences were prepared from duplicate samples of each variety and analyzed. Twenty-seven peaks or double peaks were selected for statistical analysis. For each variety, one or more of these peaks differed significantly ($p < 0.01$) from the corresponding peaks for the other four varieties (Table I). The five varieties were thus clearly distinguished from one another by the composition of the aroma essences.

This study shows that a relatively large quantity of aroma essence from maize can be prepared with sufficient reproducibility to allow a quantitative distinction to be made between certain samples or varieties by gas chromatographic analysis. The work does not necessarily imply that maize varieties in general are distinguishable by this method.

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