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Volatile Flavor Components of Coconut Meat

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INTRODUCTION

Coconut, the kernels of nuts of the coconut palm (Casus nucifera), and its oil have been produced in the tropics and subtropics from the earliest times. Large amounts of coconut and coconut products are utilized for human consumption in the areas of production. Desiccated coconut meat, known as "shredded coconut" in the United States, is used as an ingredient in the confectionery and bakery products.

Coconut possesses a pleasant, characteristic aroma which appears to be an acceptable flavor to most people. Wolf (1963) studied the organoleptic properties of grated coconut. Allen (1965) reported the presence of methylketones (C_7, C_9, C_{11}, C_{13}, C_{15}) and delta-lactones (C_6, C_8, C_{10}, C_{12}, C_{14}) in the volatile flavor constituents of coconut oil. The present work extends our knowledge of volatile constituents in coconut meat.

MATERIAL AND METHODS

Sample preparation. Coconuts were obtained from a local grocery store. Fresh coconut meat was shredded and pressed with added water (1:1, w/v) in a cloth filter to remove coconut milk. One hundred fifty grams of the shredded coconut meat were ground in a Waring blendor with distilled water (1:5, w/v) at low speed for 3½ minutes. The slurry was transferred to a 5 liter, round bottom flask placed in a water bath, and the flask was attached to a rotary flash evaporator which was subsequently connected to a Liebig condenser packed with glass beads, a spiral type (Friedrichs) condenser, and a 500-ml collection flask in an ice bath. Both water bath temperature and vacuum (with aspirator) were increased gradually until a total of 500 ml distillate was collected. Thirty-two runs of above distillation were made and the distillates combined.

The volatiles were extracted from the combined distillates with redistilled CS_2 in a continuous liquid-liquid extractor.

Gas chromatography. Components of the CS_2 extract were fractionated with a Varian Aerograph Model 1520B gas chromatograph on a 10 foot x ¼ inch OD aluminum column packed with 20% SE-30 on 60-70 mesh Anakrom AB at a helium flow rate of 60 ml/min. The temperature was programmed from 70 to 275°C at 1°C/min. Fifteen fractions were collected in 16 inch x 2 mm ID glass tubes with dry ice coolants. Each fraction was rechromatographed on a 10 foot x ¼ inch OD aluminum column packed with 25% Carbowax 20M on 60-70 mesh Anakrom AB at a helium flow rate of 60 ml/min. The

temperature was programmed from 50 to 250°C at 1°C/min. The subfractions were rechromatographed on a 10 foot x 1/8 inch OD stainless steel column packed with 25% Carbowax on 60-70 mesh Anakrom AB at a helium flow rate of 30 ml/min with temperature programming from 50 to 250°C at 1°/minute for relative retention time data against a series of ethyl ester standards.

Gas Chromatography-Mass Spectrometry. The subfractions were rechromatographed under conditions similar to those used for retention time data. The effluent was passed into a heated (200°C) helium separator (Watson and Biemann, 1964) interfaced at the inlet of a Model 12-101A Bendix Time-of-Flight mass spectrometer The elution of compounds was observed through the use of a Bendix total output integrator and a Textronix Type 545B oscilloscope. The scan rate was set to give a 5-second scan between m/e 40 and 150.

RESULTS AND DISCUSSION

An example of the chromatographic separation obtained from the volatile flavor of coconut meat on carbowax 20 M column is shown in Figure 1. Relative retention indices (I_E) of the unknown compounds were calculated relative to a series of internal ethyl ester standards, where the carbon chain length of the acid function represents a whole number (ethyl hexanoate = 6.00) (vanden Dool and Kratz, 1963).

Approximately thirty two peaks were evidenced as shown in Figure 1. Not all of the peaks are identified because of mass spectral sensitivity limitation combined with overlapping peaks and background, especially at the higher temperature region of the GLC program. Definite identification of fifteen volatile compounds was obtained as shown in Table I. The authentic compounds of the identified volatiles were sampled in bottle by untrained panelists for odor description.

In addition to even-numbered delta-lactones and methyl ketones which have been reported in coconut oil (Allen, 1965), eleven compounds i.e., octanol, 2-heptanol, 2-octanol, 2-nonanol, 2-undecanol, hexanol, octanol, 2-phenylethanol, benzothiazole, delta-undecalactone, ethyl decanoate, are for the first time found in coconut.

Relatively large amounts of delta-C_8 and -C_{10} lactones were present. Their characteristic, coconut-like aroma is responsible for the typical flavor of coconut meat.

Dimick <u>et al</u> (1969) recently reviewed the occurrence and biochemical origin of aliphatic lactones in milk fat and proposed the existence of saturated fatty acid delta-oxidation in the

ruminant mammary gland. Tang and Jennings (1968) found delta and gamma-C_8 lactones in apricot and pineapple; delta and gamma-C_{10} lactones in peach and apricot. Fioriti et al (1967) reported the presence of both delta- and gamma-aliphatic lactones in highly peroxidized soybean and cottonseed oils while none of the lactones could be found in fresh, refined soybean oil. These lactones are postulated to arise from the high levels of hydroperoxides from the unsaturated fatty acids.

Delta-lactones but not gamma-lactones are found in coconut meat (Table 1) or its oil (Allen, 1965). Although catalytic pathways such as delta-oxidation of saturated fatty acids or delta-hydroxylation of unsaturated fatty acids may be involved in the formation of delta-lactones in coconut, it is also possible that the precursors of delta-lactones may arise from the intermediate compounds involved in the biosynthesis of higher fatty acids and specific enzymes may be involved.

A large amount of n-octanol (Peak No. 9 of Fig. 1) with its lilac odor may also contribute significantly to the coconut-meat flavor. The n-octanol probably arises from its acetate which serve as an intermediate compound in the biosynthesis of fatty acids and lactones in coconut. Kohashi et al (1950) reported the preparation of n-octanol from the reduction of coconut-oil fatty acids at high temperature and pressure.

One of the distinct features of the coconut-meat flavor profile is the presence of secondary alcohols (C_7, C_8, C_9, C_{11}).

A small amount of benzothiazole was detected (part of peak

No. 20). It has been reported in butter oil (Forss et al, 1967), stale milk (Arnold et al, 1966), and Swiss cheese (Langler et al, 1967). The origin and possible precursor of benzothiozole is not known.

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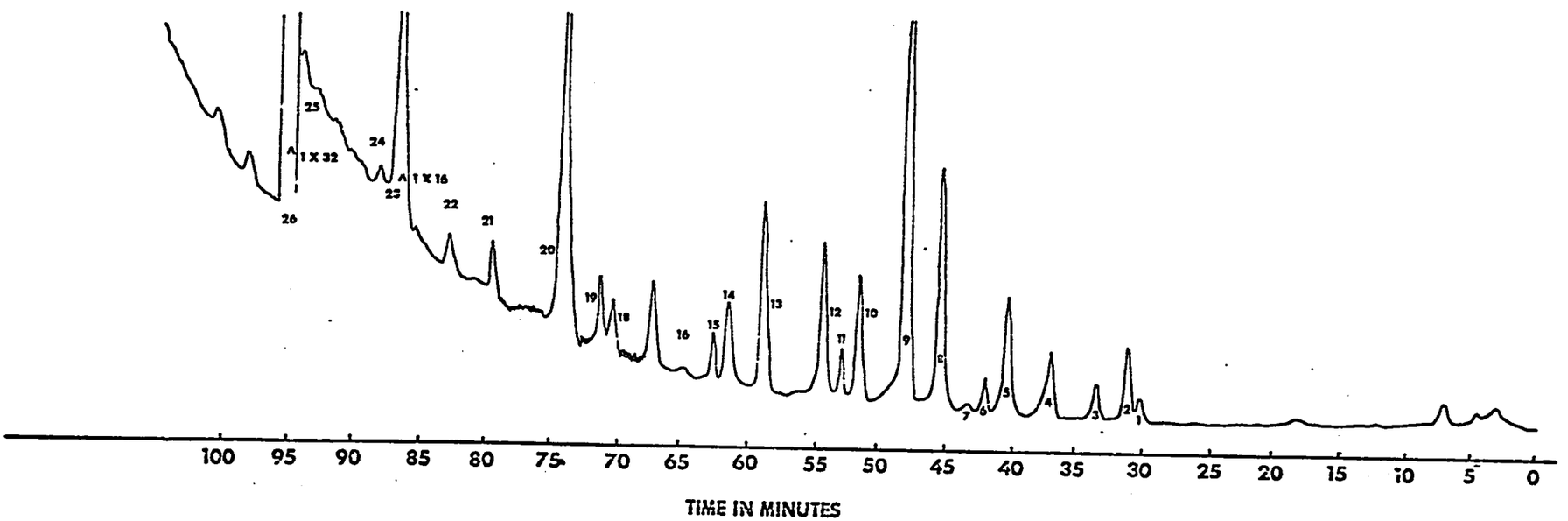
Table 1

Compounds Found in the Volatile Flavor of Coconut Meat

Compounds	I_E* Unknown	I_E* Authentic	Mass spectra identification	Odor description of the authentic compounds	Peak No. in Figure 1.
Octanol	6.60	6.58	Positive	Heavy fruity, nutty, rancid	1
2-Heptanol	6.75	6.66	Positive	Over-ripe banana, slightly pleasant	2
Hexanol	7.10	7.00	Positive	Harsh, green, grassy, fruity	3
2-Nonanone	7.58	7.50	Positive	Pleasant, fruity	4
2-Octanol	8.00	7.66	Positive	Harsh, fruity	5
2-Nonanol	8.76	8.65	Positive	Slightly fruity, pungent	8
Octanol	9.13	9.03	Positive	Citrus, lemon, lilac, rose	9
2-Undecanone	9.63	9.56	Positive	--	10
Ethyl decanoate	10.00	10.00	Positive	Pleasant, fruity	12
2-undecanol	10.73	10.55	Positive	--	13
2-phenyl ethanol	12.54	12.55	Positive	Rose aroma	18
Benzothiazole	13.06	13.05	Positive	Harsh, medicinal	20
Delta-octalactone	13.14	13.15	Positive	Buttery, coconut-like	20
Delta-decalactone	15.31	15.35	Positive	Tropical fruit, coconut-like buttery	23
Delta-undecalactone	16.40	16.39	Positive	Buttery, coconut-like	25
Dodecanoic acid (Lauric acid)	20.10	20.40	Tentative	Harsh, oily	

I_E = Relative retention time indice

Figure 1. Gas chromatogram of coconut meat volatiles on Carbowax 20 M column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ABSTRACT

Gas chromatographic and mass spectral techniques were employed in the isolation and identification of the volatile-flavor components of coconut meat. Fifteen compounds were positively identified. Odor of authentic compounds were described. Both delta-C_8, -C_{10} lactones and n-octanol were the major volatile components, and responsible for the characteristic aroma of coconut meat. The contributions of other minor components to flavor and their significance were also described.