

Evaluation of the Aroma of Cooked Spiny Lobster Tail Meat by Aroma Extract Dilution Analysis[†]

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Volatile compounds were isolated from cooked spiny lobster (*Panulirus argus*) tail meat by vacuum simultaneous distillation–solvent extraction (V-SDE) and dynamic headspace sampling (DHS). Flavor dilution chromatograms of V-SDE and DHS extracts were similar with respect to predominant odorants. The compound 2-acetyl-1-pyrroline, having a nutty, popcorn-like odor, was the most intense odorant in both types of extracts. Other potent odorants included 2,3-butanedione (creamy, buttery), 3-(methylthio)propanal (potato-like, soy sauce-like), 2-acetyl-3-methylpyrazine (burnt, popcorn-like), trimethylamine (fishy, ammonia-like), 1-octen-3-one (earthy, mushroom-like), and (*Z*)-4-heptenal (rancid, boiled potato-like). Two unidentified compounds described as marine, leather-like, and lobster-like were of relatively low odor intensity.

Keywords: *Spiny lobster; lobster aroma; lobster flavor; volatile; odor-active*

INTRODUCTION

The spiny lobster (*Panulirus argus*), also known as rock lobster or Caribbean lobster, supports major fisheries in south Florida, the Bahamas, Cuba, Brazil, and elsewhere throughout the Caribbean. The tail meat of the spiny lobster is a popular seafood; however, little is known about its flavor and aroma. In fact, only limited research has been conducted on other lobster species. Whitfield et al. (1982) studied the occurrence of the metallic off-flavors, 1-octen-3-ol and (*5Z*)-1,5-octadien-3-ol, in sand lobsters (*Ibacus peronii*). The compounds bis(methylthio)methane and trimethylarsine, having garlic-like odors, and 2,6-bromophenol (iodoform-like) were implicated as off-flavors in prawns and lobsters (Whitfield, 1990). There are no reports, however, on compounds responsible for the typical “desirable” flavor of lobsters.

Aroma extract dilution analysis (AEDA) is used for the detection of potent odorants in foods (Acree, 1993; Ullrich and Grosch, 1987). In AEDA, an aroma extract is analyzed by gas chromatography/olfactometry (GC/O) and this process is repeated for several serial dilutions of the extract until no more odors are detected. The highest dilution at which an odorant is detected is a measure of its potency and is referred to as the flavor dilution (FD) factor for that compound. AEDA has been used to identify potent odorants in cooked beef (Gasser and Grosch, 1988), bread (Schieberle and Grosch, 1987), and blue crab (Chung and Cadwallader, 1994). The objective of this study was to identify predominant odor-active compounds in cooked spiny lobster tail meat by AEDA.

MATERIALS AND METHODS

Materials. Spiny lobster (*P. argus*) tail meat was obtained from the Bahamas Department of Fisheries, Nassau. To ensure maximal freshness of the product, the lobster tails were frozen within several hours following collection. The whole frozen tails were shipped via air freight to the Louisiana State University Department of Food Science. One of the investigators (S.P.M.) accompanied the shipment on his return flight from the Bahamas, thus ensuring a minimal transit time. Upon receipt, the product was stored at -20°C until analyzed.

All standard compounds were purchased from Aldrich Chemical Co. (Milwaukee, WI) except for 2-acetyl-1-pyrroline (2-AP), which was obtained from Dr. R. Buttery (USDA, ARS, WRRRC, Albany, CA), and (*Z*)-4-heptenal, which was purchased from Alfa (Ward Hill, MA).

Sample Preparation. Lobster tail meat was cooked prior to extraction of volatile compounds as follows: whole frozen tails were thawed at 4°C , steamed in a stainless steel double boiler to an internal temperature of 80°C , and then cooled on ice. Cooked tail meat was cut into small pieces ($\approx 0.5\text{ cm}^3$) after removal of the exoskeleton.

Vacuum Simultaneous Steam Distillation–Solvent Extraction (V-SDE). Cooked lobster tail meat (1 kg) plus distilled–deodorized water (1.5 L) and internal standard [$22.9\ \mu\text{g}$ of 2,4,6-trimethylpyridine (TMP)] was extracted for 4 h with redistilled dichloromethane (75 mL) under reduced pressure in a modified SDE apparatus (catalog no. K-523010-0000, Kontes, Vineland, NJ) as described by Cadwallader et al. (1994). Sample boiling point temperature was maintained at $52\text{--}53^{\circ}\text{C}$ during extraction. V-SDE extracts were kept at -20°C overnight to facilitate water removal. The volume of the V-SDE extracts was reduced to 10 mL under a gentle stream of nitrogen, dried over 2 g of anhydrous sodium sulfate, and then further reduced to $100\ \mu\text{L}$ prior to analysis. Three V-SDE extracts were prepared and were stored at -80°C in glass vials equipped with Teflon-lined caps.

Dynamic Headspace Sampling (DHS). Cooked lobster tail meat (130 g) plus internal standard ($91.7\ \mu\text{g}$ of TMP) was placed into a 1-L purge-and-trap vessel (catalog no. 991780, Wheaton, Millville, NJ). The vessel was oriented in the DHS mode with conditions as follows: sample temperature was maintained at 60°C ; ultrahigh purity helium was swept over the sample at $200\ \text{mL}/\text{min}$; purge time was 3 h; and volatiles were trapped onto Tenax-TA (500 mg, 60–80 mesh, Chrompack, Raritan, NJ). Volatiles were eluted from the trap with 10 mL of redistilled diethyl ether. Ether extract was dried and concentrated to $100\ \mu\text{L}$ prior to analysis as described above.

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[†] Approved for publication by the Director of the Louisiana Agricultural Experiment Station as Manuscript 94-21-8389.

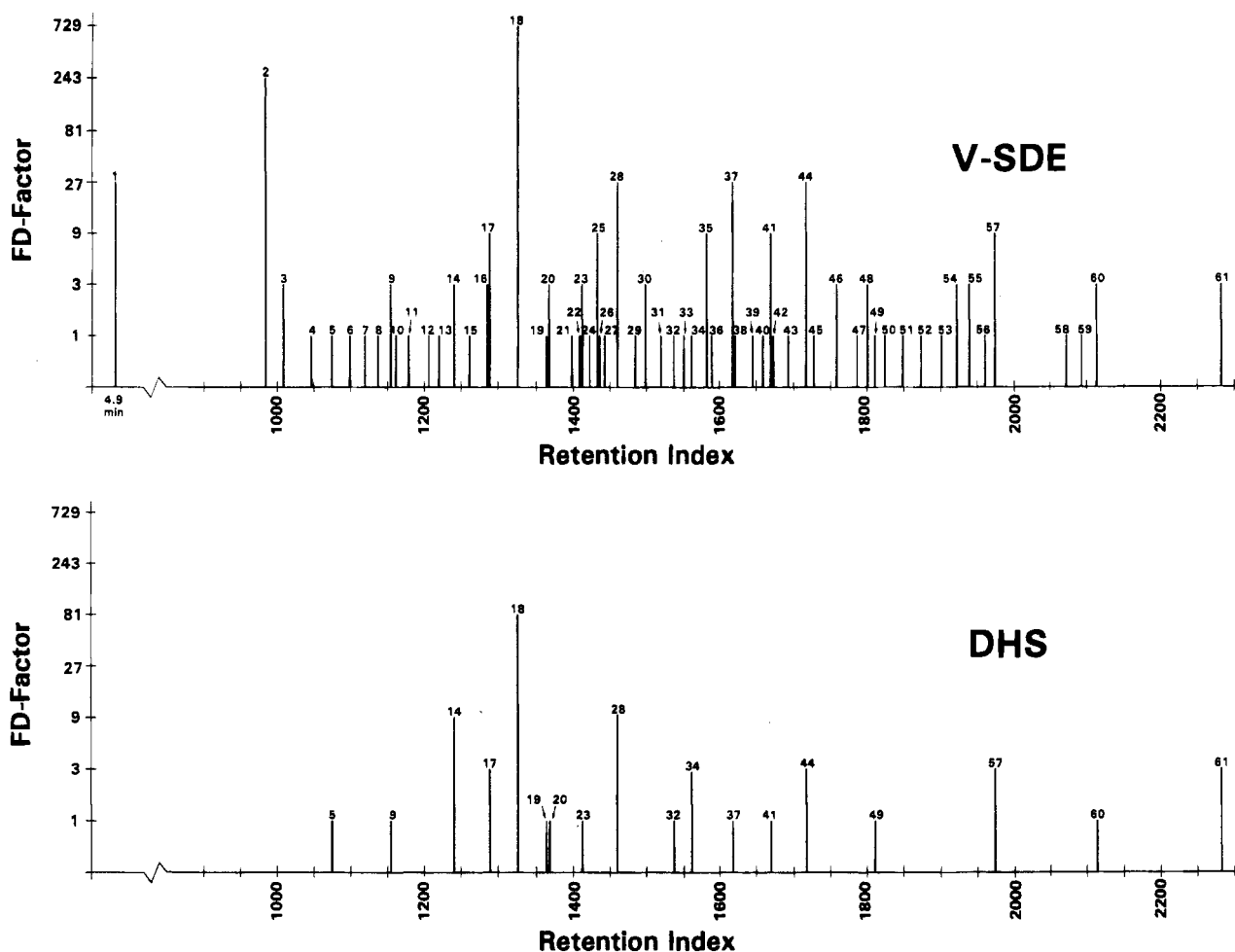


Figure 1. Flavor dilution chromatograms of volatiles isolated from cooked spiny lobster tail meat by vacuum simultaneous distillation–solvent extraction (V-SDE) and dynamic headspace sampling (DHS). Peak numbers correspond to those in Table 1.

Three DHS extracts were prepared and were stored as described previously for V-SDE extracts.

Gas Chromatography/Mass Spectrometry/Olfactometry (GC/MS/O). For identification purposes the GC/MS system was equipped with a sniffing port, which allowed for simultaneous mass spectral scanning and sniffing of GC effluents. The GC/MS/O system has been described elsewhere (Cadwallader et al., 1994; Chung and Cadwallader, 1994). Separations were performed on Supelcowax 10 columns (60 m length \times 0.25 mm i.d. \times 0.25 μ m d_f ; Supelco, Inc., Bellefonte, PA). GC conditions were as follows: 5- μ L splitless injection (30-s valve delay); 155 °C injector temperature; helium carrier gas at 25 cm/s; oven programmed from 40 to 200 °C at a rate of 2 °C/min with initial and final hold times of 5 and 30 min, respectively. MS conditions have been previously described (Cadwallader et al., 1994).

Gas Chromatography/Fourier Transform Infrared Spectrometry/Olfactometry (GC/FTIR/O). The GC/FTIR system consisted of an HP 5890 GC/HP 5965B infrared detector (IRD) (Hewlett-Packard Co., Palo Alto, CA). GC effluent was split 1:1 between IRD and sniffing port supplied with humidified air. GC conditions were the same as above except a 0.32 mm i.d. Supelcowax 10 column was used. IRD conditions have been described by Cadwallader et al. (1994).

Compound Identification and Quantification. Compound identifications were based on comparison of GC retention indices (RI) (van den Dool and Kratz, 1963), mass and infrared spectra, and odor properties of unknowns with those of authentic standards analyzed under identical conditions. Tentative identifications were based either on matching mass spectra of unknowns with those in the Wiley/NBS mass spectral database (Hewlett-Packard Co., 1988) or on matching RI values and odor properties of unknowns with those of authentic standards.

Concentrations of positively identified compounds were determined using MS response factors for each compound relative to the internal standard. Response factors were determined by analyzing standard compounds at three levels. Quantitation of coeluted compounds was achieved by mass chromatography (Hites and Biemann, 1970).

Aroma Extract Dilution Analysis (AEDA). The GC/O system used for AEDA has been described elsewhere (Cadwallader et al., 1994). Serial dilutions (1:3) of V-SDE and DHS extracts were prepared using dichloromethane as diluent. GC conditions were the same as for GC/FTIR except the oven temperature was programmed from 40 to 200 °C at a rate of 3 °C/min with initial and final hold times of 5 and 30 min, respectively.

GC/O was performed by three experienced panelists who were asked to assign odor properties to each compound detected. Each extract dilution was analyzed by all panelists. Therefore, for a particular V-SDE or DHS dilution set nine evaluations were performed. The highest dilution at which an individual component was detected was defined as its FD factor. An FD factor was assigned only if the odorant was detected during at least five of nine GC/O evaluations for a particular dilution set.

RESULTS AND DISCUSSION

Volatile components in cooked spiny lobster tail meat were isolated by V-SDE and DHS procedures. Since these methods rely on different mechanisms for compound isolation (Reineccius, 1993), compounds isolated by both methods were considered to be representative of cooked spiny lobster tail meat aroma. Both types of extracts had a strong nutty/popcorn-like aroma typical

Table 1. Odor-Active Compounds in Cooked Spiny Lobster Tail Meat

| peak no. ^a | compound | methods of identification | RI ^b | odor description ^c |
|-----------------------|---|---------------------------|-----------------|-------------------------------|
| 1 | trimethylamine | MS, RI, odor | (4.9) | fishy, ammonia |
| 2 | 2,3-butanedione | IR, MS, RI, odor | 981 | creamy, buttery |
| 3 | unknown | | 1008 | grassy, earthy |
| 4 | unknown | | 1049 | wine, fragrant |
| 5 | hexanal | IR, MS, RI, odor | 1075 | green, cut grass |
| 6 | unknown | | 1100 | sour, rancid |
| 7 | unknown | | 1122 | rotten, crabby |
| 8 | unknown | | 1137 | wine, fragrant |
| 9 | unknown | | 1155 | rotten, rancid |
| 10 | 2-heptanone | IR, MS, RI, odor | 1161 | moldy, bitter |
| 11 | heptanal | IR, MS, RI, odor | 1176 | nutty, chocolate |
| 12 | 3-methyl-1-butanol | IR, MS, RI, odor | 1204 | bitter, chocolate |
| 13 | unknown | | 1218 | skunky |
| 14 | (<i>Z</i>)-4-heptenal | MS, RI, odor | 1239 | rancid, boiled potato |
| 15 | unknown | | 1259 | garlic, onion |
| 16 | unknown | | 1286 | skunky |
| 17 | 1-octen-3-one | MS, RI, odor | 1288 | mushroom, earthy |
| 18 | 2-acetyl-1-pyrroline | IR, MS, RI, odor | 1329 | nutty, popcorn |
| 19 | 2,4,6-trimethylpyridine (IS) ^d | | 1364 | stale, pyridine |
| 20 | 2,4,5-trimethylthiazole | MS, RI, odor | 1366 | metallic, sulfury |
| 21 | 2,3,5-trimethylpyrazine | MS, RI, odor | 1398 | nutty |
| 22 | unknown | | 1413 | pyridine, gasoline |
| 23 | unknown | | 1414 | nutty, popcorn |
| 24 | unknown | | 1425 | woody, earthy |
| 25 | 2-ethyl-3,5-dimethylpyrazine | MS, RI, odor | 1434 | nutty |
| 26 | unknown | | 1436 | lamb, mutton |
| 27 | unknown | | 1445 | burnt plastic |
| 28 | 3-(methylthio)propanal | MS, RI, odor | 1453 | potato, soy sauce |
| 29 | unknown | | 1485 | mushroom |
| 30 | unknown | | 1499 | rancid, rotten |
| 31 | 1,2,3,4-tetrahydronaphthalene (?) | MS | 1523 | pine oil, bug |
| 32 | unknown | | 1534 | stale, bitter |
| 33 | unknown | | 1548 | honeysuckle, fragrant |
| 34 | unknown | | 1554 | nutty, stale |
| 35 | unknown | | 1577 | green, floral |
| 36 | (<i>E,Z</i>)-2,6-nonadienal | RI, odor | 1583 | sweet, melon |
| 37 | 2-acetyl-3-methylpyrazine | MS, RI, odor | 1615 | burnt, popcorn |
| 38 | 2-acetylpyrazine | MS, RI, odor | 1619 | nutty, popcorn |
| 39 | 2-acetylthiazole | IR, MS, RI, odor | 1647 | nutty, popcorn |
| 40 | unknown | | 1654 | waxy, mothball |
| 41 | unknown | | 1667 | meaty, savory |
| 42 | unknown | | 1673 | nutty, popcorn |
| 43 | unknown | | 1693 | rubber |
| 44 | unknown | | 1718 | sweet, tobacco |
| 45 | unknown | | 1732 | nutty, crab shell, rancid |
| 46 | unknown | | 1760 | nutty, popcorn |
| 47 | unknown | | 1789 | mushroom |
| 48 | benzo[<i>b</i>]thiophene | MS, RI, odor | 1799 | mothball |
| 49 | unknown | | 1815 | grainy, sweet |
| 50 | unknown | | 1823 | garlic, onion |
| 51 | unknown | | 1849 | manure |
| 52 | unknown | | 1870 | insecticide, fennel |
| 53 | unknown | | 1899 | meaty, savory |
| 54 | unknown | | 1920 | burnt, popcorn |
| 55 | 1-methylnaphthalene | MS, RI, odor | 1939 | mothball |
| 56 | unknown | | 1959 | seaweed |
| 57 | unknown | | 1972 | nutty, meaty |
| 58 | unknown | | 2068 | medicinal, bug |
| 59 | unknown | | 2093 | manure, bug |
| 60 | unknown | | 2116 | marine, leather, lobster |
| 61 | unknown | | 2286 | marine, leather, lobster |

^a Numbers correspond to those in Figure 1. ^b Retention index on Supelcowax 10 column. ^c Odor description as perceived by panelists during GC/O. ^d IS, internal standard.

of cooked lobster. In general, V-SDE extracts had more intense aromas than DHS extracts and were perceived as having more pronounced buttery, plant-like, and fishy odors than DHS extracts.

Flavor dilution (FD) chromatograms of the two types of extracts were similar for predominant odorants (Figure 1). Odor descriptions for compounds detected by GC/O are given in Table 1. Sixty-one and 19 odorants were consistently perceived by GC/O for original (undiluted) V-SDE and DHS extracts, respectively. The presence of more odorants in V-SDE extracts was

expected because of the greater amount of sample used for extraction. Furthermore, V-SDE is considered to be a more exhaustive extraction technique and should provide higher recoveries of volatiles compounds, especially those with low vapor pressures (Reineccius, 1993).

Identification of Potent Odorants. Popcorn-like odors were the most numerous types of odors detected by AEDA, e.g., compounds **18**, **23**, **37**, **38**, **39**, **42**, **46**, and **54**. Much of the nutty and meaty aroma of cooked lobster could be attributed to these odorants, especially the compound 2-acetyl-1-pyrroline (2-AP; **18**), which was

the most intense odorant in both V-SDE and DHS extracts. Because of its high FD factor and desirable odor, 2-AP was regarded as an important character impact component of cooked spiny lobster tail meat aroma. This compound was a character impact odorant in cooked crab meat (Chung and Cadwallader, 1994), aromatic rice (Buttery et al., 1983), and wheat bread crust (Schieberle and Grosch, 1987). It is generally accepted that 2-AP is a thermally generated compound (Buttery et al., 1983) and may be formed via the Maillard reaction (Griffith and Hammond, 1989). Recently, Schieberle (1990) demonstrated that 2-AP is formed from the reaction of 2-oxopropanal with either proline or ornithine. In general, the other popcorn-like odorants were of low intensity and most were not identified due to their low abundance. Among those identified, 2-acetyl-3-methylpyrazine (37) had a relatively high FD factor in V-SDE extracts but was of low intensity in DHS extracts. Two other popcorn-like odorants were identified as 2-acetylpyrazine (38) and 2-acetylthiazole (39) and were present in V-SDE extracts only.

In addition to the popcorn-like group of odorants, several components were perceived as having desirable nutty, meaty, or baked potato-like odors (e.g., 21, 25, 28, 41, 53, and 57). Within this group, 3-(methylthio)propanal (3-MP; 28) had the highest FD factor in both V-SDE and DHS extracts and was described as potato-like and soy sauce-like. The formation of 3-MP (or methional) in lobster may have occurred during cooking via Strecker degradation of methionine (Forss, 1979). Chung and Cadwallader (1994) described 3-MP as having a characteristic crab meat quality. In the present study, 3-MP was regarded as a necessary and important component of the desirable aroma of cooked lobster; however, 3-MP in light-exposed milk was considered to be an off-odor (Allen and Parks, 1975). Only two additional compounds in this group were identified: 2,3,5-trimethylpyrazine (21) and 2-ethyl-3,5-dimethylpyrazine (25). These thermally generated pyrazines were detected in V-SDE extracts only.

Carbonyls and alcohols contributed mostly fragrant, planty, rancid, and earthy odors. The most intense odorant in this group was 2,3-butanedione (2) and was described as creamy and buttery. This Maillard reaction product (Hodge, 1967) had the second highest FD factor in V-SDE extracts but was not detected in DHS extracts. This discrepancy might be due to the nonpolar trapping material (Tenax TA) employed during DHS, which may not have effectively adsorbed this polar odorant. Despite its absence in DHS extracts, 2,3-butanedione might have a positive impact on the aroma of cooked lobster due to its desirable odor. Two lipid-derived odorants, (*Z*)-4-heptenal (14) and 1-octen-3-one (17), had relatively high FD factors in both V-SDE and DHS extracts. The occurrence of these compounds in lobster might be undesirable since their odors were described as rancid, boiled potato-like and earthy, mushroom-like, respectively. Compounds having odor properties similar to those of 1-octen-3-one [e.g. 1-octen-3-ol and (*Z*)-1,5-octadien-3-ol] have been implicated as causative agents for the metallic off-flavor in sand lobster (Whitfield et al., 1982). (*Z*)-4-Heptenal was reported as an off-odor in alligator meat (Cadwallader et al., 1994) and could have been generated from (*E,Z*)-2,6-nonadienal (36) via retro-aldol condensation (Josephson and Lindsay, 1987). Four additional compounds in this group were identified as hexanal (5;

green, cut grass), 2-heptanone (10; moldy, bitter), heptanal (11; nutty, chocolate), and 3-methyl-1-butanol (12; bitter, chocolate). Except for hexanal, all of these odorants were detected in original V-SDE extracts only. There were many unidentified compounds with odor properties typical of this group (e.g., 3, 4, 6-9, 24, 26, 29, 30, 32-35, 44, 45, 47, and 49). Most of these odorants were of low intensity and detected in V-SDE extracts only, except for the rotten, rancid (9); stale, bitter (32); nutty, stale (34); sweet, tobacco-like (44); and grainy, sweet (49) odorants. Of these, odorant 44 might be important in cooked lobster aroma because of its relatively high intensity in both V-SDE and DHS extracts.

In general, malodorous compounds were of low intensity. The compound 2,4,5-trimethylthiazole (20; metallic, sulfury) was the only odorant in this group detected in both V-SDE and DHS extracts. The most intense odorant in this group was identified as trimethylamine (TMA; 1). This compound was described as fishy and ammonia-like and was detected in V-SDE extracts only. The presence of high levels of TMA in seafoods is undesirable (Lundstrom and Raciocot, 1983); however, at low levels TMA might impart an important crab-like quality to lobster meat. Several unidentified odorants were described as skunky (13 and 16), onion and garlic-like (15 and 50), rubber-like (43), and manure-like (51 and 59). 1-Methylnaphthalene (55), benzo[*b*]thiophene (48), and an unidentified compound (40) were described as mothball-like. Some unidentified odorants having similar attributes were described as pyridine and gasoline-like (22), burnt plastic-like (27), pine oil and bug-like (31, tentatively identified); insecticide and fennel-like (52), seaweed-like (56), and medicinal and bug-like (58).

Two seemingly important odorants (60 and 61) described as marine, leather-like, and lobster-like were detected in the RI region above 2100. These compounds were not identified. In fact, no peak was observed for either odorant. Both odorants were consistently smelled in both V-SDE and DHS extracts and were considered to have a significant positive impact on cooked lobster aroma. Kubota and Kobayashi (1988) identified two 5,8,11-tetradecatrien-2-one isomers in cooked shrimp that had odors characteristic of cooked crustaceans. No evidence could be found for the existence of these compounds in lobster even after close examination of total ion chromatograms of both V-SDE and DHS extracts by mass chromatography using the mass spectral data of Kubota and Kobayashi (1988).

Bromophenols, having salty-sea-air (Boyle et al., 1992; Lindsay, 1990) and iodoform-like (Whitfield et al., 1988) odors, are considered to be important in the flavor of some marine fish and crustacea (Boyle et al., 1992). 2,6-Dibromophenol is the most potent of these compounds with an odor threshold of 0.0005 ppb in water (Whitfield et al., 1988). Under the GC conditions employed in the present study, this compound had an RI value of 2365, which exceeded the RI values for all odorants detected by GC/O in both V-SDE and DHS extracts. Several other bromophenols were examined including 2-bromophenol (RI = 1979), 4-bromophenol (RI = 2479), 2,4-bromophenol (RI = 2610), and 2,4,6-tribromophenol (RI > 2800). It was evident from these results that bromophenols did not contribute significantly to the aroma of spiny lobster tail meat.

Levels and Odor Values of Positively Identified Odorants. Potent odorants in DHS extracts were

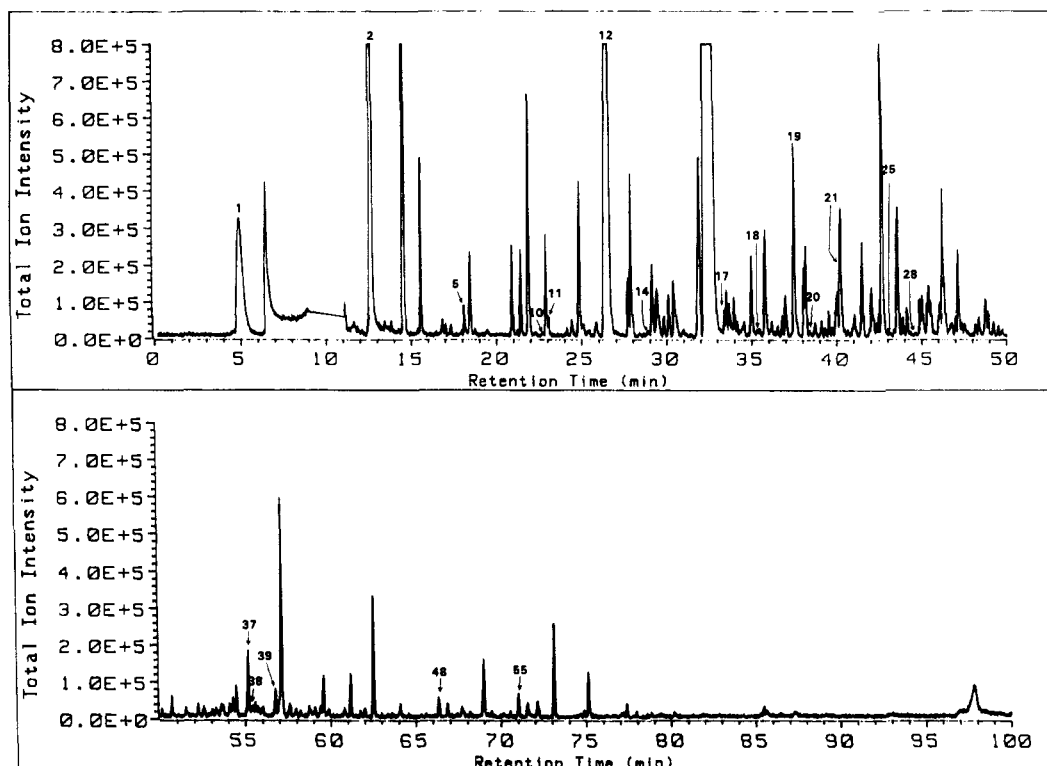


Figure 2. Total ion chromatogram of volatiles isolated from cooked spiny lobster tail meat by vacuum simultaneous distillation-solvent extraction (V-SDE). Peak numbers correspond to those in Figure 1 and Tables 1 and 2.

Table 2. Concentrations and Odor Values for Positively Identified Odorants in Cooked Spiny Lobster Tail Meat

| peak no. ^a | compound | concn ^b (ng/g) | odor threshold ^c (ng/g) | odor value ^d |
|-----------------------|-------------------------------|------------------------------|---------------------------------------|-------------------------|
| 1 | trimethylamine | 48 (±9.3%) | 2.4 ^e | 20 |
| 2 | 2,3-butanedione | 66 (±43%) | 2.6 ^h | 25 |
| 5 | hexanal | 2.8 (±52%) | 5 ^k | 0.6 |
| 10 | 2-heptanone [58] ^f | 1.3 (±41%) | 140 ^k | 0.092 |
| 11 | heptanal | 2.9 (±34%) | 3 ^k | 0.97 |
| 12 | 3-methyl-1-butanol | 137 (±33%) | 300 ^k | 0.46 |
| 14 | (Z)-4-heptenal | ND ^f | 0.04 ⁱ | |
| 17 | 1-octen-3-one [70] | 1.6 (±50%) | 0.1 ^j | 16 |
| 18 | 2-acetyl-1-pyrroline [83] | 3.0 (±39%) | 0.1 ^k | 30 |
| 20 | 2,4,5-trimethylthiazole [127] | 0.27 (±19%) | 50 ^h | 0.005 |
| 21 | 2,3,5-trimethylpyrazine [122] | 2.1 (±50%) | 400 ^l | 0.005 |
| 25 | 2-ethyl-3,5-dimethylpyrazine | 0.15 (±11%) | 0.4 ^m | 0.38 |
| 28 | 3-(methylthio)propanal | ND | 0.2 ⁿ | |
| 37 | 2-acetyl-3-methylpyrazine | 6.6 (±5.5%) | 4.0 ^h | 1.6 |
| 38 | 2-acetylpyrazine | 1.0 (±49%) | 62 ^h | 0.016 |
| 39 | 2-acetylthiazole | 3.7 (±38%) | 10 ⁿ | 0.37 |
| 48 | benzo[b]thiophene | 2.0 (±51%) | N/A ^o | |
| 55 | 1-methylnaphthalene | 2.4 (±67%) | N/A | |

^a Numbers correspond to those in Table 1 and Figures 1 and 2.

^b Average concentration of each compound based on V-SDE data ($n = 6$). Numbers in parentheses represent percent relative standard deviations. ^c Odor thresholds in water. ^d Odor value = compound concentration divided by odor threshold. ^e Numbers in brackets represent ion fragments used for mass chromatography. ^f ND, concentration not determined. ^g Devos et al. (1990). ^h Fors (1983). ⁱ McGill et al. (1974). ^j Whitfield et al. (1982). ^k Buttery et al. (1988) (odor threshold in $\mu\text{L/L}$). ^l Maga (1982). ^m Guadagni et al. (1972). ⁿ Schutte (1974). ^o Not available.

below levels required for MS detection; therefore, only V-SDE data were used for quantitative analysis. A typical total ion chromatogram (TIC) of spiny lobster tail meat volatiles isolated by V-SDE is shown in Figure 2. Only a small number of the volatile components were perceived as having odor activity by GC/O and AEDA. Levels for positively identified odorants are presented in Table 2. Most odorants were present at low parts per billion levels. The odor values for potent odorants

were consistent with their FD factors in V-SDE extracts. For example, the most potent odorant 2-acetyl-1-pyrroline (18) had the highest FD factor (729) and highest odor value (30). Odor values and FD factors also were consistent for 2,3-butanedione (2), trimethylamine (1), 1-octen-3-one (17), and 2-acetyl-3-methylpyrazine (37). In general, odor values for the less potent compounds were in good agreement with their FD factors except for 2,4,5-trimethylthiazole (20) and 2,3,5-trimethylpyrazine (21), which had odor values lower than expected.

On the basis of the quantitative data and results of AEDA, the desirable aroma of cooked spiny lobster tail meat could be primarily attributed to six odorants including 2-acetyl-1-pyrroline, 2,3-butanedione, 3-(methylthio)propanal, 2-acetyl-3-methylpyrazine, and two unidentified compounds having marine, leather-like, lobster-like odors. The potent odorants trimethylamine, 1-octen-3-one, and (Z)-4-heptenal were considered to have a negative impact on lobster aroma.

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Received for review February 1, 1995. Revised manuscript received June 28, 1995. Accepted June 29, 1995.*

JF950073F

* Abstract published in *Advance ACS Abstracts*, August 15, 1995.