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Gas Chromatographic Profile of Good Quality Raw Peanuts

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ABSTRACT

Raw Virginia peanuts were evaluated from volatiles obtained by a modified direct gas chromatographic procedure. The volatiles were eluted and absorbed onto a Tenax-MPE column which was at ambient temperatures. After the peanut sample was removed, the column was temperature programmed for the analysis. The combined peak areas of methanol, acetaldehyde, ethanol, and the acetone group (pentane, 2-propanol, propanal, and acetone) usually comprised about 80% of the total volatile peak area. Sensory data and their correlation with volatile profiles are reported.

Key Words: Peanut, volatile profile, gas chromatography, direct gas chromatography

Several procedures have been used to obtain volatiles from peanuts in an attempt to evaluate peanut quality (1-5). Pattee and co-workers (3) used a procedure in which raw peanuts were slurried with water in a blender and the volatiles (present or produced) were separated, and analyzed the head space gases by gas chromatography (GC). They found that methanol, acetaldehyde, ethanol, pentane, acetone, pentanal, and hexanal constituted most of the volatiles. In most cases pentane was the largest component. They indicated that both pentane and hexanal appear to be related to lipoxidase activity.

Brown and co-workers (5) used a procedure in which the raw peanuts were ground for one min in a blender; 740 mg of this sample was stripped at 130 with the carrier gas (N_2) onto the top of the cold (about 30 C) GC column for 23 minutes. After the sample was removed, the GC column was temperature programmed to 190 C to determine the volatiles. Very little pentane was found, but a few major and minor components were found in the volatile profile. This procedure has the advantage of determining the volatile profile directly from the ground sample and it also minimizes artifacts caused from solvent extraction or chemical modifications except for those that may occur by heating in the inlet. The procedure requires from 1 to 3 hr from the initial grinding of whole peanuts to obtaining the final results, depending on which components in the volatile profile are of interest.

The procedure that Brown et al. (5) used was based on the original direct gas chromatographic method reported by Dupuy et al. (6). This method has been used quite successfully to assess food quality of many different food types, such as, peanut butter (7, 8), vegetable oils (9-12), mayonnaise (13), rice and corn products (14), seafoods (15,16), Southern pea seeds (17), dried legumes (18), meat products (19,20), salad dressings (21), eggs (22), and molasses (23). Its versatility was further demonstrated when the method was used to study linoleic acid/lipoxygenase reaction products (24, 25).

One object of this study was to determine the volatile profile of three series of peanuts, which were in the acceptable range, to establish a data base. This data base, which shows the normal components of the volatile profile and a measure of the range of concentration, could be used in the future as a "fingerprint" to compare volatile profiles of peanuts of different quality. Other objectives were to describe a procedure that requires only 2 to 3 hr total time to evaluate raw peanuts, and that can be used routinely on commercial batches of peanuts to identify those of suspect quality. Our goal also was to describe a highly reproducible procedure that eliminates or minimizes artifacts caused by conventional extraction and concentration methods.

Material and Methods

Samples: The series of peanut samples examined were (a) W series:21 sample breeding lines grown in North Carolina in 1978, received at SRRC in June, 1979, and stored at 4 C; (b) M series:52 samples (earlier and later dig) of 26 varieties of breeding lines from a 1978 crop grown at Suffolk, Va., sent August, 1979 (38 were analyzed); and (c) 2M series:34 samples (earlier and later dig) of 17 varieties of breeding lines sent from a 1979 crop grown at Suffolk, Va., stored at ambient temperature until sent to SRRC in March, 1980, then stored at 4 C. The normal procedure after harvesting with the M and 2M series, was to shell the peanuts in November or December of the year and store the shelled peanuts in plastic bags at ambient temperatures (about 4-15 C for the winter and spring months) until used.

In these three series, a total of 93 peanut samples were analyzed in duplicate.

Analysis Procedure: The peanut samples were taken from the walk-in

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cooler and allowed to warm up to room temperature (25 C) for about 1 hr. Then, 20g of representative peanuts were selected, ground in a 473mL (pint-size) Waring Blender for about 45 sec at a Variac setting of 70% of line voltage, shaken off the walls of the container, and ground for an additional 15 seconds. 1.000 g of the ground sample was placed between glass wool in the sample tube (8.35 cm long, 9 mm OD, 6 1/2 mm ID). The sample tube was placed in the inlet of the GC (Tracor 222 equipped with dual flame ionization detectors connected to a central laboratory computer) at 130 C, stripped with N_2 for 24 min onto the top of the GC column (which was at room temperature), and removed. The Tenax-Poly MPE GC column was warmed to 50 C, held for 2 min, increased at 3/min to 225 C, then held for a total run time of about 85 min. Total and individual component volatiles were determined by using a base line that generally followed the lower valleys of the GC curve.

Sensory Data: Cler Scores (26) were determined by a private laboratory before the samples (M and 2M series) were sent to SRRC and were furnished with the samples. A score of about 40 or above is considered acceptable. Cler scores are recommended only as a preliminary screening test.

Quality scores were determined at SRRC by 15 trained panelists on a scale of 1 to 9 (1, very poor; 3, poor; 5, fair; 7, good; and 9, very good on the evaluation sheet). Evaluation was on a sample of ground roasted peanuts by the taste panel at two different sessions. These thirty values were averaged to give the quality scores. Experience with this panel indicates that most acceptable peanuts average in the 4.0 to 5.0 range. 3.0 and lower would be unacceptable and 3.5 would be borderline acceptable.

For quality evaluation, 4 samples were selected from the W series to represent the range of quality as determined by this GC method: 2 samples with the most volatiles and 2 samples with the least volatiles. Nine samples were selected from the M series; three with high Cler scores, three with medium, and three with low scores. Nine samples were selected from the 2M series to give the biggest variety found for the volatile profile, appearance, and Cler scores.

Results

Sensory Data and Volatile Profiles: The total volatile profile integrator count for the 21 samples of the W series ranged from a maximum of 325 to a minimum of 189 thousand counts. The average was 225 thousand with a standard deviation (SD) of 30.6. Duplicate runs on samples were nearly always within 4% of each other for total volatiles and many of the individual peaks. Most individual peaks (large and small) were within 10% although occasional duplicate individual peaks may differ up to 30%.

The quality scores of the four samples from the W series were 4.03, 4.00, 3.92, and 3.85 as shown in Table I. Those with higher total volatiles were the two samples in the middle. The higher ethanol (at 14.4 min), hexanal (38.6 min), and hexanol (41.1 min) contents are the major reasons for the higher total volatiles in these samples. All peaks were identified by GC-Mass spectrometry. Most of these peaks were also identified by running known standard compounds on the GC. These peaks were methanol (5.4 min), acetaldehyde (10.4 min), pentane (17.6 min), 2-propanol and propanal (18.5 min), acetone (19.1 min), N-methyl pyrrole (36.5 min), and nonanal (50.4 min). The amount of volatile material beyond 40 minutes was larger in this series of peanuts than in the two following series. Weight loss in the GC inlet was considered to be nearly all moisture and is reported as such, thus this series of 21 peanuts has an average moisture content of 8.28% (SD 0.61).

In the M series the total volatile profile integrator counts for the 38 samples ranged from a maximum of 274 to a minimum of 158 thousand. The average was 206.9 thousand (SD 28.5). This series had an average moisture content of 6.64% (SD 0.34).

Table 1. Peanut number, Cler score, and SRRC quality evaluation.

Peanut	Quality Score	Cler Score
W-12	4.03	- a/
10	4.00	-
16	3.92	-
8	3.85	-
M-15	5.13	42
-38	5.06	55
-29	5.00	55
-26	5.00	54
-28	4.77	38
-17	4.67	48
-18	4.54	46
-23	4.52	35
-20	4.45	48
2M-23	4.36	51.5
28	4.16	48.9
10	4.95	45.6
16	4.92	44.3
8	4.64	43.7
18	4.11	42.0
13	4.71	41.0
31	4.26	39.0
21	5.20	37.8

a/Cler Scores were not furnished for the W Series.

In the 2M series the total volatile profile integrator counts for the 34 samples ranged from a maximum of 235 to a minimum of 148 thousand. The average was 196.4 thousand (SD 26.5). Average moisture content was 6.34% (SD 0.28).

A table of the major peaks and the average of total component volatiles for each of the three series is given in Table II. These are average values (and standard deviation) for all of the samples analyzed in each series. These nine components comprise about 80% of the total volatiles. Also included is the combined average of all three series. Figure 1 is the volatile profile as determined for peanut sample 2M-31 which is fairly close to the average for all 93 acceptable peanut samples as listed in Table II.

These volatile profiles represent from 5 to 15 parts per million (ppm) total from 1g sample weight. GC sensitivity is such that many compounds as low as 0.01 ppm may easily be determined.

Discussion

All of the peanuts tested by sensory data were within the acceptable range for normal peanuts. Within this normal range of acceptable peanuts there was no obvious correlation between total volatiles or any particular component and sensory data.

Since sensory evaluation was based on taste and odor, it

Table 2. Average percentage of several compounds (and standard deviation) in the volatile profiles of three series of peanuts.

Series	Methanol	Acetaldehyde	Ethanol	Pentane	Acetone
W	11.44(4.00)	31.13(4.34)	12.34(5.87)	3.41(.81)	4.13(1.34)
M	25.01(6.94)	29.40(7.90)	16.28(3.08)	2.54(.89)	4.62(1.68)
2M	16.92(2.81)	31.46(4.63)	22.44(6.65)	1.71(.55)	5.87(2.10)
average[a]	18.99	30.55	17.64	2.43	4.97

Series	N-Methyl pyrrole	Hexanal	Hexanol	Nonanal	Total
W	2.81(.85)	5.18(1.84)	6.38(3.63)	2.36(.99)	79.18
M	4.24(2.21)	1.33(1.44)	.54(.30)	2.35(1.82)	86.30
2M	2.38(1.21)	.89(.36)	.44(.28)	1.45(.66)	83.55
average	3.24	2.04	1.82	2.03	83.70

[a]/average of all 93 samples

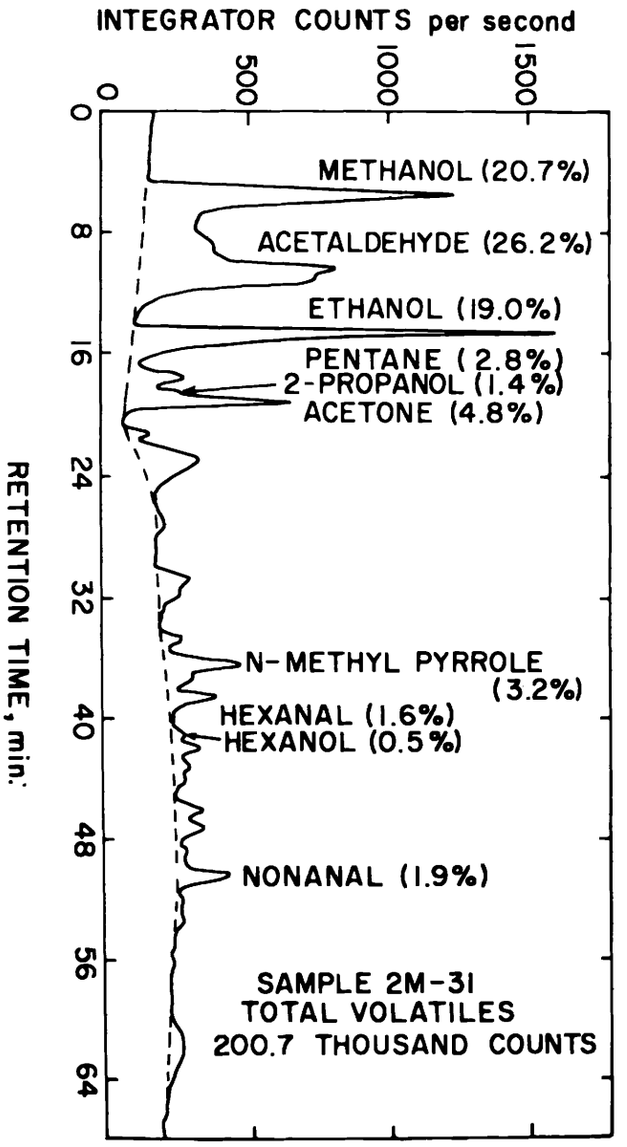

Fig. 1. Volatile profile of peanut 2M-31.

was expected that the amount of compounds found in the volatile profile would be small and below the flavor threshold for unacceptable peanuts. Minor components may be more important than the major components in the volatile profile because flavor thresholds vary many fold for different compounds.

Examination of the quality scores for the three series indicates that the M series as a group is consistently better than the W series. The values for the 2M series were more scattered than the M series. Since sensory samples were chosen to give the biggest variety possible within the acceptable range these peanuts represent a typical range that might be encountered. In both the M and 2 M series Cler scores do not match the quality scores very well. All of the quality scores are in the acceptable range but four samples have Cler scores below the recommended screening score of 40.

The volatile profile illustrated shows a typical profile for acceptable raw peanuts. Variation of individual peaks is indicated by the standard deviations listed in Table 2. Poor quality peanuts may deviate from this volatile profile in many ways such as increased total volatiles (by a factor of 2 or more), greatly (several fold) increased individual peaks normally present (such as ethanol, hexanal and hexanol), presence of large amounts of individual peaks not normally present (such as hexane), and large amounts of whole groups of compounds (greatly increased volatiles beyond N-methyl pyrrole). Volatile profiles of poor quality peanuts will be reported in future papers.

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