Analysis of Peanuts and Peanut Products for Total Lipids, Fatty Acids and Proximates

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ABSTRACT

The four major peanut types and several peanut products were analyzed for total lipids, fatty acid content, fat, ash and protein. Runner and virginia types contained similar amounts of oleic and linoleic acids that were significantly different from those found in valencia and spanish types of peanuts. Characterization of the peanut types into groups by fatty acid profiles was more definitive than by sterol profiles. No significant differences in fat, ash or protein content were found between the various peanut types. Peanut products did not always exhibit the same fatty acid and sterol profiles as peanuts.

Key Words: Peanuts, peanut types, fatty acids, sterols, groundnuts.

The nutrient value of a peanut product is closely associated with the fatty acid composition of its oil content, which influences its quality. Most of the peanuts utilized domestically appear in the retail marketplace as peanut butter, roasted-in-shell nuts, salted nuts, confectionaries and raw nuts. High linoleic acid content decreases shelf life as shown by a negative correlation between linoleic acid content and oil stability (5). Increasing the oleic/linoleic acid ratio produces a more stable peanut oil (1, 25, 26), with a longer shelf life. Nutritionally, a high linoleic acid content is desirable because the acid is an essential fatty acid and produces a hypocholesterolemic effect (9). The consensus is that polyunsaturated fat (fatty acids) lowers total blood cholesterol and low-density lipoprotein levels; lower levels of these substances are associated with reduced risk of coronary heart disease and atherogenesis (24). Monounsaturated fat may be beneficial in lowering blood cholesterol levels (4). Generally, the fatty acid composition of peanut oil is about 10% palmitic acid and 80% oleic and linoleic acids combined; these three acids account for approximately 90% of the total fatty acid content (12). Numerous studies have been conducted with peanuts to determine the effects of soil moisture (3), region (8, 12, 15, 23, 27), growth regulators (11, 13), season (5, 26), variety or genotype (5, 10, 16, 19, 22), harvest times (10, 14) and market grades (14) on the total oil content and the fatty acid composition of the oil. All of the above factors may influence the oleic/linoleic acid ratio under selected conditions, but not always by a statistically significant amount. A recent study (6) has shown that the best roasting condition for peanuts, determined on the basis of flavor and oxidative stability, is produced when the temperature at the kernel center is 185 C; roasting temperature did not significantly affect oil yield, peroxide value, iodine value, saponification value, refractive index and fatty acid composition.

The investigation reported here was undertaken to study the oil content, fatty acid composition and other components of nutritional interest of the four major peanut types and peanut-based products available in the retail marketplace.

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Materials and Methods

For this study the National Peanut Council furnished authentic runner, virginia, spanish and valencia peanuts (both roasted and raw) (Table 1, test materials 1-8) and peanut products, i.e., oils and peanut butters (Table 1, test materials 9-12). Additional peanut products (Table 1, test materials 13-16) were purchased by the authors. The peanuts and peanut products are characterized in Table 1. The extraction procedure, which uses a chloroform-methanol mixture, has been described previously by Sheppard *et al.* (20) and Hubbard *et al* (7). The methyl esters of the fatty acids were prepared by the boron trifluoride procedure of the Association of Official Analytical Chemists (AOAC) (17) as modified by Solomon *et al.* (21). The fatty acid methyl esters were analyzed by gas-liquid chromatography (GLC) using a 2 m x 4 mm I.D. glass column packed with 12-15% ethylene glycol succinate liquid phase coated on 100/120 mesh Gas Chrom-P operated at 170-190°C (7). The butyrate derivatives for sterol analysis were prepared by the method of Shepppard *et al.* (20). The sterol derivatives were analyzed by GLC on a 2 m x 4 mm I.D. glass column packed with 1% SE-30 coated on 100/120 mesh Gas Chrom-Q operated at 250-265°C (20). Moisture, protein and ash were determined by using the procedures of the AOAC (18). A sufficient test portion was taken for the extraction step so that approximately 1 g of fat was recovered. All test materials were analyzed in duplicate.

Table 1. Peanut/peanut product identification and description.

Test material[a]	Description[b]
1	Raw peanuts, runner type, 3-pound bag
2	Raw, shelled peanuts, virginia type, 450-g bag
3	Southern Roaster Nuts, salted, skinless peanuts, sealed can, runner type, 20 ounces
4	Carolina Harvest Southern Style Peanuts, vacuum-sealed can, virginia type, 11 ounces
5	Raw, shelled valencia peanuts
6	Roasted, shelled valencia peanuts
7	Raw spanish peanuts, 3 pounds
8	Roasted spanish peanuts
9	Pure peanut oil, glass bottle, 24 fluid ounces
10	100% pure peanut oil, glass bottle, 24 fluid ounces
11	Smooth peanut butter, glass jar, 12 ounces
12	Creamy peanut butter, glass jar, 12 ounces
13	Peanut butter
14	Peanut butter
15	Peanut butter and chocolate chip cookie dough
16	Peanut butter cups

[a]Test materials 1-12 provided by the National Peanut Council. Test materials 13-16 purchased from local food stores.

[b]From label of product.

Results and Discussion

The proximate values from the analysis of individual test portions are provided in Table 2. No significant differences in fat, ash or protein content were found between the various peanut types. The fatty acid and sterol compositions for the

Table 2. Concentrations of proximates found in duplicate analyses of peanut and peanut-based products.

Test material	Proximate (g/100 g)			
	Moisture	Ash	Fat	Protein
1	7.0	2.1	45.4	23.5
	6.7	2.2	47.9	22.9
2	2.0	2.1	45.4	23.5
	2.0	2.4	51.5	25.0
3	1.8	1.9	46.9	24.1
	1.9	2.0	46.2	24.0
4	1.7	2.4	51.9	26.2
	1.8	2.6	50.4	26.1
5	3.6	2.4	45.7	24.5
	3.9	2.5	45.4	24.3
6	2.7	2.5	50.0	—[a]
	2.7	2.5	48.8	22.0
7	5.3	2.2	47.6	25.0
	5.3	2.2	47.8	24.5
8	3.6	3.2	49.1	26.4
	3.8	3.3	49.1	26.7
9	<0.1	0	100.0[b]	—[a]
	<0.1	0	100.0[b]	—[a]
10	<0.1	0	100.0[b]	—[a]
	0.1	0	100.0[b]	—[a]
11	1.4	3.0	49.5	23.5
	1.1	3.0	49.1	23.7
12	2.3	3.2	49.0	23.2
	1.2	3.1	48.9	23.8
13	0.2	3.7	47.0	27.1
	0.1	3.5	48.5	26.8
14	0.3	3.3	50.0	29.8
	0.1	—[c]	49.2	—[a]
15	11.9	1.3	21.8	2.2
	12.8	1.4	21.2	2.1
16	2.4	2.2	30.5	12.3
	2.7	2.1	30.2	12.5

[a] Foamed during digestion.

[b] Not analyzed because product was essentially 100% fat.

[c] Lost in ashing oven.

Table 3. Fatty acid composition (as methyl esters) found in duplicate analyses of peanuts and peanut-based products.

Test material	Fatty acid[a] (g/100 g)										
	12:0	14:0	14:1	16:0	16:1	18:0	18:1	18:2	20:0	20:1	22:0
1	ND[b]	ND	T[c]	4.6	ND	1.4	21.4	12.4	1.0	1.3	T
	ND	T	T	4.6	ND	1.4	21.4	12.2	ND	0.8	T
2	ND	ND	T	5.2	ND	1.4	23.4	12.2	0.6	1.2	ND
	ND	ND	T	5.4	ND	1.4	23.6	13.8	1.0	1.2	T
3	ND	ND	T	5.2	ND	1.6	25.8	13.2	ND	0.8	1.6
	ND	ND	ND	4.0	T	1.6	23.8	12.4	1.0	1.0	T
4	ND	ND	T	5.2	T	1.6	23.8	14.0	1.0	T	T
	ND	ND	T	4.8	T	1.6	23.0	14.8	T	1.2	0.8
5	ND	ND	T	4.8	ND	1.4	16.6	17.8	ND	1.2	T
	ND	ND	ND	5.0	T	1.6	17.0	19.0	T	1.2	T
6	ND	ND	T	5.0	ND	1.4	17.2	16.6	1.0	1.2	T
	ND	ND	T	5.2	ND	1.6	17.8	16.8	ND	1.2	0.8
7	ND	ND	ND	5.4	ND	1.6	19.0	18.8	T	1.0	T
	ND	ND	ND	5.8	ND	1.6	19.8	19.4	ND	1.2	0.6
8	ND	ND	T	5.4	ND	1.8	16.2	17.4	1.0	1.0	T
	ND	ND	T	5.6	ND	1.8	17.0	17.6	0.8	1.0	1.0
9	T	T	T	9.6	ND	3.0	36.8	12.2	1.4	2.2	T
	ND	T	T	9.6	ND	3.3	40.2	13.0	2.0	2.4	1.8
10	T	T	T	9.8	T	2.8	42.4	29.2	T	2.6	1.8
	T	T	ND	10.0	T	2.8	44.2	30.6	T	2.8	0.8
11	ND	T	T	4.8	ND	1.8	20.0	8.4	1.0	1.2	T
	ND	ND	T	4.4	ND	1.8	18.4	9.8	1.0	1.0	T
12	ND	ND	T	4.8	T	2.2	22.4	12.8	1.0	1.2	T
	ND	ND	T	4.8	ND	2.2	22.8	13.0	1.0	1.2	T
13	ND	ND	ND	5.5	ND	2.6	18.8	14.5	ND	0.3	ND
	ND	ND	ND	5.5	ND	2.6	18.5	14.6	ND	0.3	ND
14	ND	ND	ND	5.9	ND	3.4	19.0	12.5	ND	T	ND
	ND	ND	ND	5.9	ND	3.4	20.3	12.3	ND	0.3	ND
15	ND	0.3	0.1	3.9	0.4	2.9	7.0	2.1	ND	0.2	ND
	ND	0.3	0.1	3.8	0.5	2.9	7.0	2.0	ND	0.1	ND
16	0.2	0.3	ND	5.2	ND	5.0	12.7	5.2	ND	0.3	ND
	0.2	0.3	ND	5.1	ND	5.1	12.8	5.1	ND	0.2	ND

[a] Carbon number:number of double bonds.

[b] ND = none detected.

[c] T = trace (<0.1 g/100 g).

individual test portions are provided in Tables 3 and 4, respectively. Oleic and linoleic acids were the quantitatively predominant fatty acids found in all of the peanut types (test materials 1-8).

Examination of the fatty acid data indicated that the four types of peanuts belong to two distinct groups with different fatty acid compositions and different concentrations of oleic and linoleic acid (Table 5). There were no statistical differences in stearic acid content between peanut types. The oleic acid content of the runner or the virginia type was significantly different ($P<0.01$) from that of either the spanish or the valencia type. However, no significant difference in oleic acid content was found between the runner and virginia types or between the valencia and spanish types. The runner and virginia types, grouped together, averaged 23.3 g oleic acid/100 g peanuts, which was significantly different ($P< 0.01$) from the group average of 17.6 g oleic acid/100 g peanuts for the valencia and spanish types. A similar relationship was found for linoleic acid content. There was no significant difference in linoleic acid content between the runner and virginia types or between the valencia and spanish types. When linoleic acid content was compared for groups of similar types, the linoleic acid content was significantly higher ($P < 0.01$) for the valencia and spanish group and averaged 17.9 g/100 g peanuts as compared with an average of 13.0 g/100 g peanuts for the runner and virginia group.

The sterol composition was not as definitive as the fatty acid composition in characterizing the various peanut types or groups of types. The campesterol concentrations of the runner and virginia group and the valencia and spanish group, which contained 28.2 and 41.5 mg/100 g peanuts, respectively, were significantly different ($P < 0.05$). This group difference was strongly influenced by the significant difference ($P < 0.01$) between the campesterol concentrations of the runner and valencia types, 26.3 and 55.2 mg/100 g, respectively. Also, the significant difference ($P < 0.01$) between 30.1 mg/100 g peanuts for the virginia type and 55.2 mg/100 g peanuts for the valencia type influenced the group difference in campesterol content. No other significant differences in campesterol content were found. Significant differences in stigmasterol content were also absent between peanut types and groups of types. No significant differences

Table 4. Concentrations of primary sterols found in duplicate analyses of peanuts and peanut-based products.

Test material	Sterol (mg/100 g)		
	Campesterol	Stigmasterol	β-Sitosterol
1	21.4	20.2	101.0
	21.8	25.4	119.8
2	21.5	30.7	167.0
	30.3	33.3	172.9
3	29.5	31.1	150.7
	32.6	32.1	172.1
4	35.9	37.4	200.1
	32.5	29.7	176.8
5[a]	56.9	23.8	313.2
6	58.9	32.1	314.3
	49.7	20.9	244.2
7	35.2	32.5	194.5
	38.3	35.0	207.5
8	23.6	29.1	132.7
	28.0	33.1	148.6
9	44.3	32.3	220.8
	50.1	37.9	258.0
10	82.1	55.3	390.0
	89.7	68.2	420.0
11	25.3	29.2	164.1
	28.0	31.1	167.2
12	31.9	29.3	150.1
	35.8	26.1	102.3
13[b]	ND[c]	ND	200.0
14	ND	ND	82
15	ND	ND	28
	ND	ND	27
16	ND	T[d]	47
	ND	T	45

[a] Duplicate lost during test sample preparation.

[b] No duplicate analyzed.

[c] ND = none detected.

[d] T = trace (<0.1 mg/100 g).

in β-sitosterol content were found either between groups or between the virginia and valencia types; however, significant differences ($P < 0.01$) were found between runner and virginia, runner and spanish, virginia and spanish, and valencia and spanish types. The fatty acid and sterol profiles of peanut-based products (test materials 9-16) varied considerably, compared to those of peanuts. The profile of test material 11 was typical of peanuts. However, the fatty acid profiles of the other peanut-based products were somewhat different from those of peanuts. This is not unexpected because, when the peanut ingredient comes from unblanched peanuts, the Standards of Identity (2) permit the use of "hydrogenated vegetable oil" or alternatively "_____oil" or "hydrogenated_____oil" (the blank contains the name or names of the vegetable oil source(s)). Suitable stabilizing ingredients may be hydrogenated or partially hydrogenated vegetable oil (3). All of these factors tend to produce a fatty acid profile that is no longer typical of unhydrogenated peanut oil or of the lipid extract of peanuts. Additionally, the fatty acid profile may be further altered in peanut products containing major quantities of nonpeanut ingredients, e.g., in cookies, which may contain some fat from pan shortenings along with the fat from the cereal grain used in producing the flour.

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Table 5. Mean concentrations[a] of fatty acids and sterols by peanut type and groups of types with similar fatty acid composition.

Peanut type	Fatty acid[b,c] (g/100 g)									
	16:0	18:0	18:1	18:2	20:0	20:1	22:0	Campesterol	Stigmasterol	β-Sitosterol
Runner (R)	4.6 ± 0.49	1.5 ± 0.12	23.1 ± 2.1	12.4 ± 0.66	0.5 ± 0.58	1.0 ± 0.19	0.5 ± 0.75	26.3 ± 5.6	27.2 ± 5.5	135.5 ± 31.7
Virginia (V)	5.2 ± 0.25	1.5 ± 0.12	23.5 ± 0.34	13.7 ± 1.1	0.7 ± 0.43	0.9 ± 0.55	0.3 ± 0.37	31.1 ± 6.1	32.8 ± 3.4	179.2 ± 14.5
Valencia (VA)	5.0 ± 0.16	1.5 ± 0.12	17.2 ± 0.50	17.6 ± 1.1	0.3 ± 0.49	1.2 ± 0.0	0.2 ± 0.08	55.2 ± 4.8	25.6 ± 5.8	290.6 ± 40.2
Spanish (S)	5.6 ± 0.19	1.7 ± 0.12	18.0 ± 1.7	18.3 ± 0.96	0.5 ± 0.50	1.1 ± 0.10	0.3 ± 0.19	31.3 ± 6.7	32.4 ± 2.5	170.8 ± 35.8
R + V	4.9 ± 0.46	1.5 ± 0.11	23.3 ± 1.4	13.0 ± 1.1	0.5 ± 0.45	0.9 ± 0.38	0.4 ± 0.56	28.2 ± 5.8	30.0 ± 5.2	157.6 ± 32.5
VA + S	5.3 ± 0.34	1.6 ± 0.15	17.6 ± 1.2	17.9 ± 1.0	0.4 ± 0.47	1.1 ± 0.10	0.2 ± 0.13	41.5 ± 13.9	29.5 ± 6.3	222.1 ± 72.6
All types	5.1 ± 0.44	1.6 ± 0.14	17.7 ± 6.4	15.5 ± 2.7	0.5 ± 0.47	1.0 ± 0.29	0.3 ± 0.45	34.4 ± 12.1	29.8 ± 5.0	187.7 ± 62.5

[a] Mean ± standard deviation, based on 4, 4, 4, 4, 8, 8 and 16 values, respectively, for the seven peanut types.

[b] Carbon number:number of double bonds.

[c] Values recorded as trace in Table 3 were arbitrarily assigned a value of 0.1 when mean concentrations were calculated.

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