JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Influence of Year and Planting Date on Fatty Acid Chemistry of High Oleic Acid and Normal Peanut Genotypes

PETER C. ANDERSEN*,† AND DANIEL W. GORBET‡

University of Florida North Florida Research and Education Center, Quincy, Florida 32351, and University of Florida North Florida Research and Education Center, Marianna, Florida

The effect of an early-, mid-, or late-season planting date on the fatty acid chemistry of four high oleic acid, one mid oleic acid, and five normal oleic acid peanut (*Arachis hypogaea* L.) genotypes was evaluated over a three year period. Oleic acid was also compared to other fatty acids and to indices of oil quality. High-oleic genotypes included SunOleic 97R, UF98326, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B with a mean oleic acid content between 77.8 and 82.5%. Florida MDR98, a mid-oleic cultivar, was intermediate in oleic acid chemistry (59.8−68.0%). The normal oil chemistry lines (Georgia Greene, Andru93, Florunner, 86x13A-4-2-3-2-b3-B, and UF97102) had an oleic acid content between 50.0 and 59.0%. The ratio of oleic to linoleic (O/L) was 18:1 to 51:1 for high-oleic lines and 1.7:1 to 3.5:1 for normal genotypes. When analyzed as a split−split plot in time, year had a highly significant effect ($P < 0.001$) on the eight main fatty acids, iodine value, ratio of unsaturated to saturated fatty acids (U/S), and percentage of saturated fatty acids. Thus, data were analyzed separately by year. Although genotypic effects were highly significant each year, planting date influenced oil chemistry in two of three years. During both 1999 and 2000, 11 of 12 variables were influenced by planting date and by genotype × planting date interactions. Iodine values were ∼75 for high-oleic lines compared to 90−95 for normal genotypes. The highest correlations occurred for oleic acid (18:1) and linoleic acid (18:2) ($r = -0.996$) and for oleic and palmitic (16:0) acids ($r = -0.959$). Oleic acid was also inversely related to iodine value ($r = -0.978$) and to percentage saturation ($r = -0.841$).

KEYWORDS: ***Arachis hypogaea*** **L.; fatty acids; oleic acid; peanut**

INTRODUCTION

Flavor and quality of peanut and peanut products are largely functions of lipid chemistry. Peanuts contain ∼50% oil (*1*). Palmitic acid (16:0), oleic acid (18:1), and linoleic acid (18:2) are the major fatty acids in peanuts and may comprise >90% of the total fatty acids (*2*). The remaining fatty acids, stearic (18:0), arachidic (20:0), eicosenoic (20:1), behenic (22:0), and lignoceric (24:0) acid, normally occur in weight percentages between 0.02 and 4.0%.

The genetic manipulation of peanut chemistry has the potential to improve the nutritional quality of peanuts and peanut products. Norden et al. (*3*) first identified a peanut genotype containing ∼80% oleic acid and ∼2% linoleic acid. The trait conferring a high ratio of oleic to linoleic acids (O/L) content was shown to be controlled by two recessive genes (*4*−*6*). The high oleate character is derived from a reduced Δ12 desaturase activity, and the biochemical basis for alterations in enzyme structure and function has been characterized (*7*, *8*). High O/L has been associated with greatly enhanced shelf life and decreased rancidity of roasted peanuts (*9*−*11*); however, total fat content, percent sucrose, and roast color were similar (*9*). Diets that are high in monounsaturated fatty acids and low in saturated fatty acids have reduced cholesterol and low-density lipoproteins in humans (*12*−*15*). The high O/L characteristic could confer a significant human health advantage and enhance the marketability of peanuts.

Seed maturity can also influence the fatty acid composition of peanut. The actual impact of seed maturity is dependent on genotype, climatic conditions, and genotype/climate interactions. Lower temperatures during seed development normally are associated with a more unsaturated oil due to the increased activity of oleate desaturase, which promotes the synthesis of linoleic acid. In general, oleic acid increases and linoleic acid decreases with seed maturity (*1*, *16*−*22*). Other studies have shown a reduction in oleic acid and an increase in linoleic acid with maturity (*23*, *24*), whereas Knauft et al. (*25*) observed no influence of maturity on oil chemistry. The increase in oleic acid with seed maturity is normally accompanied by a decrease in palmitic, linoleic, arachidic, eicosenoic, behenic, and lignoceric acid (*1*, *17*−*22*).

* Address correspondence to this author at 155 Research Rd., Quincy, FL 32351 [fax (904) 875-7148; e-mail PCA@mail.ifas.ufl.edu].
† North Florida Research and Education Center, Quincy.
‡ North Florida Research and Education Center, Marianna.

10.1021/jf0113171 CCC: $22.00
Published on Web 02/01/2002

Bovi (*26*), noting a negative correlation between iodine value and soil temperature, suggested that the chemical composition of peanut oil could be changed by planting dates. Sanders (*27*) reported that seed maturity induced far greater differences in the fatty acid composition than did peanut genotype of three commercial peanut cultivars tested. Far greater variations in oil chemistry now exist among contemporary peanut cultivars (*3*, *11*, *28*−*30*). For example, oleic acid content in peanut genotypes can vary from 21 to 85% and linoleic acid from 2 to 43% (*3*, *31*). Our objective was to determine the relative extent to which oil chemistry of high-oleic and normal peanut genotypes may vary with planting date over a three year period.

MATERIALS AND METHODS

Peanut Genotypes. The peanut genotypes examined included Florida MDR98, Georgia Greene, SunOleic 97R, Andru 93, Florunner, 86x13A-4-2-3-2-b3-B, UF98326, UF99621, 88x1B-OLBC1-6-1-3-1-b2-B, and UF97102. Sun Oleic 97R, UF98326, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B were homozygous for the high-oleic trait, Florida MDR98 is a mid-oleic cultivar, and the remainder were normal oil chemistry genotypes. These peanut genotypes can be placed into three maturity groups: early (Andru 93, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B), mid (Georgia Greene, SunOleic 97R, UF97102, and Florunner), and late (Florida MDR98, 86x13A-4-2-3-2-b3-B, and UF98326). In each of three years there were three planting dates: 1998 (April 17, May 13, and June 9); 1999 (April 14, May 10, and June 7); 2000 (April 18, May 12, and June 8). Plots were located at the North Florida Research and Education Center, Marianna, FL. Soil type was a Chipola loamy sand. Plots were subjected to standard culture and management practices, including a full season fungicide program for leaf spot control and irrigation. Plots were harvested on the basis of maturity. Digging days for 1998 were as follows: first planting, early (133 days), mid (143 days), and late (154 days); second planting, early (128 days), mid (138 days), and late (150 days); third planting, early (125 days), mid (130 days), and late (144 days). Digging days for 1999 were as follows: first planting, early (131 days), mid (138 days), and late (149 days); second planting, early (129 days), mid (140 days), and late (150 days); third planting, early (130 days), mid (130 days), and late (151 days). Digging days for 2000 were as follows: first planting, early (129 days), mid (136 days), and late (150 days); second planting, early (128 days), mid (139 days), and late (149 days); third planting, early (123 days), mid (130 days), and late (144 days). Mature peanut pods were removed from the vines with plot threshers and dried to 10% moisture. The dried in-shell peanuts were machine shelled, sorted, and graded (screen size = 6.35 × 19.1 mm slots). Sound, mature seeds were used for the determination of fatty acid profiles.

Peanut Oil Preparation and Analysis of Fatty Acids. Fatty acid analysis of peanut seed was accomplished using the method of Folch et al. (*32*), as modified by Christie (*33*). Approximately 1 g of peanuts was mascerated in a Waring blender (Waring Products Division, New Hartford, CT), and the contents were transferred to a 10 mL glass screw-top test tube. Approximately 10 mL of dichloromethane was added, and the test tube was thoroughly shaken and then left undisturbed overnight. The extract was filtered through Whatman No. 1 filter paper (Fisher Scientific, Fair Lawn, NJ). The volume of extract was noted and increased by 25% with the addition of deionized water. The contents were shaken thoroughly and centrifuged at 3000 rpm for 10 min. Both the aqueous layer and any precipitate (defatted peanut meal) were discarded, and 1 g of sodium sulfate was added to the remaining extract. After the remaining extract had been transferred to a new test tube, the dichloromethane was evaporated in a warm 50−60 °C water bath under a nitrogen atmosphere. Sufficient additional dichloromethane was added to bring the volume to 2 mL. Next, 100 μL of dichloromethane/lipid solution was added to 25 μL of MethPrep ll (Alltech Associates Inc., Deerfield, IL) in the autosampler vial to derivatize fatty acids to methyl esters. Nitrogen gas was added, and the vials were capped and left undisturbed for 30 min.

Fatty acid profiles were determined using a Hewlett-Packard (HP) 6890 gas chromatograph (Hewlett-Packard, Wilmington, DE) equipped with an HP flame ionization detector and an HP-225 cyanopropylphenyl dimethyl siloxane column (length = 30 m, inner diameter = 320 μm). One microliter of sample was injected using an HP autosampler and analyzed via HP Chemstation software. All samples were run in duplicate. Helium was the carrier gas. Gas flow rates per minute were 30, 30, and 300 mL/min for nitrogen (makeup gas), hydrogen, and air, respectively. A split ratio of 100:1 at an inlet temperature of 220 °C was employed. The initial oven temperature was 190 °C and was increased at 5 °C/min to 240 °C. The fatty acid methyl esters were identified by a comparison of retention times to an American Oil Chemists' Society composite standard (low erucic rapeseed oil) (Sigma Chemical Co., St. Louis, MO).

The ratio of oleic acid to linoleic acid (O/L) was calculated for each experimental unit. Iodine values (IV), which are inversely proportional to oil stability, were calculated using the formula of Cocks and Van Reds (*34*):

$$IV = (0.8601 \times \%\ \text{oleic acid}) + (1.7321 \times \%\ \text{linoleic acid}) + (0.7854 \times \%\ \text{eicosenoic acid})$$

Statistics. Each genotype was replicated four times from seed batches collected at each planting location for each of three planting dates and for each of three years. The variables of fatty acids were subjected to analysis of variance procedures of the statistical analysis system. The experimental design and analysis was a split−split plot in time. The genotype 88x1B-OlBC1-6-1-3-1-b2-B was omitted from this three-way factorial analysis because data were lacking in 2000. Because year main effects and year interactive effects were often significant each year, data were also analyzed as a factorial design with genotype and planting date as main factors for each year separately. In addition, individual genotypes were analyzed separately as a function of planting date, and means were separated on the basis of Duncan's multiple-range test.

The relationship of the variables percent linoleic acid, percent palmitic acid, ratio of unsaturated to saturated fatty acids, iodine value, and percent saturation was compared to percent oleic acid by linear regression. All data (genotype × planting date × year) were combined for these analyses.

RESULTS

Data statistically analyzed as a split−split plot in time showed highly significant year main effects and planting date main effects for 11 of 12 variables ($P < 0.001$) (**Table 1**). The only variable not significantly influenced by year or date was O/L. Genotype effects were significant for all variables. Year × planting date interactive effects were significant for all variables except lignoceric acid and O/L, whereas year × genotype effects were significant for all effects except O/L. Two-way year × genotype interactions were highly significant for all independent variables. These highly significant interactive data led us to a statistical analysis by each year separately as a genotype × planting date factorial design.

Peanut genotypes homozygous for the high oleic acid trait (SunOleic 97R, UF98326, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B) were readily distinguished from the normal genotypes on the basis of weight percentages of oleic and linoleic acids. High oleic acid and normal genotypes had oleic acid percentages of ca. 80 and 50−59%, respectively (**Tables 2**−**4**). By contrast, the weight percentage of linoleic acid was 23−28% for normal oil genotypes compared to 1.2−4.5% for high oleic acid lines. This resulted in an O/L ratio of 18:1 to 51:1 for high-oleic genotypes, compared to 1.7:1 to 3.5:1 for normal genotypes. Florida MDR98, a mid-oleic genotype, had oleic acid and linoleic acid weight percentages in the range of 59−67 and 12−21%, respectively. In all cases the combination of oleic and linoleic acids represented ∼80% of the fatty acid profiles of peanuts; palmitic acid accounted for another 5−10% of the total.

Table 1. Statistics of a Three-Way Factorial Analysis (Fatty Acid Composition Was Analyzed for Three Years for Nine Genotypes at Three Planting Dates)[a]

variable	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV[b]	U/S[c]	% saturation
year	***	***	***	**	***	***	***	***	NS	***	***	***
date	***	**	***	***	*	***	***	*	NS	***	***	***
genotype	***	***	***	***	***	***	***	***	***	***	***	***
year × date	***	***	**	**	***	***	***	NS	NS	***	***	***
date × genotype	***	***	***	***	***	***	***	***	NS	***	***	***
year × genotype	***	***	***	***	***	***	***	**	***	***	***	***

[a] NS, *, **, and *** correspond to nonsignificant or significant at $P < 0.05$, 0.01, and 0.001, respectively. [b] IV, iodine value. [c] U/S, ratio of unsaturated to saturated fatty acids.

Table 2. Fatty Acid Composition of Peanut Oil from 10 Genotypes at Three Planting Dates during 1998[a]

genotype/planting date	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
Florida MDR98												
April 17	8.65	3.11	63.39^{ab}	17.10^{ab}	1.60	1.24	3.47	1.46	3.71	85.11^{ab}	4.46	18.27
May 13	8.28	3.44	64.87^{a}	15.50^{b}	1.64	1.25	3.53	1.49	4.34	83.62^{b}	4.44	18.38
June 9	8.80	3.18	59.80^{b}	20.28^{a}	1.58	1.27	3.60	1.48	2.95	87.57^{a}	4.37	18.65
Georgia Greene												
April 17	10.00	2.62	53.02^{a}	27.44^{b}	1.29	1.23	2.87	1.54	1.93	94.09	4.46	18.31
May 13	10.31	2.55	50.23^{b}	29.52^{a}	1.25	1.29	3.20	1.64	1.70	95.35	4.27	18.96
June 9	9.89	2.52	52.42^{ab}	27.96^{b}	1.28	1.27	3.09	1.58	1.88	94.51	4.44	18.35
SunOleic 97R												
April 17	5.81	2.21	81.53^{a}	2.68	1.16	2.04	2.73	1.83	30.67^{a}	76.36	6.29	13.75
May 13	6.18	2.66	79.11^{b}	4.45	1.22	1.84	2.81	1.73	18.08^{b}	77.20	5.85	14.60
June 9	5.80	2.63	79.91^{ab}	3.88	1.27	1.93	2.82	1.77	21.85^{ab}	76.97	5.99	14.28
Andru 93												
April 17	10.22	2.38	54.28	26.37	1.21	1.30	2.73	1.52	2.07	93.38	4.55	18.05
May 13	9.96	2.48	55.05	25.28	1.25	1.36	3.01	1.61	2.18	92.21	4.46	18.31
June 9	10.19	2.35	53.41	26.99	1.24	1.35	2.90	1.56	1.98	93.74	4.48	18.25
86x13A-4-2-3-2-b3-B												
April 17	8.74	2.62	59.03	22.90	1.27	1.32	2.75	1.36	2.58	91.48	5.98	16.74
May 13	8.64	2.93	58.98	22.78	1.29	1.26	2.79	1.32	2.60	91.18	5.90	16.98
June 9	8.76	2.81	57.75	24.06	1.32	1.26	2.72	1.32	2.40	92.34	5.90	16.93
UF98326												
April 17	6.21	3.90	77.84	4.00	1.60	1.58^{b}	3.40	1.46^{b}	32.55	75.13	5.03^{b}	16.58
May 13	5.76	3.48	80.89	1.59	1.51	1.74^{a}	3.48	1.55^{a}	50.75	73.70	5.35^{ab}	15.78
June 9	5.81	3.32	80.04	2.95	1.48	1.66^{ab}	3.28	1.46^{b}	33.42	75.26	5.52^{a}	15.35
UF9621												
April 17	5.63	2.57	82.47	2.42^{b}	1.23	1.68^{b}	2.53^{b}	1.47	34.24^{a}	76.44	6.45	13.43
May 13	5.77	2.48	81.98	2.68^{ab}	1.19	1.74^{ab}	2.67^{ab}	1.48	30.64^{ab}	76.53	6.37	13.60
June 9	5.66	2.42	81.84	2.83^{a}	1.23	1.77^{a}	2.72^{a}	1.52	28.92^{b}	76.69	6.37	13.56
88x1B-OLBC1-6-1-3-1-b2-B												
April 17	6.19	3.78	80.77	1.72	1.64	1.47	2.97	1.47	47.22	73.61	5.24	16.04
May 13	6.34	3.39	80.44	2.05	1.60	1.54	3.09	1.54	40.70	73.95	5.26	15.97
June 9	6.28	3.26	80.93	1.84	1.56	1.57	3.02	1.53	44.16	74.04	5.38	15.65
UF97162												
April 17	9.73	2.40	56.28^{a}	24.19^{b}	1.26	1.40	3.04	1.71	2.33^{a}	91.40	4.50	18.13
May 13	9.99	2.52	54.84^{ab}	25.35^{ab}	1.30	1.31	3.05	1.63	2.16^{ab}	92.11	4.41	18.50
June 9	9.94	2.43	53.82^{b}	26.34^{b}	1.25	1.42	3.15	1.65	2.04^{b}	93.03	4.42	18.42
Florunner												
April 17	10.08	2.72	52.77	27.54	1.32	1.24	2.75^{b}	1.58	1.92	94.07	4.42	18.44
May 13	10.28	2.56	51.31	28.62	1.28	1.29	3.03^{a}	1.64	1.80	94.71	4.33	18.79
June 9	10.07	2.59	52.27	27.99	1.28	1.30	2.86^{ab}	1.63	1.88	94.46	4.42	18.44

statistics	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
cultivar	***	***	***	***	***	***	***	***	***	***	***	***
date	NS	NS	*	*	NS	NS	***	NS	NS	**	NS	NS
date × cultivar	NS	**	**	*	NS	***	NS	NS	NS	*	NS	NS

[a] All values are means of four replications run in duplicate. NS, *, **, and *** correspond to nonsignificant or significant at $P < 0.05$, 0.01, and 0.001, respectively. Letters that are different for planting dates within a given genotype are significantly different by Duncan's multiple range test ($P < 0.05$).

Many differences in fatty acid composition existed between high-oleic and normal lines. For example, palmitic acid tended to be up to twice as high for normal oleic acid (9−10%) compared to high oleic acid (5−8%) lines (**Tables 2−4**). Stearic, arachidic, eicosenoic, behenic, and lignoceric acids each represented between 1 and 3% of the total fatty acid profile. Iodine values were 74−77 for high-oleic genotypes and 90−96 for normal lines.

The most distinguishable feature of genotype × planting date factorial analysis was the relative prominence of genotype effects

Table 3. Fatty Acid Composition of Peanut Oil from 10 Genotypes at Three Planting Dates during 1999[a]

genotype/planting date	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
Florida MDR98												
April 14	7.96[b]	4.17[a]	67.36[a]	12.56[c]	1.85[a]	1.13[b]	3.47	1.51	5.44[a]	80.58[c]	4.27	18.95
May 10	8.46[a]	3.51[b]	62.14[b]	17.76[b]	1.68[b]	1.23[b]	3.67	1.56	3.53[b]	85.17[b]	4.29	18.88
June 7	8.70[a]	3.38[b]	58.50[c]	21.15[a]	1.60[b]	1.35[a]	3.77	1.56	2.77[b]	88.00[a]	4.26	19.01
Georgia Greene												
April 14	10.34[a]	2.87	54.47[ab]	25.12[b]	1.39	1.20[b]	2.96	1.66	2.18[ab]	91.29[b]	4.20[a]	19.21[a]
May 10	10.37[a]	2.78	55.29[a]	24.53[b]	1.34	1.22[b]	2.84	1.63	2.26[a]	91.00[b]	4.27[ab]	18.96[ab]
June 7	9.48[b]	2.90	52.89[b]	27.19[a]	1.41	1.33[a]	3.05	1.76	1.95[b]	93.63[a]	4.39[b]	18.59[b]
SunOleic 97R												
April 14	6.46[a]	2.61[ab]	81.72	2.06[a]	1.24	1.74[b]	2.48[ab]	1.69	39.75[a]	75.22[b]	5.92	14.48
May 10	6.57[a]	2.27[b]	81.99	2.16[ab]	1.12	1.84[a]	2.35[b]	1.73	38.50[ab]	75.69[a]	6.13	14.03
June 7	5.75[b]	2.68[a]	81.60	2.43[a]	1.25	1.91[a]	2.67[a]	1.73	33.73[b]	75.88[b]	6.10	14.07
Andru 93												
April 14	10.63[a]	2.59	55.35[b]	24.04[b]	1.31	1.33	2.95[b]	1.80	2.31[b]	90.29[b]	4.18[a]	19.27[a]
May 10	10.07[b]	2.73	58.85[a]	21.44[b]	1.32	1.27	2.70[a]	1.64	2.77[a]	88.75[b]	4.42[ab]	18.44[b]
June 7	9.60[b]	2.86	54.33[b]	25.73[a]	1.35	1.36	3.06[a]	1.70	2.12[b]	92.37[a]	4.39[b]	18.58[ab]
86x13A-4-2-3-2-b3-B												
April 14	9.72	2.68[b]	58.20[a]	22.49[c]	1.29	1.33	2.77[b]	1.53[ab]	2.60[a]	90.05[c]	4.57[a]	17.99[a]
May 10	8.89	2.63[b]	55.64[b]	25.48[b]	1.28	1.43	3.06[a]	1.59[a]	2.19[b]	93.11[b]	4.74[b]	17.45[b]
June 7	8.59	2.96[a]	53.50[c]	28.12[a]	1.32	1.33	2.80[ab]	1.38[b]	1.90[c]	95.76[a]	4.85[b]	17.05[b]
UF98326												
April 14	6.36[a]	3.86	78.92	3.10	1.64	1.49[b]	3.17[b]	1.48	25.72	74.41	5.05	16.50
May 10	6.09[a]	4.10	78.50	3.41	1.68	1.49[b]	3.27[ab]	1.46	34.33	74.59	5.03	16.60
June 7	5.39[b]	4.13	80.06	2.17	1.69	1.69[a]	3.39[a]	1.49	36.97	73.95	5.21	16.07
UF99621												
April 14	6.28[a]	3.01	81.14[ab]	2.49[ab]	1.38[b]	1.57[b]	2.62	1.51	32.58[ab]	75.34	5.75	14.80
May 10	6.15[a]	3.02	81.43[a]	2.25[b]	1.37[b]	1.61[b]	2.67	1.51	36.62[a]	75.20	5.78	14.72
June 7	5.61[b]	3.35	80.81[b]	2.63[a]	1.49[a]	1.73[a]	2.84	1.55	30.79[b]	75.42	5.75	14.83
88x1B-OLBC1-6-1-3-1-b2-B												
April 14	6.85[a]	4.76[a]	76.90[b]	3.14[a]	2.08[a]	1.30[b]	3.29[a]	1.69[a]	24.72[b]	72.59[b]	4.35[a]	18.67[a]
May 10	6.33[b]	4.20[b]	80.33[a]	1.59[b]	1.84[b]	1.30[b]	2.92[b]	1.49[b]	57.95[a]	72.88[b]	4.98[b]	16.77[b]
June 7	6.27[b]	3.49[c]	77.75[b]	4.60[a]	1.61[c]	1.60[a]	3.07[ab]	1.63[ab]	18.24[b]	76.09[a]	5.24[b]	16.06[b]
UF97102												
April 14	10.08[a]	2.95[a]	57.62[a]	22.05[b]	1.36[a]	1.27[b]	2.96[b]	1.71	2.63[a]	88.74[a]	4.26[a]	19.06[a]
May 10	9.64[b]	2.86[ab]	58.85[ab]	21.46[b]	1.32[ab]	1.29[b]	2.91[b]	1.67	2.75[a]	88.80[a]	4.44[c]	18.40[b]
June 7	9.69[b]	2.60[b]	51.97[b]	27.82[a]	1.29[b]	1.46[a]	3.36[a]	1.82	1.87[b]	94.02[a]	4.33[b]	18.75[c]
Florunner												
April 14	10.85[a]	2.84	54.07[a]	25.44[b]	1.36[b]	1.16	2.64[b]	1.65	2.13[ab]	91.47[b]	4.17	19.34
May 10	10.19[b]	2.99	55.14[ab]	24.37[b]	1.40[b]	1.23	2.97[a]	1.72	2.26[a]	90.60[c]	4.18	19.27
June 7	10.26[b]	3.07	53.20[b]	26.33[a]	1.44[a]	1.19	2.82[ab]	1.69	2.03[b]	92.29[a]	4.18	19.28

statistics	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
date	***	***	***	***	***	***	***	***	***	***	***	***
cultivar	***	*	***	***	***	***	***	***	NS	***	***	***
date × cultivar	***	***	***	***	***	***	***	***	NS	***	***	***

[a] All values are means of four replications run in duplicate. NS, *, **, and *** correspond to nonsignificant or significant at $P < 0.05$, 0.01, and 0.001, respectively. Letters that are different for planting dates within a given genotype are significantly different by Duncan's multiple range test ($P < 0.05$).

compared to planting date effects. For each of the three years, genotype had a significant effect on all 12 variables; however, during only two of three years did planting date strongly influence oil chemistry. For 1998, the only significant effects were attributed to genotype (**Table 2**). All fatty acid variables were significant except for lignoceric acid and O/L. Planting date or genotype × planting date interactions were not significant. For 1999 peanut genotype had a significant effect on all variables, except lignoceric acid, whereas planting date influenced palmitic, oleic, linoleic, eicosenoic, and behenic acids and iodine values (**Table 3**). Cultivar × date interactions also occurred for oleic and linoleic acids and iodine value. Both genotype and planting date were often significant for 2000 data (**Table 4**). Four significant genotype × planting date interactions also occurred.

Significant interactive effects of peanut genotypes and planting date prompted a separate statistical evaluation of planting date effects by individual genotype. Genotype was far greater a determinant of each fatty acid variable than was planting date. Typically, mean separation of the fatty acid variables was such that high-oleic and normal genotypes fell into two different categories (data not shown). For most genotypes, the weight percentages of oleic and linoleic acids varied only a few percentage points regardless of planting date. There was often a lack of a consistent effect of planting date for all cultivars. Florida MDR98, a mid-oleic cultivar, exhibited the most plasticity in oil chemistry as a function of planting date. Stearic, palmitic, oleic, and arachidic acid tended to decrease in weight percentages with a later planting date, and linoleic, eiconosoic, and behenic acid increased in concentration. There was a trend for iodine value to increase and also a trend for the O/L to decrease and U/S to increase with later planting date. A statistical analysis of high-oleic and normal genotypes and maturity season indicated no clear response patterns due to oleic acid status or maturity class as a function of planting date.

The relationships of oleic acid to other fatty acids and groupings of fatty acids inclusive of all planting dates can be found in **Figures 1−4**. Oleic acid was inversely related to

Table 4. Fatty Acid Composition of Peanut Oil from Nine Genotypes at Three Planting Dates during 2000[a]

genotype/planting date	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
Florida MDR98												
April 18	7.60	3.28^{ab}	67.98^{a}	12.18^{c}	1.59^{a}	1.25^{b}	3.33	1.49	5.64^{a}	80.52^{c}	4.72	17.29
May 12	7.66	3.52^{a}	64.67^{b}	14.59^{b}	1.66^{a}	1.27^{b}	3.50	1.52	4.44^{b}	81.85^{b}	4.50	17.86
June 8	8.05	3.05^{b}	60.20^{c}	19.19^{a}	1.47^{b}	1.38^{a}	3.43	1.46	3.15^{c}	86.05^{a}	4.63	17.45
Georgia Greene												
April 18	9.81^{a}	2.67	53.42	25.20	1.34^{ab}	1.22^{b}	2.83	1.59	2.12	90.49	4.39^{a}	18.23
May 12	9.54^{ab}	2.80	53.26	25.81	1.37^{a}	1.20^{b}	2.85	1.56	2.07	91.39	4.42^{ab}	18.11
June 8	9.23^{b}	2.65	52.66	26.25	1.32^{b}	1.30^{a}	2.90	1.59	2.01	91.72	4.52^{b}	17.69
SunOleic 97R												
April 18	6.29	2.59^{ab}	78.28	4.00	1.24^{ab}	1.72^{b}	2.42^{b}	1.64^{b}	27.86	75.60	5.92	14.17
May 12	5.74	3.19^{a}	79.31	2.60	1.39^{a}	1.70^{b}	2.51^{b}	1.63^{b}	33.30	74.04	5.78	14.46
June 8	5.60	2.23^{b}	77.94	4.24	1.15^{b}	2.08^{a}	2.76^{a}	1.83^{a}	21.96	76.01	6.21	13.56
Andru 93												
April 18	10.05^{a}	2.46	53.19^{a}	24.96^{b}	1.25^{b}	1.25	2.75	1.58	2.13^{a}	89.90^{b}	4.39^{ab}	18.10
May 12	9.99^{a}	2.90	54.00^{a}	24.18^{b}	1.41^{a}	1.22	2.78	1.58	2.24^{a}	89.24^{b}	4.26^{a}	18.65
June 8	9.74^{b}	2.70	51.63b	26.93a	1.30^{ab}	1.29	2.72	1.55	1.92^{b}	92.01^{a}	4.44^{b}	18.00
86x13A-4-2-3-2-b3-B												
April 18	9.00^{a}	2.80^{c}	57.24^{a}	23.13^{b}	1.27^{c}	1.13^{b}	2.34^{c}	1.24	2.48^{a}	90.14^{b}	4.90^{b}	16.65
May 12	8.48^{b}	3.02^{b}	56.77^{a}	23.51^{b}	1.34^{b}	1.23^{a}	2.66^{b}	1.27	2.42^{a}	90.46^{b}	4.85^{b}	16.76
June 8	8.49^{b}	3.19^{a}	54.15^{b}	25.72^{a}	1.43^{a}	1.13^{b}	2.77^{a}	1.26	2.11^{b}	91.96^{a}	4.74^{a}	17.13
UF98326												
April 18	5.52^{a}	4.32^{a}	79.82^{b}	1.26^{b}	1.77^{a}	1.44^{b}	3.05^{ab}	1.43	63.47^{a}	71.96^{b}	5.13^{a}	16.09
May 12	5.45^{a}	4.26^{a}	79.37^{b}	1.60^{a}	1.72^{a}	1.49^{b}	3.11^{a}	1.40	50.05^{b}	72.19^{b}	5.18^{a}	15.93
June 8	5.07^{b}	3.36^{b}	80.53a	1.59^{a}	1.42^{b}	1.67^{a}	2.92^{b}	1.39	51.09^{b}	73.32^{a}	5.92^{b}	14.16
UF99621												
April 18	5.95^{a}	2.87	80.24	2.38^{b}	1.32	1.55^{b}	2.38^{b}	1.37^{b}	33.92^{a}	74.34	6.06	13.90
May 12	5.80^{a}	2.77	80.30	2.53^{ab}	1.29	1.59^{b}	2.44^{b}	1.41^{b}	31.76^{ab}	74.69	6.17	13.71
June 8	5.34^{b}	2.91	79.52	2.73^{a}	1.34	1.76^{a}	2.64^{a}	1.52^{a}	29.20^{b}	74.50	6.10	13.75
UF97102												
April 18	9.96	2.55^{ab}	54.71^{a}	23.93^{b}	1.25^{ab}	1.22^{b}	2.68^{b}	1.57b	2.31^{a}	89.40^{b}	4.42	18.01
May 12	9.82	2.74^{a}	52.21^{ab}	26.03^{ab}	1.32^{a}	1.28^{b}	2.94^{a}	1.65^{a}	2.01	90.93^{ab}	4.31	18.47
June 8	9.70	2.38^{b}	51.53^{b}	27.01^{a}	1.20^{b}	1.40^{a}	2.99^{a}	1.64^{a}	1.91	91.14^{b}	4.46	17.91
Florunner												
April 18	10.27^{a}	2.58^{b}	54.88^{a}	24.91^{b}	1.27^{b}	1.14^{b}	2.40^{b}	1.40^{c}	2.21^{a}	91.19^{b}	4.52^{b}	17.91
May 12	9.70^{b}	3.44^{a}	51.90^{b}	26.26^{b}	1.51^{a}	1.14^{b}	2.73^{a}	1.55^{b}	1.98^{b}	90.95^{b}	4.18^{a}	18.93
June 8	9.61^{b}	2.55^{b}	49.99^{b}	28.56^{a}	1.28^{b}	1.38^{a}	2.91^{a}	1.70^{a}	1.76^{c}	93.49^{a}	4.42^{b}	18.04

genotype/planting date	fatty acid composition (%) 16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	18:1/18:2	IV	U/S	% saturation
cultivar	***	***	***	***	**	***	***	***	***	***	***	***
date	***	***	***	***	**	***	***	***	***	***	***	***
cultivar × date	**	***	***	***	***	***	***	***	**	***	***	***

[a] All values are means of four replications run in duplicate. NS, *, **, and *** correspond to nonsignificant or significance at $P < 0.05$, 0.01, and 0.001, respectively. Letters that are different for planting dates within a given genotype are significantly different by Duncan's multiple range test ($P < 0.05$).

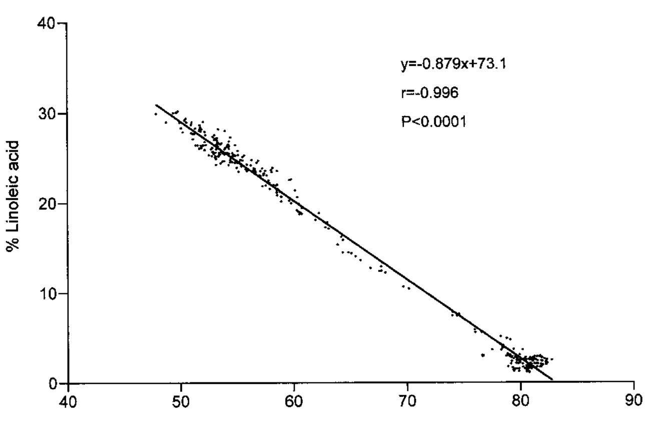

Figure 1. Relationship between proportions of linoleic acid and oleic acid in peanut genotypes.

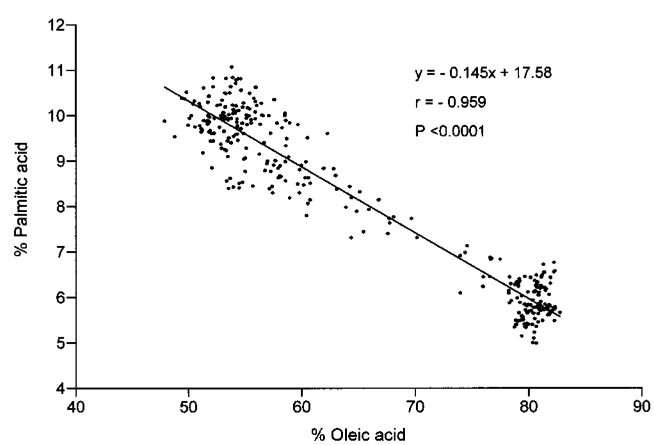

Figure 2. Relationship between proportions of palmitic acid and oleic acid in peanut genotypes.

linoleic acid ($r = -0.996$) (**Figure 1**) and to palmitic acid ($r = -0.959$) (**Figure 2**). Iodine value was inversely related to oleic acid ($r = -0.978$) (**Figure 3**). Percentage saturation was also inversely related to oleic acid ($r = -0.841$) (**Figure 4**). Oleic acid was strongly positively correlated to only eicosenoic acid ($r = 0.764$) (data not shown). We noted no difference in the correlations described above between high-oleic and normal lines. The reverse relationship was noted for each of the

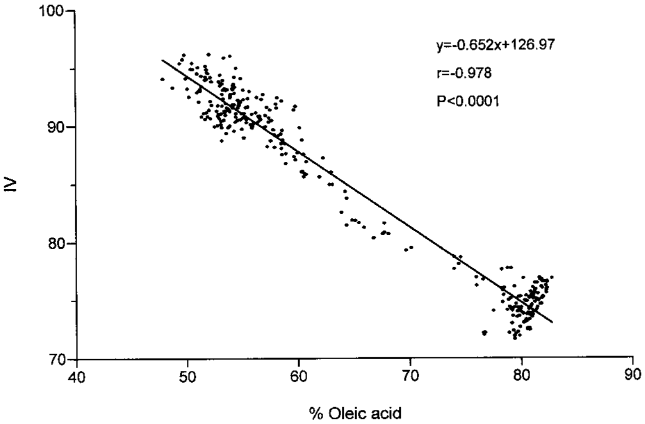

Figure 3. Relationship between iodine value (IV) and proportion of oleic acid in peanut genotypes.

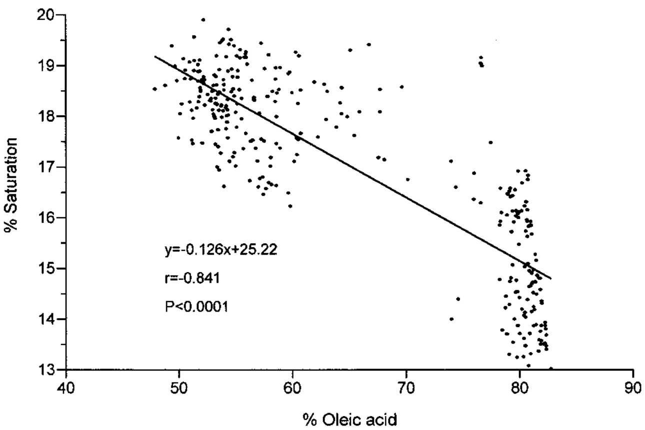

Figure 4. Ratio of percentage saturation acids in relation to proportion of oleic acid in peanut genotypes.

dependent variables with linoleic acid as the independent variable. Weak inverse relationships occurred between oleic acid and behenic acid and also between oleic and lignoceric acid (data not shown). Other correlations were noted for palmitic acid and eicosenoic acid ($r = 0.770$) and for stearic acid and arachidic acid ($r = 0.935$) (data not shown).

DISCUSSION

Year main effects were highly significant for 10 of 12 variables. This coupled with the strong year × planting date and year × genotype interactions underscores the importance of year to year variations in oil chemistry and how planting date and genotype can influence this yearly variation. Variations in year (*21*, *35*) and soil moisture conditions (*23*, *36*, *37*) are known to influence weight percentages of major and minor fatty acids, O/L, and iodine value. When genotype and planting date data were analyzed by each year separately, planting date exerted strong effects in 1999 and 2000, but not during 1998. The 1998 growing season was very dry from May thru August compared to 1999 or 2000 (data not shown), but this is of diminished relevance because plots were irrigated. Yearly temperature differences were relatively minor except during late spring (higher air and soil temperatures during June 1998) and after October, when in 1999 there was a decline in temperature (data not shown). Thus, the reasons for the lack of a planting date treatment response are not clear.

Genotypic effects far outweighed planting date effects. In contrast, Sanders (*27*) reported that seed maturity influenced fatty acid composition to a far greater extent than did peanut cultivar. However, a far greater range in oil chemistry is now represented in peanut germplasm (*3*, *11*, *28*−*30*). The four genotypes homozygous for the high oleic acid gene exhibited greatly improved oil chemistry (higher proportions of oleic acid and lower percentages of linoleic acid) compared to normal oil chemistry lines regardless of planting date. A low O/L ratio is associated with a high degree of oil instability (rancidity) (*2*, *9*−*11*). The iodine value, a measure of the degree of unsaturation and oil instability (*34*), was inversely related to oleic acid due mainly to the high coefficient ascribed to percent linoleic acid and the low linoleic acid content of high-oleic genotypes. The basis for differences between high-oleic and normal genotypes and variations in the O/L ratio is a differential activity of the enzyme Δ12 desaturase, which catalyzes the reaction of oleic acid to linoleic acid. Increasing soil temperature tends to increase oleic acid and iodine value (*26*, *36*, *38*) are also due to the influence of this enzyme. Mean air temperatures for August, September, and October were 28.1, 24.9, and 20.4 °C, respectively. Similarly, mean temperatures were 29.4, 27.9, and 22.9 °C, respectively. The increase in linoleic acid and iodine value with later planting date (and later harvest date) is consistent with this temperature effect. The O/L ratio (as well as iodine value) has been considered an index of oil stability (*11*, *39*, *40*), as linoleic acid is an unstable fatty acid (*9*−*11*).

The health benefits for diets low in saturated fats appear to be met by high-oleic genotypes. Saturated and polyunsaturated fatty acids are associated with high and low cholesterol, respectively (*41*). The recommendation from the American Heart Association and the American Health Foundation that the amount of saturated fats in the diet of humans should be reduced (*42*) is satisfied by the high-oleic genotypes as this trait was associated with a decrease in percentage saturation and an increase in the U/S. A diet of monounsaturated fatty acids has been as effective as polyunsaturated fatty acids in the reduction of low-density lipoprotein cholesterol in humans (*43*). Higher fat diets that are high in monounsaturated fatty acids and low in saturated fatty acids have reduced cholesterol and low-density lipoproteins to an extent similar to that of a lower fat, cholesterol-lowering diet (*12*−*14*). Kris-Etherton et al. (*14*) concluded that there is enough evidence to consider high monounsaturated fatty acid, cholesterol-lowering diets that include peanuts and other nut products as an acceptable, and perhaps preferable, approach to reduce the risk of cardiovascular disease in humans.

Linoleic acid was inversely related to oleic acid, and the relative proportions of each are controlled by Δ12 desaturase (*41*). The negative relationship between palmitic acid and oleic acid most likely represents an increased rate of palmitic acid elongation to stearic acid, with rapid desaturation to oleic acid via Δ9 desaturase (*41*). Eicosenoic acid was the only fatty acid proportional to oleic acid. Eicosenoic acid can be synthesized from oleic acid by the addition of an acyl group. This could also explain the positive relationship between stearic and arachidic acids.

Oleic and linoleic acids were inversely related and accounted for the greatest variability among genotypes, although many other relationships between fatty acids were noted. The above relationships noted for the 10 genotypes over three planting dates for three years were at least as good or in some cases better than that published for 600 high-oleic and normal genotypes planted during May 1996 (*28*). Year or planting date (environmental effects) did not negatively influence any of the relationships between variables of fatty acids noted for genotypes grown under roughly the same time and environmental conditions. We conclude that the biochemical relationships between variables of fatty acids noted were minimally affected by environmental conditions as compared to genetic effects.

When data were analyzed separately by year, the effect of planting date was significant for 6 variables in 1999 and 10 variables in 2000. Palmitic, oleic, linoleic, and eicosenoic acids and iodine value were affected in 1999, whereas all variables except lignoceric and O/L were influenced in 2000. The trend was for oleic acid to decrease and linoleic acid to increase with increasingly later planting date. This would be consistent with the known effects of low temperature, which increases the level of Δ12 desaturase and increases its product linoleic acid (*26*, *36*, *38*). This resulted in an increase in iodine value for 1999 and 2000. The general trend was also for stearic, palmitic, and arachidic acids to decrease and eicosenoic and behenic acids to increase with later planting date. Effects on U/S and percentage saturation were significant in 2000, but results were somewhat variable depending upon the particular cultivar.

In conclusion, it appears that oil quality can be improved relatively little in different years or by choosing planting date. This study underscores the importance of choosing the appropriate cultivar to optimize the quality of peanuts and peanut products. Similarly, other criteria in selecting a planting date (such as insect and disease avoidance, land labor availability, and market conditions) should supersede the slight alterations associated with the modest environment-dependent changes in oil chemistry.

ACKNOWLEDGMENT

The technical assistance of Xiuping Sun in gratefully acknowledged.

LITERATURE CITED

(1) Cobb, W. Y.; Johnson, B. R. Physiochemical properties of peanuts. In *Peanuts Culture and Uses*; American Peanut Research and Education Association: Stillwater, OK, 1973; pp 209−263.8.
(2) Ahmed, E. M.; Young, C. T. Composition, Quality, and Flavor of Peanuts. In *Peanut Science and Technology*; Pattee, H. E., Young, C. T., Eds.; American Peanut Research and Education Society: Yoakum, TX, 1982; pp 655−688.
(3) Norden, A. J.; Gorbet, D. W.; Knauft, D. A. Variability in oil quality among peanut genotypes in the Florida breeding program. *Peanut Sci*. **1987**, *14*, 7−11.
(4) Isleib, T. G.; Young, C. T.; Knauft, D. A. Fatty acid genotypes of five Virginia-type peanut cultivars. *Crop Sci*. **1996**, *36*, 556−558.
(5) Knauft, D. A.; Moore, K. M.; Gorbet, D. W. Further studies on the inheritance of fatty acid composition in peanut. *Peanut Sci*. **1993**, *20*, 74−76.
(6) Moore, K. M.; Knauft, D. A. The inheritance of high oleic acid in peanut. *J. Hered.* **1989**, *80*, 252−253.
(7) Bruner, A. C.; Jung, S.; Abbott, A. G.; Powell, G. L. The naturally occurring high oleate oil character in some peanut varieties results from reduced all-PC desaturase activity from mutation of aspartate 150 to asparagine. *Crop Sci.* **2001**, *41*, 522−526.
(8) Schwartzbeck, J. L.; Jung, S.; Abbott, A. G.; Mosley, E.; Lewis, S.; Pries, G. L.; Powell, G. L. Endoplasmic all-PC desaturase references the second double bond. *Phytochemistry* **2001**, *57*, 643−652.
(9) Braddock, J. C.; Sims, C. A.; O'Keefe, S. K. Flavor and oxidative stability of roasted high oleic acid peanuts. *J. Food Sci.* **1995**, *60* (*3*), 489−493.
(10) Holley, K. T.; Hammons, R. O. Strain and seasonal effects on peanut characteristics. *Univ. Ga. Coll. Agric. Exp. Stn. Res. Bull*. **1968**, *No. 32*.
(11) O'Keefe, S. F.; Wiley: V. A.; Knauft, D. A. Comparison of oxidation stability of high- and normal-oleic peanut oils. *J. Am. Soc. Oil Chem*. **1993**, *70*, 489−492.
(12) Grundy, S. M. Comparison of monounsaturated fatty acids and carbohydrates for lowering plasma cholesterol. *N. Engl. J. Med*. **1986**, *314*, 745−748.
(13) Grundy, S. M.; Florentin, L.; Nix, D.; Whelan, M. F. Comparison of monounsaturated fatty acids and carbohydrates for reducing raised levels of plasma cholesterol in man. *Am. J. Clin. Nutr*. **1988**, *47*, 965−969.
(14) Kris-Etherton, P. M.; Pearson, T. A.; Wan, Y.; Hargrove, R. L.; Moriarty, K.; Fishell, V.; Etherton, T. High-monunsaturated fatty acid diets lower both plasma cholesterol and triacylglycerol concentrations. *Am. J. Clin. Nutr.* **1999**, *70*, 1009−1015.
(15) O'Byrne, D. J.; Shireman, R. B.; Knauft, D. A. The effects of a low fat/high oleic acid diet on lipoprotein in postmenopausal hypercholesterolemic women. *Abstracts, Proceedings of the 84th American Oil Chemists' Society Annual Meeting*; AOCS: Champaign, IL, 1993.
(16) Hinds, M. J. Fatty acid composition of Caribbean-grown peanuts (*Arachis hypogaea* L.) at three maturity stages. *Food Chem*. **1995**, *55*, 7−14.
(17) Kim, N.-K.; Hung, Y.-C. Mechanical properties and chemical composition of peanuts as affected by harvest date and maturity. *J. Food Sci*. **1991**, *56*, 1378−1381.
(18) Mozingo, R. W.; Coffelt, T. A.; Wynne, J. C. Effect of seed size on fatty acid composition of peanut cultivars. *Proc. Am. Peanut Res. Educ. Soc. Inc*. **1985**, *17*, 57.
(19) Mozingo, R. W.; Coffelt, T. A.; Wynne, J. C. Market grade effects on fatty acid composition of five peanut cultivars. *Agron. J*. **1988**, *80*, 73−75.
(20) Sanders, H. T.; Landsen, J. A.; Greene, R. L.; Drexler, J. S.; Williams, E. J. Oil characteristics of peanut fruit separated by a non-destructive maturity classification method. *Peanut Sci*. **1982**, *9*, 20−23.
(21) Worthington, R. E.; Hammons, R. O.; Allison, J. R. Varietal differences and seasonal effects on fatty acid composition and stability of oil from 82 peanut genotypes. *J. Agric. Food Chem*. **1972**, *20*, 727−730.
(22) Young, C. T.; Mason, M. E.; Hammons, R. O.; Matlock, R. S.; Waller, G. R. Effect of maturity on fatty acid composition of eight varieties of peanuts grown in Perkins, OK in 1968. *J. Am. Oil Chem. Soc*. **1972**, *49*, 314−317.
(23) Hashim, I. B.; Koehler, P. E.; Eitenmiller, R. R.; Kvien, C. K. Fatty acid composition and tocopherol content of drought stressed Florunner peanuts. *Peanut Sci*. **1993**, *20*, 21−24.
(24) Lynd, J. Q.; Ansman, T. R. Effects of P, Ca with 4 K levels on nodule histology, nitrogenase activity and improved Spanco peanut yields. *J. Plant Nutr*. **1989**, *12*, 65−84.
(25) Knauft, D. A.; Norden, A. J.; Gorbet, D. W. The effects of three digging dates on oil quality, yield, and grade of five peanut genotypes grown without leafspot control. *Peanut Sci*. **1986**, *13*, 82−86.
(26) Bovi, M. L. A. Genotypic and environmental effects on fatty acid composition, iodine value and oil content of peanut (*Arachis hypogaea* L.). Ph.D. Dissertation, University of Florida, 1982; p 119.
(27) Sanders, T. H. Effects of variety and maturity on lipid class composition of peanut oil. *J. Am. Oil Chem. Soc*. **1980**, *57*, 8−11.
(28) Andersen, P. C.; Hill, K.; Gorbet, D. W.; Brodbeck, B. V. Fatty acid and amino acid profiles of selected peanut cultivars and breeding lines. *J. Food Compos. Anal.* **1998**, *11*, 100−111.
(29) Gorbet, D. W.; Knauft, D. A. SunOleic 97 peanut. *Fla. Agric. Exp. Stn. Circ.* **1997**, *No. S-400*.
(30) Knauft, D. A.; Gorbet, D. W.; Norden, A. J. SunOleic 95 peanut. *Fla. Agric. Exp. Stn. Circ.* **1995**, *No. S-398*.

(31) Stalker, H. T.; Young, C. T.; Jones, T. M. A survey of the fatty acids of peanut species. *Oleagineux* **1989**, *44*, 419−423.
(32) Folch, J.; Lees, M.; Stanley, G. H. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem*. **1957**, *226*, 497−450.
(33) Christie, W. W. *Lipid Analysis*, 2nd ed.; Pergammon Press: New York, 1982.
(34) Cocks, L. V.; Van Reds, V. *Laboratory Handbook for Oil and Fat Analysts*; Academic Press: New York, 1966.
(35) Holaday, C. E.; Pearson, J. L. Effects of genotype and production area on the fatty acid composition, total oil and total protein in peanut. *J. Food Sci*. **1974**, *39*, 1206−1209.
(36) Chiou, R. Y.-Y.; Liu, C. P.; Hou, C. J.; Liu, C. D. Comparison of fatty acid composition and oxidative stability of peanut oils prepared from spring and fall crops of peanuts. *J. Agric. Food Chem*. **1995**, *43*, 676−679.
(37) Young, C. T.; Worthington, R. E.; Hammons, R. O.; Matlock, R. S.; Waller, G. R.; Morrison, R. D. Fatty acid composition of Spanish peanut oils as influenced by planting location, soil moisture conditions, variety and season. *J. Am. Oil Chem. Soc*. **1974**, *51*, 12−315.
(38) Golombek, S. D.; Sridhar, R.; Singh, U. Effect of soil temperature on the seed composition of three Spanish cultivars of groundnut (*Arachis hypogaea* L.). *J. Agric. Food Chem*. **1995**, *43*, 2067−2070.
(39) Brown, D. F.; Carter, C. M.; Mattil, K. F.; Darroch, J. G. Effect of variety, growing location, and their interaction on the fatty acid composition of peanuts. *J. Food Sci*. **1975**, *40*, 1055−1060.
(40) Fore, S. P.; Morris, N. J.; Mack, C. H.; Freeman, A. F.; Bickford, W. G. Factors affecting the stability of crude oils from 16 varieties of peanuts. *J. Am. Oil Chem. Soc*. **1953**, *30*, 298−301.
(41) Groff, J. L.; Gropper, S. S.; Hunt, S. M. Lipids. In *Advanced Nutrition and Human Metabolism*; West Publishing: Minneapolis/St. Paul, MN, 1996; pp 113−146.
(42) Technical Committee. *Food Fats and Oils*, 5th ed.; Institute of Shortening and Edible Oils: Washington, DC, 1982; p 22.
(43) Mensink, R. P.; Katan, M. B. Effect of a diet enriched with monounsaturated or polyunsaturated fatty acids on levels of low-density and high-density lipoprotein cholesterol in healthy women and men *N. Engl. J. Med*. **1989**, *321*, 436−441.

Received for review October 3, 2001. Revised manuscript received November 28, 2001. Accepted December 3, 2001. This is University of Florida Agricultural Experiment Station Journal Series No. R-08383. This work was, in part, supported by funds from the Peanut Check off program and funds provided by the Florida Department of Agriculture and Consumer Services.

JF0113171