Effect of Maturity on the Fatty Acid Composition of Eight Varieties of Peanuts Grown at Perkins, Oklahoma in 1968[1,2]

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ABSTRACT

Eight varieties of peanuts were grown under measured field conditions. Seed obtained at five successive harvest dates and separated into three maturity levels were analyzed for fatty acid composition of oil. Mature peanuts were mostly higher in stearic (18:0) and oleic (18:1) acids, and lower in linoleic (18:2), arachidic (20:0) and behenic (22:0) acids. Oleic-linoleic ratios, which are correlated with oil stability, were higher in mature peanuts.

INTRODUCTION

In recent years there has been a determined search for the "quality factor" in peanuts. Stokes and Hull (1) found that Spanish peanuts had a higher oil content than Runner varieties. Later, John et al. (2) indicated that low and deficient rainfall at the time of maturity reduced the oil content of the kernels. Schenk (3) reported that the oil content of developing kernels of Dixie Spanish and Virginia Bunch 67 peanut fruits increased with maturity. Other workers (4,5) have shown that oil unsaturation, as measured by iodine value, reached a maximum value early in the development of the peanut fruit. Holley and Hammons (6) related the stability of oil to linoleic acid content and reported that linoleic acid accounted for ca. 85% of the variation in stability as measured under their conditions.

Worthington (7), using gas liquid chromatography (GLC) techniques, measured developmental changes in the fatty acid composition of lipid obtained from the testa, embryonic axis, and cotyledon of field grown Virginia Bunch 67 peanuts, and reported a decrease in linoleic and an increase in oleic acid content of all tissues as the fruit approached maturity. Mason and Matlock (8) and Tripp (9) have reported considerable variation in fatty acid composition of certain varieties of peanuts grown at two locations in Oklahoma. No explanation for the variation in the concentration of fatty acids was proposed.

The primary purpose of this study was to examine the influence of variety and maturity on the fatty acid composition of oil of peanuts grown under essentially normal and known field conditions.

EXPERIMENTAL PROCEDURES

This study included eight peanut varieties or highly homozygous breeding lines grown in 1968 on the Agronomy Research Station near Perkins, Okla. Because of the limitation of drying equipment, the varieties were divided into two groups (Table I). After harvest the peanut samples were dried in a forced air oven at 90 F for approximately 140 hr. Temperature and relative humidity were measured continuously with a Bristol Humidigraph and Temperature Recorder. Samples were stored at 4 C until all of the peanuts were harvested. They were then classified into maturity levels and stored at -20 C to minimize chemical changes.

Since reproducible chemical assays of peanuts required a rigidly controlled selection and classification of kernels (10-14), and size alone was not a sufficient criterion for the selection of sound mature kernels (SMK), a specific classification procedure was adopted. A description of classification of peanuts into maturity classes used in this study is summarized below.

I. Mature peanuts
   - A. Dark colored interior pericarp surface or some white on interior pericarp
   - B. Very thin faded pink colored testa (skin) or thin pink colored testa

II. Low Intermediate peanuts
   - A. Considerable white on interior pericarp
   - B. Testa not completely collapsed
   - C. Slight wrinkling of skin

III. Immature peanuts
   - A. White pericarp
   - B. Thick fleshy white-pink testa
   - C. Undersized, shriveled kernels

This method was designed to establish three discrete levels of maturity. An earlier study (15) had shown the mature and high intermediate peanuts to be similar in maturity. Therefore these two groups were combined to provide fewer samples for analysis and are referred to as mature peanut in this paper.

Oil samples were prepared by chopping the peanuts in a Serval Omni-mixer, transferring the chopped sample to Whatman No. 1 filter paper, extracting with diethyl ether, evaporating the filtrate to dryness at room temperature

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TABLE I

Harvesting Schedule for Eight Varieties Grown at Perkins, Oklahoma, 1968

Harvest	Days[a]	
	Group I[b]	Group II[b]
1st	113	120
2nd	127	134
3rd	141	148
4th	155	162
5th	169	176

[a]Total growing days from seeding to harvesting.

[b]Varieties: Argentine, Spanhoma, Dixie Spanish, Valencia (Okla. P. No. 161); harvested: Sept. 10, 24, Oct. 8, 22, Nov. 5.

[c]Varieties: Early Runner, NC 5, Ga. 61-42, Va. Bunch 67; harvested: Sept. 17, Oct. 1, 15, 29, Nov. 12.

TABLE II

Fatty Acid Composition of Argentine Peanuts Grown at Perkins, 1968

Fatty acid	Maturity	Harvest date and no. of days				
		9/10/68 113	9/24/68 127	10/8/68 141	10/22/68 155	11/5/68 169
		Per cent of total				
16:0	Mature	13.06	13.16	13.07	12.56	11.87
	Low int.[a]	12.92	12.29	13.14	12.08	11.81
	Immature	13.65	13.29	13.66	13.00	12.60
18:0	Mature	2.74	2.47	2.63	2.86	2.76
	Low int.	2.48	2.24	2.51	2.88	2.31
	Immature	2.03	2.10	2.40	2.55	1.75
18:1	Mature	40.48	41.19	41.44	41.40	40.67
	Low int.	38.28	38.44	39.78	41.08	40.30
	Immature	36.03	35.97	37.54	37.14	35.47
18:2	Mature	39.56	38.49	38.31	38.51	39.23
	Low int.	39.87	41.08	39.65	39.13	40.72
	Immature	40.57	41.32	40.14	40.86	42.74
20:0	Mature	.98	1.15	1.02	1.12	.94
	Low int.	1.24	1.05	.95	1.05	1.08
	Immature	1.13	1.04	1.10	1.10	.88
18:3 + 20:1	Mature	.72	1.07	.82	.77	.90
	Low int.	1.09	1.15	.76	.83	1.02
	Immature	1.46	1.44	1.24	1.51	1.87
22:0	Mature	1.84	2.14	2.10	2.27	2.45
	Low int.	3.30	2.70	2.61	2.14	2.18
	Immature	4.16	3.44	3.18	2.84	3.43
24:0	Mature	.51	.27	.62	.61	.78
	Low int.	.82	.82	.60	.68	.53
	Immature	.87	1.16	.86	.92	1.25
Oleic + linoleic	Mature	80.04	79.68	79.75	79.91	79.90
	Low int.	78.15	79.52	79.43	80.21	81.02
	Immature	76.60	77.29	77.68	78.00	78.21
Oleic-linoleic ratio	Mature	1.02	1.07	1.08	1.08	1.04
	Low int.	.96	.94	1.00	1.05	.99
	Immature	.89	.87	.94	.91	.83

[a]Low intermediate.

TABLE III

Fatty Acid Composition of Spanhoma Peanuts Grown at Perkins, 1968

Fatty acid	Maturity	Harvest date and No. of days				
		9/10/68 113	9/24/68 127	10/8/68 141	10/22/68 155	11/5/68 169
		Per cent of total				
16:0	Mature	12.88	12.81	12.15	12.06	12.37
	Low int.	12.70	11.68	11.64	11.40	11.33
	Immature	12.78	13.59	13.38	12.88	12.04
18:0	Mature	2.79	2.90	2.58	2.36	2.34
	Low int.	2.96	2.86	2.92	2.89	3.28
	Immature	2.66	2.44	2.06	2.21	2.53
18:1	Mature	41.85	42.23	41.46	41.02	41.03
	Low Int.	38.09	38.58	38.49	39.02	39.86
	Immature	36.56	35.14	35.20	35.30	37.09
18:2	Mature	38.08	37.10	38.94	39.66	39.84
	Low int.	37.52	38.79	38.96	39.20	38.14
	Immature	37.81	38.52	38.93	39.76	39.87
20:0	Mature	1.15	1.18	1.07	1.18	1.09
	Low int.	1.57	1.50	1.51	1.46	1.61
	Immature	1.60	1.48	1.30	1.36	1.39
18:3 + 20:1	Mature	.71	.73	.89	1.09	.95
	Low int.	1.24	1.31	1.33	1.25	1.23
	Immature	1.66	1.68	2.18	2.19	1.69
22:0	Mature	1.82	2.28	2.02	2.23	2.27
	Low int.	4.23	3.80	3.67	3.22	3.23
	Immature	5.32	5.24	4.97	4.59	3.95
24:0	Mature	.51	.60	.62	.55	+
	Low int.	1.67	1.47	1.47	1.56	1.31
	Immature	1.71	1.90	1.99	1.72	1.43
Oleic + linoleic	Mature	79.93	79.33	80.40	80.68	80.87
	Low int.	75.61	77.37	77.45	78.22	78.00
	Immature	74.27	73.66	74.13	75.06	76.96
Oleic-linoleic ratio	Mature	1.10	1.14	1.06	1.03	1.03
	Low int.	1.02	.99	.99	1.00	1.05
	Immature	.96	.91	.90	.89	.93

TABLE IV

Oleic and Linoleic Acid Composition of Six Varieties Grown at Perkins, 1968

		Harvest number[a]				
		1	2	3	4	5
Fatty acid	Maturity	Per cent of total				
Dixie Spanish						
18:1	Mature	40.95	41.53	41.39	41.42	40.83
	Low int.[b]	37.15	36.83	38.41	43.10	39.87
	Immature	34.50	33.47	35.17	35.04	36.32
18:2	Mature	39.72	38.44	37.76	38.12	39.45
	Low int.	38.32	38.65	39.36	34.55	38.01
	Immature	38.01	39.74	39.55	39.20	39.45
Valencia (Okla. P. No. 161)						
18:1	Mature	39.96	39.02	38.62	38.11	38.87
	Low int.	35.82	39.06	36.15	---	---
	Immature	34.41	34.61	33.28	---	---
18:2	Mature	41.22	42.36	42.89	43.73	42.70
	Low int.	41.36	37.04	42.01	---	---
	Immature	40.36	40.38	41.99	---	---
Early Runner						
18:1	Mature	45.11	42.63	46.08	44.16	46.20
	Low int.	43.75	43.78	41.94	44.15	41.81
	Immature	40.66	41.47	38.95	39.72	39.21
18:2	Mature	37.62	36.42	37.34	36.79	37.76
	Low int.	36.06	36.30	38.04	37.16	39.65
	Immature	36.99	36.82	40.19	39.22	40.08
NC5						
18:1	Mature	48.57	49.98	47.18	47.79	49.80
	Low int.	45.59	45.54	44.84	48.38	47.63
	Immature	44.08	43.04	42.49	45.23	45.96
18:2	Mature	34.07	30.78	36.01	33.72	33.59
	Low int.	34.40	33.70	36.04	32.99	33.44
	Immature	34.18	35.52	36.80	34.14	34.10
Ga. 61-42						
18:1	Mature	43.07	39.14	43.23	42.82	43.13
	Low int.	35.71	41.00	40.43	41.31	41.45
	Immature	39.54	38.72	38.07	37.22	38.57
18:2	Mature	38.64	36.47	37.57	36.52	37.79
	Low int.	40.10	36.26	37.41	37.29	36.45
	Immature	34.90	35.09	35.90	37.51	37.27
Va. Bunch 67						
18:1	Mature	47.15	49.62	49.94	50.57	47.28
	Low int.	45.52	44.64	46.81	46.11	46.44
	Immature	42.17	43.79	45.03	---	42.97
18:2	Mature	36.38	31.37	33.47	30.81	36.20
	Low int.	34.39	34.38	33.43	34.65	35.66
	Immature	34.48	36.19	35.09	---	36.75

[a]See Table I for harvest date and number of days from seeding to harvesting.
[b]Low intermediate.

under an explosive-proof hood (a safety precaution), and storing at 4 C in small rubber capped vials until analyzed.

Fatty acid esters were prepared by the method of Jellum and Worthington (16). The esters were analyzed on a MicroTek 220 gas chromatograph equipped with an Infotronics electronic integrator using GLC conditions described by Worthington and Holley (17). A 1.8 m x 4.0 mm ID glass U-shaped column packed with 10% diethylene glycolsuccinate (DEGS) 70/80 mesh Chromosorb W(AW) (DMCS) was used (18). Fatty acid levels were calculated by normalization of peak areas and the values of each reported as relative proportions of the total fatty acids present.

RESULTS AND DISCUSSION

A list of the varieties, harvest dates, and total number of days from seeding to harvesting for the two groups is given in Table I. Three of these varieties (Early Runner, NC5 and Va. Bunch 67) probably did not reach full maturity under Oklahoma growing conditions. Group I varieties are normally harvested in Oklahoma ca. 140 days after planting.

Data for the fatty acid composition of two varieties are presented in Tables III and IV. Oleic acid, which increases with maturity, and linoleic acid, which decreases with maturity, comprise ca. 80% of the total fatty acids present in peanut oil as noted by the O + L figures near the bottom of Tables II and III. The oleic-linoleic (O/L) ratio, an excellent indicator of oil stability (6), is also shown and is associated with maturity.

The per cent oleic acid in the mature group of Argentine peanut oil was fairly constant (40.48-41.44%) throughout the growing season with the maximum amount being measured at 141 and 155 days from planting. The decrease to 40.67% at 169 days was noteworthy and may be related to some unpublished preliminary studies on "over-mature" peanuts which indicated that the germination cycle was essentially a reversal of maturity. Argentine, being a nondormant variety, may be subject to this phenomenon. Present research is directed toward determining the point on the maturity cycle at which optimum quality and flavor is obtained, since a possible relationship may exist.

The oleic acid of the low intermediate group of peanuts (most of which would be found in peanut products because

they cannot be separated from mature kernels by conventional methods) was shown to increase (2.80%) with time of harvest reaching a maximum of 41.08% at 155 days. The linoleic acid content of the low intermediate group decreased to a low of 39.13% at 155 days. Since the stability of oil was highly negatively correlated (-0.924) with linoleic acid (6), the most stable oil would be from peanuts harvested at 155 days for this variety in this study.

Table IV shows the fatty acid composition of the new variety Spanhoma. The complete analysis of this variety is shown since it is expected to be of increasing importance in the Southwest. Spanhoma had slightly higher O/L ratios than Argentine, but also had slightly more arachidic (20:0) and behenic (22:0) particularly in the low intermediate and immature groups. Higher oleic acid values occurred earlier in the season with the Spanhoma when compared with mature seed of the Argentine variety. The low intermediate group had the most oleic acid late in the season. Using the O/L ratio and fatty acid data, it would appear that two "crops" of peanuts were obtained in this variety in 1968 and the second crop never fully matured. In future studies a more careful record of fruiting time is needed.

Data for oleic and linoleic acids are shown on the other six varieties used in this study (Table IV). Complete data as presented in Tables III and IV are available upon request and show similar results as those reported above for the Argentine and Spanhoma varieties.

Large differences between varieties are found when the oleic acid content of mature and low intermediate kernels from the third harvest date of each variety are compared. The mature Valencia seed contained 38.6% oleic, whereas the Virginia Bunch 67 contained nearly 50% oleic acid. Thus large genetic variations exist in the material examined in this study. Many companies blend runner peanuts (such as Early Runner which is grown in the southeast because of the longer growing season) with Spanish types to increase stability (shelf-life) of their product. Such blending information, although not released, can be calculated using data presented by Roberson et al. (19).

A comparison of Dixie Spanish and Argentine showed that their fatty acid composition was similar. Dixie Spanish was introduced from India and Argentine from Argentina.

In general the study has shown that mature peanuts usually contain relatively more stearic (18:0) and oleic (18:1) acid and less linoleic (18:2) and other fatty acids. Behenic (22:0) and arachidic (20:0) which were recently implicated in heart disease (20) are lower in the mature nuts.

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