JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Compositional and Sensory Comparisons between Normal- and High-Oleic Peanuts

THOMAS G. ISLEIB,[†] HAROLD E. PATTEE,*[,‡] TIMOTHY H. SANDERS,[§] KEITH W. HENDRIX,[§] AND LISA O. DEAN[§]

Department of Crop Science, Box 7629, North Carolina State University, Raleigh, North Carolina 27695-7629; Department of Biological and Agricultural Engineering, Box 7625, North Carolin State University, Raleigh, North Carolina 27695-7625; and Market Quality and Handling Research Unit, Agricultural Research Service, U.S. Department of Agriculture, Box 7624, North Carolina State University, Raleigh, North Carolina 27695-7624

The high-oleic-acid trait improves the oxidative stability of peanuts (*Arachis hypogaea* L.) and their products. The explicit effect of the trait on sensory quality, particularly on off-flavors associated with oil rancidity, has not been well documented. To assess the effect of the trait on off-flavors, data from two independent databases were analyzed to compare sensory quality and composition in normal- versus high-oleic peanut genotypes. In data collected using a sensory panel in the Department of Food Science at North Carolina State University, there were small differences between near-isogenic lines for intensities of the roasted peanut, astringent, over-roast, and nutty attributes, with the high-oleic lines exhibiting slightly greater intensities of those attributes. There were no differences for off-flavors such as fruity, painty, stale, moldy, or petroleum. In data collected from the multistate Uniform Peanut Performance Test and evaluated by a panel in the USDA-ARS Market Quality and Handling Research Unit (MQHRU) at Raleigh, NC, there were differences in chemical composition associated with the high-oleic trait, including differences in oil content, tocopherols, and carbohydrates in addition to the expected differences in fatty acid contents. There were small decreases in the intensities of the sensory attributes cardboard and painty associated with the high-oleic trait in the MQHRU data when all high-oleic lines were compared with all normal-oleic lines. Comparison of the near-isogenic pair NC 7 and N00090ol showed differences in oil and glucose contents, but not in sensory attributes. The high-oleic trait does not appear to have a major impact on sensory quality on average, although there were individual instances in which the trait was associated with shifts in sensory attribute intensities that may be perceptible to consumers.

KEYWORDS: ***Arachis hypogaea*** **L.; flavor; fatty acids; chemical composition**

INTRODUCTION

The beneficial effect on the oxidative stability of peanut (*Arachis hypogaea* L.) products resulting from elevated levels of oleic fatty acid in the seed oil has been well documented (*1*−*5*). As peanut cultivars with elevated oleic acid levels have become available to processors, questions have arisen regarding their composition and sensory quality, particularly off-flavors such as the fruity/fermented sensory attribute. There have been comparisons of normal- and high-oleic lines with regard to some sensory attributes. Pattee and Knauft (*6*) found some significant differences among four high-oleic lines, Florunner, and NC 7 for only the roasted peanut sensory attribute. In that study, all of the high-oleic lines were derived by backcrossing the Florida high-oleic gene (*7*−*9*). In a study on the effect of the high-oleic trait on intensities of the roasted peanut, sweet, bitter, and astringent sensory attributes (*10*) near-isogenic pairs of normal- and high-oleic lines were grown at specific locations. In most cases, the high-oleic member of the pair was developed by backcrossing the Florida high-oleic gene into an existing cultivar. The high-oleic trait had a positive effect on the intensity of the roasted peanut attribute, increasing it by 0.3 flavor intensity unit (fiu) averaged across seven background genotypes. Although the magnitude of improvement varied across background genotypes, the trait was never associated with a reduction in roasted peanut intensity. The increase was greatest in Tamrun 96 and Spanish genotypes Tamspan 90 and F435. Interaction between oleate level and background genotype was detected for sweet and bitter attributes. The trait had an increasing effect on the bitter attribute only in the background genotype of Tamspan 90. There was a nonsignificant increase in bitterness in the other Spanish background genotype, F435. Changes in

* Author to whom correspondence should be addressed [telephone (919) 515-6745; fax (919) 515-7760; e-mail harold_pattee@ncsu.edu].
[†] Department of Crop Science.
[‡] Department of Biological and Agricultural Engineering.
[§] Market Quality and Handling Research Unit.

10.1021/jf052353t CCC: $33.50
Published on Web 02/03/2006

bitterness in runner and Virginia-type backgrounds were close to zero or negative.

In response to the questions posed by industry, the objective of this study was to determine whether the high-oleic trait was associated with increases in off-flavors in data collected as part of ongoing flavor quality studies.

MATERIALS AND METHODS

There exist two flavor databases that can be used to address the issue of off-flavors in high-oleic peanuts: (a) the database accumulated by Dr. H. E. Pattee using the trained descriptive sensory panel in the Department of Food Science at North Carolina State University (the NCSU database) and (b) the database accumulated by Dr. T. H. Sanders using samples from the Uniform Peanut Performance Test (UPPT) and the trained descriptive sensory panel in the USDA-ARS Market Quality and Handling Research Unit (MQHRU) at Raleigh, NC (the MQHRU database). Descriptive sensory terms and intensity scales used by the two panels are similar, but slight differences do exist.

The methodology used by Pattee and co-workers has been published (*10*−*12*). In their study, a series of lines derived by backcrossing the high-oleic trait into several existing cultivars or by mutating cultivars to the trait were compared with their parent cultivars at locations in Florida, Georgia, North Carolina, and Texas. Breeders grew their high-oleic lines and parents in three-replicate tests at one or two locations. Florida high-oleic line F435-2-3-B-2-1-b4-B-B-3-b3-b3-1-B was grown at each location. Statistical analysis of the data was as previously reported (*10*).

The methodology of the USDA-ARS-MQHRU has been published in the 2003 annual report (*13*). The data from the 2003 UPPT include fatty acid profiles and concentrations of oil, tocopherol, and carbohydrates as well as paste color and sensory attribute intensities measured on bulk samples from the replicate plots grown at each of nine test locations (Suffolk, VA, and Lewiston, NC, in the Virginia−Carolina production area; Tifton, GA, Marianna, FL, and Headland, AL, in the southeastern production area; and Denver City, TX, Stephenville, TX, and Fort Cobb, OK, in the southwestern production area). Data were analyzed using the general linear models procedure (PROC GLM) of SAS statistical software (SAS Institute, Cary, NC). The analysis of variance of the 2003 UPPT data partitioned the total variation into parts due to the 9 locations, 14 genetic entries including 10 of the runner and 4 of the Virginia market type, and residual error. In this analysis, residual error included both location-by-genotype interaction and a fraction of the pooled experimental error. Among the 14 genetic entries, there were 5 high-oleic (4 runner- and 1 Virginia-type) and 9 normal-oleic lines. Two types of comparisons were made using UPPT data: (a) a comparison between the mean of all high-oleic lines and the mean of all normal-oleic lines and (b) a comparison between NCSU breeding lines N00090ol and NC 7, a near-isogenic pair. Adjusted means were obtained using the least-squares mean statement of PROC GLM. Residual error was used in all tests of significance.

RESULTS AND DISCUSSION

Data from the NCSU Database. In addition to the previously published differences observed between high-oleic and normal lines averaged across background genotypes for intensity of roasted peanut and astringent sensory attributes (**Table 1**), there were also significant differences in the intensities of over-roast (1.83 vs 1.57 fiu, $P < 0.05$) and nutty (2.69 vs 2.53 fiu, $P < 0.05$). It has been determined that 0.5 fiu is the minimum difference that sensory panelists can detect in a direct comparison for the roasted peanut attribute (*12*). Although the differences observed in this experiment were statistically significant, they were small in magnitude. It is unlikely that the aggregate of these small differences would be perceptible to the average consumer.

There were no differences between high- and normal-oleic lines averaged across background genotypes for the more

Table 1. Paste Color and Sensory Attribute Means ± SE for High- and Normal-Oleic Near-Isogenic Pairs Grown by Pattee et al. (*J. Agric. Food Chem.* **2002**, *50*, 7362–7365)[a]

oleic acid level or line identity	paste color, CIELAB L^*	flavor intensity units (1–14): roasted peanut	over-roast	under-roast	sweet	woody	fruity	painty	stale	moldy	petroleum	bitter	tongue burn index	astringent	nutty	bitter aftertaste
high	57.92 ± 0.29	3.47 ± 0.08**	1.83 ± 0.09*	2.02 ± 0.07	2.44 ± 0.07	2.85 ± 0.06	1.24 ± 0.04	1.10 ± 0.03†	1.62 ± 0.06	1.09 ± 0.03	1.00 ± 0.00	2.53 ± 0.07	2.22 ± 0.04	2.68 ± 0.06*	2.69 ± 0.06*	2.33 ± 0.05
normal	57.64 ± 0.30	3.17 ± 0.08	1.57 ± 0.10	2.18 ± 0.07	2.39 ± 0.07	2.83 ± 0.06	1.28 ± 0.04	1.17 ± 0.03	1.71 ± 0.07	1.13 ± 0.03	1.00 ± 0.01	2.49 ± 0.07	2.19 ± 0.04	2.53 ± 0.06	2.53 ± 0.06	2.37 ± 0.05
SunOleic 97R	58.02 ± 1.25a	2.63 ± 0.34def	1.88 ± 0.40abc	1.88 ± 0.31a–d	2.26 ± 0.31cde	2.92 ± 0.24b–e	1.15 ± 0.17ab	1.44 ± 0.13a	2.01 ± 0.28ab	1.26 ± 0.12ab	1.01 ± 0.02a	2.55 ± 0.31bcd	1.92 ± 0.18ef	2.72 ± 0.24abc	2.27 ± 0.26-fg	2.30 ± 0.23c–g
Sunrunner	57.28 ± 1.25a	2.48 ± 0.34def	2.10 ± 0.40ab	2.02 ± 0.31a–d	2.04 ± 0.31d–g	3.03 ± 0.24bcd	1.19 ± 0.17ab	1.48 ± 0.13a	2.23 ± 0.28a	1.26 ± 0.12ab	1.01 ± 0.02a	2.55 ± 0.31bcd	1.95 ± 0.18cef	2.72 ± 0.24abc	2.05 ± 0.26efg	2.45 ± 0.23b–f
GK-7 OL	58.65 ± 1.15a	4.16 ± 0.31ab	1.43 ± 0.37bc	1.94 ± 0.28a–d	2.81 ± 0.28bcd	2.79 ± 0.22cde	1.08 ± 0.15ab	0.22 ± 0.12d	0.55 ± 0.25d	0.51 ± 0.11d	0.94 ± 0.02b	1.53 ± 0.29e	1.86 ± 0.17f	2.54 ± 0.22abc	3.25 ± 0.24ab	1.56 ± 0.21h
GK-7	57.88 ± 1.10a	4.13 ± 0.29ab	1.51 ± 0.35bc	1.87 ± 0.27bcd	3.00 ± 0.27bc	2.79 ± 0.21cde	1.45 ± 0.15a	0.48 ± 0.11c	1.07 ± 0.24cd	0.73 ± 0.11cd	0.94 ± 0.02b	1.71 ± 0.27de	1.97 ± 0.16def	2.43 ± 0.21abc	3.21 ± 0.23abc	1.86 ± 0.20fgh
N00090ol	58.09 ± 0.78a	3.14 ± 0.21de	1.65 ± 0.25bc	2.33 ± 0.19abc	2.20 ± 0.19def	2.66 ± 0.15cde	1.34 ± 0.10a	1.20 ± 0.08ab	1.63 ± 0.17abc	1.15 ± 0.08ab	1.01 ± 0.01a	2.75 ± 0.19bc	2.43 ± 0.11ab	2.88 ± 0.15a	2.58 ± 0.16de	2.49 ± 0.14ce
NC 7	58.34 ± 0.78a	3.18 ± 0.21de	1.40 ± 0.25bc	2.61 ± 0.19a	1.98 ± 0.19efg	2.74 ± 0.15cde	1.19 ± 0.10ab	1.20 ± 0.08ab	1.55 ± 0.17abc	1.21 ± 0.08ab	1.01 ± 0.01a	2.68 ± 0.19bc	2.25 ± 0.11b–f	2.62 ± 0.15abc	2.45 ± 0.16def	2.42 ± 0.14cef
N00092ol	56.78 ± 0.78a	3.29 ± 0.21cd	1.67 ± 0.25bc	2.11 ± 0.19bcd	2.22 ± 0.19def	2.85 ± 0.15cde	1.34 ± 0.10a	1.18 ± 0.08ab	1.67 ± 0.17abc	1.21 ± 0.08ab	1.01 ± 0.01a	2.66 ± 0.19bc	2.41 ± 0.11ab	2.78 ± 0.15a	2.60 ± 0.16cde	2.51 ± 0.14ace
NC 9	57.18 ± 0.78a	2.98 ± 0.21def	1.60 ± 0.25bc	2.63 ± 0.19a	1.83 ± 0.19efg	2.81 ± 0.15cde	1.34 ± 0.10a	1.22 ± 0.08ab	1.83 ± 0.17ab	1.21 ± 0.08ab	1.01 ± 0.01a	2.92 ± 0.19abc	2.40 ± 0.11abc	2.73 ± 0.15ab	2.51 ± 0.16def	2.66 ± 0.14a–e
Tamrun OL 01	56.90 ± 0.91a	4.47 ± 0.24a	1.48 ± 0.29bc	1.54 ± 0.22d	3.78 ± 0.22a	2.40 ± 0.17ef	1.48 ± 0.12a	1.05 ± 0.09b	1.50 ± 0.20bc	1.12 ± 0.09ab	1.01 ± 0.02a	1.90 ± 0.23de	2.07 ± 0.13b–f	2.30 ± 0.17bc	3.34 ± 0.19a	1.86 ± 0.16gh
Tamrun 96	58.63 ± 0.99a	4.07 ± 0.27ab	1.00 ± 0.32c	1.97 ± 0.24a–d	3.58 ± 0.24ab	2.12 ± 0.19f	1.46 ± 0.13a	1.03 ± 0.10b	1.40 ± 0.22bc	1.01 ± 0.10bc	1.01 ± 0.02a	1.96 ± 0.25de	2.10 ± 0.14b–f	2.17 ± 0.19c	3.19 ± 0.21abc	1.91 ± 0.18fgh
Olin	58.63 ± 0.73a	3.87 ± 0.20bc	2.73 ± 0.23a	1.95 ± 0.18cd	2.18 ± 0.18def	3.08 ± 0.14bc	1.23 ± 0.10ab	1.20 ± 0.08ab	1.84 ± 0.16ab	1.11 ± 0.07ab	1.01 ± 0.01a	3.05 ± 0.18ab	2.32 ± 0.10a–e	2.74 ± 0.14a	2.74 ± 0.15bcd	2.72 ± 0.13abc
Tamspan 90	57.03 ± 0.62a	3.13 ± 0.17de	1.70 ± 0.20bc	2.05 ± 0.15cd	2.73 ± 0.15cd	2.65 ± 0.12de	1.41 ± 0.08a	1.43 ± 0.06a	2.00 ± 0.14ab	1.21 ± 0.06ab	1.02 ± 0.01a	2.48 ± 0.16cd	2.25 ± 0.09b–f	2.52 ± 0.12abc	2.33±0.13ef	2.26±0.11efg
F435 OL	58.38 ±0.36a	2.72 ± 0.10ef	1.96 ± 0.12b	2.42 ± 0.09ab	1.61 ± 0.09g	3.28 ± 0.07ab	1.08 ± 0.05b	1.42 ± 0.04a	2.13 ± 0.08a	1.25 ± 0.04ab	1.01 ± 0.01a	3.27 ± 0.09a	2.51 ± 0.05a	2.77 ± 0.07a	2.05±0.08g	2.89±0.07ab
F435	57.17 ± 1.04a	2.24 ± 0.28f	1.71 ± 0.34bc	2.12 ± 0.26a–d	1.57 ± 0.26fg	3.63 ± 0.20a	0.96 ± 0.14b	1.38 ± 0.11a	1.88 ± 0.23ab	1.30 ± 0.10a	1.01 ± 0.02a	3.11 ± 0.26ab	2.38 ± 0.15a–d	2.50 ± 0.20abc	1.94±0.22fg	3.00±0.19a

[a] †, *, and ** denote means for high-oleic lines across background genotypes that are significantly different from the mean for normal-oleics by *t* test at the 10, 5, and 1% levels of probability, respectively. Line means followed by the same letter are not significantly different by *t* test at the 5% level of probability.

objectionable off-flavors, for example, fruity, painty, stale, moldy, or petroleum. Because there was relatively little replication of specific near-isogenic pairs of high- and normal-oleic lines, there were very few instances in which statistically significant differences were detected between them with the exception of the Olin−Tamspan 90 pair, for which there were differences for roasted peanut (3.87 vs 3.13 fiu, $P < 0.05$), over-roast (2.73 vs 1.70 fiu, $P < 0.05$), woody (3.08 vs 2.65 fiu, $P < 0.05$), bitter (3.05 vs 2.48 fiu, $P < 0.05$), nutty (2.74 vs 2.33 fiu, $P < 0.05$), and bitter aftertaste (2.72 vs 2.26 fiu, $P < 0.05$). Several of these differences approach or exceed the half-unit threshold at which the difference should be perceptible to an individual panelist (*12*).

Data from the MQHRU Database. Because the high-oleic trait is known to affect concentrations of several fatty acids other than oleic and linolenic acids, it was not surprising to find significant differences between high- and normal-oleic groups for palmitic, eicosenoic, and behenic acids in addition to oleic and linolenic acids (**Table 2**). These differences translated into differences for oleic-to-linoleic ratio, iodine value, total saturates, and polyunsaturate-to-saturate ratio. It is important to bear in mind that the genetic differences between groups are likely to include other genes affecting fatty acid profile and other traits, so the effect of the high-oleic trait is confounded with other factors in this comparison. However, the differences observed in the group comparison were also observed in the comparison of backcross-derived high-oleic line N00090ol with NC 7, the recurrent parent used in the development of N00090ol. The comparison of N00090ol with NC 7 should be less confounded with other genetic differences.

Less expected were the differences between high- and normal-oleic groups in other composition traits (**Tables 2** and **3**) such as oil content (49.6 vs 48.8%, $P < 0.01$) and α-tocopherol (90.4 vs 108.5 ppm, $P < 0.01$), β-tocopherol (91.9 vs 84.7 ppm, $P < 0.01$), total tocopherols (191.7 vs 201.8 ppm, $P < 0.01$), sucrose (28522 vs 30225 ppm, $P < 0.01$), raffinose (629 vs 719 ppm, $P < 0.01$), stachyose (4010 vs 4287 ppm, $P < 0.01$), and total sugars contents (33552 vs 35602 ppm, $P < 0.01$). The difference in sugar content probably was the main factor influencing the observed difference in paste color (53.7 vs 52.3 Hunter L units, $P < 0.01$) and the sensory attributes (**Table 4**) dark roast (2.55 vs 2.76 fiu, $P < 0.01$) and raw/beany (2.56 vs 2.33 fiu, $P < 0.01$). The difference between groups for those traits was consistent with the expectation that the group with lower average sugar content would brown less upon roasting, leading to lighter color, less intense dark roast attribute, and more intense raw/beany attribute. The high-oleic group had lower intensities of the off-flavors cardboard (0.47 vs 0.63 fiu, $P < 0.01$) and painty (0.00 vs 0.02, $P < 0.05$), but the differences were very small in magnitude, and the average intensities of those attributes across all UPPT entries were very low. Differences between the high- and normal-oleic groups for intensities of other sensory attributes were not statistically detectable.

There were differences between N00090ol and NC 7 for oil content (48.5 vs 49.6, $P < 0.01$) (**Table 2**) and glucose content (41 vs 145 ppm, $P < 0.01$) (**Table 3**) and trends for sucrose (31138 vs 29181 ppm, $P < 0.10$) and total sugar content (35558 vs 33454 ppm, $P < 0.10$). No differences were detected for sensory attribute intensities (**Table 4**).

In summary, the high-oleic trait does not appear to have a major impact on sensory quality on average, although there were individual instances in which the trait was associated with shifts in sensory attribute intensities that may be perceptible to consumers. Averaged across background genotypes, differences

Table 2. Oil Characteristics from Analysis of 2003 Uniform Peanut Performance Test Samples (16 Genotypes Tested at 9 Locations)[a]

oleic acid level	oil content, % at 7% moisture	fatty acid content, % of total fatty acids: palmitic (16:0)	stearic (18:0)	oleic (18:1)	linoleic (18:2)	arachidic (20:0)	eicosenoic (20:1)	behenic (22:0)	lignoceric (24:0)	others	oleic-to-linoleic ratio	iodine value	total saturates, % of total fatty acids	polyunsaturate-to-saturate ratio	long-chain saturates, % of total fatty acids
high	49.57 ± 0.14**	6.10 ± 0.09**	2.88 ± 0.04	77.34 ± 0.52**	4.84 ± 0.48**	1.49 ± 0.02	1.88 ± 0.02**	3.34 ± 0.04**	2.40 ± 0.51	0.24 ± 0.02**	22.02 ± 0.64**	76.37 ± 0.38**	16.21 ± 0.51**	0.30 ± 0.03**	7.23 ± 0.51
normal	48.84 ± 0.12	9.65 ± 0.08	2.88 ± 0.04	51.75 ± 0.43	27.28 ± 0.40	1.49 ± 0.02	1.36 ± 0.02	3.64 ± 0.04	1.80 ± 0.43	0.12 ± 0.01	2.13 ± 0.53	92.84 ± 0.32	19.46 ± 0.43	1.42 ± 0.02	6.93 ± 0.42
N00090ol	48.48 ± 0.33**	5.53 ± 0.22**	4.05 ± 0.10**	80.46 ± 1.22**	2.48 ± 1.12**	1.79 ± 0.04**	1.35 ± 0.05**	2.76 ± 0.10	1.37 ± 1.21	0.19 ± 0.04*	31.32 ± 1.50**	74.56 ± 0.90**	15.50 ± 1.21	0.16 ± 0.06**	5.92 ± 1.19
NC 7	49.64 ± 0.33	8.97 ± 0.22	3.47 ± 0.10	58.09 ± 1.22	22.85 ± 1.12	1.57 ± 0.04	1.02 ± 0.05	2.67 ± 0.10	1.27 ± 1.21	0.08 ± 0.04	2.77 ± 1.50	90.35 ± 0.90	17.95 ± 1.21	1.28 ± 0.06	5.52 ± 1.19

[a] * and ** denote means for high-oleic lines that are significantly different from the mean for normal-oleics by t test at the 5 and 1% levels of probability, respectively.

Table 3. Tocopherol and Carbohydrate Contents and Paste (Roast) Color from Analysis of 2003 Uniform Peanut Performance Test Samples (16 Genotypes Tested at 9 Locations)[a]

	ppm												
	tocopherols				carbohydrates								
	α	β	γ	δ	total	inositol	glucose	fructose	sucrose	raffinose	stachyose	total sugars	paste color
high	90.43 ± 1.23**	3.12 ± 0.13	91.90 ± 1.44**	6.22 ± 0.15**	191.65 ± 2.22**	245 ± 9	57 ± 12	70 ± 7	28522 ± 322**	629 ± 26**	4010 ± 78**	33552 ± 340**	53.70 ± 0.24**
normal	108.54 ± 1.03	3.06 ± 0.11	84.86 ± 1.21	5.25 ± 0.13	201.76 ± 1.87	254 ± 8	61 ± 10	59 ± 6	30225 ± 270	719 ± 22	4287 ± 65	35602 ± 285	52.27 ± 0.21
N00090ol	96.31 ± 2.91	3.47 ± 0.30	64.74 ± 3.40	4.87 ± 0.36	169.27 ± 5.25	237 ± 22	41 ± 28**	50 ± 16	31138 ± 759†	498 ± 62	3627 ± 183	35588 ± 803†	51.99 ± 0.58
NC 7	98.51 ± 2.91	2.94 ± 0.30	69.95 ± 3.40	4.56 ± 0.36	175.97 ± 5.25	242 ± 22	145 ± 28	52 ± 16	29181 ± 759	494 ± 62	3342 ± 183	33454 ± 803	52.05 ± 0.58

[a] †, *, and ** denote means for high-oleic lines that are significantly different from the mean for normal-oleics by *t* test at the 10, 5, and 1% levels of probability, respectively.

Table 4. Sensory Attribute Intensities from Analysis of 2003 Uniform Peanut Performance Test samples (16 Genotypes Tested at 9 Locations)[a]

	flavor intensity units (0–15)														
	roasted peanut	sweet aromatic	dark roast	raw/ beany	wood-hull-skins	cardboard	earthy	painty	plastic/ chemical	metallic	fruity/ fermented	sweet	sour	bitter	astringent
high	4.56 ± 0.04	2.84 ± 0.03	2.55 ± 0.05**	2.56 ± 0.04**	3.12 ± 0.01	0.47 ± 0.04**	0.02 ± 0.01	0.00 ± 0.01*	0.01 ± 0.02	0.00 ± 0.00	0.12 ± 0.07	2.03 ± 0.02	0.00 ± 0.00	2.95 ± 0.03	1.08 ± 0.01
normal	4.58 ± 0.03	2.89 ± 0.02	2.76 ± 0.04	2.33 ± 0.04	3.10 ± 0.01	0.63 ± 0.04	0.02 ± 0.01	0.02 ± 0.00	0.03 ± 0.02	0.00 ± 0.00	0.25 ± 0.06	2.08 ± 0.02	0.00 ± 0.00	2.99 ± 0.02	1.08 ± 0.01
N00090ol	4.41 ± 0.09	2.84 ± 0.06	2.75 ± 0.12	2.41 ± 0.10	3.14 ± 0.03	0.62 ± 0.11	0.01 ± 0.03	0.00 ± 0.01	0.00 ± 0.05	0.00 ± 0.01	0.11 ± 0.16	1.98 ± 0.05	0.00 ± 0.00	3.07 ± 0.06	1.09 ± 0.02
NC 7	4.61 ± 0.09	2.85 ± 0.06	2.69 ± 0.12	2.38 ± 0.10	3.14 ± 0.03	0.73 ± 0.11	0.01 ± 0.03	0.00 ± 0.01	0.04 ± 0.05	0.00 ± 0.01	0.03 ± 0.16	2.02 ± 0.05	0.00 ± 0.00	2.97 ± 0.06	1.06 ± 0.02

[a] †, *, and ** denote means for high-oleic lines that are significantly different from the mean for normal-oleics by *t* test at the 10, 5, and 1% levels of probability, respectively.

that were statistically significant usually were <0.5 fiu in magnitude, suggesting that a consumer would not notice thedifference unless the aggregation of a number of such differences for different attributes would reach the level of perceptibility. Given that extension of shelf life is the primary rationale for deployment of the high-oleic trait in peanut varieties, one might have expected larger differences between high- and normal-oleic lines for the stale/cardboard and painty attributes. However, protocols used in the studies (*10*−*13*) were designed to prevent oxidation of the roasted paste samples prior to sensory analysis. Previous studies (*1*−*3*, *5*−*7*) indicate that the trait does have a large effect on oxidative stability, ostensibly retarding the onset of off-flavors associated with rancidity (stale/cardboard and painty) when samples are subjected to long-term storage or storage under adverse conditions. The fruity and moldy off-flavors are not associated with postprocessing oxidation. One would not expect a difference between normal- and high-oleic lines to develop for those sensory attributes during long-term storage.

LITERATURE CITED

(1) O'Keefe, S. F.; Wiley, V. A.; Knauft, D. A. Comparison of oxidative stability of high- and normal-oleic peanut oils. *J. Am. Oil Chem. Soc.* **1993**, *70*, 489−492.
(2) Mugendi, J. B.; Sims, C. A.; Gorbet, D. W.; O'Keefe, S. F. Flavor stability of high-oleic peanuts stored at low humidity. *J. Am. Oil Chem. Soc.* **1998**, *75*, 21−25.
(3) Bolton, G. E.; Sanders, T. H. Effect of roasting oil composition on the stability of roasted high-oleic peanuts. *J. Am. Oil Chem. Soc.* **2002**, *79*, 129−132.
(4) Pattee, H. E.; Isleib, T. G.; Moore, K.; Gorbet, D. W.; Giesbrecht, F. G. Effect of the high-oleic trait and paste storage variables on sensory attribute stability of roasted peanuts. *J. Agric. Food Chem.* **2002**, *50*, 7366−7370.
(5) Mozingo, R. W.; O'Keefe, S. F.; Sanders, T. H.; Hendrix, K. W. Improving shelf life of roasted and salted in-shell peanuts using high oleic acid chemistry. *Peanut Sci.* **2004**, *31*, 40−45.
(6) Pattee, H. E.; Knauft, D. A. Comparison of selected high oleic acid breeding lines, Florunner and NC 7 for roasted peanut, sweet and other sensory attribute intensities. *Peanut Sci.* **1995**, *22*, 26−29.
(7) Norden, A. J.; Gorbet, D. W.; Knauft, D. A.; Young, C. T. Variability in oil quality among peanut genotypes in the Florida breeding program. *Peanut Sci.* **1987**, *14*, 7−11.
(8) Moore, K. M.; Knauft, D. A. The inheritance of high oleic acid in peanut. *J. Hered.* **1989**, *80*, 252−253.
(9) 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.
(10) Pattee, H. E.; Isleib, T. G.; Gorbet, D. W.; Moore, K.; Lopez, Y.; Baring, M. R.; Simpson, C. E. Effect of the high oleic trait on roasted peanut flavor in backcross-derived breeding lines. *J. Agric. Food Chem.* **2002**, *50*, 7362−7365.
(11) Pattee, H. E.; Giesbrecht, F. G. Roasted peanut flavor variation across germplasm sources. *Peanut Sci.* **1990**, *17*, 109−112.
(12) Pattee, H. E.; Giesbrecht, F. G.; Mozingo, R. W. A note on broad-sense heritability of selected sensory descriptors in virginia-type *Arachis hypogaea* L. *Peanut Sci.* **1993**, *20*, 24−26.
(13) USDA, South Atlantic Area, Market Quality and Handling Research Unit. *Uniform Peanut Performance Tests, 2003; Chemical, Sensory and Shelf-life Properties*; Data Presented by Location; USDA-ARS-SAA Market Quality and Handling Research Unit: Raleigh, NC, 2003; 124 pp.

Received for review September 23, 2005. Revised manuscript received December 9, 2005. Accepted December 30, 2005.

JF052353T