Evaluation of Six Landrace Accessions of *Arachis hypogaea* ssp. *hypogaea* var. *hirsuta* Kohler. I. Descriptive and Sensory[1]

H. E. Pattee*[2], D. E. Williams[3], S. Sanchez-Dominguez[4], and F. G. Giesbrecht[5]

ABSTRACT

The *"hirsuta"* peanut (*Arachis hypogaea* ssp. *hypogaea* var. *hirsuta* Kohler) is severely under-represented in germplasm collections throughout the world. Reports on heritability of the roasted peanut and sweet flavor attributes suggest that it would be important to quantify the levels of these attributes in *hirsuta* peanut to determine if these landraces could provide a genetically diverse source for the improvement of roasted peanut flavor. Recent collection explorations in Mexico provided an opportunity to obtain six *hirsuta* landrace accessions which could be used to make such an evaluation. Descriptive sensory analysis of the roasted samples showed no distinct flavor characteristic differences between *hirsuta* samples and U.S. cultivars. Significantly higher intensities of the roasted peanut attribute were not present in any of the *hirsuta* samples when compared to the U.S. cultivars. Significantly higher intensities of the sweet attribute were present in some of the *hirsuta* landraces compared to the U.S. cultivars, and the sweet intensity difference between NC 7 and Florunner controls was significant. This higher intensity of sweetness may account for the preference of the *hirsuta* peanut by the Mexican locals.

Key Words: *Arachis hypogaea* var. *hirsuta*, sensory evaluation, flavor, roasted peanut, sweet, cultivars.

[1]The research reported in this publication was a cooperative effort of the Agricultural Research Service of the United States Department of Agriculture and the North Carolina Agric. Res. Serv., Raleigh, NC 27695-7643. The use of trade names in this publication does not imply endorsement by the United States Department of Agriculture or the North Carolina Agric. Res. Serv. of the products named nor criticism of similar ones not mentioned.

[2]Res. Chem., U.S. Department of Agriculture, Agricultural Research Service, Dept. of Botany, North Carolina State Univ., Box 7625, Raleigh, NC 27695-7625.

[3]Botanist, U.S. Department of Agriculture, Agricultural Research Service, National Germplasm Resources Laboratory, Beltsville, MD 20705.

[4]Prof., Dept. de Fitotecnia, Univ. Autonoma Chapingo, Chapingo, Mexico.

[5]Prof., Dept. of Statistics, North Carolina State Univ., Box 8203, Raleigh, NC 27695-8203.

*Corresponding author.

The "*hirsuta*" peanut (*Arachis hypogaea* L. ssp. *hypogaea* var. *hirsuta* Kohler) is severely underrepresented in germplasm collections throughout the world. In the U.S. National Plant Germplasm System were only five accessions specifically identified as pertaining to the var. *hirsuta* prior to a November 1992 collection exploration to Mexico (Sanchez-Dominguez and Williams, 1993). During that exploration, 12 *hirsutas* were collected from two distinct growing regions in the states of Puebla and Guanajuato. Although the local consumers of *hirsutas* have a distinct preference for their flavor (Becker, 1993), the flavor characteristics of these landraces have not been previously documented.

The reports by Pattee and coworkers (Pattee and Giesbrecht, 1990, 1994; Pattee *et al.*, 1993) on the heritability of the roasted peanut and sweet attributes in peanuts (*A. hypogaea*) suggest that it would be important to quantify the levels of these attributes in relation to appropriate control cultivars to determine if these landraces would provide a genetically diverse source for improvement of these characteristics in standard U.S. cultivars.

Materials and Methods

Genotype Resources and Handling. Six landrace accessions of *A. hypogaea* ssp. *hypogaea* var. *hirsuta* were collected from farms located in the states of Puebla and Guanajuato, Mexico during November 1993. Approximately 25 kg in-shell lots of each accession were air expressed to Raleigh, NC and placed in storage at 4-5 C and 55-60% R.H. until shelled and roasted. Florunner and NC 7 peanuts grown at Gainesville, FL during 1993 were used as comparative controls. Germplasm samples from the *hirsuta* landrace lots were sent to the USDA, Regional Plant Introduction Station, Griffin, GA, and Plant Introduction (PI) numbers were assigned to each lot. The PI numbers assigned and a description of the collection locations are given in Table 1. The PI numbers assigned to 1992 collection samples with the same location description are also given. However, it should not be concluded that the 1992 and 1993 collection samples are exactly the same.

Sample Roasting and Preparation. The peanut samples were roasted in February 1994 using a Blue M "Power-O-Matic 60" laboratory oven. The samples were ground into a paste and stored in glass jars at -20 C until evaluated. The roasting, grinding, and color measurement protocols were carried out as described by Pattee and Giesbrecht (1990) and Pattee *et al.* (1991).

Table 1. Plant Introduction numbers and descriptions for the 1993 collection and PI numbers with the same description from the 1992 collection in Mexico.

PI no.	1993 collection description	1992 PI no.
576633	Huiluco, Puebla, elev. 1800 m	576616
576634	Santiago Tetla, Puebla, elev. 1670 m	576613
576635	Tezonteopan de Bonilla, Puebla, elev. 1650 m	576614
576636	Tarandacuao, Guanajuato, elev. 2050 m	576623
576637	Tarimoro, Guanajuato, elev. 1790 m	576622
576638	Salvatierra, Guanajuato, elev. 1798 m	576619

Sensory Evaluation. An eight-member trained roasted peanut flavor profile panel at the Food Science Dept., North Carolina State Univ., Raleigh, NC was used to develop qualitative descriptive profiles and quantitatively evaluate the roasted peanut-paste samples from each genotype for these sensory attributes using a 1-14 intensity scale. Panel orientation and formation of the descriptive profiles was done in two half-day sessions with reference controls as described by Meilgaard *et al.* (1991, pp. 175-176). For the quantitative sensory evaluations two sessions were conducted weekly but never on consecutive days. Panelists evaluated four samples per session. Samples were presented in an incomplete block design to monitor variation between panel sessions. Sensory evaluation commenced the latter part of February 1994 and continued until all samples were evaluated.

Statistical Analysis. Statistical analyses were performed using procedures in the SAS (1987) system, version 6 and Giesbrecht's (1989) procedure for analysis of mixed models to estimate the components of variance. The averages of individual panelists' scores on sensory attributes were used in all analyses.

Results and Discussion

Roast Color. Peanuts must be roasted to an optimum condition, usually measured by roast color, to obtain optimum roasted peanut flavor intensity. To determine if the optimum roasting conditions had been achieved, three different roasting levels, as measured by CIELAB L^*, for the six *hirsuta* accessions were used. The roast color levels targeted were based on reports by Pattee and Giesbrecht (1990, 1994) and Pattee *et al.* (1991). Because Florunner and NC 7 have been extensively evaluated in these reports, a single target roast color range of 58 ± 2 was used. The roast color values (Table 2) for the descriptive underroast, optimum, and overroast samples for each landrace and the descriptive and sensory samples for Florunner and NC 7 show the uniformity of roast color achieved for the comparative samples. Uniformity of the overroast samples will be of particular interest in the discussion of roasted peanut optimum intensities.

Descriptive Profile. Descriptive profiling is the selection of sensory attributes present and definition of those attributes. The descriptive profile and definitions for the sensory attributes of the profile developed from the six *hirsuta* landrace accessions, Florunner and NC 7 using roasted peanut paste samples are given in Table 3. Each genotype was scored as having all attributes present in its sensory profile. Thus, there were no sensory attribute differences between the U.S. cultivars grown in Florida and *hirsuta* accessions obtained from Mexico.

Sensory Attributes. The sensory attributes of primary interest in this study are roasted peanut, sweet, and fruity. Roasted peanut and sweet are of interest because of their broadsense heritability estimates (Pattee and Giesbrecht, 1990, 1994; Pattee *et al.*, 1993). Fruity is of interest because it has been shown to linearly suppress the roasted peanut intensity response (Sanders *et al.*, 1989; Pattee and Giesbrecht, 1990, 1994; Pattee *et al.*, 1990). Thus, to find the best germplasm for roasted peanut intensity the data need to be adjusted for fruity and roast color effects. Because an incomplete block

Table 2. Roast color (CIELAB L*) means for the six var. *hirsuta* accessions, Florunner, and NC 7 samples used for descriptive and quantitative sensory evaluation.

Genotype	Roasting condition	Roast color
PI 576633	Descriptive	55.8
	Sensory	
	Underroast	61.9
	Optimum	58.7
	Overroast	52.7
PI 576634	Descriptive	55.6
	Sensory	
	Underroast	61.7
	Optimum	57.4
	Overroast	53.7
PI 576635	Descriptive	57.2
	Sensory	
	Underroast	61.5
	Optimum	56.3
	Overroast	53.1
PI 576636	Descriptive	55.7
	Sensory	
	Underroast	61.8
	Optimum	57.5
	Overroast	52.4
PI 576637	Descriptive	58.1
	Sensory	
	Underroast	61.8
	Optimum	58.0
	Overroast	53.7
PI 576638	Descriptive	55.5
	Sensory	
	Underroast	60.6
	Optimum	56.2
	Overroast	53.3
Florunner	Descriptive	55.5
	Sensory	56.6
NC 7	Descriptive	55.8
	Sensory	56.6

experimental design was used in the sensory panel presentation order, an adjustment can be made in the data for the bias of not being able to do a complete sensory analysis in one panel. The roasted peanut and fruity intensities presented in Table 4 have been adjusted for this bias. Statistical analysis of these data indicates that significant roasted peanut intensity differences exist within the *hirsuta* landrace accessions and between those accessions and NC 7 and Florunner. PIs 576633, 576635, and 576637 are significantly lower in roasted peanut intensity than PIs 576634, 576636 and 576638. No differences exist between NC 7, Florunner, PIs 576634, 576636 and 576638. PI 576635 had its maximum intensity in the overroast treatment. Also, the roasted peanut intensity in the overroast treatment of PI 576638 is almost the same as the optimum treatment response. These are variant observations relative to the other observations in this study and the previous studies conducted. Presently no explanation can be given for this variance, but further study is warranted and may provide some basic information on the generation of roasted flavor compounds not presently available. If the PI 576635 maximum response is used for comparison purposes it would be equal to the maximum response level of the other landraces.

Fruity attribute intensity differences between the landrace accessions are significant (Table 4). Compensating for this effect in the roasted peanut response values (Table 5), PIs 576635, 576636, and 576638 have significantly higher roasted peanut potentials at their maximum points than PIs 576633, 576634, and 576637. Florunner and NC 7 are not significantly different from each other nor the maximum potentials of the *hirsuta* accessions.

Table 3. Characteristics evaluated, sensory attributes and definitions from roasted, paste samples of six var. *hirsuta* landrace accessions from Mexico, and Florunner and NC 7.

Characteristic attribute	Definition
Characteristic	
Aroma	Odors perceived by the olfactory system from volatiles entering the nasal passage from the sample (Meilgaard *et al.*, 1991, p. 8)
Flavor	Impressions perceived through the chemical senses from a sample in the mouth (Caul, 1957)
Aftertaste	Impressions perceived through the chemical senses up to 1 min after a sample is removed from the mouth
Attribute	
Roasted peanut	A roasted peanut aroma or flavor
Underroast	Aroma or flavor of raw peanut, including any green note (cis-3-hexenal)
Overroast	A charred, burnt note
Bitter	Taste produced by substances such as quinine or caffeine when solubilized
Sweet	Taste produced by substances such as sucrose when solubilized
Sour	Taste produced by substances such as citric acid when solubilized
Fruity	Characterized by fermentation (alcohol) and/or reminiscent of fruit; fruity like black walnuts; also includes immature peanuts
Painty	Painty aromatic note as from an old paint can or linseed oil; includes rancid
Stale	Old, cardboardy, straw-like note
Mold	Degree to which sample has a damp, musty note
Tongue/throatburn	A burning sensation felt on the tongue and/or in the throat
Astringent	Sensations of shrinking, drawing or puckering of the skin surfaces of the oral cavity, leaving a dry feeling in the mouth
Woody/hulls/skin	Aromatics associated with base peanut character similar to dry wood, peanut hulls and skins; also dusty
Nutty	The roasted peanut-like flavor that remains after swallowing the sample

When compensation in roasted peanut intensity is made for the differences in both roast color and fruity intensity (Table 6), PI 576634 is a significantly inferior sample compared to PIs 576636, 576637, 576638, Florunner, and NC 7. PIs 576633 and 576635 are not significantly different from PI 576634 nor PIs 576636, 576637, and 576638. PIs 576636, 576637, and 576638 are grouped together but are not significantly different

Table 4. Comparison of sensory attribute intensities for six var. *hirsuta* accessions from Mexico at three roasting conditions and Florunner and NC 7.

Genotype	Attribute	Roasting condition		
		Underroast	Optimum	Overroast
PI 576633	Roasted peanut	1.6	2.1	2.0
	Fruity	5.7	7.1	7.3
PI 576634	Roasted peanut	2.1	4.8	4.2
	Fruity	2.1	1.7	2.2
PI 576635	Roasted peanut	2.7	4.2	5.1
	Fruity	2.0	2.2	2.9
PI 576636	Roasted peanut	2.3	5.0	4.1
	Fruity	2.9	3.1	3.4
PI 576637	Roasted peanut	1.9	3.5	3.1
	Fruity	5.7	5.6	6.1
PI 576638	Roasted peanut	3.0	4.8	4.7
	Fruity	4.4	2.9	3.9
Florunner	Roasted peanut		5.0	
	Fruity		2.5	
NC 7	Roasted peanut		4.8	
	Fruity		2.6	

Avg LSD_{05} =
0.5 for comparing roasted peanut differences between controls and *hirsuta*
1.0 for comparing fruity differences between controls and *hirsuta*
0.7 for comparing roasted peanut differences within *hirsuta*
1.2 for comparing fruity differences within *hirsuta*

Table 5. Comparison of roasted peanut intensities adjusted for fruity of 1.1.

Genotype	Roasting condition		
	Underroast	Optimum	Overroast
PI 576633	3.4	4.4	4.4
PI 576634	2.5	5.0	4.6
PI 576635	3.0	4.6	5.8
PI 576636	3.0	5.8	5.0
PI 576637	3.7	5.2	5.0
PI 576638	4.2	5.5	5.8
Florunner		5.6	
NC 7		5.4	

Avg LSD_{05}=
0.6 for comparing differences between controls and *hirsuta*
0.8 for comparing differences within *hirsuta*

from Florunner and NC 7.

The sweet attribute impact on the total roasted flavor impression is not fully understood and only recently has it been documented that the sweet attribute has a broadsense heritability component (H. E. Pattee, F. G. Giesbrecht, and T. G. Isleib, unpubl. data, 1994). The sweet attribute intensities have been adjusted for the bias of not being able to do a complete sensory analysis in one panel (Table 7). Significant sweet intensity differences exist within the *hirsuta* accessions and between

Table 6. Comparison of roasted peanut intensities co-adjusted for roast color of 58.3 and fruity of 1.1.

Genotype	Roasted peanut
PI 576633	4.7
PI 576634	4.4
PI 576635	4.8[a]
PI 576636	5.1
PI 576637	5.1
PI 576638	5.3
Florunner	5.2
NC 7	5.1

Avg LSD_{05}=
0.5 for comparing differences within *hirsuta*
0.5 for comparing differences between *hirsuta* and controls

[a]Adjusted value not optimum since true roast optimum based on these data is not known.

Table 7. Comparison of sweet attribute intensities for six accessions of var. *hirsuta* from Mexico at three roasting conditions and Florunner and NC 7.

Genotype	Roasting condition		
	Underroast	Optimum	Overroast
PI 576633	2.8	2.9	2.9
PI 576634	3.8	3.8	3.7
PI 576635	3.7	3.6	3.5
PI 576636	3.2	2.8	2.9
PI 576637	3.0	3.1	2.6
PI 576638	3.3	2.9	3.0
Florunner		2.7	
NC 7		2.5	

Avg LSD_{05}=
0.3 for comparing differences within *hirsuta*
0.4 for comparing differences between controls and *hirsuta*

those accessions and NC 7 and Florunner. Two accessions, PI 576634 and PI 576635, seem especially important for the significantly higher intensity of their sweet attribute. Although a link between overall roasted peanut flavor impact and sweet has not been established, it is interesting that the Mexican consumers have a distinct preference for the *hirsuta* landraces (Becker, 1993). It may be the difference in the sweet intensity that is directing this preference.

Statistical comparison of the sweet attribute intensities for Florunner and NC 7 indicates that the difference shown is significant at the P = 0.01 level, but there is presently no known impact of this difference.

Conclusions

Significantly higher intensities of roasted peanut attribute are not present in any of the *hirsuta* samples tested compared to the U.S. cultivars. Significantly higher intensities of the sweet attribute are present in some of the *hirsuta* landrace accessions compared to the U.S. cultivars and the sweet intensity difference between NC 7 and Florunner is significant. The higher intensity of sweetness may account for the preference of the *hirsuta* landraces by the Mexican consumers.

Literature Cited

1. Becker, H. 1993. Great-tasting peanuts? Try hairy! Agric. Res. 41(12):14.
2. Caul, J. F. 1957. The profile method of flavor analysis. Adv. Food Res. 7:1-40.
3. Giesbrecht, F. G. 1989. A general structure for the class of mixed linear models, pp. 183-201. *In* Applications of Mixed Models in Agriculture and Related Disciplines. Southern Cooperative Series Bulletin No. 343. Louisiana Agricultural Exp. Stn., Baton Rouge.
4. Meilgaard, M., G. V. Civille, and B. T. Carr. 1991. Sensory Evaluation Techniques. 2nd Ed. CRC Press, Inc., Boca Raton, FL.
5. Pattee, H. E., and F. G. Giesbrecht. 1990. Roasted peanut flavor variation across germplasm sources. Peanut Sci. 17:109-112.
6. Pattee, H. E., and F. G. Giesbrecht. 1994. Adjusting roast peanut attribute scores for fruity attribute and non-optimum CIELAB L* values. J. Sens. Studies 9:353-363.
7. Pattee, H. E., F. G. Giesbrecht, and R. W. Mozingo. 1993. A note on broad-sense heritability of selected sensory descriptors in virginia-type *Arachis hypogaea* L. Peanut Sci. 20:24-26.
8. Pattee, H. E., F. G. Giesbrecht, and C. T. Young. 1991. Comparison of peanut butter color determination by CIELAB L*a*b* and Hunter color-difference methods and the relationship of roasted peanut color to roasted peanut flavor response. J. Agric. Food Chem. 39:519-523.
9. Sanders, T. H., J. R. Vercellotti, P. B. Blankenship, K. L. Crippen, and G. V. Civille. 1989. Interaction of maturity and curing temperature on descriptive flavor of peanuts. J. Food Sci. 54:1066-1069.
10. SAS Institute Inc. 1987. SAS/STAT Guide for Personal Computers, Vers. 6 Ed. Cary, NC.

Accepted 14 December 1994