Sensory Quality Traits of the Runner-Type Peanut Cultivar Georgia Green and its Value as a Parent Compared with Florunnner[1]

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ABSTRACT

Georgia Green has become the dominant runner market-type peanut cultivar in the United States because of its high yield and superior disease resistance to tomato spotted wilt virus. However, the roasted peanut flavor quality of Georgia Green has not been formally reported, and questions regarding its flavor quality have been expressed by the peanut industry. The objective of this study was to compare the roasted peanut flavor qualities of Georgia Green to those of the long-time industry standard Florunner. This study also provided an opportunity to further expand investigations into the parent selection effects on progeny roasted peanut flavor quality. A total of 192 samples of cultivars Florunner, Georgia Green, and Georgia Green's parents, Southern Runner and Sunbelt Runner, were collected from 1986 to 2000 from the Southeast, Southwest, and Virginia-Carolina peanut production regions. A descriptive sensory panel evaluated flavor attributes of a roasted sound mature kernel (SMK) sample from each plot. The sensory attributes of the four genotypes were compared directly, and the data were included in a Best Linear Unbiased Prediction (BLUP) model of breeding value of 112 peanut cultivars and breeding lines. Georgia Green was not significantly different from the industry standard cultivar Florunner in the sensory attributes roasted peanut [4.5 vs. 4.1 flavor intensity units (fiu), ns], bitter (3.2 vs. 3.3 fiu, ns), and astringent (3.3 vs. 3.4 fiu, ns). It was significantly sweeter than Florunner (3.3 vs 3.0 fiu, $P < 0.05$). The BLUPs of breeding value for roasted peanut and sweet attributes of Georgia Green were among the highest of any peanut lines included in the analysis. Based on this finding, widespread use of Georgia Green as a parent should contribute to flavor improvement in peanut breeding programs.

Key Words: Parentage, roasted peanut attribute, sweet attribute, bitter attribute, *Arachis hypogaea* L., genotypes.

In developing new peanut (*Arachis hypogaea* L.) breeding lines and cultivars the primary focus is upon heritable characteristics that impact agronomic value and pest resistance because these characteristics have direct, measureable effects. Those characteristics which are heritable but do not have a directly measureable economic value can sometimes be overlooked or forgotten as new breeding lines and cultivars are developed because they do not immediately affect profit margin. One such set of quality characteristics is flavor. Failure to monitor, evaluate, and understand the potential of the proposed parents to transfer these quality characteristics to their progeny can further lead to reduced quality factors in new breeding lines and cultivars (Isleib *et al.*, 1995).

Through the research of Pattee and coworkers an understanding of the genotypic and environmental influences on roasted peanut flavor quality has been reported (Pattee *et al.*, 1994, 1997, 1998). The research also demonstrated that there are highly significant correlations among genotypic means for sensory attributes, particularly bitter with sweet and roasted peanut with sweet and bitter (Pattee *et al.*, 1997, 1998). In addition they determined that certain roasted peanut quality sensory attributes are heritable traits (Pattee and Giesbrecht, 1990; Pattee *et al.*, 1993, 1994, 1995, 1998; Isleib *et al.*, 1995) and estimated the breeding values of an array of cultivars and breeding lines using Best Linear Unbiased Prediction (Pattee *et al.*, 2001, 2002a, b, c). Thus through these efforts, peanut breeders have the means to address the long-standing objective of the peanut industry to enhance the intensity of roasted peanut flavor in peanut products.

Isleib *et al.* (2000) suggested that the large variance in roasted peanut sensory attribute of peanut varieties released since 1980 could be due to the introgression of new germplasm into the runner breeding population, particularly the use of introductions with disease resistance. PI 203396 is the source of resistance to late leafspot (*Cercosporidium personatum* [Berk. & Curt.] Deighton) in Southern Runner, Florida MDR 98 and other lines from the Univ. of Florida (Isleib *et al.*, 2001). It is also the source of resistance to tomato spotted wilt virus (TSWV) in Georgia Green and other lines from the Universities of Georgia and Florida. PI 203396's immediate descendants Southern Runner and UF 81206-2 had low scores for the roasted peanut attribute, and UF 81206-2 had an extremely high bitter score (Isleib *et al.*, 2000). In spite of having a slightly elevated bitter score, Florida MDR 98 had higher than average roasted peanut and sweet scores.

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These comparisons among leaf-spot-resistant runner-type lines illustrate the importance of monitoring flavor quality in populations into which exotic germplasm has been introgressed for the purpose of improving some narrow aspect of agronomic value. Although yield and disease resistance are critical characteristics from the viewpoint of the peanut producer, flavor quality is of utmost importance to the manufacturer and consumer and ultimately to the entire industry.

Georgia Green has become the dominant runner market-type peanut cultivar in the southeastern U.S. because of its high yield and superior disease resistance to TSWV. However, the roasted peanut flavor quality of Georgia Green has never been formally reported and questions regarding its flavor quality have been expressed by the peanut industry. The objective of this study was to compare the roasted peanut flavor qualities of Georgia Green to those of the long-time industry standard Florunner. This study also provided an opportunity to further expand investigations into the parent selection effects on progeny roasted peanut flavor quality.

Materials and Methods

Genotype Resources. Pod samples of Florunner, Georgia Green, and Georgia Green's parents, Southern Runner and Sunbelt Runner, were collected from 1986 to 2000. A total of 192 peanut samples were obtained from the Southeast, Southwest, and Virginia-Carolina peanut production regions. Forty-nine year-by-location combinations were represented in the data. All samples were obtained from plants grown and harvested under standard recommended procedures for weed and disease control, soil fertilization, digging, and harvesting for the specific location.

Sample Handling. After harvest, the in-shell sample from each plot was shipped to Raleigh, NC where it was shelled and screened to obtain the sound mature kernel (SMK) fraction. SMK fractions were obtained using official grading standards for each runner market type. The SMK fraction from each location-entry was placed in controlled storage at 5 C and 60% RH until roasted.

Sample Roasting and Preparation. The peanut samples were roasted in June and July of the year following harvest using a Blue M "Power-O-Matic 60" laboratory oven, ground into a paste, and stored in glass jars at -20 C until evaluated within the next 3 mo. The roasting, grinding, and color measurement protocols were as described by Pattee and Giesbrecht (1990) and modified by Pattee *et al.* (1997).

Sensory Evaluation. A six- to nine-member trained roasted peanut profile panel at the Food Science Dept., North Carolina State Univ., Raleigh, NC, evaluated all peanut-paste samples using a 14-point intensity scale. Panel orientation and reference control were as described by Pattee and Giesbrecht (1990) and Pattee *et al.* (1993). Two sessions were conducted each week on nonconsecutive days. Panelists evaluated six samples per session in 1986, five in 1987-88, and four per session in all subsequent years. Each year, samples were presented to the panel in an incomplete block design. The commercial creamy Jif brand peanut butter was available as a reference during each panel session. The intensity of the roasted peanut attribute of the reference was 4 flavor intensity units (fiu) based on a scale of 1 to 14. Sensory evaluation commenced in mid-June of each evaluation year and continued until all samples were evaluated. The averages of individual panelists' scores on sensory attributes were used in all analyses in this study.

Statistical Analysis. The sensory attributes analyzed were those previously shown to be genetically influenced, namely roasted peanut, sweet, bitter, and astringent (Pattee and Giesbrecht, 1990; Pattee *et al.*, 1993, 1994, 1995, 1997, 1998, 2002 a, b, c). Statistical analysis in this study was performed using the mixed-model procedure (PROC MIXED) in SAS (1992) to estimate cultivar means adjusted to a common environmental effect. The linear model included the fixed effect of cultivars and the random effects of year, location within year, replicate within year and location, and the interactions of cultivar with those environmental effects. Covariates fruity and roast color were used, as needed, based upon the findings of Pattee *et al.* (1991, 1997) and Pattee and Giesbrecht (1994). Data collected from 1999 and 2000 plots of Georgia Green, Florunner, Southern Runner, and Sunbelt Runner were added to a database of similar data collected on a wide array of germplasm in previous years, and breeding values were estimated as described by Pattee *et al.* (2001, 2002 a, b, c). In order to assess the deviation of mean sensory scores of progeny of Southern Runner and Sunbelt Runner from the mean of the two parents, the analysis was run on a data set augmented with data on two siblings of Georgia Green selected from the same cross.

Results and Discussion

Variation among the four cultivars was significant for all four sensory attributes (Table 1). Georgia Green was not significantly different from the industry standard cultivar Florunner in the sensory attributes roasted peanut [4.5 vs. 4.4 flavor intensity units (fiu), ns], bitter (3.2 vs. 3.3 fiu, ns), and astringent (3.3 vs. 3.4 fiu, ns). It was significantly sweeter than Florunner (3.3 vs 3.0 fiu, $P \leq 0.05$). Our data support an earlier report of sensory quality of Georgia Green which stated that it was "similar to" Florunner in flavor (Branch, 1996).

Table 1. Adjusted mean sensory attribute scores for four runner-type peanut cultivars and the contrast of Georgia Green with the average of its parents, Southern Runner and Sunbelt Runner.[a]

Cultivar	Roasted peanut	Sweet	Bitter	Astringent
	----------flavor intensity units----------			
Georgia Green	4.47±0.30 a	3.32±0.14 a	3.21±0.29 b	3.31±0.14 b
Florunner	4.41±0.27 a	3.00±0.12 b	3.26±0.27 b	3.36±0.10 b
South. Runner	4.03±0.29 b	2.77±0.14 c	3.67±0.29 a	3.46±0.12 ab
Sunbelt Runner	4.30±0.31 ab	2.86±0.15 bc	3.73±0.31 a	3.73±0.15 a
Georgia Green vs. midparent	0.31±0.16[ns]	0.50±0.10**	-0.49±0.15**	-0.28±0.13[†]

[a]Means followed by the same letter in a column are not significantly different by t-test ($P \leq 0.05$).

ns,†,*,** Denote contrasts that are not significant at the 10%, 5%, and 1% levels of probability, respectively.

Southern Runner, the source of Georgia Green's disease resistance, was previously reported to have sensory attribute scores near the average for runner-type cultivars while Sunbelt Runner was reported to be among the worst (Pattee *et al.*, 1998). With additional data from the 2000 crop, the relationship between the two cultivars was reversed for roasted peanut and sweet. In this study, the differences between Southern Runner and Sunbelt Runner were not statistically significant for any sensory attribute. Compared with its parents, Georgia Green was superior to Southern Runner in roasted peanut, sweet, and bitter, and superior to Sunbelt Runner in sweet, bitter, and astringent. Georgia Green was significantly different from the midparental value for sweet and bitter, indicating either nonadditive genetic control or transgressive segregation for those traits. However, when data on two Georgia Green siblings was included in the analysis, the mean of the three selections from the Southern Runner x Sunbelt Runner cross was not significantly different from the midparental value for any of the four sensory attributes, supporting the hypothesis of additive genetic control. Georgia Green's flavor profile is also different from expectation based on the previously reported BLUP breeding values for Southern Runner and Sunbelt Runner (-0.11 and -0.14 fiu for roasted peanut, +0.07 and -0.24 for sweet, and +0.01 and +0.13 fiu for bitter) which suggests that progeny of their hybrid should have poor flavor profiles. This deviation from expectation occurred because of the failure of Georgia Green's sensory values to fall near the mean of its two parents. With the currently available data it is not possible to ascribe the deviation to either nonadditive inheritance or to transgressive segregation. Indirect evidence of nonadditive genetic effects on sensory attributes was reported by Pattee *et al.* (2002) who found interaction between the genes controlling the high-oleic trait and other "background" genes. The only formal estimation of additive and nonadditive genetic effects on sensory attributes (Isleib *et al.*, 2003) was in a cross between two virginia-type genotypes, and they found that nonadditive was much larger than additive variation. Further studies of the relative influence of additive and nonadditive genetic effects are underway in populations derived from crosses among parents with putatively high breeding value for roast peanut and sweet attributes.

The correlation of newly estimated breeding values for roasted peanut attribute with those reported by Pattee *et al.* (2001) was high ($r = 0.91$ with 110 df, $P \leq 0.01$), and the outlying points represented lines (Tamspan 90, Southern Runner, and Sunbelt Runner) on which substantially more data was accumulated in the years intervening between the two calculations. Sunbelt Runner exhibited the greatest change with the new estimate being 0.47 fiu greater than the old one. This change was the result of the unexpectedly high roasted peanut value of Georgia Green, a selection from the cross of Sunbelt Runner with Southern Runner. It is to be expected that means and estimated effects will change somewhat as additional data are collected. Only after large numbers of replicated samples are included in the mean would it become more stable. The BLUPs of breeding value for roasted peanut and sweet attributes of Georgia Green were among the highest of any peanut lines included in the analysis (Fig. 1). Statistical comparison of the BLUP values was not possible, but Georgia Green was numerically superior to Florunner in both attributes. Based on this finding, widespread use of Georgia Green as a parent should contribute to flavor improvement in peanut breeding programs.

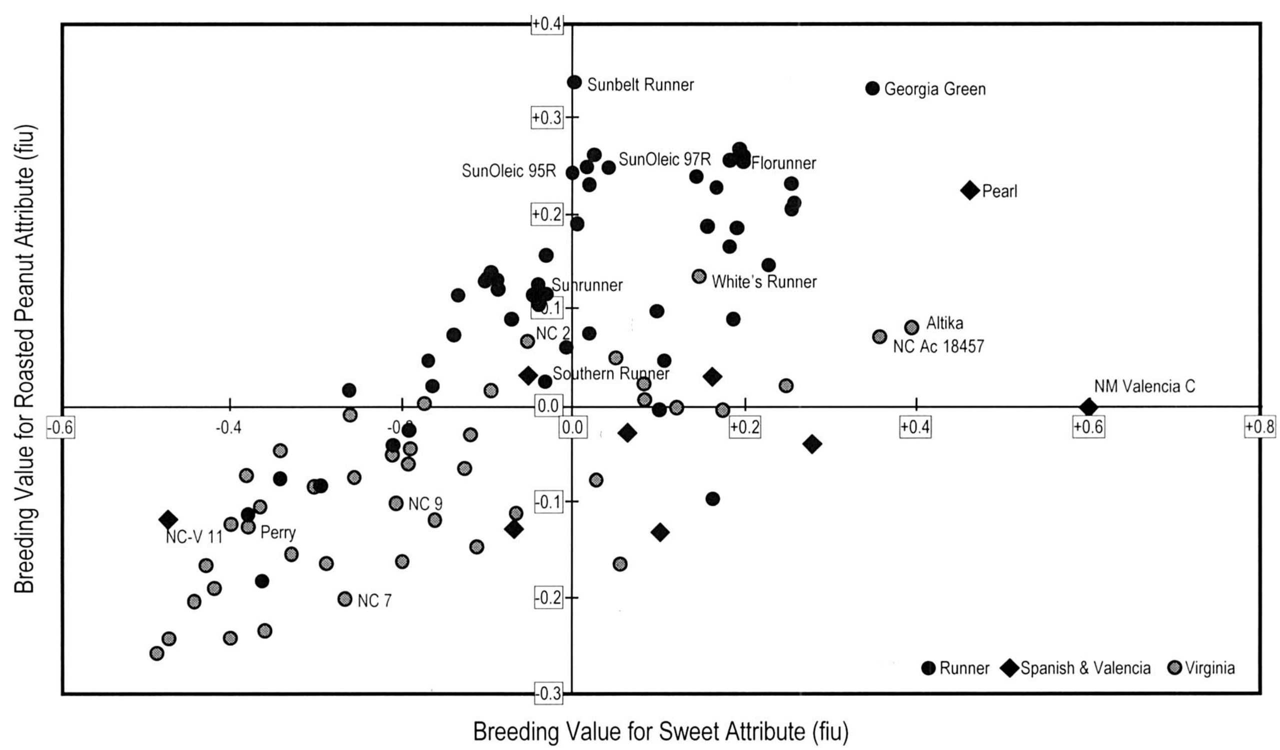

Fig. 1. Best linear unbiased predictors of breeding value for roasted peanut attribute intensity (estimated for $h^2 = 0.05$) versus sweet attribute intensity (estimated for $h^2 = 0.15$).

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