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QUALITY OF FLORIDA FRESH MARKET TOMATO GENOTYPES AS AFFECTED BY PRODUCTION ENVIRONMENT[1]

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Abstract. **Ten tomato** (Lycopersicon esculentum **Mill.) genotypes were grown at 9 production environments in Florida. Quality components measured at the table ripe stage were firmness, acidity, soluble solids, sugar/acid ratio, a/b color, vitamins A and C, and total solids. Data obtained from these analyses were pooled to establish a consumer quality index (appearance, texture, flavor, nutrition). There were differences in consumer quality among genotypes. Best quality fruit was produced at Ft. Pierce (Spring 1982) and Immokalee (Spring 1983). Tomatoes produced during the spring (Ft. Pierce and Bradenton) had a higher quality index than those grown in the fall, primarily because of firmness, soluble solids and total solids. These data do not support the assertion that consumer quality of newer tomato cultivars produced in Florida are inferior to cultivars previously grown.**

Increased consumption of fresh fruits and vegetables could be a vital link in alleviating some of the dietary problems of consumers. A reduction in obesity, a major health problem, and lower cancer risk are both associated with increased intake of fresh fruits and vegetables (1). Consumers have become more knowledgeable concerning the nutritional content of fresh vegetables and purchases are thus influenced. Fresh tomatoes are a major contributor of essential nutritional components to the human diet, providing a substantial amount of ascorbic acid, β-carotene, minerals and dietary fiber accompanied with a very minimal intake of calories (10). Consumers widely believe that newer tomato cultivars are inferior to older cultivars that have been available previously.

Variations in tomato quality (color, texture, flavor) have resulted from production factors involving fertilization, water management, and soil composition (2, 6, 7, 8). General consensus from these and numerous other reports is that quality differences are small or inconsistent and are frequently associated with environmental stress conditions. Quality differences are negligible where production provides for optimum growth of the plant.

It is generally recognized that tomato flavor is mainly attributable to the sugars and acid content and there is difference in flavor intensity between cultivars, harvest maturities and production environments (2, 4, 9, 12); there are also differences in firmness, color and total solids (2, 5).

Commercial cultivars of tomatoes in Florida have been evaluated by the senior author as to specific quality attributes or nutritional components. Fruit quality characteristics have also been studied in relation to stability among tomato genotypes grown under various environments within Florida and are being reported elsewhere. Genetic material having desirable characteristics has been identified and is being incorporated into developing cultivars. However, terminology such as "good quality" is non-definitive. From the standpoint of the consumer a tomato should have acceptable appearance, good flavor, texture and contain the desirable components for nutrition. Hence, further considerations of tomato quality in this paper will be determined based on the collective contribution of firmness, color, acidity, sweetness, vitamins A & C, and total solids (dry weight).

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The objective of this study was to determine the consumer quality (a composite of appearance, flavor, texture and nutritional content) of Florida fresh market tomato genotypes and determine whether this quality is affected when tomatoes are grown in diverse environments. For the purpose of this study all components used to establish consumer quality will be weighted equally.

Materials and Methods

Studies were conducted at Ft. Pierce, Bradenton, Gainesville and Quincy during the spring of 1982, Ft. Pierce, Bradenton and Homestead during the fall of 1982, and Immokalee during the spring of 1983. This represents 9 environments, each differing in climatic, edaphic conditions and cultural practices. Soil type and cultural practices used in each environment were previously described (11), except for Immokalee where soil type was Immokalee Fine Sand with beds 1.82 m apart, plants spaced 38 cm in a single row and N, P, K fertilizer applied at 240, 118, and 316 kg/ha, respectively.

Each study consisted of 8 genotypes; 'Castlehy 1035', 'Sunny', 'Duke', 'Flora-Dade', 'FTE-12', 'Hayslip', 'Walter PF', and 'Burgis' and 2 advanced breeding lines, 827015-IBK and D76127. Fruits were harvested at the breaker or turning stage and ripened to table ripe (USDA score 6) at 20°C and 85-95% relative humidity. Sample size consisted of 10 fruits per replication which simultaneously reached the table ripe stage. Whole fruits were used for firmness measurements. Thereafter, polar wedges from each of 10 fruits were pooled and blended for chemical analysis. Firmness was measured with an IFAS pressure tester, developed in the Vegetable Crops Department, using a load of 9.8 newtons (1 Kgf) for 5 sec with a fruit contact plate of 1.5 cm. Pressure was applied at the equatorial plane and deformation was measured in mm. A macerated and deaerated sample was used for color determinations using a digital Hunter Color Difference Meter; a/b values were used for comparison. Titratable acids (TA) were determined by electrometric titration of 10 ml of clarified juice diluted with 140 ml distilled water, adding 0.1 N NaOH to an endpoint of pH 8.1. The results were calculated as percent citric acid (TA x 0.064), the dominant acid. Soluble solids (SS) were determined with an Abbe refractometer. The sugar/acid ratio was calculated as SS/% citric acid. Determination of vitamin C was by the AOAC titration method utilizing 2,6 dichloroindophenol as the indicator dye (3) in a 20 g sample. Determination of β-carotene was according to the AOAC chromatographic column method with magnesia:super cel at 1:1 as the absorbent (3). Samples for total solids (TS) were dried to constant weight in an oven at 75°C for 72 hr. Transformation of analyses data was necessary so that the various components could be combined and equated. Data within each component (firmness, acidity, soluble solids, etc.) was multiplied by a calculated constant (5.0 ÷ component mean = constant multiplier), retaining the relative differences from the general mean. Appearance, texture, flavor and nutritional composition are all components of consumer quality but the relative importance of each attribute has not been established, therefore, in this study each component contributed equally (mean of 5.0) toward the determination of consumer quality index. A randomized complete block design with 4 replications was used. The combined data were analyzed as a split-plot design with environments as main plots and genotypes as sub-plots.

Results and Discussion

There were minor differences in consumer quality between genotypes (Table 1). The quality index for a given genotype consisted of 288 variables (9 environments, 8 components of quality, 4 replications). Large differences would have to exist for a genotype to be different with this high number of data imputs. Scrutiny of the data does not reveal any consistent pattern or quality component deviation.

Table 1. Quality of tomato genotypes grown under 9 different environments in Florida.

Genotype	Quality index[z]
827015-IBK	39.62 ab[y]
Flora-Dade	39.35 ab
FTE-12	39.08 ab
Burgis	39.07 ab
Walter PF	39.04 ab
Hayslip	38.92 bc
Castlehy 1035	38.89 bc
D76127	38.67 bcd
Sunny	38.32 cd
Duke	38.17 d
F[x]	*

[z]Quality index is a composite measurement of attributes comprising appearance, texture, flavor and nutritional composition.
[y]Means were separated by Duncan's multiple range test, 5% level.
[x]F value was significant at the 5% (*) level.

There are frequent assertions that newer tomato cultivars grown in Florida are less desirable than some of the older standards such as 'Homestead'. Previous data obtained by the senior author has indicated there is no quality difference between 'Homestead' and 'Walter PF'. Data presented here, therefore, support the assertion that quality differences exist only between 'Walter PF' and 'Sunny' and 'Duke' cultivars being commercially produced in Florida. Quality differences overall, probably result from mis-handling or vicissitudes of production season instead of cultivar characteristics.

Quantifying consumer quality is not easy. Objective analysis for color, flavor and nutritional composition by instrumentation is routine but confirmation by consumer taste panel is complex; what the judge sees or feels influences his taste. In the final analysis, the desire to determine acceptability of a product requires a consumer panel to evaluate it. We have established by objective means that appearance, flavor and nutritional composition of tomato genotypes do differ, but confirmation by a taste panel is desirable to establish relevance.

The main effect of location, or more specifically the environment for production influenced consumer quality of tomatoes (Table 2). Best quality fruit was produced at Ft. Pierce in the spring of 1982 followed by Immokalee in the spring of 1983 (Table 2). Fruits produced at Ft. Pierce (Spring 1982) were most firm, and had the highest content of acids, soluble solids and total solids; other quality attributes were average or above. The most noteworthy attribute of fruits from Immokalee were best color and vitamin A content. Environment may influence individual components of quality (firmness, acidity, sweetness, color) but when these attributes are considered as a unit (quality index) then overall effect of environment is diminished. Any given environment value consisted of 320 observations (10 cultivars, 8 components of quality, 4 replications). Such an array of values would tend to have a stabilizing effect upon variations.

Although a significant genotype/environment interaction occurred, only main effects have been considered here because the interaction accounted for less than 18% of the variation while environment accounted for 60% and

Table 2. Quality of Florida tomatoes as affected by production environment.

Environment			
Location	Season		Quality index[z]
Ft. Pierce	Spr.	82	43.31 a[y]
Immokalee	Spr.	83	41.64 b
Ft. Pierce	Fall	82	40.11 c
Homestead	Fall	82	39.50 c
Bradenton	Spr.	82	38.02 d
Bradenton	Fall	82	37.81 d
Quincy	Spr.	82	37.21 de
Bradenton	Spr.	83	36.38 e
Gainesville	Spr.	82	36.25 e
F[x]			*

[z]Quality index is a composite measurement of attributes comprising appearance, texture, flavor and nutritional composition.
[y]Means were separated by Duncan's multiple range test, 5% level.
[x]F value was significant at the 5% (*) level.

genotype accounted for only 2%. It is possible that a season (fall vs. spring) aspect was a major contributor to the 18% interaction variation.

General consensus is that fall tomatoes have lower quality as compared to spring tomatoes. In this study spring tomatoes from Ft. Pierce were superior to fall tomatoes but such was not the case for fruits produced at Bradenton. A major difference in fruit quality resulting from these environments was that spring tomatoes were much more firm, sweeter and had a higher total solids content; conversely, fall tomatoes contained more ascorbic acid (vitamin C). More extensive evaluation is needed to establish specifics of environment (season/location) effect upon various quality attributes.

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