STUDIES OF TOMATO QUALITY, IV.[1] VARIABILITY IN QUALITY AND FOOD VALUE OF TOMATOES.

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Fruits are used in the daily diet of practically all American people because of their health-insuring properties, such as vitamines, organic acids and minerals. Since fruits contain from 85 to 95 per cent water, a vary small fluctation in the percentage of water will greatly vary the amount of dry matter and consequently caloric value of the fruit.

Investigations were begun in 1925 to study the quality of tomato fruits, methods of measuring quality, and methods of improving the quality of our present varieties. In order to know the possible variability in composition, analyses were made of 38 individual fruits picked from eight plants. In collecting samples from different experiments for analysis, it was desirable to have some information as to the variability of fruits from the same plant and from different plants throughout the season.

Methods of Analysis. Fruits were collected from eight adjacent plants of the Indiana Baltimore variety which were surrounded on all sides by tomato plants. Boiling alcohol was used to kill and preserve the tomatoes for analysis. This action was hastened by cutting the whole fruits into thin pieces before they were dropped into boiling alcohol. The fruits were preserved in approximately 50 per cent alcohol. Calcium carbonate was not added to the samples, because there seemed to be little or no sucrose present. After a storage of three months, the alcoholic extract and residue of the samples was obtained in the usual manner (1).

Dry Matter. One-twentieth aliquots of the alcoholic extract and residue were placed in evaporating dishes and reduced almost to dryness on a steam bath. The dishes were transferred to a steam oven containing hydrogen and dried for a period of four hours.

Nitrogen. One-tenth aliquots of the extract and residue were placed in a Kjeldahl flask, evaporated to dryness on a steam bath, and the total nitrogen was determined by the official Kjeldahl-Gunning-Arnold method modified to include nitrates (2).

Acidity. One-tenth aliquots of the alcoholic extract were placed in a beaker which had been previously washed with boiled distilled water. The alcohol was expelled by evaporating on a steam bath with the addition of small amounts of distilled water. A one-fifth aliquot of this sample was diluted with 200cc. of boiled and cooled distilled water and tirated with one-tenth normal sodium hydroxide. Phenolphthalein was used as an indicator. The results are expressed as anhydrous citric acid.

[1] See "Literature Cited."

"Proc. Ind. Acad. Sci., vol. 38, 1928 (1929)."

Reducing Sugars. One-tenth aliquots of the alcoholic extract were evaporated on a water bath with the addition of distilled water until all the alcohol had disappeared. The solution was cleared by means of neutral lead acetate and de-leaded with sodium carbonate. Phenolphthalein was used to indicate when the solution was completely de-leaded. The Munson and Walker conditions were used in reduction. The amount of reduced copper was determined by the Shaffer and Hartman titration method (3).

Fruit Solids. Quality of tomatoes must be confined to compounds and relations between the compounds found in the dry matter or solids of the fruit. The solids contain many desirable characteristics;—(1) the bright red color, (2) the flavor which is due to the sugar and acid ratio as well as the volatile oils and perhaps esters of organic acids, (3) the calories, and (4) vitamines of the tomato.

A tomato with a high percentage of dry matter is very desirable from several standpoints. The fruit is sold either on a weight or volume basis, therefore the percentage of dry matter greatly affects the cost of each unit of food. The characteristic tomato flavors are more concentrated in fruits of low water content. The percentage of dry matter is very important for canning factories purchasing fruit for the manufacture of tomato pulp. Tomatoes are purchased from the farmers on a fresh weight basis, while the pulp is sold for use in soup and with baked beans on a water-free basis or at a definite specific gravity. Evidently the canner is buying his fruit without regard to water content and selling his finished produuct with a stated amount of water in it. Necessarily his margin of profit must be great enough to take care of the shrinkage.

Variability in Composition. Tomatoes are very variable in composition with respect to the percentage of dry matter as well as the organic compounds determined (Table I or II). It was hoped at first that these data could be used to estimate the number of fruits necessary for an adequate sample for chemical analysis. After a frequency graph was prepared from these data, the number of fruits who too limited to make such an analysis of any benefit. The only uniform results which can be observed were the greater acidity of fruits late in the season and consistent differences in composition of fruits ripened on different plants.

Heredity of the Plant and Fruit Composition. Although the number of fruits from each plant is small for statistical analysis, it was thought worth while to determine whether there was a significant difference in organic content of fruits from the different plants. No data are available on this point for tomatoes. Any information on these points should be of great importance in selection work for the improvement of varieties.

The mean for all fruits from each plant was determined by the usual statistical methods. After these mean values had been determined, the plant in every case containing the lowest value was compared with the other plants. This method was followed to insure a uniform method of comparison.

Tomato fruits from these plants according to Tables II, III, IV, and V, differ quite frequently in dry matter and acid content, only rarely in nitrogen, and never in sugar content. As the tables show, the odds in many of these comparisons is very high when one considers that odds of 22 to 1 are usually considered significant. According to these data, selection could not be satisfactorily used to increase the sugar content of fruits. If a sweeter fruit is very desirable the most logical point of attack would be to select fruits of a lower acid content as this will result in a fruit of a sweeter taste. Sugar has a marked effect on the taste of acids. Canners at the present time are in need of a variety of tomatoes of high dry matter content. Although environmental factors very likely affect the dry matter content of tomatoes, the results indicate that selection might be used advantageously to decrease the water content of the fruits.

SUMMARY.

1. Tomato plants produce fruits that are variable in composition, food value, and quality.

2. The small amount of data presented here seems to indicate that heredity of a tomato plant may be partly responsible for the variation in composition.

TABLE I. Variablilty in Composition of Tomatoes of the Same Variety.

	Dry Matter	Nitrogen	Acidity	Reducing Sugars
Maximum Percentage	10.62	5.72	11.63	45.70
Minimun Percentage	6.00	1.74	3.28	32.38
Average Percentage	7.56	2.62	6.76	39.93

TABLE II. A Statistical Analysis of Percentage of Dry Matter in the Fruits From Eight Tomato Plants.

Plant No.	Mean	Probable Error	Comparison based on Plant 2	Difference of Means	P. E. of difference	Odds Significant
2	6.36	.066				
3	7.88	.148	2-3	1.52	.152	in* to 1
4	6.90	.145	2-4	.54	.157	45 to 1
5	6.93	.169	2-5	.57	.179	31 to 1
6	7.95	.338	2-6	1.59	.343	520 to 1
7	9.15	.371	2-7	2.79	.376	427,000 to 1
8	8.62	.229	2-8	2.26	.236	in* to 1
9	7.05	.096	2-9	.69	.113	19,300 to 1

*Odds are at least 65,000,000,000 to 1.

TABLE III. A Statistical Analysis of Percentage of Nitrogen in the Fruits from Eight Tomato Plants.

Plant No.	Mean	Probable Error	Comparison based on Plant 4	Difference of Means	P. E. of difference	Odds significant
2	2.77	.035				
3	3.08	.090	4-2	.40	.067	19,300 to 1
4	2.37	.058	4-3	.71	.106	19,300 to 1
5	2.42	.068	4-5	.05	.089	1 to 1
6	2.57	.099	4-6	.20	.114	3 to 1
7	2.77	.138	4-7	.40	.149	14 to 1
8	2.49	.141	4-8	.12	.149	1 to 1
9	2.50	.118	4-9	.13	.131	1 to 1

TABLE IV. A Statistical Analysis of Percentage of Acidity in the Fruits from Eight Tomato Plants.

Plant No.	Mean	Probable Error	Comparison based on Plant 2	Difference of Means	P. E. of difference	Odds significant
2	5.25	.066				
3	8.75	.064	2-3	3.50	.011	in* to 1
4	5.25	.064	2-4	0.0	.091	0 to 1
5	7.15	.081	2-5	1.90	.104	in* to 1
6	6.35	.063	2-6	1.10	.090	in* to 1
7	8.35	.386	2-7	3.10	.123	in* to 1
8	8.50	.799	2-8	3.25	.253	in* to 1
9	5.50	.380	2-9	.25	.122	5 to 1

*Odds are at least 65,000,000,000 to 1.

TABLE V. A Statistical Analysis of Percentage of Sugar in the Fruits from Eight Tomato Plants.

Plant No.	Mean	Probable Error	Comparison based on Plant 9	Difference of Means	P. E. of difference	Odds significant
2	41.0	1.14	9-2	2.2	1.79	1.4 to 1
3	39.5	1.00	9-3	0.7	1.71	1 to 1
4	42.0	.76	9-4	3.2	1.59	18 to 1
5	39.8	.90	9-5	1.0	1.66	1 to 1
6	39.4	.70	9-6	0.6	1.56	1 to 1
7	39.4	.46	9-7	0.6	1.47	1 to 1
8	41.5	1.00	9-8	2.7	1.71	2.6 to 1
9	38.8	1.39				

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