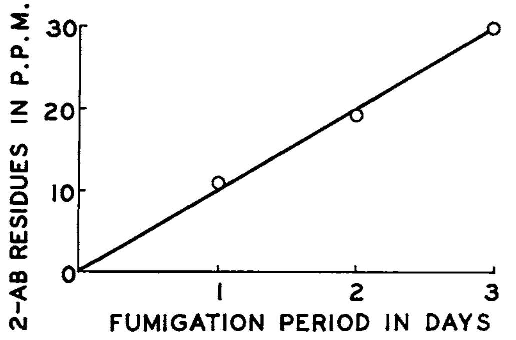

Fig. 6.—Residues of 2-aminobutane in 'Murcotts' which had been stored for 3 weeks at 70° F after fumigation for 1, 2, or 3 days at 60° F by addition of 20 ml of 2-AB to the cabinet each morning.

effects of treatment conditions on residues for both fumigation and dipping methods.

LITERATURE CITED

1. Anonymous. 1965. Temporary experimental tolerance for 2-aminobutane in apples, lemons and oranges. Fed. Reg. 30: 14,386.
2. Anonymous. 1966. Extension of temporary experimental tolerance for 2-aminobutane in apples, lemons and oranges. Fed. Reg. 31: 14,851.
3. Eckert, J. W. and M. J. Kolbezen. 1962. Control of penicillium decay of citrus fruits with 2-aminobutane. Nature. 194: (4831) 888-9.
4. Eckert, J. W., M. J. Kolbezen, and A. J. Kraght. 1966. 2-aminobutane treatments for control of citrus fruit decay. Calif. Citrograph. 52:(1) 2.
5. McCornack, A. A. and G. E. Brown. 1965. 2-aminobutane; a possible new fungicide for decay control of Florida citrus fruit. Proc. Fla. State Hort. Soc. 78: 288-92.
6. Nichols, M. S. 1938. Lift pump gas absorber. U. S. Public Health Repts. 53: 538.
7. Scherberger, R. F., F. A. Miller, and D. W. Fassett. 1960. Determination of butylamine in air. Am. Ind. Hyg. Assoc. J. 6: 471-4.

INSTRUMENTAL AND VISUAL METHODS FOR MEASURING ORANGE JUICE COLOR[1]

R. W. BARRON, M. D. MARAULJA AND R. L. HUGGART

Florida Citrus Commission
University of Florida Citrus Experiment Station
Lake Alfred

ABSTRACT

Visual color scores, using the USDA orange juice color standards, were obtained for 428 samples of commercial frozen concentrated orange juice packed during the 1965-66 and 1966-67 citrus seasons. The redness and yellowness of the reconstituted orange juices were also measured using a Hunterlab Citrus Colorimeter and a Hunter Color Difference Meter. Frequency distributions, ranges and mean values for the color measurements are presented.

Data were statistically analyzed. Highly significant simple correlations were found between the visual color scores and each of the color values, determined by both instruments, except for that when the Hunter Color Difference Meter yellowness values were used. Better correlations resulted when the Hunterlab Citrus Colorimeter readings were used than those obtained from the Hunter Color Difference Meter values.

Identical multiple correlation coefficients of 0.99 were found between the visual color scores and the redness and yellowness values determined with both instruments. Corresponding coefficients of determination were 0.98 indicating that 98% of all variations in the visual color scores of reconstituted orange juices can be explained by variations in the redness and yellowness of the juices.

INTRODUCTION

Visual color scores have been included in United States Standards for grades of canned and concentrated orange juice for many years (7, 8). Huggart and Wenzel (1, 2) used the Hunter Color Difference Meter for measuring color differences of citrus juices and concentrates. With financial assistance from the Florida Citrus Commission, Hunter Associates Laboratory, Inc., designed and built in 1963 a prototype citrus colorimeter, model E45. This experimental instrument was evaluated by Huggart, Barron and Wenzel (4). Subsequently, the Hunterlab, model D45, Citrus Colorimeter was developed (5) and became available for use in

[1]Cooperative research by the Florida Citrus Commission and the Florida Citrus Experiment Station.

quality control laboratories of citrus processing plants.

During the 1965-66 and 1966-67 citrus seasons, visual color scores of over 400 samples of reconstituted frozen concentrated orange juice were determined. The color of these products was also measured using both the Hunterlab Citrus Colorimeter and Hunter Color Difference Meter. The purpose of this paper is to report simple and multiple correlations found between visual color scores and the redness and yellowness values determined by both instruments. Also, frequency distributions, ranges and mean values are presented for all of the color measurements made.

Experimental Procedures

Frozen concentrated orange juice samples.—Products used in this study were collected semimonthly during the 1965-66 and 1966-67 citrus seasons from 25 commercial Florida plants. Midseason concentrates were packed from approximately December 15 to March 15, inclusively, and the late season samples thereafter and through June 15.

Visual color scores.—Each of the authors and one other staff member, individually, determined the visual color scores of the reconstituted orange juices. Each juice was filled into 1-inch-OD clear glass, screw cap culture tubes. The color of the juice was scored by comparing it, according to specified procedures, with that of four plastic USDA Orange Juice Color Standards (9, 10). By so doing, color scores of 36 through 40 were obtained. The tube containing the juice and the plastic Color Standards were viewed together in a Macbeth Examolite daylight model EBA-220 with a rated color temperature of 7400° Kelvin. The means of the total points given by the judges to each juice were used in the statistical analyses.

Color measurements.—The redness and yellowness of the reconstituted juices were measured, as previously reported (1, 2, 3, 5), using a Hunterlab Citrus Colorimeter (HCC) and a Hunter Color Difference Meter (HCDM). When measuring the color of orange juice, the CR scale of the HCC and the "a" scale of the HCDM indicate redness and the respective CY and "b" values indicate yellowness.

Statistical analyses.—Simple and multiple correlation coefficients were calculated between visual color scores of the reconstituted orange juices and the HCC and HDCM values. Least squares and short-cut grouping methods, as outlined by Kramer and Twigg (6), were used.

Results and Discussion

Frequency distribution of visual color scores. It is generally known that the color of late season frozen concentrated orange juices is better than that in concentrates packed during the midseason. This is again evident from the frequency distribution of visual color scores for reconstituted midseason and late season samples of com-

Table 1. Frequency distribution of visual color scores for reconstituted midseason and late season samples of commercial frozen concentrated orange juice packed during two citrus seasons.

Visual color scores	1965-66 Mid	1965-66 Late	1966-67 Mid	1966-67 Late
	No. of samples		No. of samples	
	114	94	118	102
	% of samples		% of samples	
40	-	11.7	-	-
39	3.5	57.4	-	33.3
38	7.1	27.6	3.4	55.9
37	44.7	2.2	48.3	10.8
36	44.7	1.1	48.3	-

mercial frozen concentrated orange juice (Table 1), since the late season products were given the higher color scores. Also, it indicates that the color of the 1965-66 concentrates was better than that in products packed during the 1966-67 season.

Frequency distribution of color measurements.—The frequency distribution of the CR and CY values of the Hunterlab Citrus Colorimeter (HCC) for the reconstituted frozen concentrated orange juices are shown in Table 2 and that for the "a" and "b" values of the Hunter Color Difference Meter (HDCM) in Table 3. The redness, as measured by both instruments, was greater in the late season juices. Distributions of the CY values (Table 2) show that the yellowness was also greater in the late season samples packed during both seasons. However, the frequency distributions of the "b" values (Table 3) indicate that the yellowness was greater in the 1965-66 late season concentrates but less in the late season samples packed during the 1966-67 season.

The ranges and means for the HCC and HCDM redness and yellowness values for the 428 reconstituted orange juices are listed in Table 4.

Statistical analysis.—Simple correlation coefficients (r) between the visual color scores and the redness or yellowness values, measured by both instruments, for the midseason and late season samples are presented in Table 5. All of the coefficients between the visual color scores and the HCC - CR or CY values and the HCDM "a" values were significant at the 99% level of

Table 2. Frequency distribution of Hunterlab Citrus Colorimeter redness and yellowness values for reconstituted midseason and late season samples of commercial frozen concentrated orange juice packed during two citrus seasons.

	1965-66		1966-67	
	Mid	Late	Mid	Late
Redness values - CR	No. of samples		No. of samples	
	114	94	118	102
	% of samples		% of samples	
43-45	0.9	25.6	-	6.9
40-42	3.6	40.3	-	44.2
37-39	3.5	26.5	1.7	35.2
34-36	25.3	5.4	10.1	10.7
31-33	42.1	2.2	51.7	3.0
28-30	21.9	-	33.1	-
26-27	2.7	-	3.4	-
Yellowness values - CY				
88-89	-	10.7	-	2.0
86-87	2.7	37.1	-	11.8
84-85	5.2	27.6	1.7	37.2
82-83	17.5	22.4	5.0	38.2
80-81	32.4	-	33.1	5.9
78-79	33.4	1.1	42.3	4.9
76-77	7.7	1.1	17.0	-
74-75	0.9	-	0.9	-

Table 3. Frequency distribution of Hunter Color Difference Meter redness and yellowness values for reconstituted midseason and late season samples of commercial frozen concentrated orange juice packed during two citrus seasons.

	1965-66		1966-67	
	Mid	Late	Mid	Late
Redness	No. of samples		No. of samples	
values - "a"	114	94	118	102
	% of samples		% of samples	
0.0 to -0.9	-	4.3	-	-
-1.0 to -1.9	1.8	27.6	-	5.9
-2.0 to -2.9	2.6	40.4	-	41.2
-3.0 to -3.9	12.3	21.3	1.7	42.1
-4.0 to -4.9	29.8	6.4	12.7	9.8
-5.0 to -5.9	45.6	-	42.4	1.0
-6.0 to -6.9	7.9	-	37.3	-
Less than -6.9	-	-	5.9	-
Yellowness values - "b"				
33.0 - 33.9	1.8	11.7	0.9	-
32.0 - 32.9	16.7	46.8	3.4	-
31.0 - 31.9	29.8	36.2	0.9	1.0
30.0 - 30.9	22.8	5.3	11.0	4.9
29.0 - 29.9	26.3	-	25.4	17.8
28.0 - 28.9	2.6	-	40.6	44.0
27.0 - 27.9	-	-	14.4	27.4
26.0 - 26.9	-	-	3.4	4.9
25.0 - 25.9	-	-	-	-

confidence. However, only one of the four correlation coefficients between the HCDM "b" values and the color scores was significant. This was for the midseason 1965-66 samples. Previously, Wenzel and Huggart (11) pointed out that the correlation between the visual color scores and the HCDM "b" values of either orange concentrates or the reconstituted juices was not as good as that between the color scores and the -"a" values.

All of the simple correlation coefficients found when the HCC - CR or CY values were used were greater than those obtained using the HCDM "a" or "b" readings. Also, the CR and CY values are of more practical importance in view of the opinion of Kramer and Twigg (6) that a correlation coefficient of 0.90 or better is an excellent indicator of human evaluation. However, they consider that a correlation coefficient of 0.80 or better is satisfactory for use, although a higher correlation is desirable.

Significant correlation at the 99% level of confidence was found between the HCC - CR and CY values as indicated by simple correlation coefficients of 0.922 and 0.864 when the 1965-66 or 1966-67 redness and yellowness values for the reconstituted juices were used.

Simple correlation coefficients between the HCC - CR and HDCM "a" values and between the HCC - CY and the HCDM "b" values were

Table 4. Ranges and means for Hunterlab Citrus Colorimeter and Hunter Color Difference Meter redness and yellowness values for reconstituted midseason and late season samples of commercial frozen concentrated orange juice packed during two citrus seasons.

Season	No. of samples	Hunterlab Citrus Colorimeter Range	Hunterlab Citrus Colorimeter Mean	Hunter Color Difference Meter Range	Hunter Color Difference Meter Mean
1965-66		Redness values - CR		Redness values - "a"	
Mid	114	26.2-43.6	32.7	-6.8 to -1.4	-4.9
Late	94	32.1-45.2	40.3	-4.6 to -0.4	-2.4
		Yellowness values - CY		Yellowness values - "b"	
Mid	114	74.7-86.8	80.2	28.0-33.2	30.8
Late	94	77.3-88.9	85.1	30.6-33.9	32.1
1966-67		Redness values - CR		Redness values - "a"	
Mid	118	26.2-38.3	31.2	-7.7 to -3.7	-5.8
Late	102	31.0-43.1	39.0	-5.0 to -1.4	-3.0
		Yellowness values - CY		Yellowness values - "b"	
Mid	118	74.3-84.3	79.0	26.7-33.0	29.0
Late	102	77.7-87.9	83.5	26.3-31.1	28.3

0.843 and −0.074, respectively, when the 1966-67 data were used. This showed significant correlation only between the redness values as measured by both instruments.

Using only the data obtained from the examination of all of the 1966-67 concentrates, multiple correlation coefficients (R) were calculated between the visual color scores and both the HCC-CR and CY and the HCDM "a" and "b" values. Unexpectantly, these multiple correlation coefficients were found to be practically identical. When the Hunterlab Citrus Colorimeter readings

Table 5. Simple correlation coefficients between visual color scores and Hunterlab Citrus Colorimeter and Hunter Color Difference Meter redness and yellowness values for reconstituted midseason and late season samples of commercial frozen concentrated orange juice packed during two citrus seasons.

	1965-66		1966-67	
	Mid	Late	Mid	Late
	No. of samples		No. of samples	
	114	94	118	102
HCC values	Hunterlab Citrus Colorimeter			
Redness - CR	0.855**	0.799**	0.746**	0.800**
Yellowness - CY	0.880**	0.834**	0.640**	0.616**
HCDM values	Hunter Color Difference Meter			
Redness - "a"	0.718**	0.580**	0.463**	0.629**
Yellowness - "b"	0.492**	-0.020	-0.076	-0.177

** Significant at 99% level of confidence.

were used, the coefficient was 0.994 as compared to 0.993 obtained by using the Hunter Color Difference Meter values. The corresponding coefficients of determination (R^2) were 0.988 and 0.986 which indicate that over 98% of all variations in the visual color scores can be explained by variations in the redness and yellowness of the reconstituted juices.

ACKNOWLEDGMENTS

Thanks are expressed to all of the companies in Florida who furnished samples of frozen concentrated orange juice used to obtain the data presented in this report.

The assistance of Ben Wood in the summation of data and calculations necessary for this study was appreciated.

LITERATURE CITED

1. Huggart, R. L. and F. W. Wenzel. 1954. Measurement and control of color of orange concentrate. Proc. Florida State Hort. Soc. 67: 210-216.

2. Huggart, R. L. and F. W. Wenzel. 1955. *Color* differences of citrus juices and concentrates using the Hunter Color Difference Meter. Food Technol. 9: 27-29.

3. Huggart, R. L., F. W. Wenzel and R. W. Barron. 1965. A nomograph relating subjective and objective methods for measuring color of Florida orange juices. Proc. Florida State Hort. Soc. 78: 219-222.

4. Huggart, R. L., R. W. Barron and F. W. Wenzel. 1966. Evaluation of Hunter citrus colorimeter for measuring the color of orange juices. Food Technol. 20: 109-111.

5. Hunter, Richard S. 1967. Development of the citrus colorimeter. Food Technol. 21: 100-105.

6. Kramer, Amihud and Bernard A. Twigg. 1966. Fundamentals of quality control for the food industry. Second Edition, The Avi Publishing Company, Inc., Westport, Connecticut. 541 p.

7. USDA. 1950. U. S. Standards for grades of canned orange juice. Agr. Marketing Service, Washington, D. C.

8. USDA. 1955. U. S. Standards for grades of frozen concentrated orange juice. Agr. Marketing Service, Washington, D. C.

9. USDA. 1963. Scoring color of orange juice products with the USDA 1963 orange juice color standards. Agr. Marketing Service, Washington, D.C.

10. USDA. 1964. U. S. Standards for grades of frozen concentrated orange juice. Agr. Marketing Service, Washington, D. C.

11. Wenzel, F. W. and R. L. Huggart. 1962. Relation between Hunter color-difference meter values and visual color of commercial frozen concentrated orange juice. Proc. Florida State Hort. Soc. 75: 331-336.

TOTAL AND NITRATE NITROGEN AND SOLIDS CONTENT OF PROCESSED TOMATOES AS AFFECTED BY FERTILITY AND VARIETY

JOHN HAL JOHNSON

Department of Food Science
University of Florida
Gainesville

AND

PAUL G. ORTH

Sub-Tropical Experiment Station
Homestead

ABSTRACT

Two varieties of tomatoes Homestead 24 (H24) and Tropi-Red (TR), were grown under eight fertilization treatments at Homestead, Florida. Two levels each of nitrogen (N), phosphorous (P), and potassium (K) were applied. The fruit was composited according to treatment, processed, and analyzed for nitrate-nitrogen (NO_3–N), total N, and solids. NO_3–N in H24 increased with increased N, P, and K levels. However, TR increased in NO_3–N with increased K at the lower level of N but decreased in NO_3–N with increased K at the higher level of N. TR NO_3–N was not affected by the higher level of P. Mean NO_3–N values of 43.0 and 29.3 ppm were obtained for H24 and TR, respectively. The NO_3N values were reduced by two-thirds and extensive internal tinplate corrosion developed during seven months storage of the processed fruit.

Increased N fertilization caused an increase in total N with both varieties. With few exceptions, however, increased fertilization resulted in lower solids. Mean values for total N and solids were 113 and 149 mg N/100 gm and 4.80 and 5.49 percent for H24 and TR, respectively. The total N/NO_3–N ratio decreased with increased fertilization of H24 but not with TR. Mean ratio values of 118 and 233 were obtained for H24 and TR, respectively.

INTRODUCTION

High fertilization levels are variously utilized by plants. Nitrate nitrogen may be reduced to

Florida Agricultural Experiment Stations Journal Series No. 2784.