



Fruit and Vegetable Program
Specialty Crops Inspection (SCI) Division

SUBJECT: Tomato Products Spectrophotometer Studies

In March 2008 Processed Products Branch (PPB) in cooperation with the University of California, Davis (UCD) completed a study of the Minolta Konica CR410 spectrophotometer for use in the evaluation of "color" in tomato products. The study was initiated to consider additional instruments for approval at the request of instrument suppliers. PPB currently maintains a list of approved instruments including the Hunter Lab D25-D2 series; Agtron M400, M500, and E5M Colorimeters; and BYK Gardner models XL20, XL23, XL-805, and Colorgard 2000/05.

The study compared the Hunter Lab Scan XE from Hunter Lab and the UCD reference spectrophotometer (Hunter Lab Scan 5100) to the Minolta Konica model number CR410.

Samples of commercially prepared tomato products were purchased from grocery stores in the Davis, Sacramento, Vacaville, CA and Reston, VA areas. The illuminant used for the color study was CIE illuminant C. The standard observer was 1931, 2 degrees Standard Observer.

As a result of the study and determinations made by PPB, the following spectrophotometers and the equations associated with each instrument are approved for the calculation of the color score for products covered by the U.S. Standards for Grades of Canned Tomato Sauce, Tomato Juice, Tomato Juice from Concentrate, Tomato Paste, Tomato Puree, Concentrated Tomato Juice, and Tomato Catsup.

Minolta Konica model number CR410

Tomato Sauce Score: TSS = -51.231 + 1.463 a + 13.986 b - 1.021 b²

Tomato Catsup Score: TCS = -50.28 + 9.956 a - 0.263 a² - 2.76 b

Tomato Juice Score: TJS = 25.51 + 1.406 a - 2.97 b

Tomato Paste and Puree Score: TPS = -1.345 + 1.253 a + 7.733 b - 0.574 b²

where a and b are from Hunter L, a, b values.

BYK Gardner Color View

Tomato Sauce Score: TSS = -227.607 + 1.154 a + 33.615 b - 1.278 b²

Tomato Catsup Score: TCS = -59.387 + 5.635 a - 0.0990 a² + 0.414 b

Tomato Juice Score: TJS = 95.652 + 0.956 a - 11.840 b + 0.379 b²

Tomato Paste and Puree Score:

TPS = -2.63270 + 13.822 log b - 7.422 log L + 0.0234 a - 1.002 b + 0.295 L

where L, a, and b are readings reported by the instrument.

HunterLab ColorFlex 4500L

Tomato Sauce Score: TSS = -153.100 + 1.187 a + 22.332 b - 0.864 b²

Tomato Catsup Score: TCS = -80.888 + 8.355 a - 0.144 a² - 1.194 b

Tomato Juice Score: TJS = 25.963 + 0.989 a - 1.787 b

Tomato Paste and Puree Score: TPS = -81.582 + 1.069 a + 15.390 b - 0.591 b²

where a and b are readings reported by the instrument.

Hunter D25A-9000

Tomato Sauce Score: TSS = -180.263 + 1.145 a + 26.413 b - 1.012 b²

Tomato Catsup Score: TCS = -99.999 + 9.532 a - 0.166 a² - 0.936 b

Tomato Juice Score: TJS = 25.715 + 0.956 a - 1.748 b

Tomato Paste and Puree Score: TPS = -58.296 + 1.093 a + 12.120 b - 0.480 b²

where a and b are readings reported by the instrument.

Hunter Lab Scan XE

Tomato Sauce Score: TSS = -149.176 + 1.139 a + 21.608 b - 0.826 b²

Tomato Catsup Score: TCS = -81.964 + 8.321 a - 0.142 a² - 1.129 b

Tomato Juice Score: TJS = 25.114 + 0.939 a - 1.638 b

Tomato Paste and Puree Score: TPS = -40.926 + 1.061 a + 9.473 b - 0.376 b²

where a and b are readings reported by the instrument.

The following equations are used for the calculation of color score for the previously approved colorimeters for tomato products. 1/

Hunter D25-D2 Colorimeter

Tomato Sauce Score: TSS = -154.39 + 1.1142 a + 22.596 b - 0.86736 b²

Tomato Catsup Score: TCS = -74.937 + 7.5172 a - 0.1278 a² - 0.8051 b

Tomato Juice Score: TJS = 29.600 + 0.8835 a - 1.8553 b

Tomato Paste and Puree Score: TPS = -46.383 + 1.0211 a + 10.607 b - 0.42198 b²

where a and b are readings reported by the instrument.

Agtron M400 and M500 Colorimeters

Tomato Sauce Score (tentative): TSS = -25.002 + 1.5234 R - 0.0092174 R² - 0.25817 G

Tomato Catsup Score (tentative): TCS = -5.3411 + 1.0309 R - 0.00745 R² - 0.15663G

Tomato Juice Score: TJS = 28.629 + 0.1428 R - 0.24197 G + 0.14176 B

Tomato Paste and Puree Score: TPS = 20.850 + 0.828 R - 0.004335 R² - 0.283 G + 0.312 B

R = Red, G = Green, B = Blue

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These equations are based on Hunter a and b values referenced in the initial study by USDA at UC Davis entitled, "[Color Scoring Tomato Color Measure](#)", by George Marsh, James Buhlert, Sherman Leonard, Teri Wolcott and Julie Heil, Dept. of Food Science and Technology, University of California, Davis, July 15, 1980.

Agtron E5M Colorimeters

Tomato Sauce Score (tentative): TSS = 38.936 - 0.45231(E5M Reading)

Tomato Catsup Score: TCS = No equation is available for an accurate color score for catsup.

Tomato Juice Score: TJS = 40.898 - 0.35759 (E5M reading)

Tomato Paste and Puree Score: TPS = 54.250 - 0.005265 (E5M Reading)²

For Tomato Paste and Puree having a brown or burnt visual appearance the Agtron E5M meter reading yields accurate “substandard” scores.

BYK Gardner XL20, XL23, XL-805, and Colorgard 2000/05 Colorimeters

Tomato Sauce Score (tentative): TSS = -193.20 + 1.0211 a_L + 27.649 b_L - 1.0175 b_L²

Tomato Catsup Score: TCS = -40.511 + 4.7767 a_L - 0.07791 a_L² - 0.56986 b_L

Tomato Juice Score: TJS = 34.094 + 0.71464 a_L - 1.7883 b_L

Tomato Paste and Puree Score: TPS = -46.383 + 1.0211 a_L+ 10.607 b_L - 0.42198 b_L²

where a_L and b_L are readings reported by the instrument.
