# NOTES

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# Hunter *b* Color Measurements of Papaya Using a Two-filter System

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Papaya (*Carica papaya* L.) grown in Hawaii cannot be shipped to the mainland United States or to the markets in Japan without first being treated for possible fruit fly infestation. Currently, the so-called "double-dip" treatment (2) is being used for this purpose. This treatment consists of immersion of the fruit in 42°C water for 30 min, followed by a second immersion in 49° water for 20 min. Since this treatment is only effective in killing organisms near the surface of the fruit, it cannot be used on a fruit that has ripened to the point where insects may have penetrated deeply.

Fruit fly infestation depends on fruit ripeness (3): in nature, mature green and color-break papayas are not found to be infested, and one-quarter-ripe papayas are rarely infested. It is reasonable to conclude that fruit fly infestation, if it occurs, will only be at the surface for relatively green fruit. Quantitatively, the specific regulation for fruit to qualify for the double-dip method is that the blossom end of the fruit should have a Hunter *b* value <23.5, and the yellowest spot on the fruit should have a Hunter *b* value <27.5. The Hunter *b* value is a color index indicating relative yellowing (1). The Hunter color indexes often are used in specifying citrus and other fruit color (4).

In packinghouses, a Hunter colorimeter is used routinely to obtain *b* values for a fruit sample from each batch to be treated. A more efficient system would use an on-line device that measures the color of every fruit. Such devices are commercially available, but only sense light through two detectors rather than recording a complete spectrum, as is done with the Hunter colorimeter. This paper reports that two filters may be chosen, one for each detector, to enable on-line devices to calculate the Hunter *b* values.

We have chosen Corion filters S40-450-F and P70-550-F, designating them filters F and G, respectively. Nineteen standards were used in these measurements, with the color ranging from green to yellow and the Hunter *b* value ranging form 6 to 29. The standards were illuminated and the reflected light detected by an on-line fruit sorting device: a GE1876 lamp and a Hamamatsu R372 photomultiplier. $I_F$ and $I_G$ are, respectively, the photomultiplier currents with filter F and filter G placed in the light path. The Hunter *b* values for each standard were calculated using the empirical equation:

$$b = 7(c_1I_F - c_2I_G) / (c_1I_F)^{1/2} + c_3 + c_4I_F + c_5I_F^2 \quad [1]$$

where constants $c_1$ through $c_5$ are 1.08, 6.4767, 0.644, −0.125, $2.152 \times 10^{-3}$, respectively. Fig. 1 shows the results of *b* calculated form Eq. [1] for each of the 19 colored standards compared with values obtained using the type of colorimeter used in the fruit packinghouses. The agreement is excellent, the correlation coefficient, r, for these 19 pairs of data being 0.9996. We conclude that, in principle, a two-filter on-line Hunter *b* measuring device is possible.

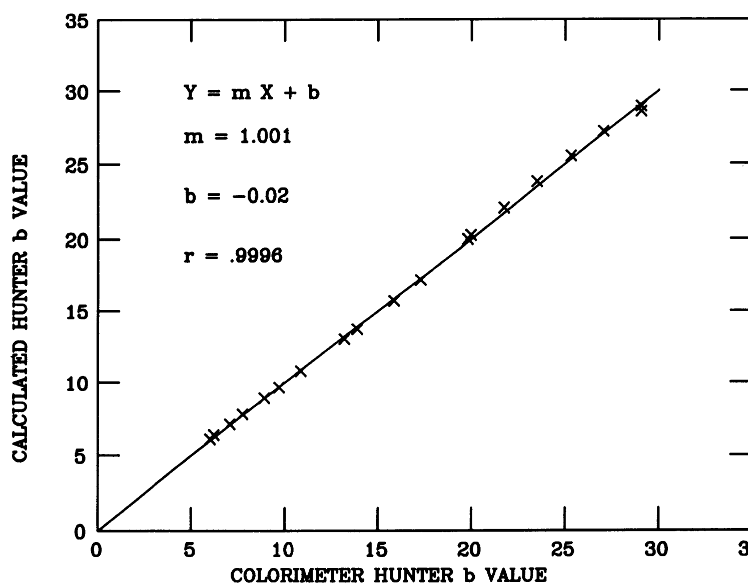


Fig. 1. The Hunter *b* values for 19 color standards as calculated using the two-filter method and Eq. [1] vs. the value from direct measurement using a Hunter colorimeter.

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