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Effect of Cultivars and Weather Change on Hunter 'L,' Hue Angle, and Chroma Values of Red Raspberry Grown in Maine

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Abstract

Hunter 'L,' hue angle and chroma values were compared at the time of harvest in different red raspberry cultivars grown in Maine over three years. 'Killarney' was less dark, more yellow, and was highest in chroma. 'Boyne' was darker, more red than yellow, and was lowest in chroma. In the second year due to environmental changes during the growing season values for Hunter 'L,' hue angle and chroma were significantly ($p \leq 0.05$) changed in raspberry cultivars.

Introduction

Red raspberries (*Rubus ideaus* L.) are grown throughout the temperate regions of the world, and each region has its own distinct cultivars (2). Red raspberries are noted for their attractive color. It is used in blended juices, beverages and other food products for flavor and color (17). Raspberry juice concentrate is an important commercial product (16). The relatively high cost of red raspberry fruit makes red raspberry puree, juice and concentrate of high economic value (14). Color intensity in raspberry fruit affect processing characteristics and consumer acceptance (16). Information on raspberry color at harvest is important for the food processor.

Reports in the literature regarding fresh raspberry color include the study of anthocyanin pigments (14, 16), color changes in fresh red raspberries at different storage temperature (6), and changes in the coloring and total anthocyanin content of raspberry during frozen storage (9, 10). In some instances, processing and storage effect on anthocyanin pigments, color and appearance was a part of these studies (7).

Hunter color parameters have been used to determine the color of berries (1, 4, 7, 12, 13, 16). The major objective of this investigation was to compare the color of different red raspberry cultivars grown in Maine at harvest. A secondary objective was to study the effect of environmental conditions during growing season on raspberry color over three years.

Material and Methods

Source of Fruit:

This study was conducted during three consecutive years (1989, 1990, and 1991). Fresh raspberries of four commonly grown cultivars ('Boyne,' 'Festival,' 'Killarney' and 'Prestige') were obtained from Whistling Wings Farm (Biddeford, Maine). The raspberries were hand-picked between 9:00 to 11:00 AM. Fruit was picked only from the upper canopy and selected on the basis of good overall color and ease of separation from the bush. Ten pints of each cultivar were refrigerated (4-5°C) immediately after harvest at the farm. Raspberries were transported same day to the Department of Food Science and Human Nutrition, University of Maine, Orono, Maine in coolers containing crushed ice. 'Festival' and 'Killarney' were not available in 1990 because of environmental conditions. Cultivars were picked once in every year from the same field for this study.

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Measurement of Color:

In all three years color of fresh raspberries was measured on the day of harvest by weighing one hundred grams of fruit into the colorimeter cup and placing on a Hunter Lab Scan II Spectrocolorimeter (Hunter Associate Laboratory, Inc., Reston, VA). The D_{65} (Northern daylight) source, 25 mm diameter illuminated area and 30 mm in diameter aperture were used to scan the samples. Color was measured as Hunter 'L,' 'a,' and 'b' values. The Hunter 'L' scale ranges from no reflection ('L' = 0, black) to perfect diffuse reflection ('L' = 100, white); the Hunter 'a' scale ranges from green (negative values) to red (positive values), and the Hunter 'b' scale ranges from blue (negative values) to yellow (positive values). All reading was taken in triplicates. The 'a' and 'b' values were used to calculate hue angle and chroma by using the following equations (3).

$$\text{Hue Angle} = 57.3(\text{ATAN}(B/A))$$
$$\text{Chroma} = (A^2 + B^2)^{1/2}$$

Data from three years was analyzed using the analysis of variance (ANOVA) procedure of the Statistical Analysis System (8). All significant testing was done at the 5% significance level.

Results and Discussion

In 1989 and 1991 investigation, Hunter 'L' (lightness index) value for 'Festival' and 'Killarney' fruit was significantly higher ($p \leq 0.05$) than for 'Boyne' and 'Prestige.' 'Boyne' and 'Prestige' were darker in color than the 'Festival' and 'Killarney' at the time of harvest. In 1990 'Boyne' was significantly higher ($p \leq 0.05$) in Hunter 'L' value than 'Prestige.' 'Boyne' was the darkest in color, while 'Killarney' was the lightest in color in 1989 and 1990. In 1990 both cultivars 'Boyne' and 'Prestige' were significantly ($p \leq 0.05$) lighter in color than 1989 and 1991 (Fig. 1).

Hue angle (relationship of a/b) was significantly higher ($p \leq 0.05$) in 'Festival' and 'Killarney' than 'Boyne' and 'Prestige' in 1989 and 1991. Thus 'Boyne' and 'Prestige' were more red than yellow in color than 'Festival' and 'Killarney' in these two years. 'Boyne' and 'Prestige' were significantly ($p \leq 0.05$) higher in hue angle in 1990 than 1989 and 1991. 'Killarney' was less red than

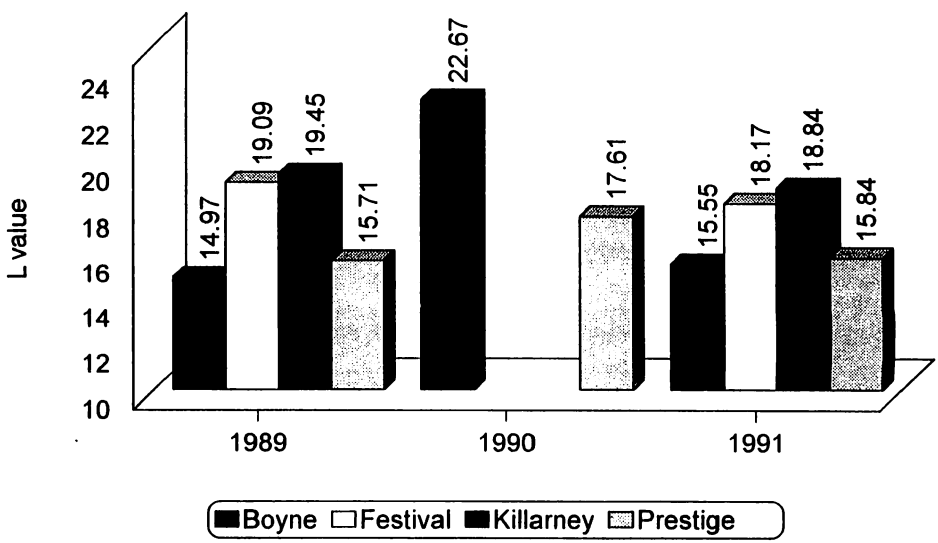

Figure 1. L value of four raspberry cultivars in different years.

yellow in color, while 'Boyne' was more red than yellow in 1989 and 1991. In 1990 'Boyne' had a significantly ($p \leq 0.05$) lower hue angle than 'Prestige' (Fig. 2).

'Boyne' and 'Prestige' had significant less chroma (intensity/saturation of color) than 'Festival' and 'Killarney' fruit in 1989 and 1991. 'Killarney' was the highest in chroma while 'Boyne' was the lowest in chroma among all these cultivars in 1989 and 1991. 'Boyne' and 'Prestige' had significantly higher ($p \leq 0.05$) chroma in 1990 than 1989 and 1991. In 1990 'Boyne' was significantly higher ($p \leq 0.05$) in chroma than 'Prestige' (Fig. 3).

In summary, Hunter 'L' and chroma showed similar trends for 1989 and 1991, but different in 1990, and cultivars differ in similar ways. Hue on the other hand, although statistically different showed only small differences which are probably not meaningful.

Composition of the same cultivar could be influenced by environmental factors such as rainfall and percentage of sunshine during the growing season (15). Mean values for monthly rainfall, temperature and percent possible sunshine during the growing season of raspberries (Table 1) show that average values for rainfall and sunshine percentage was higher during 1989 and 1991. The data might indicate that high rainfall and sunshine percentage during growing season of raspberry would result in lighter and less red than yellow color fruit. Dale (2) also reported that environmental condition could influence different factors contributing to fruit size, fruit set and affect cultivars differently. Delay in harvest increased redness and darkness in strawberries. However maturity level affected only Hunter 'L' value, which resulted in darker fruit with greater maturity (11). During our investigation, 1990 raspberry harvests were made comparatively later than in 1989 and 1991, because of environmental conditions. Other possible reasons for the color variation in the same cultivar could be the amount of organic acids present in raspberry in that season. Organic acids will influence the stability of anthocyanin pigments in the fruit (14). Rainfall and sunshine during the growing season of raspberries has a definite effect on their organic acid contents (5).

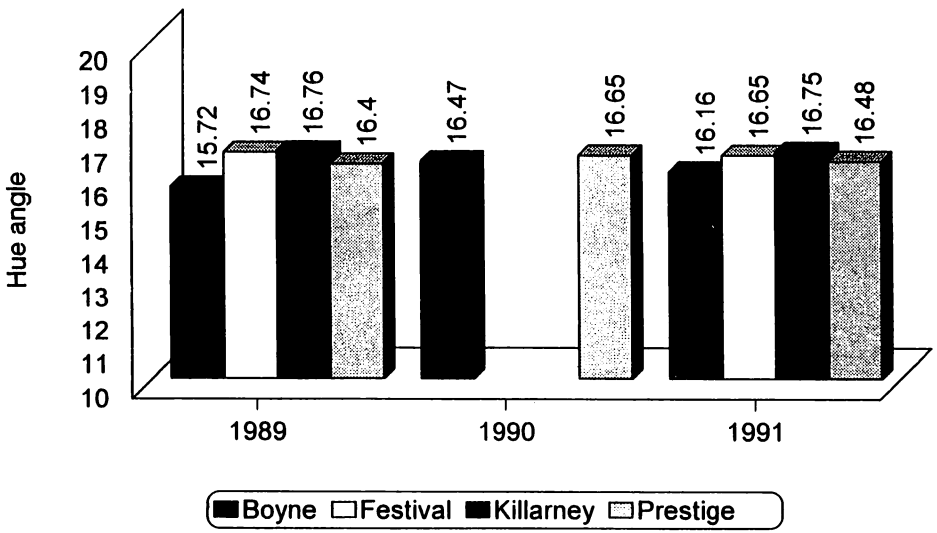

Figure 2. Values for hue angle of four red raspberry cultivars in different years.

Table 1. Average rainfall, temperature and sunshine during growing season of raspberries.[1]

	Avg. rainfall (cm)			Avg. temperature (°C)			Avg. possible sunshine (%)		
Month	1989	1990	1991	1989	1990	1991	1989	1990	1991
May	22.2	13.3	9.6	13.1	11.0	14.5	44	42	59
June	11.4	10.5	3.7	17.7	16.9	18.6	50	49	54
July	6.4	8.2	6.0	20.8	21.3	21.2	64	60	61
August	4.4	4.8	38.7	14.7	21.0	21.1	62	63	58

[1]Data supplied by National Weather Service Forecast Office, Portland International Jetport, Portland, ME.

Knowledge of environmental conditions during the growing season of raspberry will help to determine the changes in color of fruit in that season. Food processors make their decisions on use for a particular cultivar depending on the color of the raspberry. Light red colored fruit may be used in different food products than dark red colored fruit, i.e. for jam rather than juice.

In this study if environmental conditions during growing season were normal, 'Killarney' was lightest, less red than yellow in color, and highest in chroma among the four cultivars tested. 'Boyne' was darkest, more red than yellow, and lowest in chroma value than the other cultivars.

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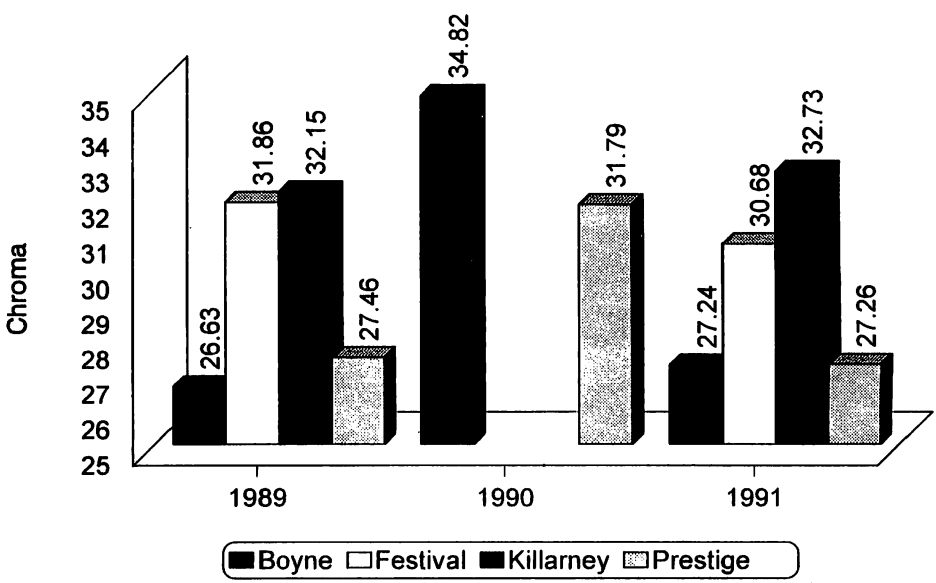

Figure 3. Values for chroma of four raspberry cultivars in different years.

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Seed Number and Berry Nutrition

In both cultivars ('Croatina' susceptible and 'Barbera' resistant to stalk necrosis) the final size and chemical composition of the grape berries were related to their seed number, one seeded berries were smaller than 2-3-4 seeded berries. Ca, Mg and K contents of berries increased with increasing berry seed number, but the seeds had less influence on mineral concentrations per unit of berry weight. In general Ca and Mg concentrations decreased after veraison independently of seed number per berry, whereas K concentration remained constant or increased slightly. K concentration in 'Croatina' berries was higher than in 'Barbera' particularly at ripening. Ca content increased until the berry weighed 0.8 g in 'Croatina' and 1 g in 'Barbera,' up to 0.3 and 0.5 mg per berry respectively and then remained constant until 100 days after anthesis. Final content of Ca was higher in 'Barbera' than in 'Croatina.' K content in both cultivars increased during the entire period of berry growth, whereas Mg content was affected by cultivar. In 'Croatina' it increased moderately until almost 76 days after bloom and then decreased, whereas for 'Barbera' higher content was observed before veraison (2 seeded berries), at verasion (1-3 seeded berries) and soon after veraison (4 seeded berries). From Boselli et al. 1995. J. Hort. Sci. 70(3):509-515.