



### Natural alternatives to the use of color-add Citrus Red No.2



Xiuxiu Sun <sup>a</sup>, Elizabeth Baldwin <sup>a</sup>, Mark Ritenour <sup>b</sup>, Anne Plotto <sup>a</sup>, Jinhe Bai <sup>a\*</sup>  
<sup>a</sup> USDA, ARS, USHRL, 2001 S. Rock Rd, Ft. Pierce, FL 34945  
<sup>b</sup> Indian River Research and Education Center, University of Florida, 2199 S. Rock Rd Ft. Pierce, FL 34945

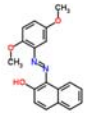
### Introduction


- Orange peel color is an important attribute for consumer product acceptance.
- Oranges such as 'Parson Brown' and 'Hamlin' attain full maturity in terms of interior quality in the early fall, but often with a green colored peel.



### Introduction

- Citrus Red No. 2 (CR2) has been listed by the International Agency for Research on Cancer (IARC) and European Union (EU) as a group 2B carcinogen.
- Therefore, a replacement of CR2 with natural or food grade colorants would benefit the Florida citrus industry.


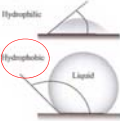




AKA: the color added to citrus peels  
Causes urinary tumors in rats

### Introduction

- **The basic requirements for potential alternatives:**
  - ✓ 1) red and orange colors that produce an acceptable orange color in treated peel
  - ✓ 2) hydrophobic characteristics so that the color can remain on the fruit surface and not transfer to hands, containers or packaging

### Objectives

- Compare the color characteristics and stability of different natural colorants
- Find an alternative dye for color-added citrus fruits

### Materials and Methods

**Natural Colorants**

- Annatto suspension (8% bixin)
- Paprika O/S FANS445
- β-carotene O/S FANS446
- Durabrite<sup>®</sup> carrot oleoresin
- Durabrite<sup>®</sup> paprika oleoresin

Hydrophobic Carotenoid compounds

**Dilutant**

- Pure pine oil

**Wax**

- Carnauba-based, solids content: 24.2 ± 0.5%

**Fruit**

- Orange fruits (*Citrus sinensis* var. Hamlin)

### Color measurements

- CIELAB was used for determining the color coordinates
- Color was expressed as CIE  $L^*$ ,  $a^*$ ,  $b^*$  and  $a^*/b^*$  ratio
- $L^*$ : lightness read from 0 (black) to 100 (white)
- $a^*$ : (+) red color; (-) green color
- $b^*$ : (+) yellow color; (-) blue color
- A larger  $a^*/b^*$  ratio indicates a darker orange color, and is recognized as the preferred color for oranges
- Quantitative discoloration:  $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$  The value indicates a total change of lightness, red/greenness, and yellow/blueness

### Evaluation of colorants by test paper

- 0.5 mL of each colorant (2 ppm in pine oil) solution was dropped on a test paper and casted by using a 4-mil (101.6  $\mu\text{m}$ ) casting tool with a speed of 1  $\text{cm s}^{-1}$ .
- Papers were dried at RT for three hours.
- Color values were measured using a colorimeter and colorants showed comparable redness to CR2 were selected for further evaluation.

The CIELAB results of CR2 and five natural colorants on test paper dried for 3 hours at 23 ° C under 300 Lux of standard fluorescent white light.

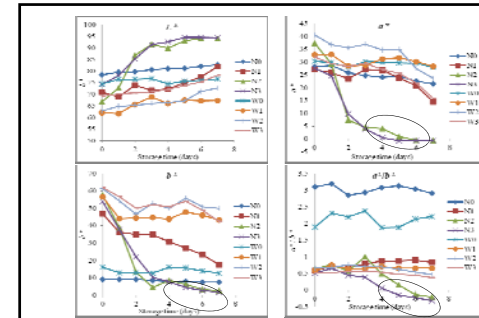
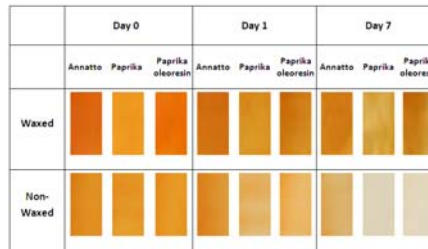
	$L^*$	$a^*$	$b^*$	$a^*/b^*$
CR2	76.82 b #	31.09 c	10.52 c	2.96 a
Annatto	54.30 e	45.57 a	39.44 b	1.16 b
Paprika	67.38 d	36.98 b	56.67 a	0.65 c
$\beta$ -Carotene	87.83 a	-1.96 d	53.14 a	-0.04 e
Carrot oleoresin	88.13 a	-5.09 e	57.35 a	-0.01 e
Paprika oleoresin	72.76 c	30.08 c	55.61 a	0.54 d

# Mean values followed by different letters within a column indicate significant differences using Duncan test ( $p < 0.05$ ). CR2: Citrus Red No. 2.

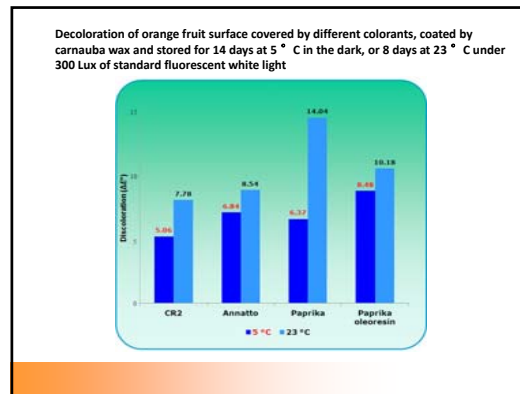
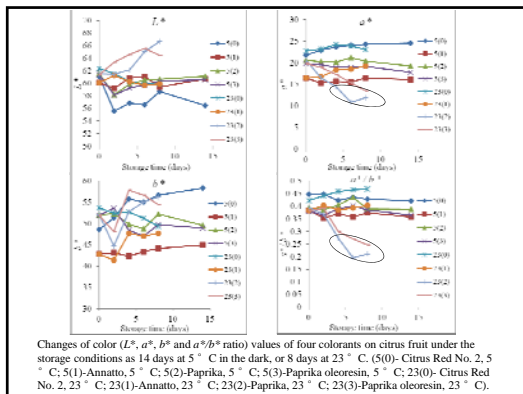
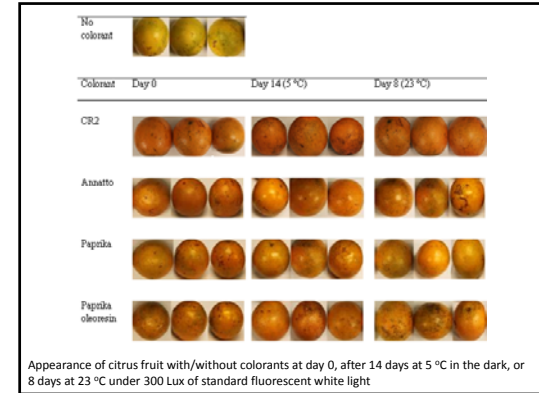
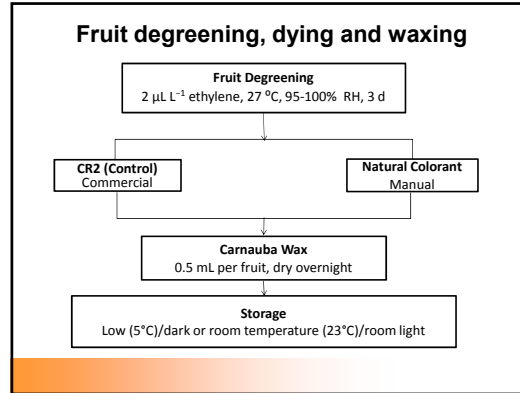
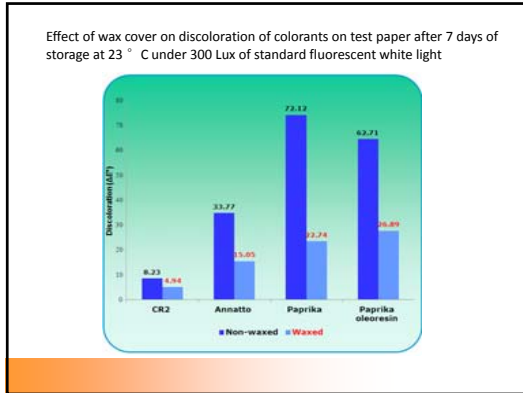
### Evaluation of colorants by test paper

- Test papers with selected colorants were coated with carnauba wax by using a 2-mil (50.8  $\mu\text{m}$ ) casting tool to cover the colorant layer.
- The wax cover was allowed to dry for two hours at RT.
- Color values were measured on the same day, and then at least once per day for up to seven days at room temperature (23 ° C), under 300 Lux of standard fluorescent white light.

### Paper experiment pictures



Changes of color ( $L^*$ ,  $a^*$ ,  $b^*$  and  $a^*/b^*$  ratio) values of four colorants with or without wax covering on test papers over 7 days of storage at 23 ° C (N0-Citrus Red No. 2, non-waxed; N1-Annatto, non-waxed; N2-Paprika, non-waxed; N3-Paprika oleoresin, non-waxed; W0- Citrus Red No. 2, waxed; W1-Annatto, waxed; W2-Paprika, waxed; W3-Paprika oleoresin, waxed)



### Conclusions

- This study investigated the effect of five oil-soluble natural colorants on citrus fruit peel color.
- Test paper and fruit evaluation showed that annatto, paprika and paprika oleoresin exhibited red and orange color when applied to both paper and orange peel.
- Annatto was relatively stable under all conditions and regularly out performed our other natural colorants.
- Annatto would be the most successful replacement of CR2 for use as a natural colorant on citrus fruit.

## Acknowledgement

### Coauthors and cooperators

Dr. Jinhe Bai, USDA, ARS, USHRL  
Dr. Elizabeth Baldwin, USDA, ARS, USHRL  
Dr. Anne Plotto, USDA, ARS, USHRL  
Dr. Mark Ritenour, U. of Florida, IFAS  
Dr. Bob Hagenmaier

### Companies

Food Ingredient Solutions, LLC  
WILD Flavors Inc  
Kalsec



Thank You !