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INTRODUCTION

The color of orange peel is a significant attribute influencing consumer product acceptance. In the subtropical climate of Florida, early season fruits such as ‘Parson Brown’ and ‘Hamlin’ attain full maturity in internal quality during early fall, but often still have green colored peel. Citrus Red II (CR2) is a commercial citrus dye used in Florida, but has been listed by the EU and IARC as a group 2B carcinogen. Therefore, a replacement of CR2 with natural or food grade colorants would benefit the citrus industry. The objectives of this research were to compare the color characteristics and stability of different natural colorants in order to find an alternative dye for color-added citrus fruits.

MATERIALS & METHODS

Orange fruits:

- *Citrus sinensis* var. Hamlin

Colorant, solvent and wax materials:

- Annatto suspension; paprika; β -carotene; Durabrite® carrot oleoresin; Durabrite® paprika oleoresin; Citrus Red No. 2 (CR2, the control); carnauba-based wax; and pure pine oil

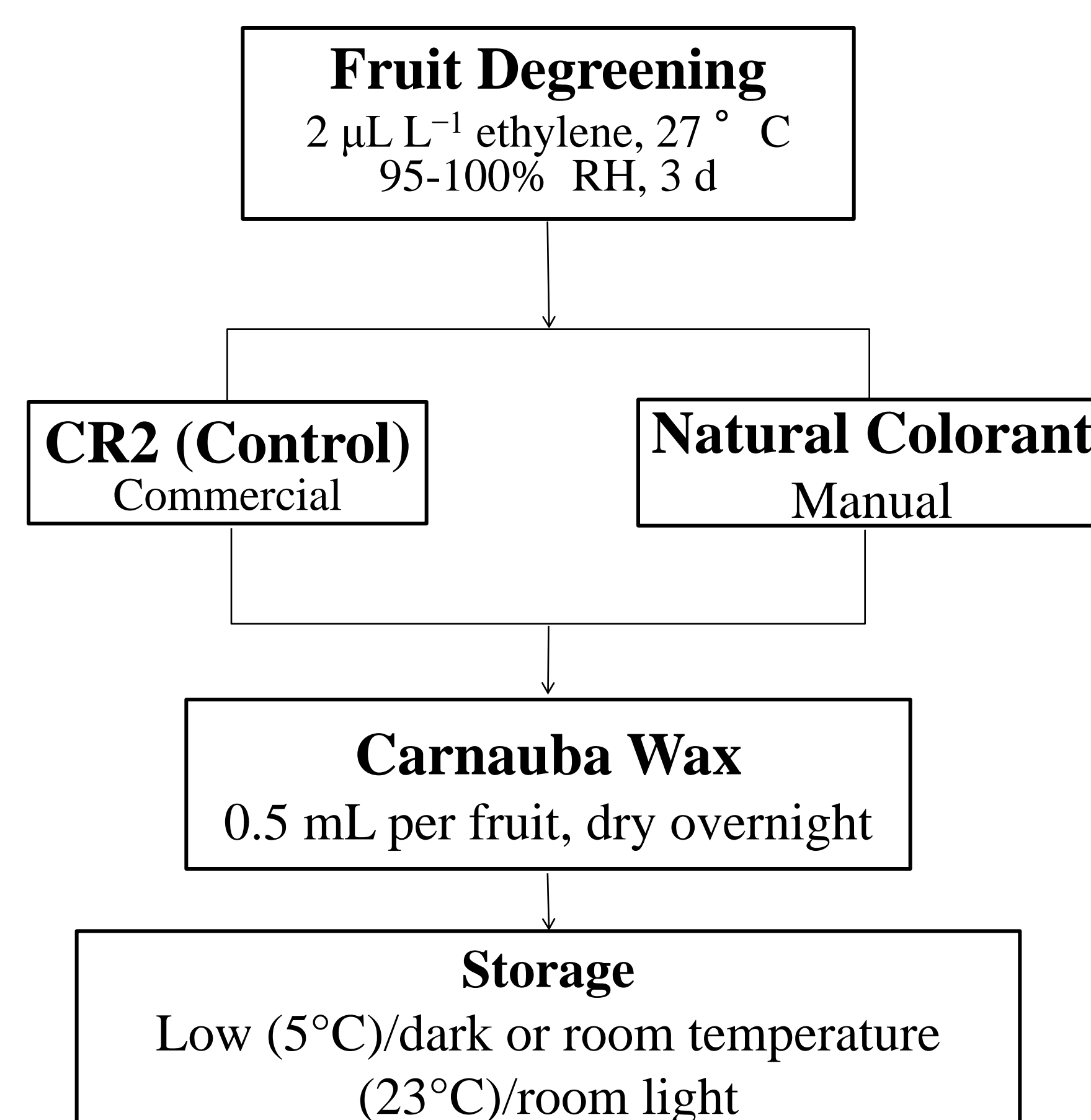
Color measurements:

- CIELAB was used for determining the color coordinates by using a colorimeter

Evaluation of colorants by test paper:

- 0.5 mL of each colorant solution was dropped on a test paper and casted by using a 4-mil casting tool with a speed of 1 cm s⁻¹

Fruit degreening, dying waxing and storage:



RESULTS

Table 1. 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.

Colorant	L*	a*	b*	a*/b*
CR2	76.82 b ^z	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
β -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

Fig. 1. 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 under 300 Lux of standard fluorescent white light.

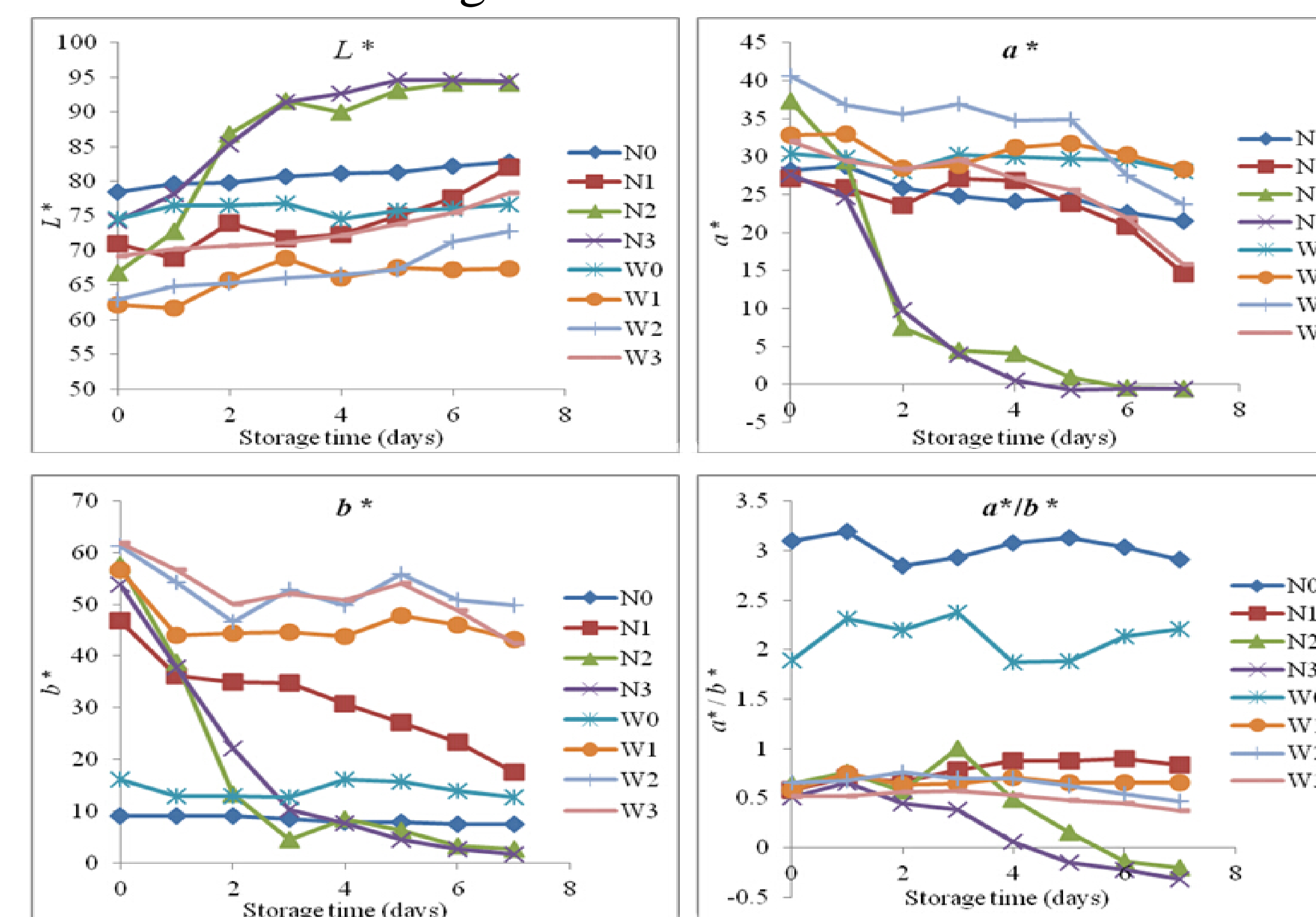
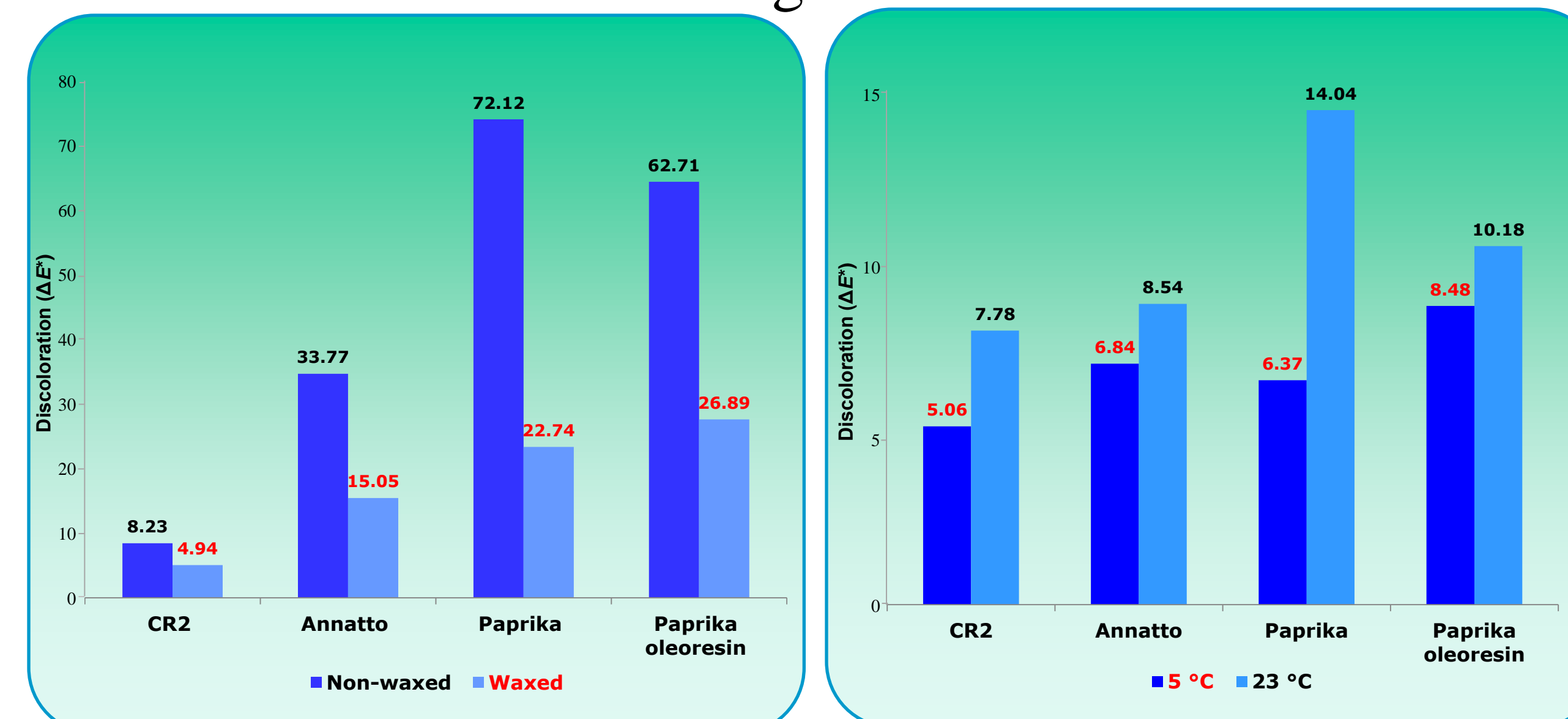


Fig. 2. Effect of wax cover (left) and temperature (right) on discoloration of colorants on test paper under 300 Lux of standard fluorescent white light.



RESULTS

Fig. 3. Changes of color (L*, a*, b* and a*/b* ratio) values of four colorants on citrus fruit over 14 days at 5° C in the dark, or 8 days at 23° C under 300 Lux of white light.

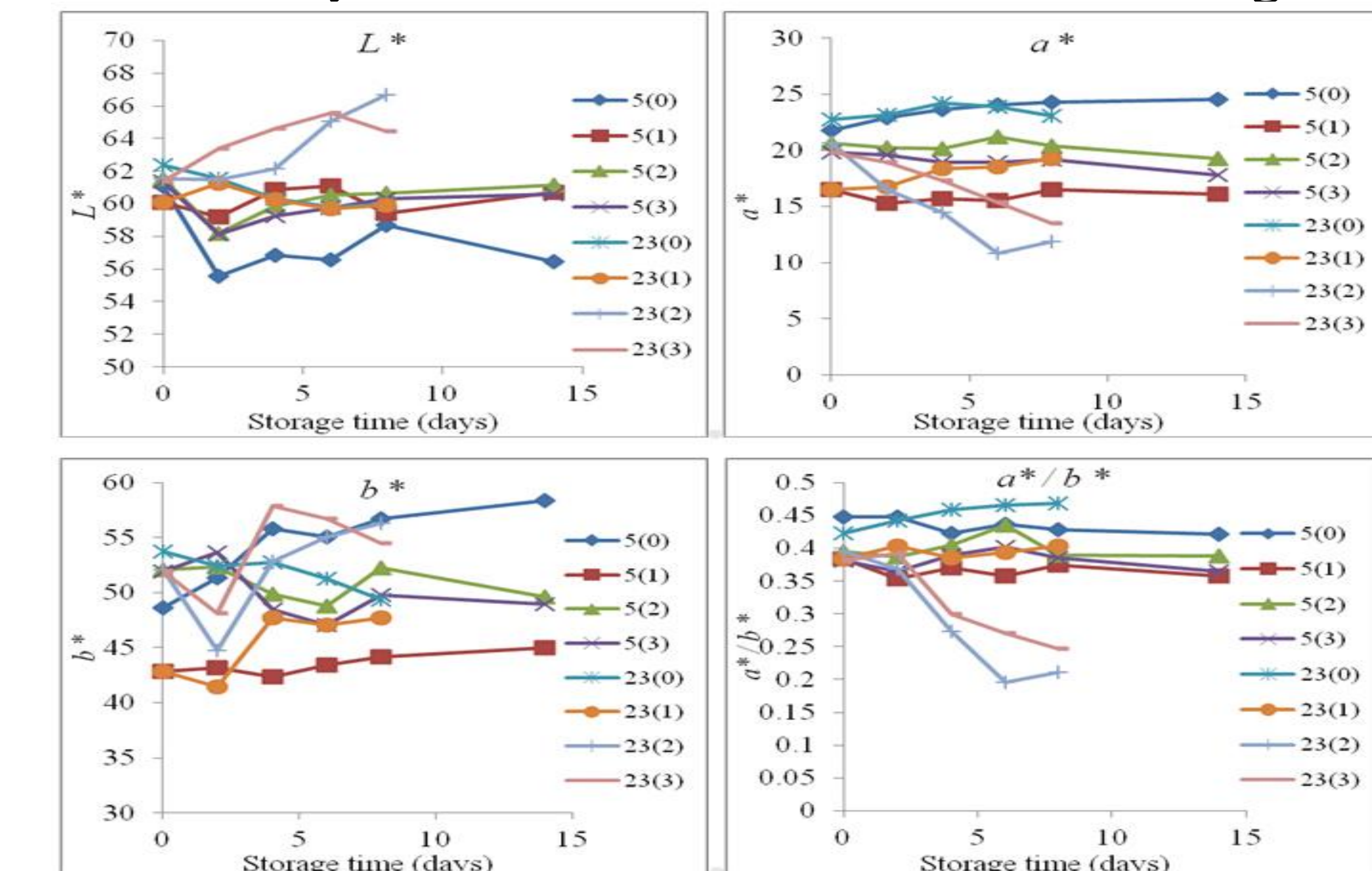
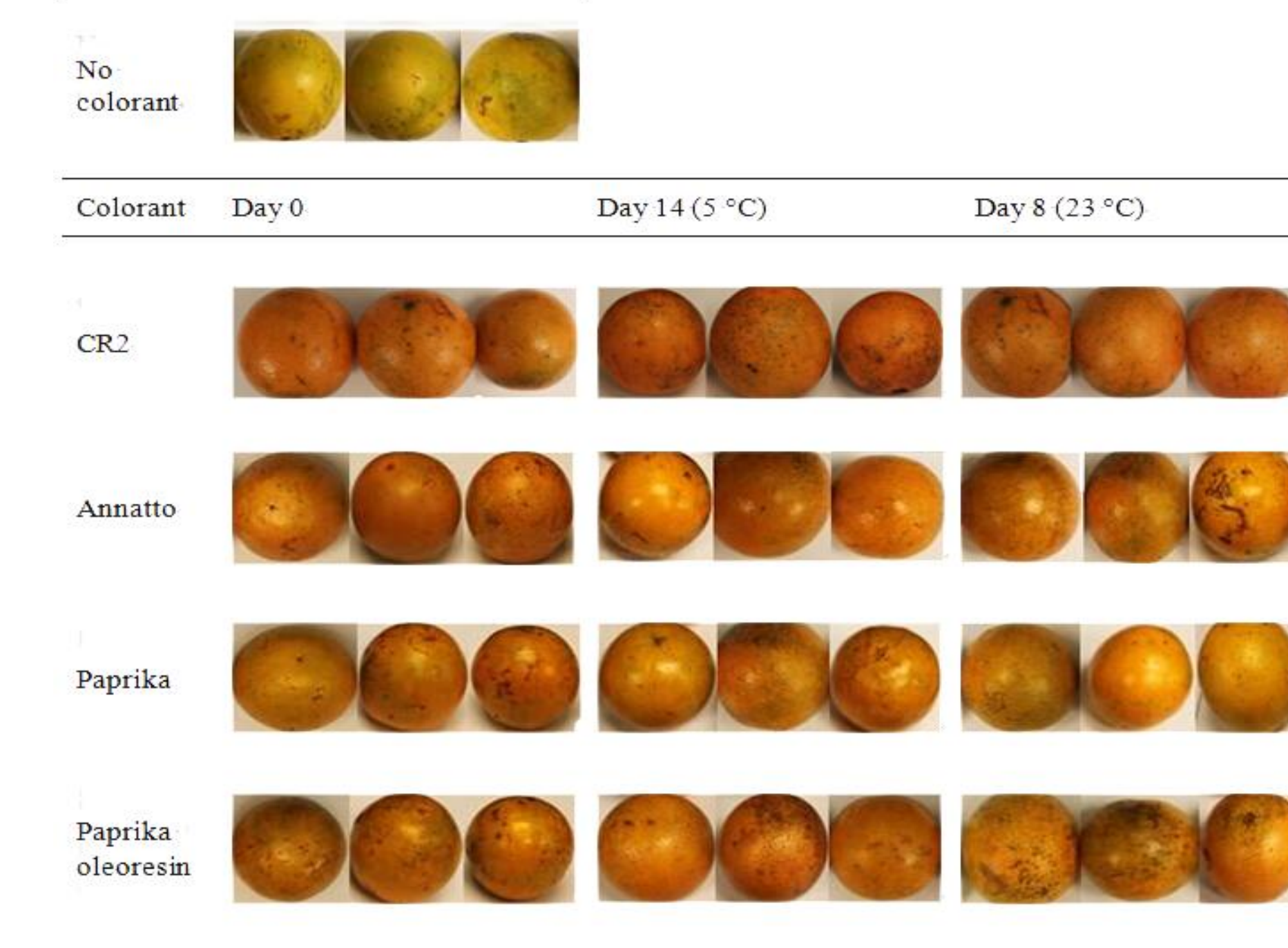


Fig. 4. Appearance of citrus fruit with or without colorants at day 0, after 14 days at 5° C in the dark, or 8 days at 23° C under 300 Lux of standard fluorescent white light.



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 resulted in red and orange color when applied to both test paper and ‘Hamlin’ orange peel.
- Annatto was relatively stable under all conditions, including simulated marketing conditions.
- The degradation of these natural colorants is highly associated with oxygen, temperature, light and storage time.
- The experiments suggest that annatto would be the most successful replacement of CR2 for use as a natural colorant on citrus fruit.