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EFFECTS OF DRYING ON PUMPKIN AND GREEN PEPPER COLOUR

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Abstract: The present work evaluates the effect of different drying treatments on the colour of green bell peppers and pumpkin, which were dried using two different methods: air drying and freeze-drying. The treatments in air drying were carried out at 30 ºC and 70 ºC. Overall, it was possible to conclude that air drying at 30 ºC produces small changes in colour of green pepper whereas air drying at 70 ºC and freeze drying originate more intense colour changes. The increase of temperature on air drying augments the colour saturation of dried pumpkin while decreases the hue angle by a linear relationship. In addition, the chroma of dried pumpkin decreases significantly with the freeze drying, while the hue angle is maintained constant as compared with the fresh vegetable.

Keywords: Green pepper, pumpkin, colour, air drying, freeze drying

INTRODUCTION

Portuguese cuisine is rich in using fresh vegetables, such as pumpkin and green pepper, on soups, salads, sauces, packet food, desserts and many convenience foods.

The chemical composition, associated to the antioxidants and vitamins, makes these two vegetables important in the diet, either for their nutritional value or health protective functions. The bright orange colour indicates that the pumpkin is high in β-carotene, an important carotenoid precursor to vitamin A in the human body (Weinstein et al., 2004).

Pumpkin has been under attention in the past years because of the nutritional and health protective value of their proteins and oil from the seeds as well as the polysaccharides from the fruits (Barbara & Murkovic, 2004; Cailia et al., 2007).

Fluted pumpkin seed flours have been used as protein supplements as documented by Giami & Bekebain, (1992) and Giami & Isichei (1999). The digestibility of bread with pumpkin seed proteins improved in *in vitro* essays (El-Soukkary, 2001). Some studies indicate that a diet rich in pumpkin could reduce blood glucose and that pumpkin polysaccharides had hypoglycemic activity (Cai et al., 2003; Chen et al., 1994; Li et al., 2003; Xiong and Cao, 2001; and Zhang and Yao, 2002). Furthermore, it was also reported that pumpkin protein-bound polysaccharides could increase the levels of serum insulin, reduce the blood glucose levels and improve tolerance to glucose, thus allowing to develop a pumpkin based product with antidiabetic properties (Li et al., 2005).

During the last few years bell pepper (*Capsicum annuum* L.) has gained consumer interest due to their vitamin and antioxidant contents (Penchaiyaa et al., 2009; Simonne et al., 1997; Vega-Gálvez et al., 2008).

Bell peppers present different nutritional compositions, depending on the variety and stage of maturity, but are naturally also rich in ascorbic acid, provitamin A carotenoids and minerals that have an important health-protecting effect (Faustino et al., 2007). In addition, peppers are rich in flavonoids and other phytochemicals (Simonne et al., 1997). Ascorbic acid and provitamin A carotenoid contents are affected by cultivars and maturity stage.

Ascorbate acts in oxidation/reduction reactions with metal ions associated with metalo-enzymes and as a free radical scavenger in animal and plant tissues (Foyer, 1993). Carotenoids with nine or more conjugated double bonds are quenchers of reactive oxygen species and function as antioxidants at low oxygen pressure (Bendich, 1989). Also, they may protect tissues against free radical damage and peroxidation (Machlin and Bendich, 1987).

Because of their antioxidant properties, substances such as ascorbic acid, carotenoids, and vitamin E are currently object of much attention, particularly attending to possible prevention of certain types of cancer (Olson, 1989; Ziegler, 1989; Krinsky, 1989), cardiovascular disease (Kritchevsky, 1992), atherosclerosis (Mezetti et al., 1995), and delay of the aging process.

Most bell pepper fruits are green at the unripe stage, turning red as they ripen. However, the fruits of unusual bell pepper cultivars are white, yellow, orange, purple, brown, or black. Fruits from these pepper varieties go through different color changes as compared to the standard green-to-red varieties (Simonne et al., 1996).

Bell peppers, like other vegetables, are quite perishable, originating high losses due to storage problems and marketing, among others. An alternative to the consumption of fresh vegetables is their dried form, which allows their use during the off-season. However, the drying process can have a strong impact on the quality of the dehydrated products. For a consumer, the colour of a product is a primary perceived characteristic that plays an important role on food. Therefore, the evaluation of the colour after drying assumes a key role since this characteristic is often expected to be as similar as possible to the fresh product. Furthermore the changes of colour can the related with the degradation of carotenoids during processing that have important antioxidant properties (Gonçalves et al., 2007).

The present work aims to compare the colour of the pumpkin and the green bell pepper in fresh and after drying using two different methods, namely freeze-drying and air drying at different temperatures.

MATERIALS AND METHODS

Pumpkin and green bell pepper were purchased in a local market, washed and cut to samples of approximately 2x2 cm and dried in ventilated oven and freeze drier. The pumpkin was dried peeled the bell pepper was dried with skin.

For the convective drying, an electrical stove WTB Binder with ventilation was used. The stove was operated at constant temperatures of 30 ºC, 50 ºC and 70 ºC, and the air flow was 300 m^3/h.

For the freeze drying, the samples were frozen in a conventional kitchen freezer, and then left in the freeze-drier (model Table Top TFD5505) for 38 hours at a temperature between - 47 ºC and - 50 ºC, and a pressure of 5 mTorr (0,666 Pa).

The colour of the fresh and dried samples was assessed using a handheld tristimulus colorimeter (Chroma Meter - CR-400, Konica Minolta) calibrated with a white standard tile. A CIE standard illuminant D65 was used to determine CIE colour space coordinates, L*a*b* values (Fig. 1). This system is suggested by Mendonza et al. (2006) as the best colour space for quantification in foods with curved surfaces.

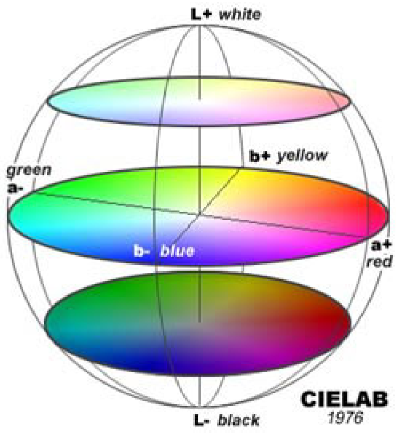

Fig. 1. CIELAB colour space

These cartesian coordinates can be used to calculate the polar or cylindrical coordinates (Fig. 2): L*HºC, with Hº representing the hue angle and C the chroma, as defined by equations (1) and (2):

$$\begin{cases} H^o = arctg\,(b^*/a^*),\ for\ a^*>0\ ;\ b^*>0 \\ H^o = 180^o + arctg\,(b^*/a^*),\ for\ a^*<0\ ;\ b^*>0 \\ H^o = 270^o + arctg\,(b^*/a^*),\ for\ a^*<0\ ;\ b^*<0 \\ H^o = 360^o + arctg\,(b^*/a^*),\ for\ a^*>0\ ;\ b^*<0 \end{cases} \quad (1)$$

$$C = \sqrt{a^{*2} + b^{*2}} \quad (2)$$

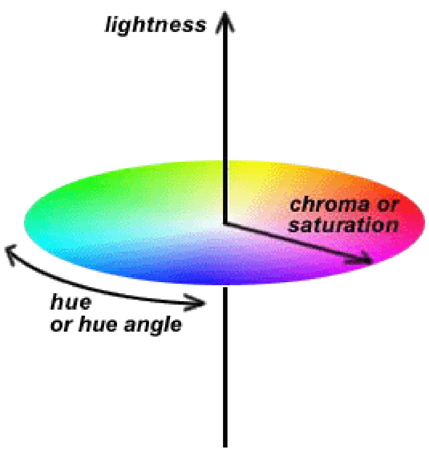

Fig. 2. Cylindrical colour coordinates

The total colour change (ΔE), was the parameter considered for the overall colour difference evaluation, between a dried sample and the fresh vegetable (designated with an index 0) on equation (3):

$$\Delta E = \sqrt{(L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2} \quad (3)$$

Fresh vegetables were used as the reference and a larger ΔE denotes greater colour change from the reference material.

DISCUSSION OF RESULTS

Fig. 3 shows the CILAB colour parameters for the green bell pepper, in the fresh form and after drying with different conditions.

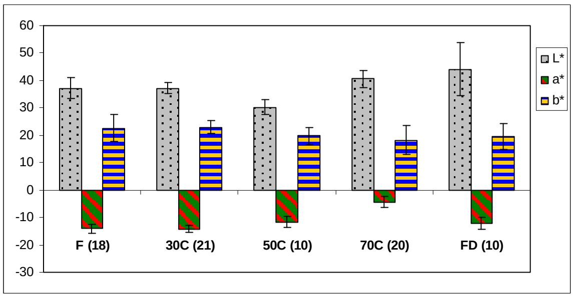

Fig. 3. CIELAB colour parameters of green pepper: lightness (L*) and colour parameters a* and b*. F stands for fresh, 30 ºC, 50 ºC and 70 ºC stand for convective drying at different temperatures and FD stands for freeze drying. The number of measurements is in parenthesis, and the scatter bars represent the standard deviation.

The values for the L*, a* and b* coordinates of the fresh green pepper were 37.22, -14.11 and 22.52, respectively. In general, the air drying at 30 ºC produced no remarkable changes in the colour parameters of peppers, as compared with the fresh vegetable. However, the increase of temperature from 30 ºC to 70 ºC allowed both coordinates L* and a* to rise and b* coordinate to decrease. In particular, the greenness parameter (a*) presents a mean value about 3 times higher that the mean value obtained for the samples of pepper dried at 30 ºC, indicating that the samples dried at 70 ºC present a much lesser intensity of the green colour than the fresh product. The dried vegetable at 70 ºC turns the final product lighter and less green (pale yellow colour) with L*a*b* coordinates with values of 40.59, -4.35 and 18.27, respectively. The decrease of the a* and b* values may be due to decomposition of chlorophyll and other pigments, and non-enzymatic reactions (Maskan, 2001). Hence, with the high air temperature the rate of colour degradation becomes faster as a result of the high energy transferred to the food material. The freeze drying causes a more pronounced lightening of vegetable surface and a less loss of green colour (L*= 44.12, a*= -12.11, b*= 19.59).

Fig. 4 presents the chroma and hue angle of fresh and green pepper dried by convective and freeze drying. The results show colour stability for the samples dried at 30 ºC and a decrease of the colour intensity of the vegetable when dried at 70 ºC, shifting towards the slightly yellow region. These colour alterations may be explained by heat carotenoid degradation as stated by Gonçalves et al. (2007). The freeze drying treatment has a small effect on chroma of the product. The hue angle of fresh bell pepper is about 122º, which represents a colour in the yellow/green region (hue angle between 90° and 180°).

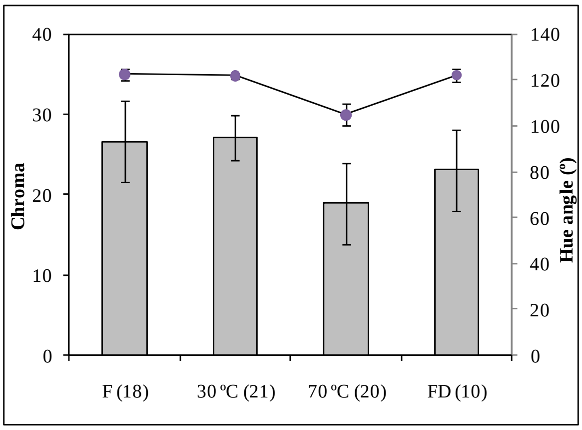

Fig. 4. Chroma (bars) and Hue angle (line) for pepper: F stands for fresh, 30 ºC and 70 ºC stand for convective drying at different temperatures and FD stands for freeze drying. The number of measurements is in parenthesis, and the scatter bars represent the standard deviation.

The total colour difference ΔE, which is a combination of the L*, a* and b* values, as given by equation (3), is a colorimetric parameter extensively used to characterize the variation of colour in foods during processing. The colour difference parameter has a value of 0.5 to the pepper dried at the lower temperature of 30 ºC and rises to 11.1 at the highest temperature of 70 ºC. The freeze drying treatment induces a decrease in the intensity of colour between those of the air drying at 30 ºC and at 70 ºC (ΔE = 7.8).

The average values of the colour parameters for pumpkin in fresh, and after air and freeze-drying are presented in Table 1 for L* (brightness), a* (redness), b* (yellowness), respectively.

The fresh pumpkin exhibited a light yellow colour, with L*, a* and b* equal to 68.97, 18.21 and 49.82, respectively. The results show a decrease of the L coordinate and an increase of a* and b* with the increasing of air temperature. However, the effect of temperature is smaller in L coordinate than in a* and b* parameters, which turns the samples more reddish and yellowish as the temperature raises.

Table 1**.** Colour parameters of fresh and air dried and freeze dried pumpkin

		L*	a*	b*
Fresh product		68.97 (±1.97)	18.21 (±0.71)	49.82 (±2.22)
Air drying	30 ºC	65.32 (±3.10)	24.29 (±2.38)	52.41 (±4.73)
	70 ºC	63.38 (±2.19)	28.01 (±3.43)	57.26 (±4.79)
Freeze drying		77.70 (±0.79)	15.25 (±1.30)	41.43 (±0.97)

Comparing the two methods of drying it is possible to conclude that the lightest dried pumpkin was obtained by freeze drying.

The chroma and hue angle for the fresh and dried pumpkin are presented in fig. 5. The increase of temperature from 30 ºC to 70 ºC increases the colour saturation while diminishes the hue angle by a linear relationship.

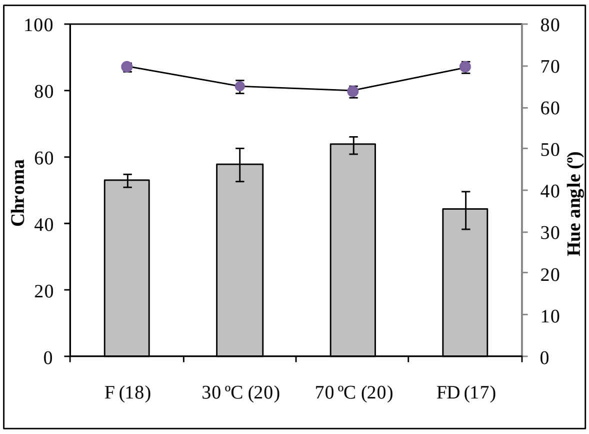

Fig. 5. Chroma (bars) and Hue angle (line) for pumpkin: F stands for fresh, 30 ºC and 70 ºC stand for convective drying at different temperatures and FD stands for freeze drying. The number of measurements is in parenthesis, and the scatter bars represent the standard deviation.

The increase in temperature from 30 ºC to 70 ºC has changed the colour difference parameter from 7.6 to 13.5, and the freeze drying makes the samples more dully than the fresh pumpkin allowing a colour difference of 12.4.

CONCLUSIONS

The present work evaluates the effect of different drying treatments on the colour of green bell peppers and pumpkin, which were dried using two different methods: air drying and freeze-drying.

The results obtained for the green pepper enable us to conclude that the air drying at 30 ºC produces very small changes in colour whereas the air drying at 70 ºC originates more intense colour changes. The values of L* have risen, while values of a* and b* have decreased during hot air drying. The colour change of freeze dried peppers was small, as compared with the vegetables dried at high temperature. In order to preserve the colour of this vegetable, the most convenient method to dry the green pepper is the air drying at 30 ºC, followed by the freeze drying treatment.

The increase of temperature on air drying increases the colour saturation of dried pumpkin while it decreases linearly the hue angle. Moreover, the chroma of dried pumpkin decreased significantly with the freeze drying while the hue angle is maintained constant when compared with the fresh vegetable.

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