UDC 664.521 : 543.42 : 621.796
APTEFF, 35, 1-280 (2004) BIBLID: 1450–7188 (2004) 35, 59-64
Original scientific paper

COLOUR CHANGE IN PEPPER (*Capsicum annuum*) DURING STORAGE

Aleksandra N. Tepić and Biserka L. Vujičić

Powders of pepper were stored at ambient temperature, exposed to daylight. The final quality was evaluated by measuring the extractable colour by the American Spice Trade Association (ASTA). Also, the possibility of using surface colour measurement, as a supplement to extractable colour measurement was investigated. The use of the chromatic attributes L, a and b, suggested by the Commision Internationale de l'Eclairage (CIE), i.e., of the CIELAB space, made it possible to find the correlation between ASTA and apparent colour of paprika.

KEYWORDS: Pepper; colour measurement; storage; quality

INTRODUCTION

The range of food products that contain pepper or its chemical constituents is really wide. Paprika extracts are also used in pharmaceutical and cosmetic products. Yellow, orange and red colours of pepper originate from the carotenoid pigments formed in the fruit during ripening. Over 30 different carotenoids have been identified in capsicum fruits (1). Some of them are provitamin A carotenoids, essential to human nutrition, and the oxygenated carotenoids that have been studied as anti-cancer agents.

Since paprika is used as a colouring agent in food, its market value depends partly on the red colour. Many factors affect pepper colour loss during storage, and the most important is oxidative degradation of carotenoids, caused by exposure to heat, light or oxygen.

Colour of peppers can be evaluated from three different aspects (2): surface (apparent) colour, extractable colour, and carotenoids profiles (3 – 8). Ectractable and surface colour measurements are standard quality evaluations in the spice industry (9 – 16). Surface colour measurements are used to specify colours perceived by the human eye. Verbal descriptions of colours can be difficult and confusing, because two people may describe the

Aleksandra N. Tepić, BSc., Assist., Dr. Biserka L. Vujičić, Prof., University of Novi Sad, Faculty of Technology, 21000 Novi Sad, Bulevar Cara Lazara 1, Serbia and Montenegro

same colour in very different terms. The perception of colour varies according to the sensitivity of observer, the size of the object being viewed, the light source and illumination, the background colour and contrast, and the angle at which the object is viewed. Quantifying colours, or expressing colours numerically, facilitates colour communication and standardization (17). Surface colour varies according to cultivar, growing conditions, dehydration, milling and storage conditions. Extractable colour is a measure of total pigment content. Current procedures for measuring extractable colour (total pigments) in dehydrated capsicums and oleoresins were developed and approved by the Association of Official Analytical Chemists (18) and the American Spice Trade Association (ASTA) (9, 19). Extractable colour is measured using a spectrophotometer and is expressed in ASTA units. Generally, the higher the ASTA colour value, the greater the effect on the brightness or richness of the final product. Paprika with 200 ASTA colour units would give a brighter red to a finished product than an equivalent amount with 100 ASTA colour units (2).

EXPERIMENTAL

Samples. Aleva NK cultivars of paprika powder from two different regions (Djala and Stara Pazova) were used. Samples were purchased from the factory "Aleva" Novi Kneževac and stored at ambient temperature (20°C ± 2) in transparent bottles, exposed to daylight and shaken occasionally. Apparent (surface) colour and extractable colour were measured in paprika powders before storage and then monthly, for 4 months.

Apparent (surface) colour measurements. Surface colour was measured using a tristimulus photoelectric colorimeter MOM Color 100. The values L, a, b, λ, a/b and hue angle (h) were determined.

Extractable colour measurements. The extractable colour was measured according to ASTA 20 method (20). An amount of 0.07 – 0.11 g of paprika powder was put into a graduated 100 ml flask. Aceton was added to the mark, the mixture was shaken and kept in the dark for 4h. An aliquot of the transparent decanted extract was taken. The absorbance of the solution was measured using a JENWAY 6105 UV/VIS spectrophotometer, set at 460 nm and calibrated with an acetone blanc. ASTA 20 colour units were calculated from

$$\text{ASTA } 20 = \frac{\text{Absorbance} \times 16.4 \times \text{I}_\text{f}}{\text{weight of sample}(\text{g})}$$

where I_f is a correction factor for the apparatus, which is calculated from the absorbance of a standard solution of potassium dichromate, ammonium sulphate and cobalt sulphate.

RESULTS AND DISCUSSION

Changes of ASTA 20 units during storage of paprika powders from two different localities (Djala and Stara Pazova) are presented in Figure 1. The results are in correlation with those of Osuna-Garcia et al. (17).

The Stara Pazova sample had a higher initial colour (225.95 ASTA units) than Djala (206.73 ASTA units). After 4 months storage, Stara Pazova lost 45.42 ASTA units, i.e. 20,10%, while Djala lost 60.14 ASTA units, i.e. 29.09% of the prestorage colour. The losses were high because samples were stored at room temperature, which accelerates colour loss rates.

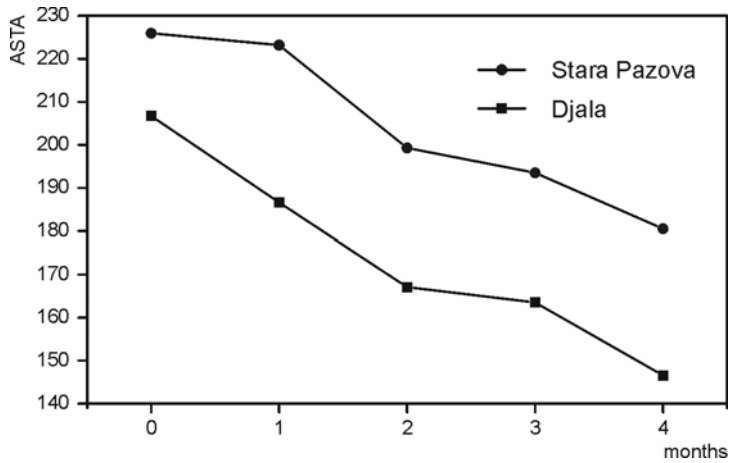

Fig. 1. Changes of ASTA values in paprika powder during storage

Changes of parameters of apparent colour of Djala and Stara Pazova samples during storage are presented in Tables 2 and 3, respectively.

Table 1. Changes of surface colour of Djala sample during storage

Parameter*	**0**	**1**	**2**	**3**	**4**
a	27.97	34.29	26.11	27.99	30.44
b	23.08	29.55	23.52	26.86	31.17
L	39.46	43.21	48.22	46.94	44.17
λ (nm)	599	601	597.5	597	596
a/b	1.21	1.16	1.11	1.04	0.98
h	39.53	40.75	42.01	43.82	45.68

*a – red component; b – yellow component; L – brightness; h – hue angle, h=arctg b/a

Table 2. Changes of surface colour of Stara Pazova sample during storage

Parameter*	**0**	**1**	**2**	**3**	**4**
a	31.91	30.41	27.89	29.15	30.88
b	25.78	21.03	23.98	25.89	29.25
L	36.87	46.36	44.74	42.36	41.43
λ (nm)	601	602	598	598.5	599
a/b	1.24	1.45	1.16	1.13	1.06
h	38.93	34.67	40.69	41.61	43.45

*a – red component; b – yellow component; L – brightness; h – hue angle, h=arctg b/a

From the chromatic attributes it can be seen that the a/b ratio decreased during storage, and the arctg b/a (hue angle) increased from 39.53 up to 45.67 (Djala) and from 38.93 up to 43.45 (Stara Pazova), which is the change from red to orange in the colour circle (2). These changes could have been the consequence of the applied agricultural conditions and meteorological factors, i.e. temperature, sunshine and rainfall (21), which influenced different levels of tocopherols and other antioxidants in pepper fruits. In this work, correlations between extractable colour (ASTA units) and hue angle were observed. Namely, while ASTA units decreased during storage, hue angles increased, indicating colour change from red to orange hues. Also, during storage hue angles of Stara Pazova pepper sample were lower than those for Djala samples, indicating less decolouration.

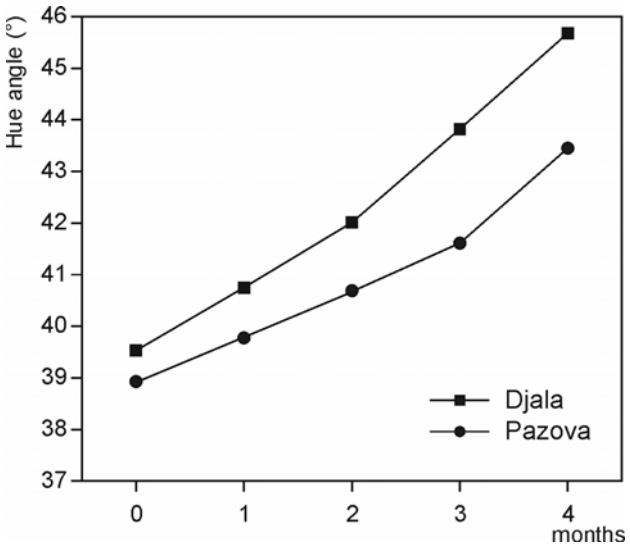

Fig. 2. Changes of hue angle in paprika powder during storage

CONCLUSION

The presented results show that the colour loss of paprika powders was significant. Pepper from Djala region lost 29.09 % (from 225.95 to 180.53 ASTA), while that from Stara Pazova lost 20.10 % (from 206.73 to 146.59 ASTA) of the initial colour. It is clear that Stara Pazova pepper behaved better than Djala, from the point of retaining colour.

ACKNOWLEDGMENT

These results are part of the project "Advancement of production and manufacturing of spice paprika – ground spice paprika", supported by the Ministry of Science, Technologies and Development of the Republic of Serbia.

1. Deli, J. and Gy. Tóth: Carotenoid composition of the fruits of *Capsicum annuum* Cv. Bovet 4 during ripening. Z. Lebensm. Unters. Forsch. A **205** (1997) 388-391.
2. Wall, M.M. and P.W. Bosland: Analytical methods for color and pungency of chiles (capsicums), in Instrumental Methods in Food and Beverage Analysis. Eds. D. Wetzel and G. Charalambous, Elsevier Science B. V., London (1998) pp 347-373.
3. Levy, A., S. Harel, D. Palevitch, B. Akiri, E. Menagem and J. Kanner: Carotenoid pigments and β-carotene in paprika fruits (*Capsicum* Spp.) with different genotypes. J. Agric. Food Chem. **43**, 2 (1995) 362-366.
4. Weissenberg, M., I. Schaeffler, E. Menagem, M. Barzilai and A. Levy: Isocratic non-aqueous reversed-phase high-performance liquid chromatographic separation of capsanthin and capsorubin in red peppers (*Capsicum annuum* L.), paprika and oleoresin. J. Chromatogr. A **757** (1997) 89-95.
5. Breithaupt, D.E. and W. Schwack: Determination of free and bound carotenoids in paprika (*Capsicum annuum* L.) by LC/MS. Eur. Food Res. Technol. **211** (2000) 52-55.
6. Cserháti, T., E. Forgács, M.H. Morais, T. Mota and A. Ramos: Separation and quantitation of colour pigments of chili powder (*Capsicum frutescens*) by high-performance liquid chromatography-diode array detection. J. Chromatogr. A **896** (2000) 69-73.
7. Müller, H.: Determination of the carotenoid content in selected vegetables and fruit by HPLC and photodiode array detection. Z. Lebensm. Unters. Forsch. A **204** (1997) 88-94.
8. Deli, J., Z. Matus, P. Molnár and Gy. Tóth: Separation and identification of carotenoids from different coloured paprika (*Capsicum annuum*) by reversed-phase high-performance liquid chromatography. Eur. Food Red. Technol. **213** (2001) 301-305.
9. Mínguez-Mosquera, M.I., M. Jarén-Galán, J. Garrido-Fernández: Color quality in paprika. J. Agric. Food Chem. **40**, 12 (1992) 2384-2388.
10. Gómez-Ladrón de Guevara, R., J.E. Pardo-González, R. Varón-Castellanos and F. Navarro-Albaladejo: Evolution of color during the ripening of selected varieties of paprika pepper (*Capsicum annuum* L.). J. Agric. Food Chem. **44**, 8 (1996) 2049-2052.
11. Niento-Sandoval, J.M., J.A. Fernández-López, L. Almela and J.A. Muñoz: Dependence between apparent color and extractable color in paprika. Col. Res. Appl. **24**, 2 (1999) 93-97.
12. Krajayklang, M., A. Klieber and P.R. Dry: Colour at harvest and post-harvest behaviour influence paprika and chilli spice quality. Postharv. Biol. & Technol. **20** (2000) 269-278.
13. Madrid, R., F. Navarro, I. Collados, E. Consuello and A.L. Alarcon: Development of colour in red pepper fruits in soilless culture. J. Hort. Sci. & Biotech. **74**, 2 (1999) 175-180.
14. Gómez, R., J.E. Pardo, F. Navarro and R. Varón: Methods for estimating color in paprika pepper varieties (*Capsicum annuum* L.). La Rivista di Scienza dell Alimentazione **26**, 3/4 (1997) 91-96.
15. Klieber, A. and A. Bagnato: Colour stability of paprika and chilli powder. Food Australia **51**, 12 (1999) 592-596.
16. Halász-Fekete, M., E. Huhn and P. Záhonyi-Racs: Tristimulus measurement of ground paprika colour. Int. Agrophysics **4** (1984) 501-507.

17. Osuna-Garcia, J., M.M. Wall and C.A. Waddell: Natural antioxidants for preventing color loss in stored paprika. J. Food Sci. **65**, 5 (1997) 1017-1021.
18. Assoc. Off. Anal. Chem. (AOAC). Official Methods Analysis. Virginia: AOAC (1984).
19. Amer Spice Trade Assoc (ASTA). Official Analytical Methods. New Jersey: ASTA (1985).
20. FAO/WHO. Specifications for identity and purity of food colours (28th session of the Joint FAO/WHO expert committee on food additives). FAO Food and Nutrition Paper 31/1. FAO: Rome (1984) 105-9.
21. Márkus, F., H.G. Daood, J. Kapitány and P.A. Biach: Change in the carotenoid and antioxidant content of spice red pepper (paprika) as a function of ripening and some technological factors. J. Agric. Food Chem. **47**, 1 (1999) 100-107.

ПРОМЕНА БОЈЕ МЛЕВЕНЕ ЗАЧИНСКЕ ПАПРИКЕ (*Capsicum annuum*) ТОКОМ СКЛАДИШТЕЊА

Александра Н. Тепић и Бисерка Л. Вујичић

Узорци млевене зачинске паприке сорте Алева НК, са два локалитета складиштени су на собној температури, изложени дневом светлу. Квалитет боје је одређен мерењем екстрактабилне боје, ASTA 20 методом и мерењем површинске боје. Параметри којима се дефинише површинска боја (CIE Lab) најближи су утиску који се ствара при опажању оком. Током складиштења узорака дошло је до негативне промене боје, тј. смањења садржаја укупних пигмената (опадање ASTA вредности и промена "hue angle"-а од црвених ка жутим пигментима у CIE систему), чиме је утврђена корелација између параметара површинске боје и садржаја укупних пигмената (ASTA).

Received 7 April 2004
Accepted 28 May 2004