INFLUENCE OF PARTICLE DIAMETER ON THE COLOUR OF GROUND PEPPER (*Capsicum annuum* L.)

Aleksandra N. Tepić, Zdravko, M. Šumić, Mirjana B. Vukan

The influence of particle diameter of ground paprika on its colour was examined in this study. Six samples of industrial ground paprika, from various phases of milling, and different particle size were purchased from the factory. Extractable colour (ASTA) and surface colour (*L*, *a**, *b**, C, λ), as the most important colour indicators, were measured. Increasing the grinding level caused the increase of ASTA and red coordinate (*a**) value, and decrease of yellow coordinate (*b**) value, as well as lightness of the samples, as a consequence of the increase of the specific surface area of sample particles.

KEYWORDS: Ground paprika, ASTA, surface colour, particle size

INTRODUCTION

Paprika (*Capsicum annuum* L.) is one of the most important crops in the world and in Serbia. Apart from its use as raw vegetable, there are numerous food, pharmaceutical and cosmetic products containing paprika, or some of its constituents.

During industrial production of ground paprika, dried paprika is coarsely milled using hammer mills, to particles up to 2-3 mm in diameter. In order to produce powder, these particles are further milled using stone mills. At the end of the process, the finest powder is obtained by sieving ground paprika through the sieve.

The influence of fruit maturity, pre-treatment applied, drying conditions, methods and kinetics on the quality of ground pepper had been the subject of interest to many authors (1-6).

The main quality parameter of ground spice paprika is its colour. It can be defined from three different aspects: extractable colour, surface colour, and carotenoid profile.

The most common and very simple method for the determination of paprika colour is the spectrophotometrical measurement of its extractable colour. It can be measured according to several procedures, described by Association of Official Analytical Chemists (7, 8) and the American Spice Trade Association (9).

The colour of the specified product depends much on the variety, growing conditions, dehydration and storage conditions, and powder coarseness as well. However, the personal perception of colour varies in dependence of the sensitivity of the eye, the size of the

---

Dr Aleksandra Tepić, assistant professor, tepical@uns.ac.rs; Zdravko Šumić, BSc; Mirjana Vukan, BSc, University of Novi Sad, Faculty of Technology, Bulevar Cara Lazara 1, 21000 Novi Sad, Serbia
object being viewed, background colour, illumination, etc. (10). Since the verbal description of colour could be difficult and confusing, its numeric quantification is of great use. Surface colour represents the human visual perception of the colour.

A system that is most commonly used for colour measurements is the CIELAB system, established by the International Commision on Illumination (11). Since the CIELab defines colours more closely to the human colour perception, this system is often used in the quality control of coloured products. Three colour coordinates for the determination of colour are lightness ($L^*$), red/green coordinate ($a^*$), yellow/blue coordinate ($b^*$). Hue angle ($h^\circ$) and chroma ($C$) can be calculated from $a^*$ and $b^*$, and they are simpler to conceptualize (10). Hue, as the arctangent $b^*/a^*$ defines the kind of colour. Samples with $h^\circ=0$ are purplish-red, $90^\circ$ are yellow, $180^\circ$ - bluish-green and $270^\circ$ - blue. Paprika samples usually have hue angle values from 30 to $45^\circ$ (red to orange range on the colour wheel). Chroma is a measure of colour saturation. The higher the chroma, the more vivid the sample (10).

Apart from variety, degree of maturity, drying and storage conditions, particle size plays an important role in paprika colour perception.

The aim of this work was to investigate the effect of particle size on the extractable and surface colour of paprika.

**EXPERIMENTAL**

Six samples of commercial ground paprika, harvested in 2009, were obtained from Aleva a.d. company, Novi Kneževac, the most important producer of ground paprika in Serbia. Sample No.1 was coarsely milled, samples 2-6 were taken from different stages of milling, and sample 6 was the final product, the finest powder.

The mean diameter of the particles was measured by sieving the sample through Ewreka sieves (Germany) (12). The paprika that remained on the sieve was measured, and the rest was further sieved through the sieve of smaller porosity. The mean diameter of particles was calculated as follows:

$$\frac{100}{d} = \sum \left( \frac{m_i}{d_i} \right)$$

where: $m_i$ - mass percent of fraction $i$; $d_i$ - mean diameter of the $i$ fraction

*Extractable colour measurements.* Extractable colour was measured according to ASTA 20 method (9). 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 JENWAY 6105 UV/VIS spectrophotometer, set at 460 nm and calibrated with an acetone blanc. The ASTA 20 colour units were calculated from:

$$\text{ASTA } 20 = \frac{\text{Absorbance} \times 16.4 \times I_i}{\text{weight of sample} (g)}$$
where $I_r$ 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.

Apparent (surface) colour measurements. Surface colour was measured using Minolta Chromameter CR 400. The values $L^*$, $a^*$, $b^*$, $h^\circ$, $c$ and $\lambda$ were determined.

All determinations were done in three replicates, and the results are presented as mean values. SD values were determined using Excel 2003.

RESULTS AND DISCUSSION

The quality of ground paprika is mainly determined by its seasoning power – capsaicin content (13), its natural colour, its particle size and water content (14, 15). The particle sizes of examined samples of ground paprika are presented in Table 1.

Table 1. Particle size of examined ground paprika samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mean diameter, d (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.479</td>
</tr>
<tr>
<td>2</td>
<td>0.339</td>
</tr>
<tr>
<td>3</td>
<td>0.312</td>
</tr>
<tr>
<td>4</td>
<td>0.244</td>
</tr>
<tr>
<td>5</td>
<td>0.229</td>
</tr>
<tr>
<td>6</td>
<td>0.220</td>
</tr>
</tbody>
</table>

Oil seed gives ground paprika fine, shiny and intensive colour, and some stability due to the presence of natural antioxidants as well (16).

One of the most important indicators of paprika quality is its ASTA value. The ASTA value dependence on the particle diameter is given in Figure 1.

Figure 1. Effect of particle size on the extractable colour of ground paprika
As can be seen, decreasing the particle size from 0.479 to 0.220 mm (2.17 fold) caused an increase in the ASTA value from 31.10 to 86.95 units (2.8 fold). This trend is a direct consequence of particle size change, i.e. of the increase in the particle specific surface, which caused better and more intensive colour extraction. The greatest difference was noticed between samples 1 and 2, probably due to the largest increase in specific surface. Moreover, it should also be emphasized that ASTA value of the finest powder, 86.95 ± 0.916, which is still acceptable, was considerably lower than the values reported by other authors (17). The reason for a relatively low extractable colour lies in the fact that raw material used for its production was stored for almost a year, and it is well known that many factors affect colour loss in paprika during the storage, with carotenoid degradation as the most important, caused by exposure to heat, light or oxygen.

Visual evaluation of the product, besides extractable colour, is of fundamental interest, since it affects consumer’s acceptability of the product and determines the real commercial value of the product (18). Sample with highest particle diameter was the lightest (46.99 ± 0.229). Other samples, having smaller particle sizes, were darker (42.66 ± 0.456 - 43.62 ± 0.286), indicating that the increase of specific surface caused samples darkening to some degree. The tested samples were somewhat lighter than reported in other studies (17, 19, 20). The red/green coordinate (a) values were in the range (23.82 ± 0.569)-(31.06 ± 0.421), and slightly differed in samples 4-6. The yellow/blue coordinate values were highest in sample 1, with the smallest particle size (35.25 ± 0.20), and slightly differed between samples 2-6. Changes in L, a* and b* values indicate that the decrease of the ground paprika particle size causes the darkening of the samples, decrease of yellow, and increase of red component at the same time (Figure 2).

As reported Wall and Bosland (10), hue angles of ground paprika are in the range of 30-45°. According to their statement, it is obvious that h° of ground paprika samples examined in this research were closer to yellow in the colour wheel of the CIELab system.
On the basis of trichromatic coefficients, $a^*$ and $b^*$ values, chroma (C) and dominant wavelength were calculated (Table 2). According to Wall and Bosland (10), samples 4-6 were more vivid. All samples had dominant wavelength in the range of orange colour.

<table>
<thead>
<tr>
<th>Sample</th>
<th>C</th>
<th>$\lambda$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42.54 ± 0.311</td>
<td>591.3 ± 4.163</td>
</tr>
<tr>
<td>2</td>
<td>42.17 ± 0.244</td>
<td>593.2 ± 0.289</td>
</tr>
<tr>
<td>3</td>
<td>42.08 ± 0.749</td>
<td>593.9 ± 0.115</td>
</tr>
<tr>
<td>4</td>
<td>43.13 ± 0.406</td>
<td>595.3 ± 0.289</td>
</tr>
<tr>
<td>5</td>
<td>44.26 ± 0.337</td>
<td>595.1 ± 0.321</td>
</tr>
<tr>
<td>6</td>
<td>43.26 ± 0.312</td>
<td>595.2 ± 0.529</td>
</tr>
</tbody>
</table>

As valid Serbian Regulations for ground paprika demand measuring the extractable colour of samples as the most important quality defining parameter, and as Duncans's multiple range test showed that there was a significant difference between ASTA for samples 5 and 6, grinding of dried paprika to particle size of 0.222 is completely justified.

**CONCLUSION**

Based on the results of this research, it can be stated that the decrease of ground paprika particle size caused better and more intensive colour extraction, and as a consequence, the increase of extractable colour (ASTA). The increase of grinding level, i.e. the decrease of particle diameter, also caused a decrease of the yellow, and increase of red coordinate, as well as the darkening of the sample, making samples with smaller particle size more acceptable from a sensory point of view.
Acknowledgement

This work is a part of the Project No 114-451-02503/2010, financially supported by the Provincial Secretariat for Science and Technological Development of Vojvodina.

REFERENCES

16. M. I. Mínguez-Mosquera, A. Pérez-Gálvez and J. Garrido-Fernández: Carotenoid content of the varieties Jaranda and Jariza (Capsicum annuum L.) and response


УТИЦАЈ СТЕПЕНА УСИТЊЕНОСТИ НА БОЈУ МЛЕВЕНЕ ЗАЧИНСКЕ ПАПРИКЕ (Capsicum annum L.)

Александра Н. Тенић, Здравко М. Шумић, Мирјана Б. Вукач

У раду је испитан утицај пречника честица млевене зачинске паприке на боју. Из фабрике је набављено шест узорака индустријске паприке из различитих фаза прераде (млење), различитих величина честица. Испитани су садржај екстраховане боје (ASTA) и површинска боја (L, a*, b*, c, λ), као најважнији параметри боје. Повећање степена уситњености изазвало је пораст ASTA вредности и удела црвене боје (a*) и истовремено смањење удела жуте боје (b*), као и светлоће узорака, као последица повећања специфичне површине честица испитиваних узорака.

Received 24 September 2010
Accepted 22 October 2010