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INFLUENCE OF THE HEAT TREATMENT ON THE COLOUR OF GROUND PEPPER (*Capsicum annuum*)

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Red pepper (Capsicum annuum L.) is one of the most important vegetables in the world. The main ground pepper quality attributes are extractable colour, surface colour, qualitative and quantitative carotenoid content. In this work, the influence of heat treatment on ground pepper quality was investigated. Microbiological status was examined in non-sterilized and sterilized ground pepper. Colour changes were assessed by measuring the extractable colour (ASTA) and surface colour, using a photocolorimeter. The obtained results showed that at the end of experiment, non-sterilized samples had higher colour values in comparison to the sterilized ones. Also, colour deterioration was heightened at room temperature.

KEYWORDS: Ground pepper, extractable colour, surface colour, microbiology, sterilization

INTRODUCTION

Red pepper (*Capsicum annuum* L.) belongs to the Solanaceae family. Capsicum fruits can be used in the food industry as colorants and spices, in the pharmaceutical and cosmetic industries in the form of a powder (paprika) or concentrated extract (oleoresin).

The colour of ripe fruits of red pepper is due to high concentration of pigments, i.e. carotenes (β-carotene, α-carotene) and oxygenated carotenes, also known as xanthophylls (capsanthin, capsorubin, zeaxanthin, violaxanthin). Some of them have provitamin A activity (β-carotene, α-carotene, β-cryptoxanthin), and some act as antioxidants (1). The predominant carotenoid in paprika is capsanthin, exclusive to Capsicum species. Beside capsanthin, there are up to thirty different pigments contributing to paprika colour (2). These pigments occur in non-esterified, mono- and di-esters with fatty acids.

Apart from the mentioned features, carotenoids are susceptible to degradation, oxidation and isomerization, due to the influence of light, temperature, heat, enzymes, metals, etc. during storage, losing colour as a consequence (3, 4, 5).

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In the paprika pepper varieties (*Capsicum annuum* L.) colour can be considered the main quality factor, since it determines its commercial value. At present, there are different analytical methods to evaluate paprika colour by pigment extraction using a selective solvent, the ASTA 20.1 method being the most used and worldwide accepted because of its reliability. On the other hand, and for obvious reasons, the use of tristimulus colorimetry is becoming widely used (6, 7, 8). Surface colour measuring is the method for describing of colour changes closest to sensory (visual) perception, i.e. the changes that can be noticed by observation (9). The CIELAB colour space is the most widely used system today. The elements of perceived colour are lightness (L), hue (h) and chroma, and they are determined from the $L^*a^*b^*$ coordinates. The hue and chroma colour aspects are easier to conceptualize than a^* and b^* values. A sample with hue angle of 0° is purplish-red, 90° is yellow, 180° is bluish-green and 270° is blue. Paprika samples typically have hue angles of 30°-45°, which is a reddish-orange hue. A sample with a hue angle of 30° and a chroma of 50 would be reddish-orange and bright; a sample with a hue angle of 45° and a chroma of 30 would be a dull, orange colour. Hue angles of 55-60 indicate a commercially unacceptable orange-yellow colour (7, 10).

As dried condiment, ground paprika is very susceptible to microbial contamination. Therefore, the manufacturers decided to apply sterilization in order to decrease the number of microorganisms present in the final product. However, it has been noticed in practice that sterilized paprika lost its colour more intensively in comparison to the non-treated (non-sterilized) one. The aim of this work was to evaluate the level of colour loss in sterilized and non-sterilized ground pepper samples.

EXPERIMENTAL

Two groups of ground pepper samples were purchased from the factory „Aleva“, Novi Kneževac. The non-sterilized ground pepper (first group) was divided in two parts and stored at room (18-20°C) and refrigerator (4-6°C) temperatures. The samples were shaken occasionally. The sterilized ground pepper (second group) samples were treated as previously described and stored under the same conditions.

Dry matter and *ash content* were determined according to valid regulation (11).

Extractable colour (ASTA 20.1) measurement was carried out by weighing 0.07-0.1 g of ground pepper into a 100 ml measuring flask and adding acetone to the volume. The glass was shaken and left in the dark for 4 h. The portion of extract was used for the spectrophotometric measurement at 460 nm with an acetone blank (12). The ASTA units were calculated as follows:

$$ASTA\ 20.1 = \frac{A \times 16.4}{m} \times I_f \qquad [1]$$

where A is the absorbance of acetone extract; I_f is the correction factor for the instrument, calculated from a standard solution of potassium dichromate and ammonium and cobalt sulphate; *m* is the mass of sample weighed.

Surface colour was measured using a tristimuli colorimeter MOM Color 100; from the parameters *a* and *b* the hue angle (*h*°) values were calculated (7).

Microbiological analyses were performed according to valid regulations (13).

RESULTS AND DISCUSSION

In the ground pepper samples pathogenic microorganisms were not found. The total colony counts decreased from 250,000 (before sterilization) to 8,000 (after sterilization), i.e. about 30 times; the number of moulds decreased about 160 times, related to the initial count. Total colony counts, as well as the number of moulds and yeasts, corresponds to the regulations of the legal act (13). The results of microbiological determinations are presented in Table 1.

Table 1. Changes of number of microorganisms during processing of ground pepper

Sample	Ground pepper before sterilization	Ground pepper after sterilization
E. coli	0	0
Coagulase positive staphylococci	0	0
Proteus species	0	0
Total colony counts	250000	8000
Moulds	1600	10
Yeasts	0	0

It is advisable to sterilize this condiment before distribution, because of its specific processing, as well as its broad application in human nutrition.

Dry matter of the ground pepper after sterilization was 93.08%, and the ash content was 6.01%, which corresponds to the regulations (14).

The colour of ground pepper is determined by oil content, pericarp/seed ratio, as well as processing parameters (drying time and temperature, grinding conditions, powder delicacy, storage conditions). The results of extractable colour (ASTA) measurements in non-sterilized and sterilized ground pepper are shown in Tables 2 and 3. The presented results are the mean values of three replicates.

Table 2. Changes of ASTA units in non-sterilized ground pepper

Duration (days)	NS-R	NS-F
0	96.75	
15	95.84	95.23
30	89.69	95.06
45	89.77	93.69
60	86.81	93.71
90	79.17	89.31

NS-non-sterilized; R-room temperature storage; F-refrigerator storage

Table 3. Changes of ASTA units in sterilized ground pepper

Duration (days)	S-R	S-F
0	95.06	
15	94.71	93.63
30	87.64	92.42
45	89.95	92.16
60	84.11	92.14
90	75.00	86.12

S-sterilized; R-room temperature storage; F-refrigerator storage

The highest extractable colour was measured in the non-sterilized ground pepper sample at the beginning of the experiment (96.75) (Figure 1). Sterilization caused a certain deterioration of the colour, and, as a consequence, the measured ASTA value of sterilized pepper was slightly lower (95.06) at the beginning of the study.

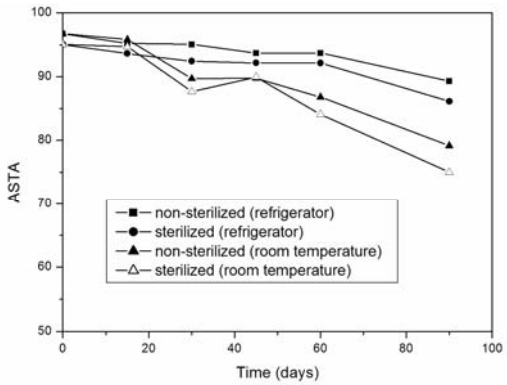

Figure 1. Changes of sterilized and non-sterilized ground pepper extractable colour during storage under different storage conditions

Samples stored at room temperature, NS-R and S-R, lost 18.17 and 21.10%; samples stored in refrigerator, NS-F and S-F, lost 7.69 and 9.40% the initial colour after 90 days of storage, respectively. Moreover, non-sterilized samples after 90 days of storage retained more initial colour, i.e. the ASTA values for NS-R and S-R (stored at room temperature) were 79.17 and 75.00, respectively; for NS-F and S-F (stored in refrigerator) the ASTA values were 89.31 and 86.12. The results confirmed the literature findings that higher storage temperatures facilitate colour loss of ground pepper during storage (15-17).

Three months of storage is a short period of time to notice significant changes in the investigated samples. Namely, low storage temperature itself was enough to protect the pepper colour from its deterioration. Changes were intensified at higher temperatures. Also, they were less distinguishable and developed slower in non-sterilized samples.

Along with extractable colour, surface colour is very important in determining the ground pepper quality. The results of L^*, a^*, b^* and h values are presented in Table 4.

As the results in Table 4 show, non-sterilized pepper (NS) changed its lightness from the initial 34.84 to 37.58-37.82, depending on the storage conditions. On the contrary, sterilized pepper became slightly darker, e.g. L^* changed from 37.42 to 35.43-35.30. Moreover, both parameters, a^* and b^* in sterilized samples decreased. Hue angles of samples did not change during storage. On the basis of the above results it can be concluded that surface colour itself cannot be sufficient for evaluating of ground pepper colour, but extractable colour as a fast, along with HPLC as the most accurate and reliable method, can give the most valuable data about the qualitative and quantitative characteristics of ground pepper.

Table 4. Surface colour changes in ground pepper during storage under different storage conditions

Sample	Time (days)	L^*	a^*	b^*	h
Sterilized	0	37.42	34.11	41.65	50.68
Non-sterilized	0	34.87	34.76	41.86	50.29
NS-R	15	37.44	34.08	41.67	50.72
	30	38.70	28.33	31.86	48.36
	45	38.16	34.88	39.20	48.34
	60	38.65	19.81	37.27	62.00
	90	37.58	34.43	35.51	45.88
S-R	15	34.86	34.72	41.72	50.35
	30	37.04	34.60	42.43	50.80
	45	37.33	31.55	35.49	48.36
	60	35.67	34.53	43.29	50.77
	90	35.43	32.63	39.20	50.23
NS-F	15	38.48	32.38	39.44	50.61
	30	38.56	32.72	38.62	49.73
	45	38.44	33.54	38.78	49.14
	60	39.19	34.98	44.68	51.94
	90	37.82	33.96	41.37	50.62
S-F	15	36.13	34.83	42.32	50.55
	30	37.46	34.91	42.24	50.43
	45	37.05	29.59	34.04	49.00
	60	36.13	32.02	36.25	48.55
	90	35.30	31.97	35.77	48.21

CONCLUSION

Paprika, *Capsicum* annuum, is one of the oldest, most important, and widely used carotenoid food colorants. Colour and quality are associated in the sense that the higher the colour level, the better the quality of the spice is. However, the loss of colour during storage needs to be considered. Although heat treatment causes more intensive colour loss of ground pepper, in order to decrease the initial number of microorganisms it is advisable to apply HTST (high temperature-short time) method, i.e. sterilization.

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УТИЦАЈ ТОПЛОТНОГ ТРЕТМАНА НА БОЈУ МЛЕВЕНЕ ЗАЧИНСКЕ ПАПРИКЕ

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Паприка (*Capsicum annuum* L.) је једна од најзначајнијих повртарских култура у свету и код нас. Основно мерило квалитета млевене зачинске паприке је њена екстрахована боја, површинска боја и квалитативни и квантитативни састав каротеноида. У раду је утврђен утицај термичке обраде на квалитет млевене зачинске паприке. Испитивана је микробиолошка слика узорака пре и после стерилизације, праћен интензитет промена боје методом ASTA 20.1 и мерењем површинске боје фотоколориметром.

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