COLOUR MEASUREMENT OF MIXED PAPRIKA POWDERS

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Abstract
We investigated the changes in the colour coordinates mixing paprika powder samples, because the paprika powder products are made by mixing several quality powders. The CIELab colour system was used for colour characterization. Colour measurements were performed with a HunterLab Miniscan XE Plus colour measuring instrument. It was detected that the colour coordinates (L^*, a^* and b^*) of a product prepared by mixing paprika grist samples can be determined as the averages of the colour coordinates weighted with the mass fractions for the basic samples.

Key words: (maximum 6): papika powder, colour coordinates, colour measurement

INTRODUCTION

The paprika powder is a special spice of hungarian cuisine. It is also used as a natural food colour and as flavouring, too. The colour of paprika powder is very important, because the consumer concludes its colouring power based on its colour. The colouring power is determined by quality and quantity of colouring agent of paprika squarely. The colour of the powder is influenced by its particle size, oil content and moisture content and first of all the colour agent content. The instrumental colour measurement isn't used in the industrial practise, the development of the colour of the paprika powder is made based on the empirical facts; therefore the quantity of the colour of the final-product often isn't correct. This justifies the application of a more modern process that is based on values measured by instrument. The qualification of the colour of paprika powder is made without application of objective instrument, too. The results of scientific examinations demonstrate that the instrumental colour measurement is useable in the course of manufacturing process of paprika powders. Since the 1970s a number of papers have been published on measurements of the colour of paprika powders (Horváth és Kaffka, 1973, Drdak et al., 1980, Huszka et al., 1984, Drdak et al., 1989). Measurements have been performed relating to the changes in the colour stimulus components X, Y and Z of powders during mixing (Huszka et al., 1984) and to the correlation between visual sensing and the instrumentally measured colour characteristics (Huszka et al., 1985, H.Horváth, 2007). The effects of ionizing irradiation on the colour of paprika powder were investigated by Fekete-Halász et al. (1996). Minguez et al. (1997) analysed how the colour of the powder is changed by the ratio of the yellow and red pigments within the total colouring agent content. The effects of ionizing irradiation on the colour of paprika powder were investigated by Fekete-Halász et al. (1996). Minguez et al. (1997) analysed how the colour of the powder is changed by the ratio of the yellow and red pigments within the total colouring agent content. Chen et al. (1999) investigated the effects of particle size in Korean cultivars and established that the lightness coordinate of the powder was influenced by the particle size. There are many papers about the changes in the colour characteristics of the paprika during different dryings and storage processes (Park et al., 2007, Banout et al., 2011, Topaz et al., 2011, Chetti et al., 2012). In case of the Korean cultivars, no significant change in colour characteristics was detected when the moisture content varied between 10% and 15% (Chen et al., 1999). H.Horváth and Hodúr (2007a) investigated hungarian paprika powders and depicted that the colour of the powder was observed turning into darker and deeper red while increasing moisture content.

In the industrial practise the paprika powder products are made by mixing several quality powders. So, in our earlier work we investigated the colour coordinates of mixed paprika powders, the colour coordinates measured by Minolta CR tristimulus colour measuring instrument (H.Horváth , 2007b). In this paper we investigated the colour coordinates of paprika powder mixtures measured by HunterLab Miniscan XE Plus colour measuring instrument.

MATERIAL AND METHOD

Characterization and measurement of the colour

Colour measurements were carried out with a HunterLab Miniscan XE Plus colour measuring instrument. The CIELab colour system was used for colour characterization. In this colour space the colour points are characterized by three colour coordinates. L^* is the lightness coordinate ranging from no reflection for black (L^*=0) to perfect diffuse reflection for white (L^*=100). The a^* is the redness coordinate ranging from negative values for green to positive values for red. The b^* is the yellowness coordinate ranging from negative values for blue and positive values for yellow.

The total colour change is given by the colour difference (ΔE^*_{ab}), in terms of the spatial distance between two colour points interpreted in the colour space: (Hunter, 1987)

$$\Delta E^*_{ab} = \left[\left(L^*_1 - L^*_2\right)^2 + \left(a^*_1 - a^*_2\right)^2 + \left(b^*_1 - b^*_2\right) \right]^{1/2} . \qquad (1)$$

the If $1.5 < \Delta E^*_{ab} < 3$, then the colour difference between two paprika grists can hardly be visually distinguished, if $\Delta E^*_{ab} > 3$, then colour difference between two paprika grists can be visually distinguished (H.Horváth, 2007b).

Colour measurement of mixed paprika powders

The different paprika powder samples were mixed. Mixtures of 2–4 basic samples were prepared in different ratios. The mixtures were prepared 99 times. We prepared 44 mixtures from 2 components, 35 mixtures from 3 components and 20 mixtures from 4 components. In all cases, the powder mixtures were homogenized, and their colour coordinates were then determined in 3 parallel measurements and then averaged. The basic paprika powder samples were measured too.

Calculation of colour coordinates of the mixed paprika powders

A study was made whether the colour coordinates of a grist sample produced by mixing different basic paprika grist samples could be determined as averages of the coordinates of the basic samples weighted by mass.

Namely for **n** different paprika grist samples(basic samples) with known colour coordinates:

$$L^*_i \; ; \; a^*_i \; ; \; b^*_i \quad (i = 1,...,n)\,,$$

from which mixtures are prepared in such a way that $\mathbf{m_i}$ (i = 1,..., n) is the mass fraction of sample **i**, it was investigated whether the colour coordinates of the mixtures obtained after homogenization could be calculated by the following formula:

$$L^*_v = \frac{\sum_{i=1}^{n} m_i L^*_i}{\sum_{i=1}^{n} m_i}\,, \quad a^*_v = \frac{\sum_{i=1}^{n} m_i a^*_i}{\sum_{i=1}^{n} m_i}\,, \quad b^*_v = \frac{\sum_{i=1}^{n} m_i b^*_i}{\sum_{i=1}^{n} m_i} \qquad (1)$$

The theoretical colour coordinates of the grist samples were calculated from the colour characteristics of the basic samples on the basis of the mixing ratio, using equation (1). The values obtained with the two methods were analysed and the colour differences ΔE^*_{ab} of two colour points were calculated for every mixture.

Measurements in the industrial circumstances

Five mixtures were measured in the industrial circumstances. Mixtures were made from 2, 3, 4, 5 and 6 components. The colour coordinates of paprika powders were measured before mixing and after were measured of the colour coordinates of the mixed paprika powders.

Then the theoretical colour coordinates of the mixtures were calculated from the colour characteristics of the basic samples on the basis of the mixing ratio, using equation (1)..

RESULTS AND DISSCUSIONS

The Figures 1, 2 and 3 show the relationships between the measured and calculated colour characteristics of paprika powder mixtures. The regression lines and determination coefficients are given in the figures.
It is obvious that the data pairs fit to the line y = x well, with a determination coefficient of 0.705 at least, the correlations are significant between them at a level p=0.01 for all three coordinates.
The maximum difference between two values is 2.31 for L^* lightness coordinate, 1.19 for a^* redness coordinate and 2.21 for b^* yellowness coordinate in case of 2-component mixtures. The average difference is 0.81 for L^*, 0.51 for a^* and 0.54 for b^*. The calculated colour differences between two colour points are presented on Fig. 4.

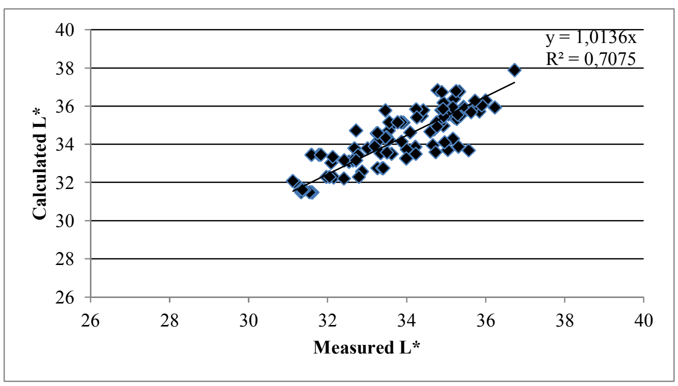

Fig. 1. Relationship between measured and calculated lightness coordinates

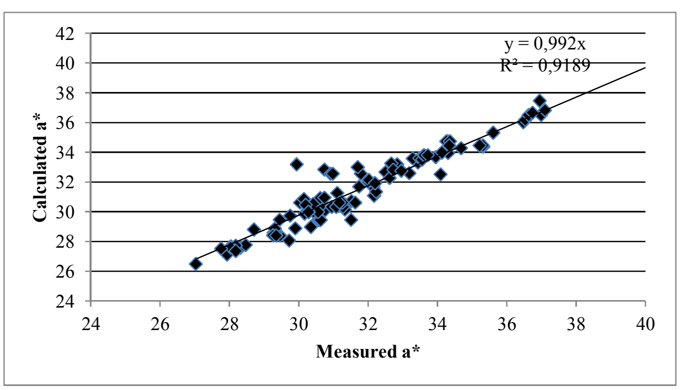

Fig. 2. Relationship between measured and calculated lightness coordinates

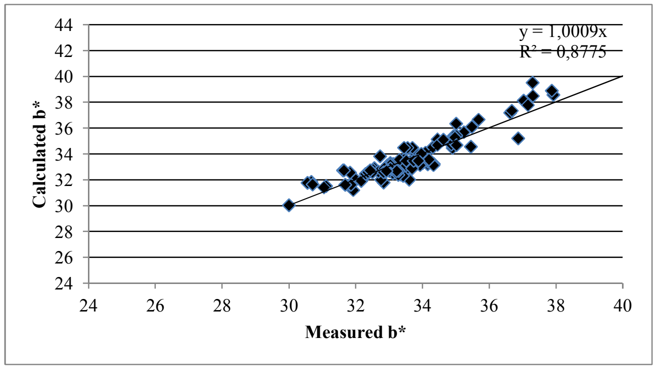

Fig. 3. Relationship between measured and calculated lightness coordinates

On the Fig. 4. we can see that the ΔE^*_{ab} colour difference values don't exceed the well perceptible threshold of the total colour difference 3, and in 69 % of the mixtures are less than 1.5 what is the perceptible threshold of the total colour difference.

The maximum difference between two values is 1.59 for L^* lightness coordinate, 2.06 for a^* redness coordinate and 1.68 for b^* yellowness coordinate in case of 3-component mixtures. The average difference is 0.70 for L^*, 0.63 for a^* and 0.61 for b^*. The calculated colour differences between the calculated and the measured colour coordinates are presented on Fig. 5. The values depict that ΔE^*_{ab} colour difference is less than 3 unit in all cases, and less than 1.5 unit in 78 % of the mixtures.

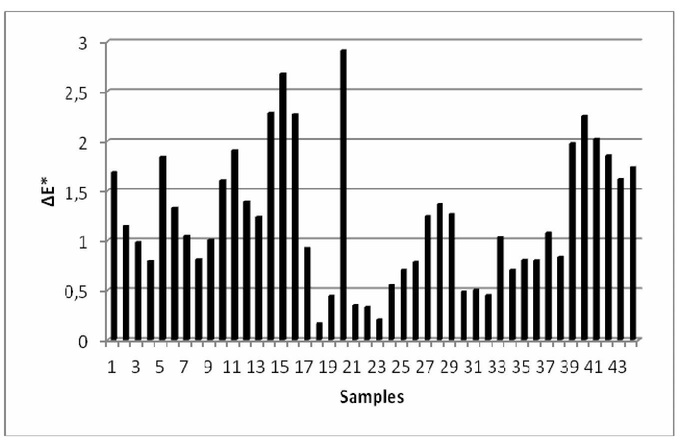

Fig. 4. Colour differences calculated between measured and calculated coordinates in case of 2 components mixtures

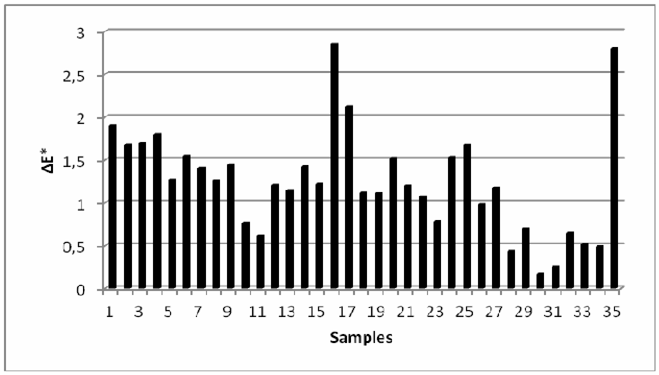

Fig. 5. Colour differences calculated between measured and calculated coordinates in case of 3 components mixtures

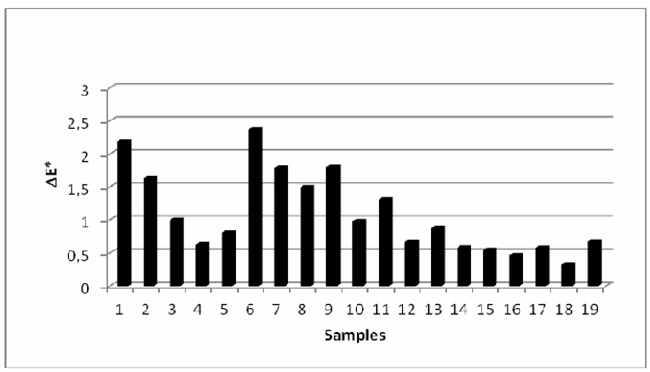

Fig. 6. Colour differences calculated between measured and calculated coordinates in case of 4 components mixtures

The maximum difference between two values is 1.22 for L^* lightness coordinate, 2.08 for a^* redness coordinate and 1.2 for b^* yellowness coordinate in case of 4-component mixtures. The average difference is 0.61 for L^*, 0.67 for a^* and 0.37 for b^*. The calculated colour differences between the calculated and the measured colour coordinates are presented on Fig. 6. We can see, that ΔE^*_{ab} colour difference less than 3 unit in all cases, and less than 1.5 unit in 79 % of mixtures.

In the Table 1 we can see results of measurements made in industrial circumstances. The values of the measured and the calculated colour coordinates and their differences are represented. The ΔE^*_{ab} colour difference values calculated between measured and calculated colour coordinates are presented too. The results depict that the ΔE^*_{ab} colour difference values don't exceed the perceptible threshold of total colour difference 1.5, and the maximum difference between calculated and measured colour coordinates is 1.26 unit

Table 1. Result of measurements were made in the industrial circumstances

Calculated values			Measured values			Differences			
L*	a*	b*	L*	a*	b*	ΔL*	Δa*	Δb*	ΔE*
29.83	32.75	31.81	30.04	33.42	32.62	0.21	0.67	0.81	**1.070**
31.96	32.98	34.97	31.91	32.68	35.10	-0.05	-0.30	0.13	**0.332**
33.17	32.18	33.36	32.93	33.43	34.11	-0.24	1.26	0.75	**1.480**
30.45	32.36	31.43	29.99	32.88	31.76	-0.46	0.53	0.33	**0.775**
32.07	31.64	34.68	31.63	32.83	34.63	-0.44	1.19	-0.05	**1.270**

CONCLUSIONS

We can state that these measurements confirm that the colour coordinates (L^*, a^* and b^*) of a product prepared by mixing paprika grist samples can be determined as the averages of the colour coordinates weighted with the mass fractions for the basic samples in accord with our earlier results (H.Horváth, 2007 b).

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