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TRISTIMULUS MEASUREMENT OF GROUND PAPRIKA COLOUR

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A b s t r a c t. Colour as a major component of appearance, is one of the primary quality factors, along with flavour, aroma and texture which influences sensory acceptability of ground paprika.

The possibility of using instrumental colour analysis was investigated to supplement or substitute sensory colour quality evaluation of paprika powders. Colour coordinates (according to CIE 1976 L*a*b*) of powders, the extractable colour, the water content and particle sizes were determined on 210 samples of paprika powders, and sensory analysis was performed by a trained laboratory test panel. Samples were obtained during seasons 1991 and 1992 and were representatives of the whole Hungarian paprika production for these years. Samples differed in colour very much, the colour difference was more then 30 units. A mathematical method, Cluster Analysis, was used to create colour clusters of colour points of paprika powders in CIELab space. Based upon our experiments a simple and accurate computer method is suggested for powders. Moreover, the results indicated that instrumental methods may be used as a supplement to, or as a substitution for, sensory analysis.

K e y w o r d s: ground paprika, colour measurement

INTRODUCTION

Till the end of the 1950s both in Hungary and in international practice the only method of qualification was based on the colour of the ground red pepper. In recent decades with the spreading of spectrophotometric measurements evaluation on the basis of extracted pigment content was emphasized [2,3].

Apart from these methods, evaluation on the basis of colour has remained a practical method whose task is to rank the samples by subjective colour sensation into a prechosen colour standard series of red pepper powders. Mostly this range has 5-6 elements and equals with the number of the qualification classes. This method of colour evaluation has its own disadvantages. Both the evaluation and the choice of the colour standards are subjective. It also varies depending on time, area, factory and even within one year depending on time and storing [1].

Besides the extracted colouring the evaluation of the colour of the powder is also important in the qualification because the colour is a parameter that expresses the joint effects of oil content, water content, raw material compound (proportion of the skin, stem, penducle, seed) as well as the technological parameters (drying heat, grinding pressure, dispersion of granules). Thus the colour expresses more and other factors of the characteristics of the powder than the colouring content does, therefore, it is desirable to carry out the evaluation of the colour of the red pepper powder and the colour classification with an objective method, as well as to utilize it in the qualification together with the colouring content. The purpose of this paper is to present an objective method for the qualification of the colour of ground red pepper. This method has been tested for Hungarian ground red peppers with the help of instrumental colour measuring and the computerized qualification method of the CIELab colour coordinates.

MATERIALS AND METHODS

Material

Samples were collected representing red pepper powders grown and produced in Hungary in the years 1991 and 1992. We tested the parameters of 210 types of powders whose pigment content, moisture, granule sizes, raw material compounds and production technologies varied in a wide region (Table 1). On the basis of visual evaluation we had samples from pale yellow to brownish red and purple, a great many varieties of the red.

Table 1. Intervals of chemical and physical parameters of ground paprika samples

Parameters	Values
Extracable pigment (g/kg)	1.5 - 8.5
Water content (%)	5.0 - 10.0
Particle size (μm)	250 - 500
Milling pressure	small (cylinder mill) high (millstone)
Technology	mill domestic laboratory
Quality of raw material	First class: only skin and seed of paprika Third class: skin, stems, peduncles, seeds of paprika

Colour-measuring

The CIELab colour coordinates of the samples were defined by Hunter LabScan type spectral colorimeter. Its measuring geometry was 0/45°. The powder was placed in a sample-holder of optical glass bottom in a layer of lem thick without pressing. The light spot was 2.44 mm. We carried out 3 parallel colour-measurements with each sample and the colour coordinates were averaged. Evaluation was done in a CIELab 1976 colour system [4].

Statistical method

In the evaluation and the development of the method the appropriate menu points of the Statgraphic 2.6 statistic program, the regression analysis and the Seeded method of the Cluster Analysis were used.

Visual evaluation

The samples that were arranged into the same colour classes were placed into small sample-holders. For the colour-evaluation the preparation of the surface and the lighting were done according to the MSZ 11851 standard [5]. Evaluation was done by an expert sensory panel of two researchers and one student.

RESULTS AND DISCUSSION

The CIELab colour coordinates of 210 powder samples were projected on the b* L* and a* b* colour planes (Fig. 1). It can be seen on the planes that the colour points of the samples representing the various Hungarian red pepper powders were placed in a well-defined part of the CIELab colour space. The extension of the colour space is great and the value of the max colour difference is nearly 30 units. The theory of our classification is the following:

1. The colour standards are marked out proportionally in this colour space.
2. Among the colour standards a sequence is defined for the definition of the degree of redness.
3. With the application of marked colour standards as class seeds of value of redness and by the use of the Seeded method of the Cluster Analysis, we carried out the computerized classification of the sample or set of samples whose a*b*L* colour coordinates were defined by measurement.

Determination of colour standards

It can be seen in the b*L* region (Fig. 2) that it can be attached onto the points with the method of linear regression. The attachment is close and it is proved by the correlation coefficient ($r=0.87$) and the low value of the standard error of estimation (1.64). This simplifies the indication of the class seeds because they can be indicated at regular intervals

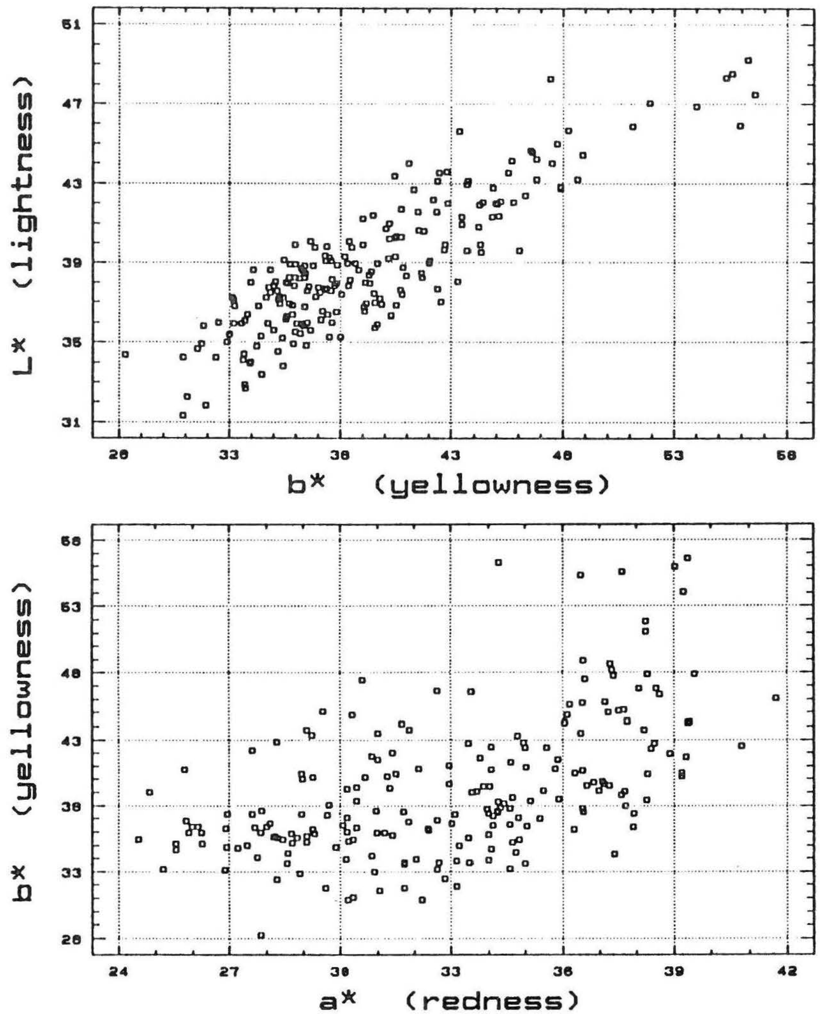

Fig. 1. Colour coordinates of 210 samples of ground paprika projected on to b*, L* and a*, b* colour plane.

on the line within the region. The b* coordinate region was divided into 2 intervals the central points of which are 15 units from each other. Therefore, the coordinates of b* of seeds were indicated. For the indication of a* coordinates of the class seeds the a*b* projection were used. The a* coordinate interval was divided into 3 regions in a distance of 6 units from one another. The centres of the intervals are the a* coordinates of the seeds. The reason for the difference between b* and a* intervals is that in the expression of the extent of redness the change in the a* coordinate has a significantly greater role than the role b* coordinate has. It has to be noted however that in this part of the region a decrease of the b* coordinate causes an increase in the perception of redness even in the case of constant a* but to a less extent. The colour standard coordinates of the 6 seeds of clus indicated with the above method are described in Table 2. The places of the seeds in CIEL*a*b* colour space can be found in Fig. 3.

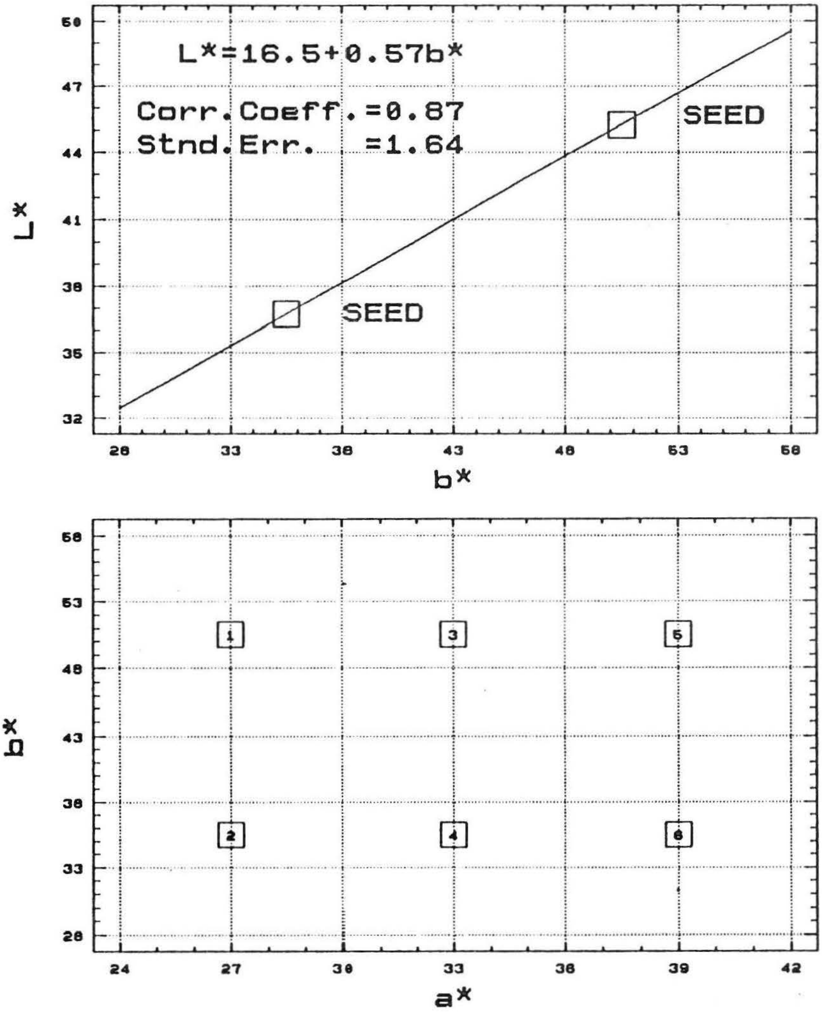

Fig. 2. Colour coordinates of seeds of colour classes projected on to b*, L* and a*, b* colour plane.

Table 2. CIELab coordinates of seeds of colour classes

Number of seeds	L*	a*	b*
1	45.25	27	50.5
2	36.71	27	35.5
3	45.25	33	50.5
4	36.71	33	35.5
5	45.25	39	50.5
6	36.71	39	35.5

The sequence of colour standards, the extent of redness

The criterium of the development of the colour sequence is the expression of the increasing extent of the sensation of redness. For the development of the sequence of redness we used the characteristics of sensation of quarter I of CIEL*a*b* colour space, i.e. the following characteristics.

a) Starting from any point of colour quarter I, the increase of the extent of redness

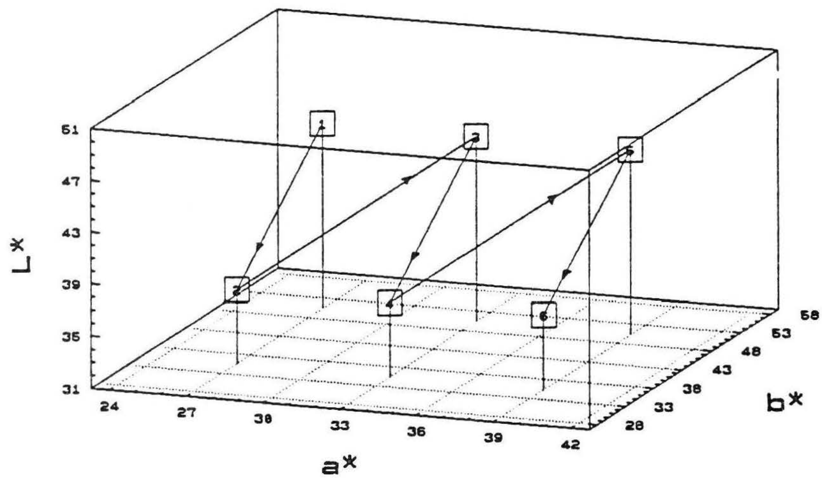

Fig. 3. Colour coordinates of seeds of colour classes and the direction of redness in the CIELab colour space.

can be achieved if at unchanged a* (red) coordinate value we proceed towards the decrease of b* (yellow) coordinate. In the case of red pepper samples, this goes together with a proportional L* (lightness) decrease.

b) A specific increase in the extent of redness can be achieved if in the given quarter of a region at unchanged b* and L* coordinate values we proceed increase of a* coordinate means an increase of a so-called higher-ranked value of redness than the b*, L* decrease. The direction of increase of the extent of redness was determined on the basis of the above statements. This was shown in Fig. 3 in the CIEL*a*b* colour space. In the figure the line indicates the direction of the row of redness of the colour standards. To the various classes and/or standards the index of redness equivalent to the extent of increasing redness was attached. The reddest class is indicated by index 6.

The computerized colour classification of the powders

The theory of colour classification is the following. The sample is arranged into the class which has the smallest difference of colour from the colour standard, i.e., the ΔE_{ab}* difference of colour in the CIELab colour region. The descriptive meaning of this difference in colour and at the same time, its basis of calculation is the distance in the region between the two coulor points. The so-called Seeded method of Cluster Analysis known in mathematical statistics complies with the above theory of colour classification. Therefore, we carried out a Cluster Analysis with the Seeded method at the given colour points of the sample where the seeds acted as colour standard points and their coordinates were marked by us as described above. It can be seen in Fig. 4 how the 210 samples got into the various colour classes and the samples got their appropriate index of redness (Fig. 4).

With the help of computerized colour classification, we arranged samples of the same colour class into groups and the visual evaluation was done on the following basis:

1) How unified and homogeneous are the colours of the samples arranged into groups by the computer on the basis of perception?

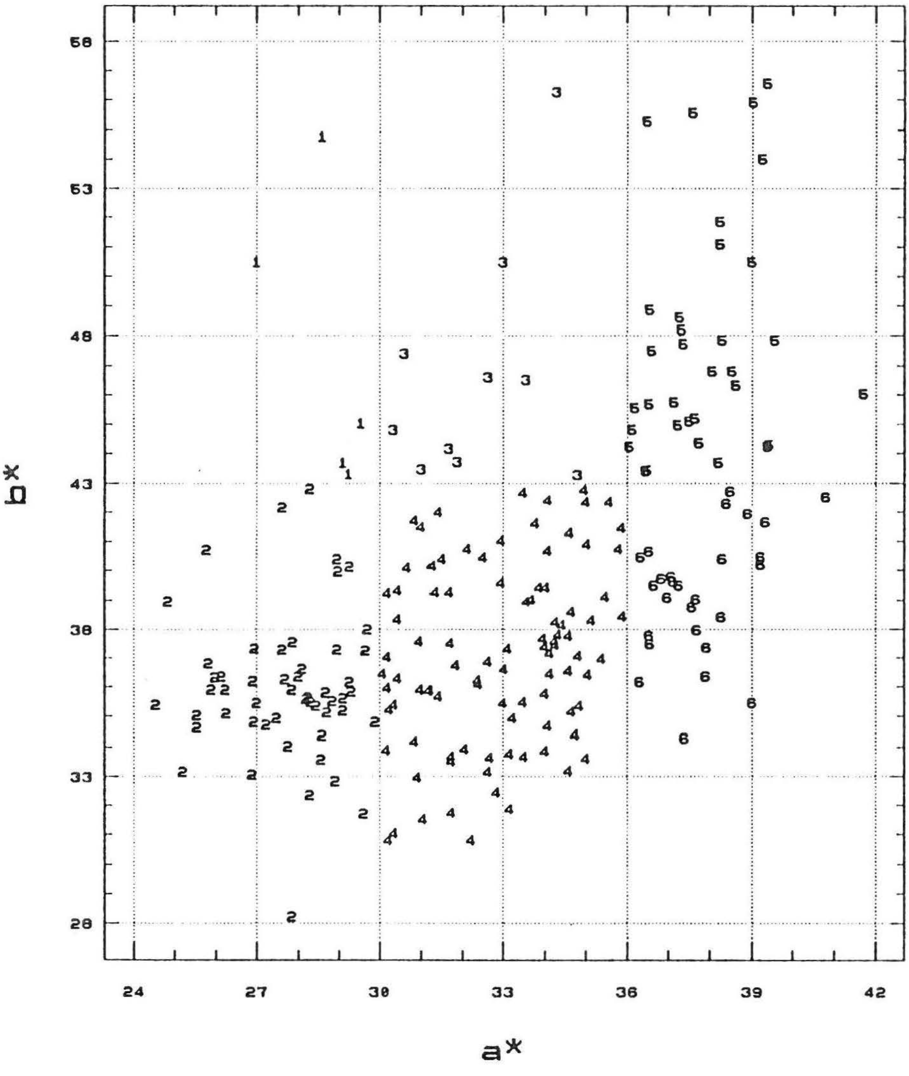

Fig. 4. Colour classes of 210 samples of ground paprika.

2) Whether the colour of the set of samples of the various colour classes differ in an easily perceptible way ?

3) If the increase of the perception of red complies with the row of redness determined by ourselves ?

Evaluation done on the above basis was the following:

1) We perceived significant differences in colours in the samples of the various colour classes. The reason for this is the relatively great difference that is allowed, i.e., a difference of max. 15 units. In later measurements, it is advisable to narrow it and increase the number of the classes.

2) The colours of the samples of the colour classes could easily be distinguished by the senses and regarding their they vary to an approximately similar extent.

3) The increase in the perception of redness complied with the indicated direction.

CONCLUSIONS

For the evaluation of the hues of various red pepper powders a computerized colour classification system has been developed the basis of which is the measurement of the tristimulus colour values. By virtue of this method each powder can easily be attached with so-called redness index can provide an easily understandable information for both the tester and the buyer on the quality of the colour of the sample, and it can also be incorporated into a complex qualification system that is based on points.

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