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# CONTRIBUTION OF ATTRIBUTES IN DEFINING THE SENSORY PROFILE OF FRESH PEPPER FRUIT (*Capsicum annuum* L.)

# DOPRINOS SVOJSTAVA U DEFINISANJU SENZORSKOG PROFILA SVEŽEG PLODA PAPRIKE (*Capsicum annuum* L.)

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## ABSTRACT

*The aim of this study was to consider the contribution of individual attributes in the sensory profile of the fresh pepper fruit using Analysis of Variance (ANOVA) and Principal Component Analysis (PCA). Four traditional Serbian red pepper cultivars, grown in Leskovac area and produced by seed sowing or transplanting, were evaluated in this study. Sensory profiling was performed by the trained panel, using a generic descriptive method. ANOVA showed the importance of the many selected attributes with different levels of significance. The final list of attributes (shape, colour intensity, shininess, pericarp colour uniformity, amount of seeds at placenta, size of placenta, harshness, elasticity, odour and sweetness) that were contributed to the differentiation of the tested samples was obtained on the basis of three derived PC analysis. To establish the final attribute list, a larger set of samples should be tested in future to derive general conclusions.*

***Key words:*** *fresh pepper, sensory profile, appearance, texture, flavour.*

## REZIME

*Senzorski profil i nutritivna vrednost svežeg voća i povrća su kritični faktori za prihvatljivost od strane potrošača. Karakteristike koje čine prepoznatljiv kvalitet povrća su uglavnom senzorska svojstva izgleda, boje i teksture. Plodovi paprike pokazuju veliku raznovrsnost veličine, oblika, boja, arome i ljutine. Cilj ovog istraživanja je bio da se razmotri doprinos pojedinih atributa u senzorskom profilisanju sveže paprike, korišćenjem analize varijanse (ANOVA) i analize glavnih komponenti (PCA). U istraživanju su korišćene četiri tradicionalne srpske sorte crvene paprike uzgojene u okolini Leskovca ('Turšijarka', 'Nizača', 'Džinka', i 'Lokošnička nizača'). Paprike su proizvedene uzgojem ili iz semena ili iz rasada, što je činilo ukupno osam uzoraka za ispitivanje. Senzorsko profilisanje je sprovedeno uz primenu panela utreniranih ocenjivača, koristeći opšti deskriptivni metod. ANOVA je pokazala da su sledeći atributi važni sa različitim nivoima statističke značajnosti: oblik, intenzitet boje, hrapavost, elastičnost, krckavost i sočnost ($p < 0{,}001$); ljutina ($p < 0{,}01$); sjaj, ujednačenost boje perikarpa i žvakljivost pokožice ($p < 0.05$). Konačna lista atributa (oblik, intenzitet boje, sjaj, ujednačenost boje perikarpa, količina semena u semenoj loži, veličine semene lože, hrapavost, elastičnost, mirisa i slatkoća), koja je doprinela diferencijacije ispitivanih uzoraka, dobijena je na osnovu tri izvedene PCA. Za uspostavljanje konačne liste atributa neophodno je u budućnosti testirati veći broj uzoraka kako bi se izvukao opšti zaključak.*

***Ključne reči:*** *sveža paprika, senzorski profil, izgled, tekstura, aroma.*

## INTRODUCTION

The sensory profile and the nutritional value of fresh fruits and vegetables are critical factors for consumer acceptance (*Barrett et al., 2010*). The characteristics that impart a distinctive vegetable quality are mainly sensory attributes of appearance, flavour, and texture. Structure of fruit on the cross section (skin, outer wall, placenta with seeds) is also important for quality assessment *(Ponjičan et al., 2012)*. Colour and textural properties are also important for fruits and vegetables which are grown for further processing by drying *(Radojčin et al., 2011)*, such as pepper. Consumers prefer fresh sweet peppers with no traces of decay, insect infestation or mechanical injury, and also have a uniform size, colour, firmness and crispness (*Selahle et al., 2015*). The taste of sweet peppers is determined by the sugar and organic acid contents (*Selahle et al., 2015*). Pepper flavour is a complex trait, influenced by environmental factors during growth and postharvest processing (*Eggink et al., 2012b*). Studies have been mainly focused on characterization of volatile and/or non-volatile components in cultivated or wild *Capsicum* species, and correlations between biochemical compounds and sensory attributes determined by panel are usually omitted (*Eggink et al., 2012a*). These findings led to the in-depth descriptions of sensory techniques available for measuring the quality of vegetables in general (*Meilgaard et al., 1999; Lawless and Heymann, 1998*).

Pepper fruits show large diversity of size, shape, colour, flavour and pungency (*Orbán et al., 2011; Ayuso et al., 2007*). The intense and characteristic of pepper red colour originates from carotenoid pigments which are synthesized during ripening (*Kevrešan et al., 2009*). Fruit ripening is a complex, genetically programmed process that can cause dramatic changes in the sensory quality (*Prasanna et al., 2010*). Ripening of red pepper fruits occurs gradually and may be monitored for changes in colour, from green to brown and further to red (*Kevrešan et al., 2009*). The main pigments in red fruits are capsanthin and capsorubin, considered as exclusive to *Capsicum* genus (*Matsufuji et al., 2007; Ayuso et al., 2007*).

The list of descriptors used to create the sensory profile of fresh fruit or vegetable is extensive, usually containing irrelevant and redundant terms, and therefore cannot be used for fast evaluation of different fresh products. The multidimensional approach enables evaluation of relative importance and contribution of descriptors in products' differentiation because it provides visualization of all products as well as correlations between descriptors simultaneously. Identification of descriptors' closeness and weights enables their elimination or grouping (ISO 11035, 2002). In the analysis of multivariate data such as that which descriptive analysis provides, Principal Component Analysis (PCA) technique have been used to explore underlying patterns in the different samples and among the sensory variables. Of the number of multivariate techniques available, PCA is one of the most appropriate statistical methods for investigating relationships between variables in single blocks data. In PCA, some tests applied to determine the importance and contribution of the principal components to indicate the number which should be retained. A linear combinations of the original variables are derived which could explain the maximum amount variation in the data sensory set and which are orthogonal, uncorrelated and perpendicular to each other.

Considering all mentioned above, the aim of this study was to consider the contribution of individual attributes in defining the sensory profile of the fresh pepper fruit.

*Table 1. The established list of attributes and definitions*

| Attribute | Abbreviation | Definition |
|---|---|---|
| ***Appearance*** | | |
| *Fresh fruit* | | |
| Shape | **SH** | Shape of pepper (from sphere to maximal length/diameter ratio) |
| Colour intensity | **C** | Intensity of fruit red colour (from light orange to dark red) |
| Shininess | **SHI** | Shiny appearance resulting from the tendency of a surface to reflect light energy at one angle more than at others (from dull to shiny) |
| *Cross-section* | | |
| Pericarp colour uniformity | **PCU** | Areas of pericarp coloured differently from red at the cross-section of fruit (from low to high) |
| Pericarp thickness | **PT** | Thickness of pericarp seen at the cross-section of fruit (from thin to thich) |
| Amount of seeds at placenta | **AS** | Amount of seeds attached to placenta seen at the cross-section of fruit (from small to large) |
| Size of placenta | **SP** | Relative size of placenta with regard to the size of fruit (from small to large) |
| ***Surface texture and mouthfeel*** | | |
| Harshness | **H** | Surface textural attribute that describes the amount of wrinkles on the pepper surface (from smooth to rough) |
| Elasticity | **E** | Degree to which a deformed material returns to its original condition after the deforming force is removed (from plastic to elastic) |
| Crispness | **CR** | Mechanical textural attribute related to the force needed to chop the pepper into pieces in the mouth (from low to high) |
| Skin chewiness | **SC** | Mechanical textural attribute related to the amount of work required to masticate a solid product into a state ready for swallowing (from low to high) |
| Juiciness | **J** | Perception of water released from pepper during mastication (from low to high) |
| ***Flavour (chemical sensation)*** | | |
| Odour | **O** | Sensation perceived by means of the olfactory organ in sniffing certain volatile substances (from low to high) |
| Sweetness | **S** | Fundamental taste associated with a sucrose solution (from low to high) |
| Pungency | **P** | Sensation of heat in the mouth (from low to high) |

## MATERIAL AND METHOD

### Material

Four local Serbian red pepper cultivars ('Turšijarka', 'Nizača', 'Džinka', and 'Lokošnička nizača') were used for sensory analysis in this study. These cultivars were grown at different localities in the municipality of Leskovac and produced either by direct seed sowing or by transplanting of small plants in the garden. Seeds were propagated by the pepper producers. For display in the diagrams and tables, samples were labelled as follows: 1–'Turšijarka', 2–'Nizača', 3–"Džinka", 4–'Lokošnička nizača'. The letter S indicates direct sowing, while the letter R indicates transplantation. Peppers were harvested in red ripe stage and stored in refrigerator (+4 °C) for 24 hours prior to sensory evalution. Samples were washed with tap water before presentation to panellists.

### Methods

Sensory profiling was performed by the eight trained panellists, aged between 25 and 50 years, selected from previously trained academic staff of the Institute of Food Technology, Novi Sad. The sensory evaluation was carried out in the single booths under defined conditions according to ISO 8589 (2007). During the corresponding number of sessions, the panellists were provided with the attributes determined through consensus that discriminate among the pepper samples. On the first session (50–60 min), assessors were served three samples from the product set. Then they were asked, individually and quietly, without conversation, to determine a list of attributes that discriminate among the given samples. They are told that the attributes must be actionable in the sense that it can be made a reference standard for it. Once all panellists evaluated the samples, each panellist was asked to read the attributes they perceived. All used words were written on a board and those words which were repeated several times were grouped together. At the next training session, the panellists were given another subset of pepper samples from the product set which were frequently more similar to one another than the first subset and the whole process was repeated. During this session, the potential reference standards to anchor the attributes were also showed the panel. The process was repeated as many times as was necessary to allow the panel to see all samples in the product set and to ensure that all potential attributes have been listed. In the third training session, the panel leader worked with the panel to determine which of the listed attributes could actually be used in the evaluation (Table 1).

The attributes were evaluated using a 10 cm non-structured line scale. Sensory evaluation was performed in two replications, under identical conditions in order to obtain reproducible results

All samples were presented to each assessor at the same time.

The order of sample presentation was completely randomized among assessors, identified with three random numbers. Distilled water was provided to cleanse the palate between samples during evaluation.

The obtained data were considered by analysis of variance (ANOVA) to determine the samples which caused significant variations in attribute means using PanelCheck V1.4.0, 2010 (www.panelcheck.com) as relatively simple and easy software to analyze these data. In order to explore the relationships among the established sensory attributes and to estimate the relative importance and contribution of attributes for products differentiation, PCA analysis was performed using the Software XLSTAT, version 2012.2.02 (www.xlstat.com).

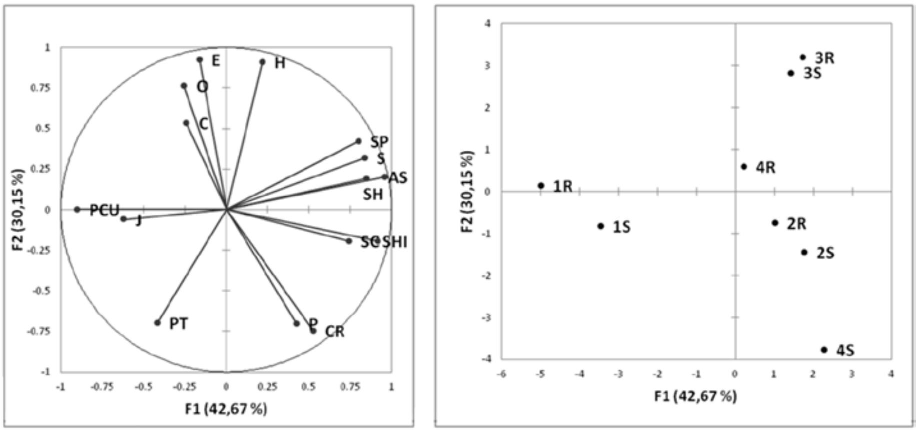


*Fig. 2. PCA plot of sensory attributes and fresh pepper samples (abbreviation cues are in Table 1)*

## RESULTS AND DISCUSSION

ANOVA and MCT (Multiple Comparison Test) were used to determine the samples which caused significant variations in attribute means. The means of the samples for each attribute were calculated as mean separation value using Fisher's (MCT test at different significance levels. The obtained results ar presented in Fig. 1 using the statistical data analysis softwar PanelCheck.

Significant sample effect could be seen at following sensor attributes: shape, colour intensity, harshness, elasticity, crispnes and juiciness ($p < 0.001$); pungency ($p < 0.01$); shininess pericarp colour uniformity, and skin chewiness ($p < 0.05$). Thi points out that evaluated pepper samples differed among eac other mainly by above mentioned attributes.

PCA was performed on the correlation matrix of 1 attributes to explore the relationships among the established sensory variables. As shown in Fig. 2, the first two principal components (F1 and F2) explained 72.82 % of the total variance (F1=42.67 %, F2=30.15 %). The higher value of the factor loadings ($p \geq 0.5$), the more important that variable is to corresponding axis. Therefore, the properties with the high positive or negative loadings summarized the meaning of the first two components *(Bower, 2009)*. Thus, attributes with squared cosine values lower than $p \geq 0.5$, such as pericarp thickness and pungency, were excluded from further PC analysis.

In addition, the first sequential PCA was performed on the correlation matrix of the remaining attributes, and the first two factors explained 74.76 % of the total variance (data not shown).

However, two attributes (crispness and skin chewiness) had squared cosine values lower than 0.5, and therefore were also eliminated. The second sequential PCA was performed, and the first two factors explained 76.65 % of total variance (F1=49.61 %, F2=27.04 %). All remaining attributes showed high correlations with principal components (Fig. 3). Elimination of attributes did not contribute to significant change of products' positions in PCA plot (Fig. 2), but pepper samples were more separated than after the first sequential PCA (Fig. 3).

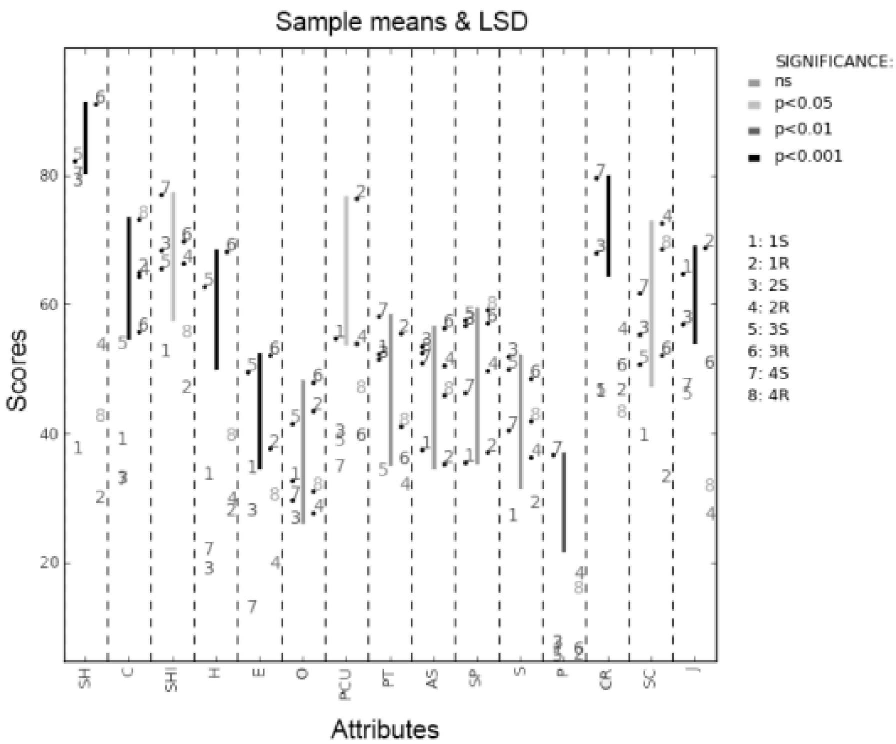


*Fig. 1. Sample means and least significant difference (LSD) for the sensory evaluation; significance of differences between the samples are calculated using F-test (abbreviation cues are in Table 1)*

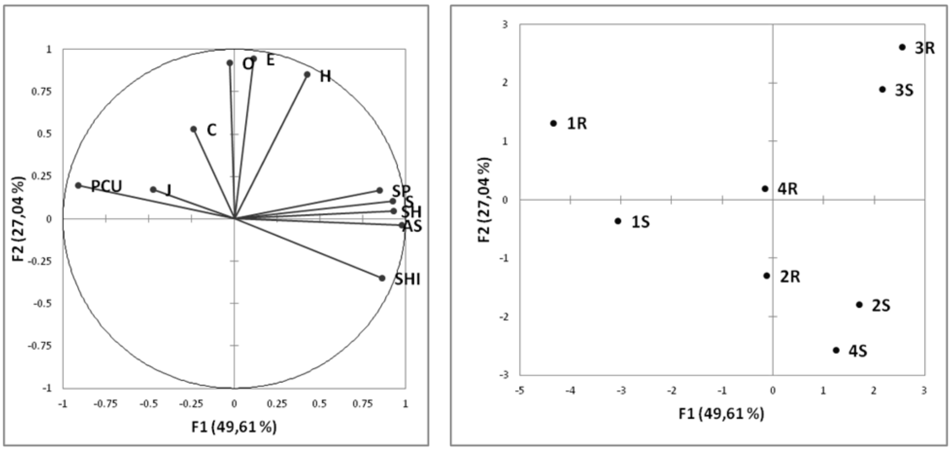


*Fig. 3. The second sequential PCA plot of sensory attributes and fresh pepper samples (abbreviation cues are in Table 1)*

## CONCLUSION

The final attribute list (shape, colour intensity, shininess, pericarp colour uniformity, amount of seeds at placenta, size of placenta, harshness, elasticity, odour and sweetness) which contributed to the differentiation of the tested pepper samples was obtained on the basis of three derived PCA analysis. To establish the final attribute list in the sensory profiling of fresh pepper, a larger set of samples should be tested in the future to derive general conclusions.

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