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Original research paper

IDENTIFICATION AND SELECTION OF THE DESCRIPTORS FOR ESTABLISHING A SENSORY PROFILE OF TOMATO BY A MULTIDIMENSIONAL APPROACH

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ABSTRACT: The objective of this research was to create the list of descriptors that would determine the quality differences between the fresh tomato samples. The samples purchased from local markets were evaluated by a trained panel. The free choice profiling (FCP) method was used for the generation of descriptors. One way of reducing the number of descriptors was performed on the basis of their classification by geometric means (M). Sequential principal component analysis (PCA) was carried out in order to exclude descriptors with low contribution to the total variance. The final list included descriptors of appearance (11), texture (3), odour (2), and taste (2), and their definitions as well. This research confirmed that the multidimensional approach could be used as a good sensory method for developing the sensory profile of fresh tomato.

Key words: *descriptors*, *sensory profile, multidimensional approach, tomato*

INTRODUCTION

Quality of fresh tomato is determined by nutritional value and sensory properties (appearance, texture, and flavour) (Kader et al., 1978). The sensory analysis is commonly used to determine the optimal harvest maturity and storage conditions, as well as to monitor the quality changes during postharvest life of agricultural products. Moreover, it is the essential part of a new tomato cultivar breeding process (Echeverria et al., 2008). Many researches of tomato sensory quality were dedicated to comparison of results obtained by trained sensory panel and/or consumers with instrumental data. In general, they were mostly focused on tomato flavour (Sinesio et al., 2000; Maul et al., 2000; Tandon et al., 2003; Berna et al, 2005; Krumbein et al., 2004). The relationship between the sensory perception and instrumental measurements of ripe harvested tomatoes stored under retail conditions were investigated by Auerswald et al. (1999). The results of quantitative descriptive analysis were significantly correlated with some instrumental measurements (colour, firmness) and chemical analyses (titratable acidity, reducing sugars, etc.). Furthermore, this research showed which of perceptible changes during storage were important for consumers.

In order to create the sensory profile of tomato, it is necessary to select appropriate descriptors. They are defined as product's perceptible attributes that are assessed on the intensity scale. The list of descriptors can be determined by the consensus method, the independent method as well as by the multidimensional approach for establishing a product's profile (ISO 11035, 1994). However, this list is extensive, usually containing irrelevant and redundant terms, and therefore cannot be used for fast evaluation of different 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, 1994).

Hongsoongnern and Chambers (2008) conducted one of more comprehensive researches of tomato sensory properties using PCA with both the correlation and covariance procedures in order to investtigate the relationships within the sensory set-data. They also created a lexicon for texture and flavour characteristics of fresh and processed tomatoes that included 5 aroma attributes, 10 texture attributes and 18 flavour attributes including 6 taste and mouthfeel attributes. Moreover, they provided definitions, references and intenseties on a 15-point scale for each attribute.

PCA is applied extensively in sensory analysis for identification and selection of descriptors (Hayakawa et al. 2010), investigation of panel consonance and interacttions among different sensory attributes (Echeverria et al. 2008), and selection of descriptive terms (Barcenas et al. 1999).

Referring to all mentioned above, the objective of this research was to create the list of descriptors that would determine the quality differences between the fresh tomato samples.

MATERIAL AND METHODS

Samples

Five samples of fresh tomatoes were selected to cover all possible qualitative differences in terms of size, shape, colour and firmness that could be observed during sensory evaluation. All samples were purchased from local markets on the day of evaluation.

Sensory evaluation

Sensory profiling was performed by the seven trained panellists, 6 females and 1 male, aged between 25 and 50 years. They were 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 SRPS ISO 8589 (1998). Each assessor could use the instructions for generating the detailed list of descriptors as guidelines during evaluation. All samples were presented to each assessor at the same time. The free choice profiling (FCP) method was performed for the generation of descriptors. The intensity scale (from 0 - absence of perception to 5 – strong perception) was applied to express intensity of each observed descriptor (SRPS ISO 4121, 2002). Similar descriptive terms were grouped together in order to simplify obtained list by consensus method. During the session, panel leader together with panellists discussed each proposed descriptor, where redundant, synonymous and vague terms were removed from the list.

Data analysis

To explore the relationships among the established sensory descriptors and to estimate the relative importance and contribution of descriptors for products differentiation, PCA analysis was performed using the Software XLSTAT, version (2012.2.02) (http://www.xlstat.com/).

RESULTS AND DISCUSSION

The list of 39 descriptors, selected on the basis of panellists' perception, is presented in Table 1, along with their abbreviations and geometric means (M - values) for each product. The first reduction of descriptors was performed on the basis of their classification by M - value, which is the square root of the product of frequency (F) and relative intensity (I) of each descriptor:

$$M = \sqrt{(F \cdot I)} \quad (1)$$

where is:

F – number of descriptor's mentions divided by the total possible number of this descriptor's mentions, expressed as percentage.

I – sum of intensities given by the entire panel for descriptor divided by the maximum possible intensity of this descriptor, expressed as percentage.

Table 1.
Initial list of descriptors, abbreviations and M – values for each product

Descriptor	Abbreviation	M – value (%)				
		Product 1	Product 2	Product 3	Product 4	Product 5
Whole fruit						
Shape regularity	SH	81.24	84.85	88.32	70.71	73.48
Size	S	63.89	60.61	47.38	53.45	49.49
Colour	C	82.81	95.62	87.83	67.61	65.47
Colour uniformity	CU	81.06	94.11	91.03	58.55	58.55
Surface smoothness	SS	25.56	23.90	23.90	22.13	20.20
Mechanical damage	MD	43.89	49.19	32.20	51.64	51.64
Scar size	SCS	12.78	11.07	9.04	11.07	9.04
Scar regularity	SCR	6.39	12.78	14.29	6.39	11.07
Skin cleanness	SC	23.90	23.90	25.56	18.07	18.07
Skin brightness	SB	60.61	49.49	60.61	47.38	47.38
Surface green decolourization	SGD	15.65	20.20	20.20	27.11	9.04
Firmness	F	83.00	89.44	85.63	68.31	84.33
Skin wilting	SW	42.86	45.18	42.86	49.49	53.45
Skin elasticity	SE	15.65	11.07	22.13	27.11	25.56
Cross -section						
Cross-section colour	CSC	47.38	62.27	63.89	55.33	62.27
Cross-section colour uniformity	CSCU	68.21	63.89	73.40	58.55	73.40
Fruit fleshiness	FF	22.13	22.13	22.13	28.57	27.11
Fruit compactness	FC	58.90	60.61	49.49	67.01	60.61
Juice leakage	JL	57.14	55.33	62.27	60.61	64.52
Vessels	V	58.55	58.55	77.46	65.47	73.68
Unripe layers	UL	12.78	9.04	14.29	6.39	9.04
Cross-section green decolourization	CSGD	6.39	6.39	6.39	12.78	9.04
Skin thickness	ST	22.13	22.13	18.07	25.56	23.90
Skin peeling	SP	33.20	33.20	15.65	15.65	15.65
Seeds	SEEDS	12.78	12.78	11.07	6.39	9.04
Texture in mouth						
Skin chewiness	SCH	49.49	62.60	71.71	71.71	47.81
Firmness	FM	40.41	34.99	38.33	27.11	31.30
Solubility	SM	11.07	12.78	9.04	14.29	14.29
Juiciness	J	33.20	46.07	47.81	44.26	33.20
Chewiness	CH	53.45	69.99	53.45	75.05	51.11
Mealiness	M	46.07	31.30	29.28	19.17	24.74
Covering of oral cavity	COC	12.78	11.07	12.78	12.78	12.78
Odour and taste						
Odour	OD	84.52	79.28	69.69	56.42	63.25
Off-odour	OOD	6.39	6.39	6.39	18.07	9.04
Sour taste	SOT	44.26	36.14	49.49	42.38	36.14
Sweet taste	SWT	56.42	51.51	77.46	53.45	71.71
Off-taste	OFFT	12.78	9.04	14.29	6.39	9.04
Flavour	FL	15.65	22.13	22.13	20.20	27.11
After taste	AT	33.20	34.99	20.20	25.56	38.33

The shaded small M values and M values which did not contribute to good differentiation of the samples were removed from further data processing.

PCA was performed on the correlation matrix of 25 retained descriptors (variables). The first two principal components (F1 and F2) explained 70.41% of the total variance (F1=40.93%, F2=29.48%). Shaded descriptors were excluded from further analysis because of their low squared cosines (Table 2).

Namely, a high magnitude (near to +1 or -1) for factor loading means that the variable is highly correlated with that factor, but >0.5 can be enough for importance (Bower, 2009). Bearing in mind the fact that the preconditions for the application of PCA are more conceptual than statistical, the first sequential PCA was performed on the correlation matrix of the remaining descriptors (Pestorić, 2011).

The first two factors explained 82.32% of the total variance. In this step, cross-section colour was eliminated from the list of descriptors, as well as firmness evaluated by palpatory technique (Figure 1). It was less convenient textural descriptor than firmness evaluated in mouth, considering the squared cosines values.

Table 2.
Squared cosines of descriptors after first reduction of their number

Descriptor	F1	F2
SH	**0.864**	0.000
S	0.023	**0.966**
C	**0.580**	0.097
CU	**0.715**	0.039
MD	**0.643**	0.199
SCR	0.272	0.255
SB	**0.703**	0.001
F	**0.604**	0.008
CSC	0.006	0.413
CSCU	**0.382**	0.246
FC	**0.774**	0.225
JL	0.067	**0.739**
V	0.004	**0.966**
SP	0.173	**0.810**
SCH	0.010	0.157
FM	**0.912**	0.043
J	0.009	0.092
CH	0.346	0.099
M	**0.503**	0.347
OD	**0.577**	0.417
OOD	**0.825**	0.017
SOT	0.207	0.157
SWT	0.140	**0.740**
OFFT	**0.868**	0.038
AT	0.026	0.298

Values in bold correspond for each variable to the factor for which the squared cosine is the largest

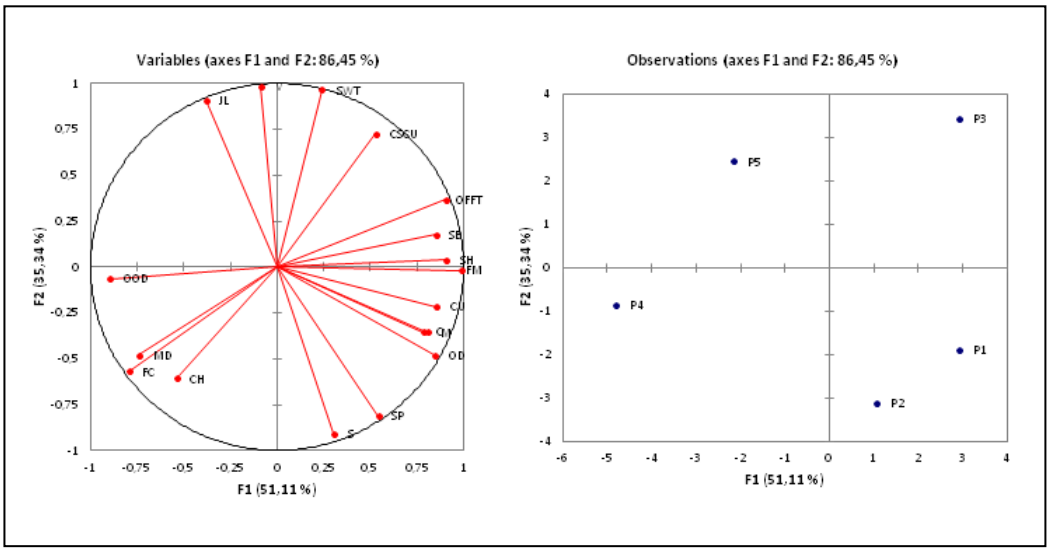

Figure 1. PCA plot of relationship between the descriptors and differentiation between the samples after the first reduction

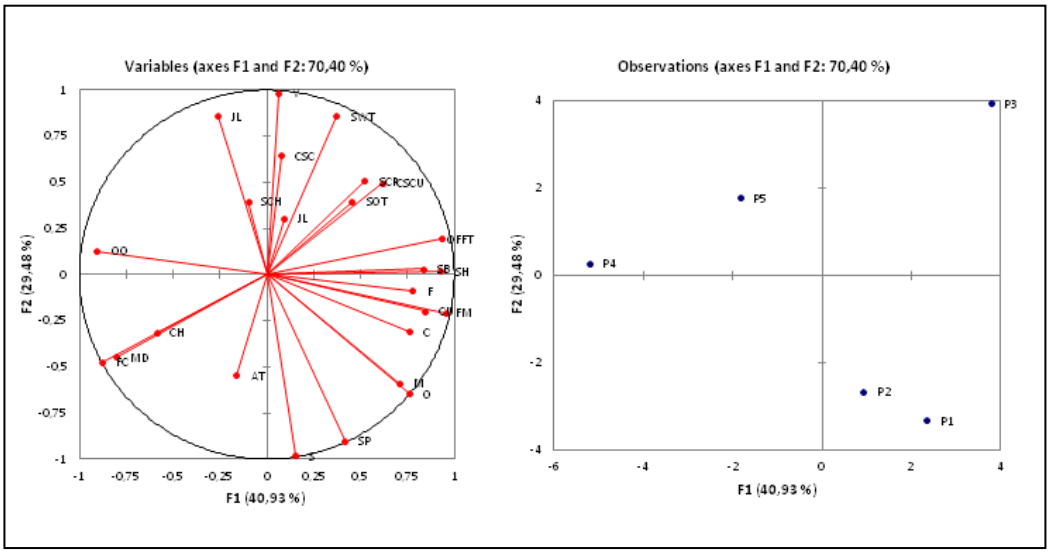

Figure 2. PCA plot of relationship between the descriptors and differentiation between the samples after the third reduction

The second sequential PCA explained 86.45% of the total variance (F1=51.11%, F2=35.34%). All retained descriptors showed high correlations with principal components (Figure 2).

Elimination of descriptors and the performed sequential PCAs did not contribute to significant change of products' positions in PCA plot (Figures 1 and 2). Products P1 and P2 were both located in the fourth quadrant and they had some similarities in terms of size, skin peeling, odour, mealiness and colour uniformity. Product P3 is distinguished from other samples by its cross–section colour uniformity, P4 by off–odour, mechanical damage and fruit compactness, and P5 by juice leakage.

Established sensory profile of fresh tomato is presented in Table 3.

Table 3.
The established final list of descriptors and definitions.

Descriptor	Abbreviation	Definition
APPEARANCE		
Whole fruit		
Shape regularity	**SH**	Symmetry of the fruit (cultivar characteristic)
Size	**S**	Size of the fruit (cultivar characteristic)
Colour	**C**	Intensity of fruit red colour
Colour uniformity	**CU**	Areas coloured different from red
Mechanical damage	**MD**	Size and number of scars and bruises
Skin brightness	**SB**	Reflection of light from skin
Cross-section of the fruit		
Cross-section colour uniformity	**CSCU**	Areas coloured different from red in the cross-section
Fruit compactness	**FC**	Appearance of cavities in the cross-section
Juice leakage	**JL**	Amount of juice leaked after cutting with knife
Vessels	**V**	Number of vessels seen in the cross-section
Skin peeling	**SP**	Amount of peel separated from mesocarp after cutting by knife
TEXTURE IN MOUTH		
Firmness	**FM**	The force required to cut through the tomato sample using the front teeth.
Chewiness	**CH**	The length of time required to masticate the tomato to a state of swallowing.
Mealiness	**M**	Geometrical texture attribute relating to the perception of the size and shape of particle in the tomato sample
ODOUR		
Odour	**OD**	Tomato characteristic odour
Off-odour	**OOD**	Non characteristic odour
TASTE		
Sweet taste	**ST**	The fundamental taste associated with a sucrose solution
Off-taste	**OFFT**	Non characteristic taste

CONCLUSIONS

This research showed that the application of the multidimensional method can be suitable tool for identifying and selecting descriptors for establishing the sensory profile of the fresh tomato. These descriptors are useful for quality differentiation of tomatoes on the market, and determination of the optimal harvest maturity and storage conditions.

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ИДЕНТИФИКАЦИЈА И ОДАБИР ДЕСКРИПТОРА ЗА УТВРЂИВАЊЕ СЕНЗОРСКОГ ПРОФИЛА ПАРАДАЈЗА МУЛТИДИМЕНЗИОНАЛНИМ ПРИСТУПОМ

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Сажетак: Циљ овог истраживања је стварање листе дескриптора која ће омогућити одређивање квалитативних разлика између узорака свежег парадајза. Узорци купљени на локалним пијацама су оцењени од стране обученог панела. Метода профилисања слободним избором (free-choice profiling – FCP) коришћена је за генерисање дескриптора. Један начин смањења броја дескриптора је изведен на основу њихове класификације по геометријским срединама (M). Секвенцијална анализа главних компоненти (Principal component analysis – PCA) је изведена да би се уклонили дескриптори који дају мали допринос укупној варијанси. Дескриптори изгледа (11), текстуре (3), мириса (2) и укуса (2) су укључени у коначну листу, као и њихове дефиниције. Ово истраживање је потврдило да мултидимензионални приступ може бити коришћен као добра сензорска метода за развој сензорског профила свежег парадајза.

Кључне речи: *дескриптори, сензорски прифил, мултидимензионални приступ, парадајз*

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