POMOLOGIA CROATICA
Vol. 17 - 2011., br. 3-4

Original scientific paper
Izvorni znanstveni članak

Physical and chemical characteristics and sensory evaluation of pomegranate fruit of (*Punica granatum* L.) cv. ”Glavaš”

Fizikalne i kemijske karakteristike i senzoričko ocjenjivanje plodova šipka (*Punica granatum* L.) sorte ‘Glavaš’

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ABSTRACT

Physical, chemical and sensory characteristics of pomegranate fruits of cultivar ‘Glavaš’ were investigated. External and internal fruit quality was assessed by standard parameters (fruit and aril weight and dimensions, soluble solids, total acid) and sensorial quality by panel tests (fruit size, shape and colour; juiciness, sweet/acid taste). Among locations ‘Stolac3’ and ‘Buna 3’ have significantly distinct physical characteristics. The highest fruit weight was at ‘Buna 3’. Location ‘Stolac 1’had significantly higher values of total soluble solid content (17,63 ºBrix) and acidity of fruit juice (3,16 g/L). Large differences in sensory scores for fruit taste were found between locations.

Key words: *Punica granatum* L., sensory evaluation, fruit quality

SAŽETAK

Istraživane su fizikalne, kemijske i senzoričke karakteristike plodova šipka sorte ‘Glavaš’. Vanjska i unutarnja kakvoća ploda ocijenjena je standardnim parametrima (masa ploda i arilusa, dimenzije ploda i arilusa, suha tvar, ukupne kiseline) i senzoričkim ocjenjivanjem panel testom (krupnoća ploda, oblik i boja ploda i arilusa, sočnost, slatkoća/kiselost).

Između istraživanih lokacija statistički značajne razlike u fizikalnim karakteristikama ploda javljaju se na lokacijama ‘Stolac 3’ i ‘Buna 3’. Najveća masa ploda izmjerena je na lokaciji ‘Buna 3’. Lokacija ‘Stolac 1’ značajno se razlikuje u sadržaju suhe tvari (17,63 ºBrix) i ukupnih kiselina (3,16 g/L). Senzoričkim ocjenjivanjem utvrđene su razlike u okusu između plodova na različitim lokacijama.

Ključne riječi: *Punica granatum* L., senzoričko ocjenjivanje, kakvoća ploda

INTRODUCTION

Pomegranate (*Punica granatum* L.) is a highly valued crop and is widely cultivated in Mediterranean countries. It is an ideal crop for the sustainability of small holdings, as pomegranate is well suited to the topography and agro-climate of arid and semi-arid regions (Ercisli and Gadže, 2010). Pomegranate fruits are important for human health because of their high antioxidant capacity and a high polyphenols and anthocyanins content (Gil et al., 2000). Pomegranate fruit maturity status is commonly assessed based on external (skin) colour, aril and juice colour and acidity of juice (Cristosto et al., 2000). Will consumers and manufacturers acceptit depends on the combination of several quality attributes that are related to the physico-chemical properties including size, skin color, sugar content, acidity and flavour (Gozlekci et al., 2011).

Based on the organoleptic properties (sugar-acid ratio) of pomegranate fruit, cultivars are classified into three groups: sweet, sour-sweet and sour. Fruits have traditionally been consumed as fresh fruit and processed into juice. In western Herzegovina a few local pomegranate cultivars are used in traditional plantations. Recently, there has been high demand and public awareness for its cultivation and it is getting more commercialised in the country. The fruits are usually sold in local markets for fresh consumption. In the frame of this growing interest it is highly important to know fruit characteristics.

Sensory quality attributes and nutritive value of fruit play an important role in consumer satisfaction and they influence further consumption. Sensory ratings of fruit by panelists and physical measurements of fruit properties are useful methods in the evaluation of fruit quality (Čolarić et al., 2005). Sensory quality is a difficult concept to define, it should be comprehended as interaction between the product and the consumer. It is necessary to establish a relationship between the physical and chemical composition of the product and its sensory attributes such as color, texture, aroma (volatile compounds) and taste (sweet, sour, salty and bitter sensations), as well as between the sensory perceptions and the acceptability for the consumer (Escribano et al., 2010).

Taste, aroma, texture and appearance are generally considered to be among the most important sensory attributes. Taste is related to water-soluble compounds. Sweetness is mostly attributable to mono and disaccharides rather than to other compounds. Sour tastes are reliably linked up with organic acids and pH.

Local residents put cv. 'Glavaš' in a sweet-sour group, therefore they like to use it in juice production. 'Glavaš' cultivar is the most common cultivar of pomegranate orchards in western Herzegovina. Fruit has a rounded shape, very

big size with thick peel. Basic colour of fruit is yellow with red colouration on the sunny side. Arils are big and juicy, light red in color (Ugarković et al., 2009).

The objective of this study was a sensory evaluation and characterization of important external and internal quality attributes of the main pomegranate cultivar 'Glavaš' grown at nine locations in western Herzegovina.

MATERIALS AND METHODS

The study was conducted on the pomegranate cultivar 'Glavaš' grown in western Herzegovina. Samples were harvested at the optimum harvest time during 2010 at nine different locations and transported to the laboratory of the Federal AgroMediterranean Institute of Mostar. Ten representative pomegranate fruits of each location were used for pomological and chemical analysis.

Pomological properties

Fruits were weighed individually on a balance of accuracy of 0.001 g. Length and diameter of the fruit and calyx were measured with a digital Vernier calliper. The measurement of fruit length was made on the polar axis of fruit, i.e. between the apex and the end of the stem. The maximum width of the fruit, as measured in the direction perpendicular to the polar axis, is defined as the diameter. Arils were manually separated from the fruits, and total aril content was weighted. Replicate measurements of the skin thickness on the opposite sides were made using digital Vernier calliper (Tehranifar et al., 2010). Fruit colour was scored as appearance by panellist. Maturity index was expressed as total soluble solid / acid ratio. Fruit juice content was determined by extracting the contents of replicate samples of 100 g of arils per fruit using a juice extractor. Then juice was analyzed for the following chemical properties.

Total soluble solid, acidity and pH

Total dry matter (DM) was obtained by drying homogenised pomegranate arils at 105 ºC to a uniform mass (AOAC., 1995). Soluble Solid Content (SSC, %) was measured using an Abbe refractometer (A. Krüss Optronic, Germany) calibrated against sucrose. Acidity was measured according to the AOAC method (AOAC., 1995) and expressed in g/L as citric acid. pH value was measured with a pH meter (Mettler Toledo, Switzerland).

Sensory evaluation

The sensory panel consisted of 9 people (4 men and 5 women, aged 31–55), familiar with pomegranate fruit. A minimum amount of information on the

nature of this evaluation was provided to the panel in order to avoid any bias. Each panelist individually evaluated the fruit and aril in succession. Fruit quality was assessed as fruit and aril size, shape and colour; juiciness, sweet and acid taste.

Samples, either for visual evaluation or flavour were blind labeled with random four digit codes, and the sample order was randomized. During flavour evaluation panelists rinsed their palates with room temperature water between samples. The rating for each characteristic was based on a five-point scale (1: unacceptable; 2: poor; 3: fair; 4: good and 5: excellent).

Analysis of variance was performed using STATISTICA 7. The differences were compared using LSD test at P=0.05.

RESULTS AND DISCUSSION

Some physical properties of the pomegranate cultivar 'Glavaš' are shown in Table 1. There were statistical differences among cultivars at different locations in most of characteristics (P<0.05).

Table 1. Pomological characteristics of the pomegranate cv. 'Glavaš' grown at nine locations in western Herzegovina

Tablica 1. Pomološke karakteristike šipka sorte 'Glavaš' uzgajane na devet lokacija na području zapadne Hercegovine

Location Lokalitet	Fruit weight (g) Masa ploda (g)	Fruit width (mm) Širina ploda (mm)	Fruit thickness (mm) Debljina ploda (mm)	Fruit length (mm) Visina ploda (mm)	Peel thickness (mm) Debljina kore (mm)	Arils weight (g) Masa arilusa (g)
Buna 1	661,05b	106,69bc	100,37b	94,69b	9,03b	310,33d
Buna 2	658,78b	107,52bc	99,96b	92,38cd	7,32c	310,45d
Buna 3	749,67a	110,76ab	106,46a	102,18a	7,05cd	420,12a
Buna 4	623,19d	108,26abc	100,39bd	92,55cd	9,89a	195,33h
Ljubuški	634,71c	100,07c	98,19d	96,40bcd	6,50de	300,22e
Stolac 1	506,01e	104,54c	97,90d	90,96cd	6,81de	294,48f
Stolac 2	612,92d	111,81ab	101,20bcd	90,60d	6,78cde	315,26c
Stolac 3	748,88a	114,05a	106,80a	99,54ab	5,91ef	358,13b
Vitina	613,86d	111,07ab	102,63abc	94,31bcd	6,31e	259,35g

Means followed by the same letters are not statistically different (LSD P=0.05)
Ista slova označuju da nema statistički značajnih razlika (LSD P=0.05)

Average fruit weight of the pomegranate cultivar 'Glavaš' ranged from 506,01 g ('Stolac 1') to 749,67 g ('Buna 3'). Among locations 'Stolac 3' and 'Buna 3' have significantly more distinct physical characteristics than 'Ljubuški' and 'Stolac 1' that has similar physical properties. According to Pekmezci and Erkan (http://www.ba.ars.usda.gov/hb66/113pomegranate.pdf) Turkish standard of pomegranate sizes of fruit are defined as small (150 to 200 g); medium (201 to 300 g); large (301 to 400 g) and extra large (401 to 500 g).A significant difference was observed in peel thickness and 'Buna 4' had the highest value (9,89 mm) while 'Stolac 3' had the lowest value (5,91 mm). Arils weight was significantly higher in 'Buna 3'. The chemical properties obtained from juice in arils of the pomegranate cultivar 'Glavaš' are given in Table 2. There are significant statistical differences (P<0.05) among cultivars on different locations.

Table 2. Chemical characteristics of the pomegranate cv. 'Glavaš' grown at nine locations in western Herzegovina

Tablica 2. Kemijske karakteristike šipka sorte 'Glavaš' uzgajane na devet lokacija na području zapadne Hercegovine

Location /Lokalitet	Total Soluble Solid (ºBrix) /Suha tvar (ºBrix)	Total acid (g/L) Ukupne kiseline (g/L)	pH	Maturity Index Index zrelosti
Buna 1	15,53b	2,79b	2,95de	6b
Buna 2	15,43b	2,67c	2,91ef	6b
Buna 3	15,05bc	2,43e	2,89f	6b
Buna 4	15,20bc	2,21f	3,26a	7ab
Ljubuški	13,95d	2,55d	3,05bc	5c
Stolac 1	17,63a	3,16a	2,65g	6b
Stolac 2	14,78c	2,55d	3,01bcd	6b
Stolac 3	15,25bc	2,67c	3,06b	6b
Vitina	15,35b	1,97g	3,00cd	8a

Means followed by the same letters are not statistically different (LSD P=0.05)
Ista slova označuju da nema statistički značajnih razlika (LSD P=0.05)

The total soluble solid content (17,63 ºBrix) and acidity of fruit juice (3,16 g/L) values were significantly higher in 'Stolac 1'. The pH value ranged from 2,65 ('Stolac 1') to 3,26 ('Buna 4') in juice. Türkmen and Ekşi (2011) reported that according to AIJN proposal, the minimum brix degree of pomegranate juice should be 14,0 ºBrix indicates the percentage of water-soluble solids in fruit juice and can be affected by many factors: cultivar, growth region, growth year and maturity level of the fruit (Türkmen and Ekşi, 2011). According to acidity

values, pomegranate juices were classified as sweet (<1%), sour-sweet (1-2%) and sour (>%2) (Onur and Kaska, 1985). Martinez et al. (2006) reported classification established by maturity index (MI) for Spanish varieties by Melgarejo (1993,1998). They classified cultivars: sweet cultivars –MI 31-98; sour-sweet cultivars – MI 17-24; sour cultivars – MI 5-7. According to the given results the cultivar 'Glavaš' can be classified as a sour pomegranate.

The other fruit characteristics according to panel test of the pomegranate cultivar 'Glavaš' are given in Table 3

Table 3. Fruit characteristics of the pomegranate cv. 'Glavaš' grown at nine locations in western Herzegovina

Tablica 3. Karakteristike ploda šipka sorte 'Glavaš' uzgajane na devet lokacija na području zapadne Hercegovine

Location/ Lokalitet	Fruit shape/ Oblik ploda	Peel colour/ Boja kore	Aril colour/ Boja arilusa
Buna 1	rounded	Dark red	Dark red
Buna 2	rounded	Yellow	Red
Buna 3	rounded	Yellow-pink	Red
Buna 4	rounded	Yellow-pink	Light red
Ljubuški	rounded	Light red	Pink
Stolac 1	rounded	Red	Red
Stolac 2	rounded	Light red	Red
Stolac 3	rounded	Red	Light red
Vitina	rounded	Yellow-red	Dark red

Cultivar 'Glavaš' according to high score for fruit size (Figure 1.) has very attractive fruits by appearance.

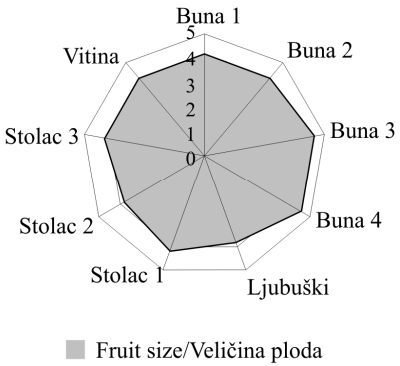

Figure 1. Average scores for fruit size

Graf 1. Prosječne ocjene za krupnoću ploda

Among the tested cultivars the average scores for fruit and aril colour and shape were different between locations (Fig. 2,3).

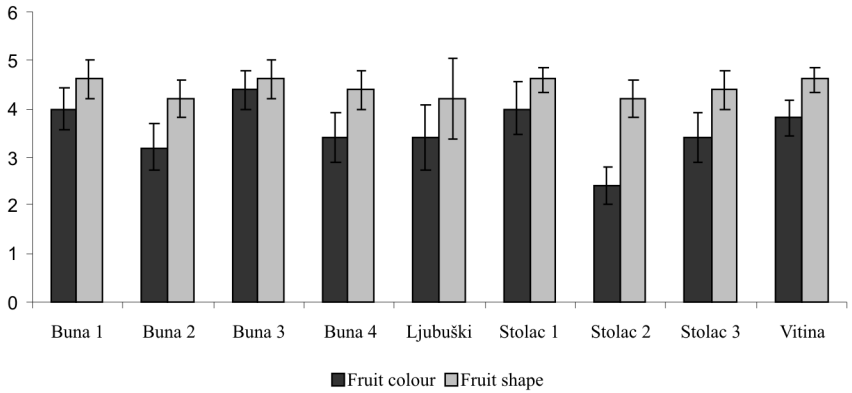

Figure 2. Mean values with SD for fruit colour and fruit shape

Graf 2. Srednje vrijednosti sa standardnom pogreškom za boju ploda i oblik ploda

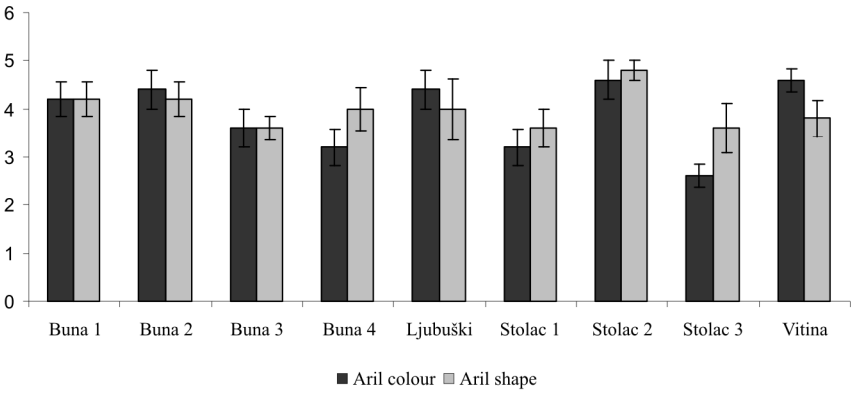

Figure 3. Mean values with SD for aril colour and aril shape

Graf 3. Srednje vrijednosti sa standardnom pogreškom za boju arilusa i oblik arilusa

Taste is determined mainly by organic acid–sugar content balance of the fruit, and these compounds serve as unequivocal markers for sensory attributes assessment and genotype characterization (Melgarejo et al., 2000; Poyrazoglu et al., 2002). Big differences in sensory scores for fruit taste were found between locations (Fig. 4-6).

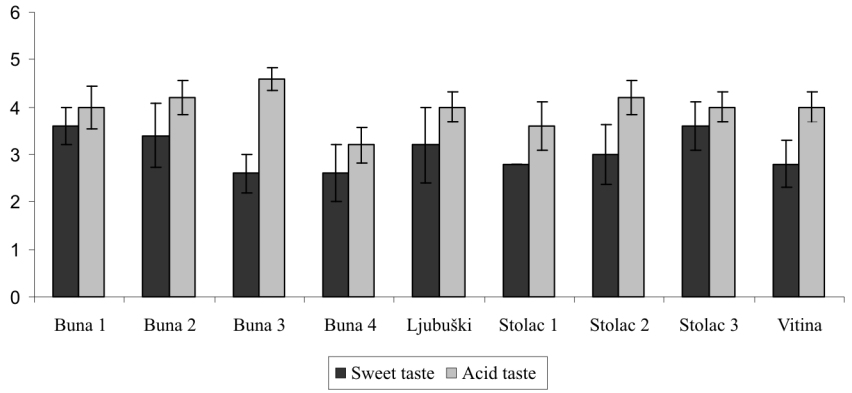

Figure 4. Mean values with SD for arils sweet and acid taste

Graf 4. Srednje vrijednosti sa standardnom pogreškom za slatkoću i kiselost arilusa

Čolarić et al. (2005) suggested that analytical measurements of titratable acids and soluble solids could not be substituted for sensory evaluation of perceived sweetness and sourness. For instance, acidity (or sourness) could be an interesting trait for several purposes (blending juice of other fruits for example) (Hasnaoui et al., 2010). High dark red aril colour, high SSC and relatively high acidity of pomegranate arils are considered to be a good choice for both fresh fruit and juice markets (Ozgen at al., 2008).

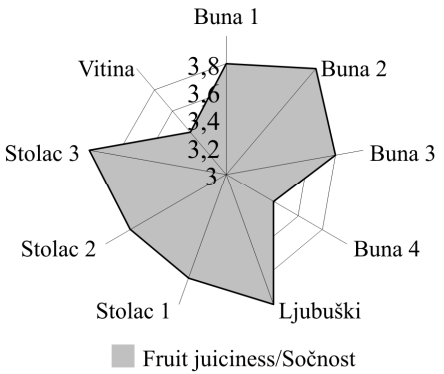

Figure 5. Average scores for fruit juiciness

Graf 5. Prosječne ocjene za sočnost

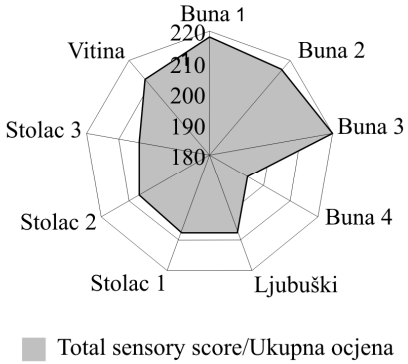

Figure 6. Values of total sensory score

Graf 6. Ukupna ocjena senzoričkog ocjenjivanja

CONCLUSION

The instrumental and sensory investigations of the pomegranate cultivar 'Glavaš' grown at different locations showed significant differences among cultivars in the chemical, physical and sensory quality. Location, agricultural practice and microclimate conditions influence variations among the same cultivar.

Analytical measurements could not be substituted for sensory evaluation, consumer's perception of sweetness and sourness of juice was different. Fruit and aril colour and shape were not important reasons for preferring a pomegranate. Sweetness and sourness of juice were the two biggest reasons of the lowest scores of panel test.

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