Karakashova, Lj., Babanovska-Milenkovska, F., Velkoska-Markovska, L., Markova, S., Stamatoska, V., Durmishi, N., Bogdanovska, V., Karakashov, Lj. (2024). Quality properties of squeezed fresh and frozen pomegranate juices. Agriculture and Forestry, 70 (2): 77-92. https://doi.org/10.17707/AgricultForest.70.2.06

DOI: 10.17707/AgricultForest.70.2.06

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QUALITY PROPERTIES OF SQUEEZED FRESH AND FROZEN POMEGRANATE JUICES

SUMMARY

The pomegranate fruit (*Punica granatum* L.) is characterized by a low energy value, but a high biological value and is desirable for both adults and children. Pomegranate fruits as a raw material is ideal for the production juices. Therefore, in this research were used two varieties of pomegranate fruits: *Karamustafa* and *Hicaz*, grown in Valandovo, R. North Macedonia. To produce the pomegranate juices with good quality properties it is important to have quality raw material. For that purpose, 30 fruits of each variety were taken to estimate the morphometric characteristics (mass, height and width). The production of the fresh pomegranate juices was with cold squeezing of both varieties of the pomegranate fruits, and then the juices were frozen, without using additives.

To determine the quality properties of squeezed fresh and frozen juices from the fruits of both pomegranate varieties, were applied different laboratory methods. Therefore, were analysed the following parameters: total dry matter, soluble dry matter, total sugars (sucrose, fructose and glucose), total acids (citric acid), vitamin C, anthocyanins, polyphenols and minerals. According to the

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Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.
Recieved:04/03/2024 *Accepted:23/05/2024*

performed analysis, the frozen juice of the *Karamustafa* variety had higher average values for: soluble dry matters (17.50 %) and polyphenols (131.86 mg/L). The estimation of the sensory properties was done descriptively and by using the scoring method (max. 20 points). The variety *Hicaz* had sweeter, more acceptable taste, and on the other hand the variety *Karamustafa* had more intensive color, due the higher contain of the anthocyanins.

Keywords: pomegranate juice, fresh, frozen, squeezed juice, quality properties

INTRODUCTION

Pomegranate as fruit is characterized by a low energetically, but a high biological value, due it is widely used in human nutrition. Pomegranate fruits represent an ideal raw material for the production of various types of processed products, among which juices have taken a special place. Fresh pomegranate fruits may be unavailable in certain periods during the year, while pomegranate processed products can be used throughout the year. For the production of juice, it is necessary to use pomegranate varieties with a higher content of dry matter - sugars, vitamins, mineral and coloured matters, with a pleasant taste and aroma. Pomegranate juice due a high biological value is desirable for both adults and children.

Pomegranate is one of the oldest fruit crops in the world. The pomegranate (*Punica granatum* L.,) belongs to the order *Mytreles*, *Lythraceae*, subfamily *Punicoideae*, genus *Punica* L., (known as pomegranate, pomegranate, rosehip). Two species are important for fruit growing: *Punica granatum* L. and *Punica nana*. It is widespread in countries where there are conditions for cultivation, such as: Chile, Argentina, the south of the United States and South Africa. The largest producers of pomegranate in the world are the countries of the Mediterranean Region (Milošević, 1997).

The attractiveness of the fruits, as well as their quality, largely depends on the morphometric characteristics of the fruits, such as: mass, height and width. On the other hand, these parameters represent the basis for the determination the type and varieties of the fruits. The values of the morphometric characteristics depend on the variety (genotype), the cultivation conditions (climatic and soil) and the applied agrotechnical and pomotechnical measures.

According to Teixeira da Silva et al., (2013), in their research were examined the more pomometric properties of pomegranate fruits, and found differences between the varieties in terms of: the size of the fruit, the colour of the skin, which is usually from yellow, purple to pink, i.e. red. The colour of the arils of the fruit is characterized from creamy whitish to red, and the fruits are characterized by different content of juice, containing various amounts of sugars, acids and present tannins.

The authors Markovski et al. (2017) made an examination of the more pomometric properties, such as the length, width and weight of the fruit as well as the colour of the arils in several varieties of pomegranate, including the

varieties: *Lifanka*, LC, *Bejnarija*, *Karamustafa* and *Hicaz*. Among the examined varieties, the variety *Karamustafa* is characterized by an attractive and most attractive dark red colour of the arils. In the *Hicaz* variety, the lowest statistical value of the content of coloured matters on the arils was confirmed. The authors also indicate that the *Hicaz* variety is characterized by the dark red colour of the arils and therefore has found great use in the processing industry for the production of juice and vinegar.

The authors Pekmezi & Erkan (2000) made an examination of the quality properties of pomegranate fruits intended for consumption, indicating that the pomegranate fruit have a high quality if it has a smooth skin and if it is free of cracks and bruises. They also recommend using fruits with a greater amount of extracted juice and with a favourable ratio of sugars and acids. When using the whole pomegranate fruit, the content of separated juice is from 45 to 65 %, while when using separated arils from the pomegranate fruit, the content of separated juice is from 76 to 85 % in relation to its mass. Based on the size, a classification of pomegranate fruits was made. According to classes, there are: small, with a mass of 150 to 200 g and a diameter of 65 to 74 mm, medium, from 201 to 300 g and a diameter of 75 to 84 mm, large, from 301 to 400 g and a diameter of 85 to 94 mm and extra-large fruits with a mass of 401 to 500 g and a diameter of 94 to 104 mm.

The chemical composition of the fruit is characteristic for each species and variety. The average chemical composition characterizes each variety, and differences may occur due to the influence of different climatic, agrotechnical conditions of cultivation and the degree of maturity (Niketić – Aleksić, 1994).

In fresh pomegranate fruits, carbohydrates (glucose, fructose and sucrose) are the most represented, which are present in a relatively high amount, up to 20 %, and the water content ranges from 70 to 95 %. There is also a high content of mineral matters, ranging from 0.25 to 2 %, and as the most represented are: potassium, calcium, phosphorus, sodium, magnesium, iron, manganese, cobalt, sulphur, chlorine and iodine. The pomegranate abounds with a high content of organic acids. The most biologically valuable ingredients in pomegranate fruit are vitamins: vitamin C, vitamins from the B group (B-complex), vitamin K, carotenoids and other vitamins (Katalinić, 2010).

The authors Tehranifar et al., (2010) analysed the chemical composition of the fruits of several varieties of pomegranate, and found that the content of soluble dry matter ranges from 1.37 to 15.07 °Brix. The content of total sugars ranges from 13.23 to 21.72 g/100 g of fresh pomegranate fruit, the pH value from 3.16 to 4.09, total acids from 0.33 to 2.44 g/100 g, and the content of ascorbic acid from 9.91 to 20.92 mg/100 g in fresh pomegranate fruit. The content of total polyphenols ranges from 295.79 to 985.37 mg/100 g of fresh pomegranate, and the anthocyanins present range from 5.56 to 30.11 mg/100 g, in fresh pomegranate fruit. Based on the analysis, the authors confirm that the variety is an important factor and has a great influence on the physico-chemical properties of the pomegranate fruit.

Each plant species produces specific primary metabolites responsible for the growth, development and reproduction, as well as secondary metabolites which provides plants biotic and abiotic factors protection. Phenols are a group of secondary metabolites due to pronounced antioxidant, antimicrobial, antifungal and even anticancer activity. Many studies have confirmed that the peel and seeds of wild pomegranate, as its biowaste, are a valuable source of bioactive substances, as phenols, flavonoids and anthocyanins (Krivokapic et al., 2022).

Preservation means the application of different processes, i.e. technological procedures with an aim to preserve the quality properties of the product to a greater extent and for a longer period of time, and at the same time to prevent its spoilage and the degradation of some components (Marković, 2018).

The juices, according to their physical characteristics, are a specific type of product, but according to their chemical composition, they are products that are closest to fresh fruit. To produce juice, the most important characteristic of the fruit is its juiciness, the content of sugars and acids, and the content of coloured and aromatic matters is of special importance. Also, the fruits should be healthy and with certain varietal characteristics (fruit shape, components proportion in the dry matters, etc.), and to be technologically mature, with a good mechanical and chemical composition. As significant factors are: the type of fruit, the variety, agro-ecological and agro-technical conditions of cultivation, the moment of harvesting, the conditions of transportation and storage of the raw material after harvesting until the processing period (Niketić – Aleksić, 1994).

From a technological point of view, the structure of the pomegranate is very specific and complicated because the fruits have a large number of lamellae that separate the arils. The peel and lamellae of the pomegranate fruits have a high content of tannins and their presence in the juices is undesirable. Therefore, for processing of the juices it is recommended to separate the arils from the lamellas and the peel. The pomegranate juice is valued because it has a specific taste, smell and colour due to the presence of anthocyanins, which have certain therapeutic and certain medicinal properties. The taste of the obtained juices is a little bitter, because it contains certain amounts of tannins matters. According to research, it was determined that in fresh pomegranate fruits, the energy value was 300 J/100 g, the total acidity was 1.5 % (expressed through the amount of citric acid) and the content of soluble dry matter was 20 % (Niketić – Aleksić, 1994).

Punicalagin is one of the main bioactive substances that contributes to the total antioxidant capacity of wild pomegranate fruit (*Punica granatum* L.). The wild pomegranate juice shows up to eight times stronger antioxidant activity than the juice of grapes, cranberries and oranges, and three times stronger than the activity of red wine and green tea (Krivokapic et al., 2022).

According to Dipakkumar (2007), it is better to perform the juice extraction with moderate pressure and thus to avoid releasing high quantities of tannins in the juice. With the extraction of juice from the pomegranate fruit cut

into quarters, by using a hydraulic press, under moderate pressure, 36.41 % of juice is obtained from the total mass of the fruit.

The cold-pressing technique enables the transfer of most primary and secondary metabolites found in the original ripped fruit, from the fruit to the juice through the fruit crush at room temperatures, at a low speed. The extraction process generates almost no heat and preserves the juice's nutritional quality. Another critical factor associated with the juice nutritional value is the quality of storage conditions, mainly temperature and time (Llupa et al., 2022).

In practice, different equipment is used for squeezing pomegranate juice, but it has been established that the equipment has an impact on the amount of extracted juice, and thus on the amount of dry matter, pH-value and total acids. Also, the equipment affects the physico-chemical properties of the juice (Ismail et al., 2014).

Juices can be preserved by applying a low temperature. With this method of preservation are obtained final products with a quite high-quality, where both the sensory and the nutritional properties are preserved. Namely, preservation by freezing is a procedure where the temperature of the product is reduced to a state of freezing, during which practically all chemical and biochemical reactions are stopped. Microbiological activities are also stopped, part of the present microflora dies, biochemical process has slowing down, that is, the action of enzymes is prevented. In order to preserve the quality properties of the final product, it is recommended that the frozen product be stored at a temperature of -18 °C (Vračar, 2012),

The quality of the frozen product is greatly influenced by the storage temperature, as well as the storage period. Any increase in storage temperature has the effect of reducing the quality of the frozen product (Niketić – Aleksić, 1994).

The choice of the packaging material for the juices is of particular importance because it has its impact on the quality reduction of the juice during storage, in case if it is transparent and lets the light through, thus causing a change in the colour of the juice and in the nutritional properties (Dinesh and Ramasamy, 2016).

The authors Zaouay et al., (2014) emphasize that on the content of anthocyanins, a special influence has the content of acids. They determined a higher anthocyanin content of 47 mg/100 mL in juice obtained from the fruits of sour-tasting pomegranate varieties, and in the juices obtained from the fruits of sweet pomegranate varieties, they determined a lower anthocyanin content of 34.21 to 43.11 mg/100 mL.

Researches related to the qualitative and quantitative analysis of anthocyanins is of great significance, because the commercial value of fresh pomegranate fruits and their processed products depends on the type and amounts of anthocyanins. According to Gil et al., (1995), anthocyanins are a very significant component of the chemical composition of the juice obtained from the pomegranate fruit and are in correlation with the variety, the stage of maturity

and the location where the fruit was grown. In juice obtained from pomegranate fruit harvested at the stage of full technological maturity, the content of anthocyanins ranges from 50 to 100 ng/g of fresh aril.

The purpose of this paper is to compare the impact of a processing technology on the quality in terms of chemical and sensorial properties for obtained pomegranate juices, by using two varieties of pomegranate fruit, *Hicaz* and *Karamustafa*. For obtaining pomegranate juices, the pomegranate fruits have been squeezed with pressing, and afterwards have been used as fresh and frozen pomegranate juices.

MATERIAL AND METHODS

In this research were used two varieties of pomegranate fruit, *Hicaz* and *Karamustafa*, that are grown in Valandovo region, North Macedonia.

The variety *Karamustafa* originates from Asia Minor, where there are several varieties. It has been cultivated in our country for a long time and it is a domesticated variety, accepted in the List of domestic and foreign recognized or approved varieties of fruit crops (Official Gazette of RM, No. 41/2006). This variety is adapted to our climate and soil conditions and it is mostly grown in the area of Valandovo.

The variety *Karamustafa* (Figure 1) is an autochthonous variety whose fruits are characterized by a high mass, a yellow-green colour of the skin, and in the stage of technological maturity it is yellow-red. Regarding the content of total acids, this variety belongs to the group of sweet pomegranate variety. The colour of the juice obtained from the fresh fruits of the *Karamustafa* variety varies from light pink to pink (Dimovska et al., 2017).

Figure 1. Pomegranate fruits of the *Karamustafa* variety

The pomegranate fruits of *Hicaz* variety (Figure 2) originates from Turkey. It is characterized by a pronounced red skin colour, and the colour of the grains (arils) and the juice obtained from the fruits is characterized by a dark red colour (Polat et al., 2012).

The pomegranate fruits were harvested at full technological maturity. After the harvest, 30 fruits were taken of each variety of pomegranate, *Hicaz* and

Karamustafa, to analyse their pomometric properties. Afterwards were analysed the chemical composition and sensory properties of the fresh squeezed and frozen juices obtained from the *Hicaz* and *Karamustafa* varieties.

Figure 2. Pomegranate fruits of the *Hicaz* variety

From the morphometric properties of pomegranate varieties *Hicaz* and *Karamustafa*, the following measurements were performed: the height and width of the analysed pomegranate fruits varieties were determined with a caliper with an accuracy of ± 0.1 mm; the average mass of the fruits was determined by measuring with a digital analytical balance of the type "Sartorius" with an accuracy of ± 0.01 g. The results were expressed as the mean value of consecutive measurements of 30 pomegranate fruits.

The sensory evaluation of fresh pomegranate fruits was performed descriptively for the following parameters: colour, taste, smell and consistency. On the other hand, the sensory evaluation of the squeezed fresh and frozen juice was performed according to the scoring sensory method (point-system), with a maximum of 20 points (Karakashova and Babanovska–Milenkovska, 2012).

The chemical analyses were made in order to determine certain parameters, according of which the quality and nutritional properties was estimated of the squeezed fresh and frozen juice, obtained from the two pomegranate varieties. For this purpose, various standard laboratory methods had been applied to determine the following chemical parameters: total dry matter by drying the samples in an oven dryer, at 105 ºC to obtaining constant mass; soluble dry matters were determined with a digital refractometer, type – Mettler Toledo Refracto 30 GS, with previous calibration and automatic temperature regulation of 20 °C; total acidity by using titration solution 0.1 M of NaOH and 1 % solution of phenolphthalein as indicator; determination of sugars by applying HPLC-method with RI-detector; the mineral matters (total ash) was determined by a gravimetric method, by incineration and burning of samples in a Muffle oven, at a temperature of 525 ± 25 °C (Vračar, 2001); determination of Vitamin C was performed by using a solution of .0.1 N I_2 and 1 % starch solution as an indicator (Famakopeja, 1984); anthocyanins were determined by

spectrophotometric method, where the measurements were performed on the absorption of light by the samples at a wavelength of 540 nm; polyphenols were determined by spectrophotometric method, where the measurements were performed on the absorption of light by the samples at a wavelength of 765 nm (Folin and Ciocalteu, 1927).

The obtained results from the research of the pomometric properties of the both pomegranate varieties and from the analysis of sensory and chemical properties of squeezed fresh and frozen juices, have been statistically calculated, with the statistical package R 3.5.1. An ANOVA analysis of variance was performed for all the obtained results, and the significance testing of the differences between the average values for each analysed property was performed using the LSD-test, at the 0.05 and 0.01 significance level.

Processing operation for obtaining fresh and frozen squeezed juices

The harvest of the pomegranate fruit was performed by hands, in the early morning hours. The fruits were in the stage of full technological maturity. The pomegranate fruits then were packed in cardboard boxes. After harvesting, they were stored in a room at a temperature of 4 °C, in order to preserve the quality of the raw material.

Before starting the processing of raw material, the inspection and selection were made, by visual control of the raw material in order to remove those pomegranate fruits where a rotting process was observed, as well as the pomegranate fruits with unacceptable mechanical damages. Afterwards, the following operations were performed on the raw material: washing, cutting into two halves by using a stainless steel knife, then the juices were squeezed by pressing the halves with a manual press.

The procedure of technological washing was carried out in order to remove mechanical impurities and the largest number of microorganisms from the surface of the fruit. The fruits were well washed, because they were not peeled. The washing process was performed with pure water, which is chemically and bacteriologically proper in accordance of the national regulation. The pomegranate fruits were cut in half, with a stainless steel knife, in order to avoid loss of vitamin C. The cut halves of pomegranate fruits were pressed by using a manual press, due the internal parts were released and fresh squeezed juice were extracted. In order to obtain juice with a more stable colour, this procedure should be performed in as short time interval as possible. The crushed mass is passed through a sieve, during which the small parts and seeds will pass through, and the large parts and lamellae remain on the sieve, after which they are gradually removed. The suspended particles in the pomegranate juice were separated by using sieves, made of stainless steel and with very small openings. The fresh squeezed juice, which still contains finely dispersed particles, was filtered through coarse filter paper (with larger pores). In this way, juice without sediment was obtained. By this operation, a larger amount of pectin matters was removed. The obtained filtrated fresh squeezed pomegranate juice was packed in appropriated packaging. This kind of juice, produced without any additives was

kept at low temperature, up to 4 °C and used within 24 hours, due the possibility of losing its nutritional and biological values.

By intention to keep nutritional and biological values of fresh squeezed juice and to prolong the shelf life of the juice, it was frozen. The process of preservation with a low temperature was performed at a temperature below -18 °C, without any additives (as preservatives or sweeteners). After the process of freezing, the pomegranate juice packed in glass or plastic package, was stored in a freezer, at temperature of at least -18 °C or lower. All production phases for fresh and frozen squeezed pomegranate juice are presented in the scheme 1.

Scheme 1. Phases of production squeezed fresh and frozen pomegranate juices

RESULTS AND DISCUSSION

Before approaching the technology of fruit processing, it is necessary a more detailed acquaintance with its technological properties, above all with the mechanical and chemical composition of the fruits (Karakashova, 2011).

The morphometric characteristics of the fruits (mass, height and width) in both analyzed pomegranate varieties are represent in table 1.

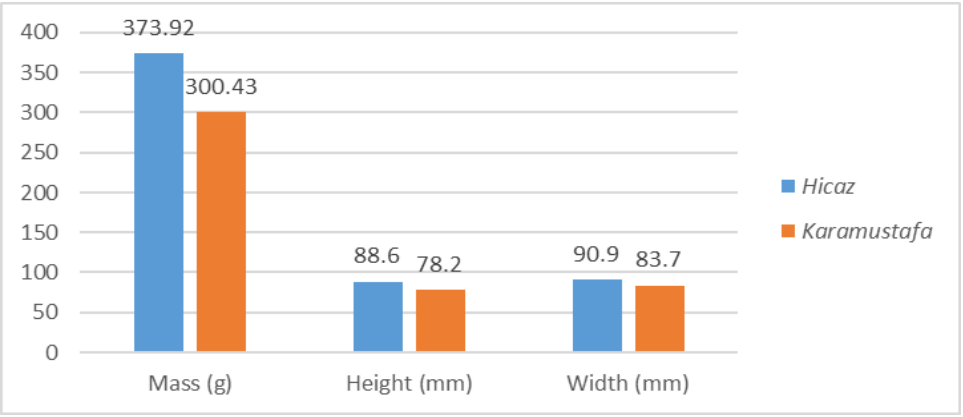
Table 1. Morphometric characteristics of pomegranate fruits, varieties *Hicaz* and *Karamustafa*

Variaty		Mass (g)			Width (mm)			Height (mm)		
	N	min	max	$\bar{x}$	min	max	$\bar{x}$	min	max	$\bar{x}$
Hicaz	30	288.32	773.05	373.92	81.70	114.10	90.90 b	81.00	108.50	88.60 b
Karamustafa	30	215.78	422.97	300.43	74.70	95.70	83.70 a	69.90	95.40	78.20 a
LSD 0.05				90.24			0.41			0.50

N - number of examined fruits;

$\bar{x}$ - mean value of each measurement of 30 fruits per pomegranate; the values for each morphometric characteristic of the fruits of the *Hicaz* and *Karamustafa* varieties, marked with different letters, are statistically significantly different from each other ($p < 0.05$).

The average value from the measurement of the morphometric characteristics of 30 pomegranate fruits, for each examined varieties, *Hicaz* and *Karamustafa* are presented in graph 1.



Graph 1. The average value of weight, height and width of pomegranate fruits, varieties *Hicaz* and *Karamustafa*

From the results in graph 1 and table 1, statistical analysis was performed. According to data it can be concluded that: the variety *Hicaz* was characterized by a higher average weight of the fruits (373.92 g) comparing to the variety *Karamustafa* (300.43 g), and no statistically significant difference was determined; the fruits of the variety *Karamustafa* were characterized by a lower average height of 78.20 mm compared to the fruits of the variety *Hicaz* (88.60 mm), and a statistically significant difference was found; the average value for the width of the fruits of the *Hicaz* variety was 90.90 mm, and the fruits of the *Karamustafa* variety had a smaller average width of 83.70 mm, and statistically significant difference was determined. The results obtained in this research for mass, height and width of the fruits of the two pomegranate varieties *Hicaz* and *Karamustafa*, comparing to the results obtained in research by other authors, it can be concluded that there are small deviations of the obtained values what is result from our climate and soil conditions.

The chemical composition of fruits means the content of all the ingredients of the product, including water. The components of the chemical composition, their quantity and mutual ratio are responsible for the sensorial, nutritional and biological properties of the product.

From the laboratory analysis in this research, the obtained average results presented in the table 2 are for comparison of the chemical composition of the fresh squeezed juice from the pomegranate fruits, varieties *Hicaz* and *Karamustafa*. According to the data that were statistically evaluated (table 2), the average values for each chemical property of fresh squeezed juice from the pomegranate fruits, varieties *Hicaz* and *Karamustafa*, that are marked with different letters, are significantly statistically different from each other ($p < 0.05$).

Table 2. Chemical composition of fresh squeezed juice from the pomegranate fruits, *Hicaz* and *Karamustafa* varieties

Variety	Total dry matters (%)	Soluble dry matters (%)	Sugars (%)		Total acids (%)	Vitamin C (mg/100 g)	Anthocyanins (mg/L)	Polyphenols (mg/L)	Mineral matters (%)
			Glucose	Fructose					
Hicaz	22.22	15.80	12.21a	7.69a	1.82b	17.00b	500.00b	43.96a	1.30b
Karamustafa	21.14	16.00	12.50	8.00	0.34a	15.00a	236.00a	46.50b	0.86a
LSD 0.05	**2.27**	**1.8**	**1.50**	**0.82**	**0.22**	**1.39**	**9.29**	**0.81**	**0.07**

The comparison of the average content of examined chemical parameters in squeezed fresh and frozen juices, from *Hicaz* and *Karamustafa* varieties pomegranate fruits are presented in the table 3.

Table 3. Comparison of examined chemical parameters in squeezed fresh and frozen juices, from *Hicaz* and *Karamustafa* varieties pomegranate fruits

	Fresh squiezed juice		Frozen squiezed juice	
Variety/parameters	*Hicaz*	*Karamustafa*	*Hicaz*	*Karamustafa*
Total dry matters (%)	22.22	21.14	15.04	16.33
Soluble dry matters (%)	15.80	16.00	16.08	17.50
Glucose (%)	12.21	12.50	7.15	8.78
Fructose (%)	7.69	8.00	5.60	6.61
Total acids (%)	1.36	0.84	2.06	0.58
Vitamin C (mg/100 g)	17.00	15.00	12.64	12.65
Anthocyanins (mg/L)	500.00	236.00	730.90	234.86
Polyphenols (mg/L)	43.96	46.50	115.71	131.86
Mineral matters (%)	1.30	0.86	0.22	0.24

From the table 3 it can be concluded that the average values for the content of total dry matters ranges from 22.22 %, in the squeezed fresh juice obtained from the fruits of the *Hicaz* variety, up to 21.14 % in the squeezed fresh juice obtained from the *Karamustafa* variety. For the squeezed frozen juice, the content of total dry matters for the *Karamustafa* variety was higher (16.33 %) in relation of the *Hicaz* variety (15.04 %). The average values for the content of

total dry matters in the squeezed fresh juices obtained from the both varieties of pomegranate fruits, are statistically significantly different at the level of significance $p < 0.05$.

The average values for the content of soluble dry matter ranges from 16.00 % in the squeezed fresh juice obtained from the fruits of the *Karamustafa* variety, to 15.80 % in the squeezed fresh juice obtained from the fruits of the *Hicaz* variety. The content of soluble dry matter, as average values, were 16.08 % for the squeezed frozen juice of the *Hicaz* variety and 17.50 % for the squeezed frozen juice of the *Karamustafa* variety. The statistical analysis of the obtained average values for the content of soluble dry matter did not show statistically significant differences between the varieties.

In the squeezed fresh juice obtained from the fruits of the *Karamustafa* variety, higher average values for glucose content were determined, 12.50 %, in relation to the squeezed fresh juice obtained from the fruits of the *Hicaz* variety, 12.21 %. The higher average value for glucose content was determined (8.78 %), for the squeezed frozen juice of *Karamustafa* variety, and lower average value for glucose content (7.15 %) was determined for the squeezed frozen juice of *Hicaz* variety.

The higher average values were determined for the fructose content (8.00 %) in the squeezed fresh juice obtained from the fruits of the *Karamustafa* variety compared to the squeezed fresh juice obtained from the fruits of the *Hicaz* variety (7.69 %). The lower average value for fructose content was determined (5.60 %), for the squeezed frozen juice of *Hicaz* variety, and higher average value for fructose content (6.61 %) was determined for the squeezed frozen juice of *Karamustafa* variety. Regarding the statistical analysis of glucose and fructose content in the squeezed fresh juices obtained from the pomegranate fruits of the both examined varieties, no statistically significant differences were determined.

In terms of the average values for the content of total acids (expressed through citric acid) were within the range from 0.34 %, in the squeezed fresh juice obtained from the fruits of the *Karamustafa* variety, up to 1.82 % in the squeezed fresh juice obtained from the *Hicaz* variety. The average values for the content of total acids (expressed through citric acid) were within the range from 0.58 %, in the squeezed frozen juice obtained from the fruits of the *Karamustafa* variety, up to 2.06 % in the squeezed frozen juice obtained from the *Hicaz* variety. The statistical processing of the obtained data for this property showed statistically significant differences between the both examined varieties, at the significance level $p < 0.05$.

The average values for the content of vitamin C ranges from 15 mg/100 g in the squeezed fresh juice, up to 12.65 mg/100 g in the squeezed frozen juice, obtained from fruits of the *Karamustafa* variety and from 17 mg/100 g, in the squeezed fresh juice, up to 12.64 in the squeezed frozen juice, obtained from the *Hicaz* variety. Regarding the statistical data, statistically significant differences was found between the two varieties, at the level of significance $p < 0.05$.

According to the average values for anthocyanins, the content was within the range from 236 mg/L, in squeezed fresh juice obtained from fruits of the *Karamustafa* variety, up to 500 mg/L in squeezed fresh juice obtained from the *Hicaz* variety. The average values for anthocyanins, the content was within the range from 236.86 mg/L, in squeezed frozen juice obtained from fruits of the *Karamustafa* variety, up to 730.9 mg/L in squeezed frozen juice obtained from the *Hicaz* variety. Statistical processing of the obtained data for this property showed statistically significant differences between the two varieties, at the significance level $p < 0.05$.

The phenolic compounds presence is essential and directly influences the fruit juice quality by contributing into organoleptic characteristics, affecting the colour, astringency, and aroma (Llupa et al., 2022). According to the data from the table 3., it can be noted that the average content of total polyphenols ranges from 43.96 mg/L in squeezed fresh juice obtained from the *Hicaz* variety, up to 46.50 mg/L in squeezed fresh juice obtained from the fruits of the *Karamustafa* variety. The average values of the total polyphenols content in squeezed frozen juices were from 115.75 mg/L from the *Hicaz* variety and 131.86 mg/L from the *Karamustafa* variety. The statistical processing of the obtained data for this property showed statistically significant higher differences between the squeezed fresh juices obtained for both varieties, at the level of significance $p < 0.05$.

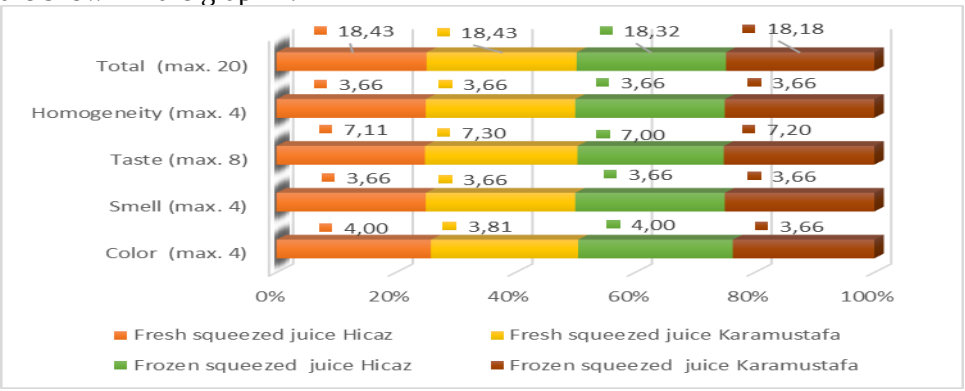
Comparing the presented results with the results of Radunić et al. (2017) paper which talks about the content of phenols, flavonoids and anthocyanins of wild pomegranate (*Punica granatum* L.) juice from the territory of the Mediterranean part of Croatia, which states that the content of total phenols is 679.6 mg/100 g dry matter (DM), total flavonoids 393.6 mg/100 g DM and total anthocyanins 81.06 mg/100 g DM.

In the research of Krivokapic et al. (2022), were determined the content of total phenols and anthocyanins in the samples of seed extract obtained from the fruits of wild pomegranate, collected from different location in Montenegro. The content of total phenols in seed extract were in range from 89.07 ± 2.52 up to 189.77 ± 7.81 as milligrams of gallic acid equivalent per 100 grams of dry matter (mg GAE/100 g DM). Also, the obtained results in the research of Gözlekçi et al. (2011) were in range from 125.3 to 177.4 mg GAE/100 g DM, while the amount of total phenols compared to the research of Peng et al. (2019) where the obtained values range from 62 to 68 mg GAE/100 g DM. The results for the total anthocyanins were presented as cyanidin-3-glucoside equivalents per gram (mg C3GE/g). The highest amount of total anthocyanins was recorded in the extract of the locality Škaljari, and the lowest in the extract of the locality Carev Laz and the results were in the range from 2.73 ± 0.56 to 4.34 ± 0.39 mg C3GE/g. In relation to the research of Parseh and Shahablavasani (2019) where the content of total anthocyanins of wild pomegranate seed extract was 28 mg C3GE/g, the obtained results of this research deviate and the content of total anthocyanins was lower.

For the content of mineral matters, it can be stated that the average values range from 0.86 % in the squeezed fresh juice obtained from fruits of the *Karamustafa* variety, up to 1.30 % in the squeezed fresh juice obtained from the *Hicaz* variety. The lower average value for mineral matters content was determined (0.22 %), for the squeezed frozen juice of *Hicaz* variety, and higher average value for mineral matters content (0.24 %) was determined for the squeezed frozen juice of *Karamustafa* variety. Statistical processing of the obtained results for this property showed statistically significant differences between the two varieties of pomegranate fruits, at the level of significance $p < 0.05$.

The estimation of the sensory properties of the fresh pomegranate fruits of the *Hicaz* and *Karamustafa* varieties, was performed descriptively for the following parameters: colour, taste, smell and consistency. There are differences in the crust colour of the fruit and in the taste, where the variety *Hicaz* has characteristic red colour, with acidic taste, and the variety *Karamustafa* had yellow-pink red colour, with sweet, astringent taste. The smell and consistency were characteristic for the both varieties.

The obtained results of sensory evaluation of fresh and frozen squeezed juices obtained from two varieties of *Hicaz* and *Karamustafa* pomegranates fruits are shown in the graph 2.



Graph 2. Comparison of the results from sensory evaluation (max. 20) of fresh and frozen squeezed pomegranate juice obtained from *Hicaz* and *Karamustafa* varieties

From the data presented in the graph 2, the variety *Hichaz*, had same average values for the colour (4.00 of max. 4.00), smell (3.66 of max. 4.00) and homogeneity (3.66 of max. 4.00) for fresh squeezed and frozen squeezed juices, while the taste had 7.11 for fresh and 7.00 for frozen squeezed juice (of max. 8). For the variety *Karamustafa*, the smell (3.66 of max. 4.00) and homogeneity (3.66 of max. 4.00) had same average values for fresh squeezed and frozen squeezed juices. The fresh squeezed juices had higher average values for colour (3.81 of max. 4) and for taste (7.30 of max. 8) than the same properties for frozen squeezed juices of the *Karamustafa* variety. Based on these data, the higher total average points (18.43 of max. 20) were obtained for fresh squeezed juices both varieties Hicaz and *Karamustafa*, while for the frozen squeezed juices the total

average points 18.32 of max. 20, was for *Hicaz* and 18.18 of max. 20, was for *Karamustafa* variety.

CONCLUSIONS

According to the morphometric characteristics in terms of height, width and mass, higher values were determined in the *Hicaz* variety. In terms of the examined chemical ingredients, statistically significant differences were determined between the *Hicaz* and *Karamustafa* pomegranate varieties, for the content of sugars and acids, as well as for the content of polyphenols and anthocyanins. According to the results of the sensory examination of the squeezed fresh and frozen juice from the *Hicaz* and *Karamustafa* pomegranate variants, there were some differences in the colour and taste. The variety *Hicaz* contain more anthocyanins, and on the other hand the variety *Karamustafa* had sweeter, more acceptable taste.

Based on the previously examined properties, it can be concluded that the pomegranate fruits of the *Hicaz* and *Karamustafa* varieties are characterized by good quality properties and it can be used as an appropriate raw material for further processing. Also, generally can be said that the application of the freezing procedure does not have a significant impact on the quality characteristics of the obtained juice and the use of this procedure is recommended, so that, the pomegranate juice can be used throughout the year.

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