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The Influence of Drying on the Nutritional, Microbiological, and Sensory Value of *Diospyros kaki* L. (Japanese persimmon) Consumed in Herzegovina

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Abstract

Diospyros kaki L. (Japanese persimmon) has been introduced from Asian countries to Herzegovina, where it is mostly consumed fresh. This study investigates the differences in nutritional, microbiological, and sensory values of persimmons consumed in one of the Herzegovinian regions, following drying processes at 70 °C/12 h, 85 °C/10.5 h, and 100 °C/5.5 h, together with their effects on fruit texture, mass, and composition. The notable increase in sugar content emphasises the potential of dried Japanese persimmon as a nutritious snack. No significant increase in microorganism representation was observed across all samples. Persimmons dried using a dehydrator exhibited the most preserved nutritional properties, and were rated highest in sensorial evaluations. However, due to its high water content and browning, the sample dried at 100 °C in an autoclave was excluded from sensory testing.

Keywords

Japanese persimmon, drying, nutritional composition, sensory analysis, microbiology

1 Introduction

Japanese persimmon (*Diospyros kaki* L.), commonly known as kaki, belongs to the *Ebenaceae* family and is rich in bioactive compounds such as dietary fibres, carbohydrates, various vitamins, and minerals. Cultivated for thousands of years, the fruit is believed to have originated in China[1] but later spread to Korea, Japan, and eventually to other regions where it gained exotic status. Despite its introduction to Europe in the late 19th century, there has been a growing demand for Japanese persimmons, due to increased consumer awareness of its beneficial health impacts. The Mediterranean region, with its suitable climate, has seen an increase in kaki production, reaching 110,000 tonnes.[2–4] Although over 400 species from the *Ebenaceae* family are planted globally,[5] the varieties in the Herzegovinian region belong specifically to the *Diospyros kaki* species, selectively cultivated in China and Japan.[6] The Mediterranean climate of the southern Herzegovina agroecological area is particularly suitable for Japanese persimmon cultivation, expanding its growth beyond subtropical borders, as evidenced by its cultivation in the lower Neretva region.[6] The introduction of Japanese persimmon to Herzegovina dates back approximately 100 years, facilitated by local sailors from Italy, Greece, and Turkey.[6] Persimmons exhibit variations in pulp colour influenced by pollinators, with certain varieties remaining stable or constant, while others undergo colour changes.[7] The taste of persimmons also varies between astringent and non-astringent varieties, with astringent types requiring post-harvest treatment to remove the astringent taste.[4] The ripening process involves a transition from a hard and bitter state to a soft and sweet condition, posing challenges in marketing and distribution, although some varieties are edible prior to complete ripening.[8]Japanese persimmon has attracted the attention of scientists advocating health promotion, due to its cultivation without chemicals, resulting in fruit and derived products free of harmful residues.[9] The rich phytochemistry of Japanese persimmon has paved the way for new dietary research aimed at treating a variety of ailments. Potential health benefits include its effectiveness against free radical production, hypercholesterolemia, diabetes, cancer, skin diseases, hypertension, *etc.* The main phytochemicals found in the fruit include carotenoids, tannins, phenolic compounds, proanthocyanidins, flavonoids, and catechins, alongside high levels of vitamin C, sugar, and fibre.[10] It can be considered a good source of fibre, given that an average serving of 168 g containing 6.05 g of fibre provides 15.9 % of the recommended daily fibre intake for men, and 24.2 % for women.[11]Despite the numerous health benefits, the rapid decay of Japanese persimmons requires efforts to extend their shelf life. Among various preservation strategies,[11] drying is the commonly employed method, not only prolonging shelf life but also reducing astringency by decreasing the tannin content.[12]

During the drying process, the non-astringent variants tend to brown, which is why astringent types are commonly used for drying.[13] However, drying can also adversely affect fruit quality[14], leading to browning, wrinkling, loss of rehydration ability, loss of volatile components, burning,

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loss of heat-sensitive biologically active substances, and enzyme loss, *etc*. The presence of oxygen during processing is undesirable due to the oxidation of partially decomposed components, especially at higher temperatures. The drying process must retain the raw-stage sensory properties of the dried products. Most of the unwanted changes in raw materials during drying occur due to high temperatures. The mildest degree of thermal damage manifests as slight discolouration. With greater damage, the taste, rehydration ability, and nutritional value of the product deteriorate as vitamins are destroyed and proteins and other biologically important heat-sensitive substances denature. In addition to the drying temperature, an important parameter is the duration of the process running at high temperatures.[15] This study aimed to evaluate the impact of various drying conditions on the nutritional, sensory, and microbiological aspects of Japanese persimmons. Four samples (J1, J2, J3, J4), were examined, with J1 serving as the fresh Japanese persimmon control. Drying conditions for J2, J3, and J4 included 70 °C for 12 h, 85 °C for 10.5 h, and 100 °C for 5.5 h, respectively. The primary objectives of this study were to identify the optimal drying method for preserving the nutritional value and sensory qualities of Japanese persimmons, essential for ensuring the fruit's year-round market availability and usability. This holds particular significance for regions with favourable agroclimatic conditions, allowing access to the product beyond the typical harvest season. The aim is to present a novel, nutritionally enriched dried fruit with an extended shelf life, contributing to human health. Successful implementation of this approach could position the enhanced Japanese persimmon as a long-lasting, premium-quality dried fruit, establishing it as a valuable and sought-after product in the market.

2 Experimental

The preparation of samples intended for drying was performed at the Faculty of Agriculture and Food Technology laboratory in Mostar. Subsequent analyses of the nutritional composition and microbiological status of Japanese persimmon samples were performed in Zagreb in January 2020, specifically at the Analytical Chemistry Laboratory and the Food Microbiology Laboratory of the Croatian Veterinary Institute.

2.1 Preparation of persimmons for drying

Japanese persimmons were sourced from various localities and plantations in Herzegovina, including Potoci, Livač, Cim, Rodoč, and Ljubuški, within a maximum distance of approximately 60 km. All samples were collected fresh and divided into four groups, each containing approximately 5 kg of the fruit. Sample groups were designated as follows: J1 represented fresh persimmons, while samples J2, J3, and J4 underwent drying at different temperature and time conditions. Due to their appearance and astringent taste, it was presumed that the samples belonged to the *Tipo* and *Costata* varieties, which is to be confirmed through genetic testing. The fruits were harvested in November and December 2019, and in January 2020. The fruit was washed, peeled, weighed, and sliced to about 1 cm thickness. Subsequently, a portion of the raw material (in the form of fresh slices) was vacuum-sealed into plastic bags and frozen at −20 °C (J1).

2.2 Drying of persimmons

Japanese persimmons, weighing 500 g per sample, underwent drying using both a dehydrator (GORENJE, FDK 500 GCW, France) and an autoclave (BINDER FD 23, GmbH, Germany). Three distinct drying temperatures and durations were applied, as outlined in Fig. 1: J1 represented the control sample of fresh Japanese persimmon not subjected to drying; J2 underwent drying at 70 °C for 12 h; J3 underwent drying at 85 °C for 10.5 h; and J4 – underwent drying at 100 °C for 5.5 h. For the dehydrator method (J2), the prepared raw material was placed across five drying trays, with the temperature set to 70 °C and the initial drying time set to 6.5 h.

Fig. 1 – Samples of fresh and dried Japanese persimmon: (J1) fresh Japanese persimmon (control sample); (J2) drying at 70 °C/12 h; (J3) drying at 85 °C/10.5 h; (J4) drying at 100 °C/5.5 h

Slika 1 – Uzorci svježe i sušene japanske jabuke: (J1) svježa japanska jabuka (kontrolni uzorak); (J2) Sušenje na 70 °C/12 h; (J3) Sušenje na 85 °C/10.5 h; (J4) Sušenje na 100 °C/5,5 h

The trays were then placed into the dehydrator in reverse order, with the drying time set at 5.5 h at the same temperature. Once the drying process was complete, the device turned off automatically, and the dried samples (J2) were allowed to cool to room temperature. In the autoclave method (J3 and J4), a layer of baking paper was placed on the dryer trays before arranging the samples. The autoclave temperatures were set at 85 °C and 100 °C, with drying times of 10.5 h and 5.5 h, respectively. Once dried, the samples were removed along with the baking paper, and allowed to cool to room temperature. The dried material was then weighed and vacuum-sealed in plastic packaging. The prepared samples were stored in a freezer at −20 °C until analysis.

2.3 Nutritional analysis

To ensure sample homogeneity, a Grindomix GM200 knife mill (Retch, Haan, Germany) was employed, processing 500 g of each sample. Validated standard and internal an-

alytical methods were applied for nutritional analysis, with the results expressed as grams per 100 grams (g/100 g) equivalent to percentages (%). Five grams of each sample were used for the water content analysis, while 1.5–2 g, 3 g, 1.5 g, and 5 g were used for ash, fat, protein, and sugar content analysis, respectively. Water content determination was conducted after drying in a thermostat (Memmert UF75 Plus, Schwabach, Germany) at 103 ± 2 °C according to method HRN ISO 6496:2001.[16] After water content determination, the samples were stored at 4 °C pending analysis of other nutritional parameters within 48 h. The ash content was determined using the gravimetric method according to HRN ISO 5984:2004[17] in a muffler burning furnace at 550 ± 25 °C (Program Controller LV 9/11/P320, Nabertherm, Germany). The Kjeldahl method (HRN ISO 5983-1:2008[18] and HRN ISO 5983-2:2010[19]) was applied for crude protein content determination, involving organic matter destruction at 420 °C using a block digestion unit (Unit 8 Basic, Foss, Denmark), followed by a combination of titration and distillation (Vapodest 50s, Gerhardt, Germany). Crude fat content was determined using the Soxhlet method (HRN ISO 6492:2001),[20] involving hydrolysis and extraction of fat with petroleum ether (Soxtherm 2000, Gerhardt, Germany). Sugar content was determined using a commercial enzyme kit (Saccha-rose/D-Glucose/D-Fructose, UV-test, R-Biopharm, Germany) according to the manufacturer's instructions. Carbohydrate content was calculated by subtracting the sum of water, ash, crude protein, and crude fat content from the total content. Based on fat, protein, and carbohydrate contents, the energy value was calculated and expressed in kJ.

2.4 Microbiological tests

The microbiological acceptability of the prepared Japanese persimmon samples (J1-J4) was assessed according to the Guidance on Microbiological Food Criteria[21] and the Regulation (EC) 2073/2005,[22] which stipulates that these products must not contain *Listeria monocytogenes*.

Microbiological analyses were conducted using standard methods: EN ISO 6579-1:2017 for *Salmonella* spp.;[23] ISO 15213:2004 for sulphite-reducing *Clostridia*;[24] ISO 21527-1:2012 for yeasts and moulds;[25] EN ISO 21528-2:2017 for *Enterobacteriaceae*;[26] EN ISO 11290-1:2017 for *Listeria monocytogenes*;[27] EN ISO 4833-1:2013 for aerobic mesophilic bacteria;[28] and EN ISO 6888-1:2003 for coagulase-positive *Staphylococci*.[29] Microbial counts were expressed as Colony-Forming Units per g (CFU/g).

2.5 Sensory evaluation

The sensory evaluation of dried Japanese persimmons was conducted by third-year undergraduates from the University of Zagreb, Faculty of Food Technology and Biotechnology in January 2020, and first-year graduates from the University of Mostar, Faculty of Agriculture and Food Technology in February 2020. The total number of assessors participating in the sensory evaluation was 59. However, due to poor organoleptic properties, the sample dried at 100 °C for 5.5 h was not used for sensory evaluation but was only displayed. Consumer opinions were obtained using the 9-point hedonic scale,[30,31] the Just-About-Right (JAR) scale[30,31], and the paired comparison test.[32] On the 9-point hedonistic scale, sensory properties (colour, texture, smell, taste, and overall impression) were rated for liking. The JAR scale assessed sensory properties (colour, texture, smell, and taste) based on their ideal intensity levels. In the paired-comparison test, the sample that scored the lowest was preferred the most.

Fig. 2 shows J2 (A), J3 (B), and J4 (C) samples arranged on four identical sensory evaluation plates.

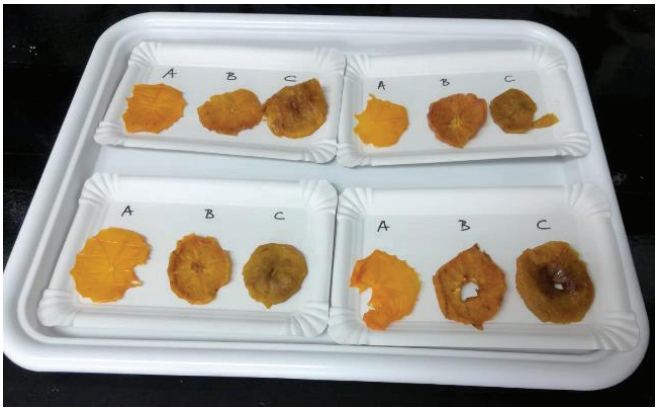

Fig. 2 – Samples of Japanese persimmon served on four sensory evaluation plates: J2 (A) drying at 70 °C/12 h; J3 (B) drying at 85 °C/10.5 h; J4 (C) drying at 100 °C/5.5 h

Slika 2 – Uzorci japanske jabuke servirani na četiri tanjura za senzornu procjenu: J2 (A) sušenje pri 70 °C/12 h; J3 (B) sušenje pri 85 °C/10,5 h; J4 (C) sušenje pri 100 °C/5,5 h.

2.6 Statistical analyses

Each of the four samples was analysed in triplicate, and the results of the nutritional composition analysis were reported as mean ± standard deviation. The data processing was conducted using IBM SPSS Statistics for Windows (Version 20.0. Armonk, NY: IBM Corp.). Analysis of variance and the *post-hoc* LSD test were performed at a significance level of 5 % ($p < 0.05$). The results of the sensory evaluation were processed in Excel, and the results obtained using the 9-point hedonic scale were subjected to t-testing. For the JAR scale, frequency distribution diagrams were generated for each sensory property, and conclusions were drawn based on the most preferred intensity of each property. Based on the aforementioned, the decision on the need for sensory property changing or preservation was made. The paired-comparison test enabled the calculation of the sample ranking sum.

3 Results and discussion

3.1 Differences in fruit masses and colour changes during drying

Japanese persimmon samples were weighed fresh and after drying, revealing a 70–80 % weight decrease due to

dehydration during drying. The size of the fruit affects the physicochemical characteristics of the dried Japanese persimmon, with smaller fruits experiencing more pronounced weight loss, while larger fruits remain harder.[33] Tannins, vital bioactive molecules in Japanese persimmon, are found in higher concentrations in larger fruits.[34] In this study, colour changes during drying were observed. Samples dried in a dehydrator at 70 °C/12 h (J2) assumed an appealing, intense orange colour. However, samples dried in a laboratory oven (autoclave) at 85 °C/10.5 h (J3) and 100 °C/5.5 h (J4) turned unattractively brown due to oxidation at higher temperatures, indicating a non-enzymatic browning reaction.[35] Specifically, the device used for drying sample J2 operates on the principle of vertical airflow dehydration. The process begins with heating starting from the bottom of the device and gradually moving along the trays, starting the fan. This method prevents water retention in raw materials. However, the disadvantage of this device is uneven drying. To address this, after 6.5 h the trays were rearranged in the opposite order before continuing the drying process. On the other hand, the device used for drying samples J3 and J4 does not operate on the same principle; rather, it functions more like a kitchen oven. This allows for water retention responsible for product browning. Browning indices were lower in fresh fruit compared to the samples dried in three ways: freeze-drying, oven-drying, and vacuum oven-drying.[36] The freeze-dried samples exhibited less browning than the other samples. Vacuum oven-dried samples showed the highest browning index due to longer drying duration. The development of discolouration during vacuum oven-drying or oven-drying is probably related to the destruction of pigment and ascorbic acid, and the non-enzymatic browning reaction. Fruits and vegetables often contain phenolic compounds and a group of Cu-containing enzymes known as polyphenol oxidases. During drying, enzymes are released after degradation of plant tissue, leading to the formation of oxidised phenol forms, and further polymerisation leads to the formation of brown pigments.[36] A good method of colour preservation is immersion in a sugar solution before drying.[37] The addition of sulphur dioxide can help preserve colour by slowing down browning reactions.[35] Colour is a primary indicator of dried food quality, with storage temperature also influencing brightness of the sample.[38]

3.2 Nutritional analyses results

Table 1 presents the nutritional composition of the analysed samples. Significant differences were observed between fresh fruit and fruit dried using the three drying methods detailed previously for all analysed properties (variables), except for fat content (%), where no significant differences were found between fresh and dried fruit (Table 1).

The water content in the dried samples ranged between 12.77 % and 24.33 %. This reduction in water content was a result of evaporation during the drying process. However, samples J3 and J4 dried at higher temperatures (85 °C/10.5 h and 100 °C/5.5 h), exhibited a higher percentage of water compared to sample J2 dried at 70 °C/12 h. This difference can be attributed to the operational principles of the drying devices. Unlike the GORENJE dehydrator, which utilises airflow to prevent water retention as described in the previous section, the Binder device operates as an autoclave without ventilation or airflow, facilitating water retention. Drying the Japanese persimmons at different temperatures and using different devices also led to a significant increase ($p < 0.05$) in sugar content. Although sample J2 exhibited the highest sugar content at 70.09 %, no statistically significant difference was observed compared to the sugar content in samples J3 and J4. Heat treatment during drying caused water to evaporate, leading to the formation of crystallized structures of soluble sugars.[39] Destruction of sugar molecules is favoured at higher temperatures, which are then prone to chemical transformation.[40] Soluble tannin levels are closely associated with sugar content. The enzyme tannase is responsible for the hydrolysis of tannins. Its activity increases at temperatures above 40 °C, and reaches optimum for enzyme activity at 45 °C, resulting in the breakdown of tannins. In contrast, the enzyme is deactivated upon heating above 90 °C. Heat treatment, therefore, removes the astringent taste that comes from tannins, and stimulates the secretion of sugar to the surface, where it crystallizes, thus creating a sweet, candied product.[40] The highest protein content was determined in sample J3 (3.32 %), significantly differing from that of the other dried samples (J2 and J4; $p < 0.05$). The ash content also increased during drying, with the highest ash content measured in sample J2 at 13.30 %, and differed significantly from that of samples J3 and J4 ($p < 0.05$). The energy

Table 1 – Nutritional composition of fresh and dried persimmon samples
Tablica 1 – Nutritivni sastav uzoraka svježe i osušene japanske jabuke

Mean ± Standard deviation							
Analysed samples	Water / %	Carbohydrates / %	Sugar / %	Protein / %	Fat / %	Ash / %	Energy / kJ
J1	78.57 ± 0.12^a	19.22 ± 0.29^b	18.86 ± 0.27^b	0.67 ± 0.04^c	0.23 ± 0.01^a	0.90 ± 0.15^c	346.67 ± 7.37
J2	12.77 ± 0.15^d	71.22 ± 1.67^a	70.09 ± 1.67^a	2.48 ± 0.11^b	0.24 ± 0.24^a	13.30 ± 1.72^a	1261.67 ± 31.57
J3	19.67 ± 0.29^c	70.66 ± 2.77^a	69.40 ± 2.71^a	3.32 ± 0.45^a	0.16 ± 0.03^a	6.39 ± 2.63^b	1263.67 ± 53.63
J4	24.33 ±1.21^b	68.82 ± 2.75^a	67.77 ± 2.72^a	2.85 ± 0.10^b	0.19 ± 0.03^a	4.30 ± 1.60^b	1225.00 ± 47.76

J1 – fresh Japanese persimmon (control sample); J2 – drying at 70 °C/12 h; J3 – drying at 85 °C/10.5 h; J4 – drying at 100 °C/5.5 h
According to the LSD test, the means that differ significantly ($p < 0.05$) are marked with different letters
J1 – svježa japanska jabuka (kontrolni uzorak); J2 – sušenje na 70 °C/12 h; J3 – sušenje na 85 °C/10,5 h; J4 – sušenje pri 100 °C/5,5 h. Prema LSD testu, srednje vrijednosti koje se znatno razlikuju ($p < 0.05$) označene su različitim slovima.

Table 2 – Microbiological properties of fresh and dried persimmon
Tablica 2 – Mikrobiološka svojstva svježe i osušene japanske jabuke

Mean ± Standard deviation							
Analysed samples	Unit	m	M	J1	J2	J3	J4
Salmonella spp.	cfu/g	n.d. in 25 g n.n. u 25 g		n.d. n.n.	n.d. n.n.	n.d. n.n.	n.d. n.n.
Sulphite-reducing clostridia	cfu/g	10 (J1, J2, J3) 10^2 (J4)	10^2 (J1, J2, J3) 10^3 (J4)	<10	<10	<10	$<10^2$
Yeasts and moulds	cfu/g	10^2 (J1, J2, J3) n.d. in 25 g (J4) n.n. u 25 g (J4)	10^3 (J1, J2, J3) n.d. in 25 g (J4) n.n. u 25 g (J4)	$<10^2$	$<10^2$	$<10^2$	n.d. n.n.
Enterobacteriaceae	cfu/g	10^2	10^3	$<10^3$	$<10^2$	$<10^2$	$<10^2$
Listeria monocytogenes	cfu/g	n.d. in 25 g n.n. u 25 g		n.d. n.n.	n.d. n.n.	n.d. n.n.	n.d. n.n.
Aerobic mesophilic bacteria	cfu/g	10^4	10^5	$<10^5$	$<10^4$	$<10^4$	$<10^4$
Coagulase-positive staphylococci / *Staphylococcus aureus*	cfu/g	10	10^2	<10	<10	<10	<10

n.d. in 25 g – not detected in 25 g, m – the limit value below which the results are considered satisfactory, M – the limit value above which the results are considered unsatisfactory. J1 – fresh Japanese persimmon (control sample); J2 – drying at 70 °C/12 h; J3 – drying at 85 °C/10.5 h; J4 – drying at 100 °C/5.5 h

n.n. u 25 g – nije nađeno u 25 g, m – granična vrijednost ispod koje se rezultati smatraju zadovoljavajućim, M – granična vrijednost iznad koje se rezultati smatraju nezadovoljavajućima. J1 – svježa japanska jabuka (kontrolni uzorak); J2 – sušenje pri 70 °C/12 h; J3 – sušenje pri 85 °C/10,5 h; J4 – sušenje pri 100 °C/5,5 h

value of Japanese persimmon can be considered low, providing evidence supporting the notion that this fruit can serve as a substitute for sweets. The energy value established for the fresh J1 sample was three times lower than that of the dried samples (J2, J3 and J4), but the differences between the samples in this regard lack significance. This can be attributed to the higher water content in the fresh J1 sample as opposed to the dried samples (J2, J3 and J4), in which the sugar content increased, contributing to the increase in energy value.

3.3 Results of microbiological tests

With reference to the Regulation (EC) 2073/2005[22] and/or the Guidance on Microbiological Food Criteria,[21] different criteria were applied to the tested samples, resulting in varying limit values for bacteria found in fresh and dried fruit. Microbiological examination of Japanese persimmon samples for aerobic mesophilic bacteria was carried out for all samples (J1, J2, J3 and J4), although such testing is not specifically required for fresh-cut fruit. The increase in the presence of aerobic mesophilic bacteria and *Enterobacteriaceae* in the fresh Japanese persimmon sample (J1) can be attributed to its higher water content (78.57 %) compared to that of the dried samples (J2, J3 and J4). It is important to note that, based on the criteria provided in the Guidance, the established presence of bacteria in the tested samples (J2, J3 and J4) did not exceed the upper limit values (Table 2).

Microbiological examination of the investigated samples for yeasts and moulds revealed no difference in the established concentrations regardless of the differences in sample preparation. While differences in yeast and mould concentrations might be expected due to differences in water activity values among the differently prepared samples, the uniformity of the results can be attributed to the application of a high temperature (100 °C), which reduced the microflora present in the dried samples, or to the proper storage and preparation of the fresh sample. No increase in sulphite-reducing *Clostridia* or coagulase-positive *Staphylococci* was observed in the analysed samples (J1, J2, J3 and J4) based on the lower limit values 'm' specified in the Guidance on Microbiological Food Criteria.[21] One study on the influence of tannin extract from persimmon *Shaguyihao* against methicillin-resistant *Staphylococcus aureus* from pork demonstrated the importance of tannins' antimicrobial activities in disrupting bacterial cell walls and membranes, thereby inhibiting cell proliferation processes.[41] In the tested samples (J1, J2, J3 and J4), the presence of *L. monocytogenes* and *Salmonella* spp. was not detected, confirming that all the Japanese persimmon samples met the adopted microbiological criteria, and were suitable for distribution in the market.

Given that the samples were stored at freezing temperature (–20 °C), it was expected that such conditions would reduce the number of certain microorganisms and prevent their growth. No changes in microbial population were observed in the dried Japanese persimmon under various storage conditions (−20, 5, 12, and 25 °C). This may be the result of the low water activity (a_w) characteristic of dried fruit, which impedes the growth of microorganisms regardless of the storage temperature.[30] While some moulds can still grow on dried food at very low a_w values, most spores are sensitive to heat treatment.[42]

3.4 Results of sensory evaluation

The results of the 9-point hedonic scale for samples J2 and J3 (Fig. 3), and the results obtained on the JAR scale are presented (Fig. 4).

The fresh J1 sample was not included in the sensory evaluation, because the study primarily aimed at assessing consumer opinion on the sensory properties of dried products. Fresh persimmon was unsuitable for sensory evaluation due to its softness, which would have made consumption for evaluation purposes rather difficult. Sample J4, which exhibited poor organoleptic properties and retained excessive water on the surface of the persimmon slices after storage, was only displayed but not tasted. Namely, sample J4 after thawing was adversely affected by the retained water, resulting in poor texture and an unattractive brown colouration. Sample J3 received higher consumer ratings on the 9-point hedonic scale.[30,31] According to the results obtained on the JAR scale,[30,31] the flavour of sample J2 was poor, while that of sample J3 was ideal. Samples J2 and J3 sample had an insufficiently intense smell, while the tex-

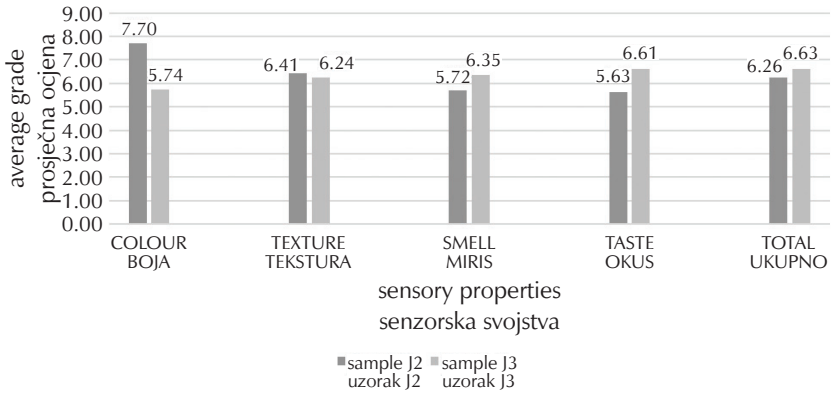

Fig. 3 – Rating of persimmon samples on the 9-point hedonic scale (J2 – drying at 70 °C/12 h; J3 – drying at 85 °C/10.5 h)
Slika 3 – Ocjena uzoraka japanske jabuke na hedonističkoj ljestvici od 9 stupnjeva (J2 – sušenje pri 70 °C/12 h; J3 – sušenje pri 85 °C/10,5 h)

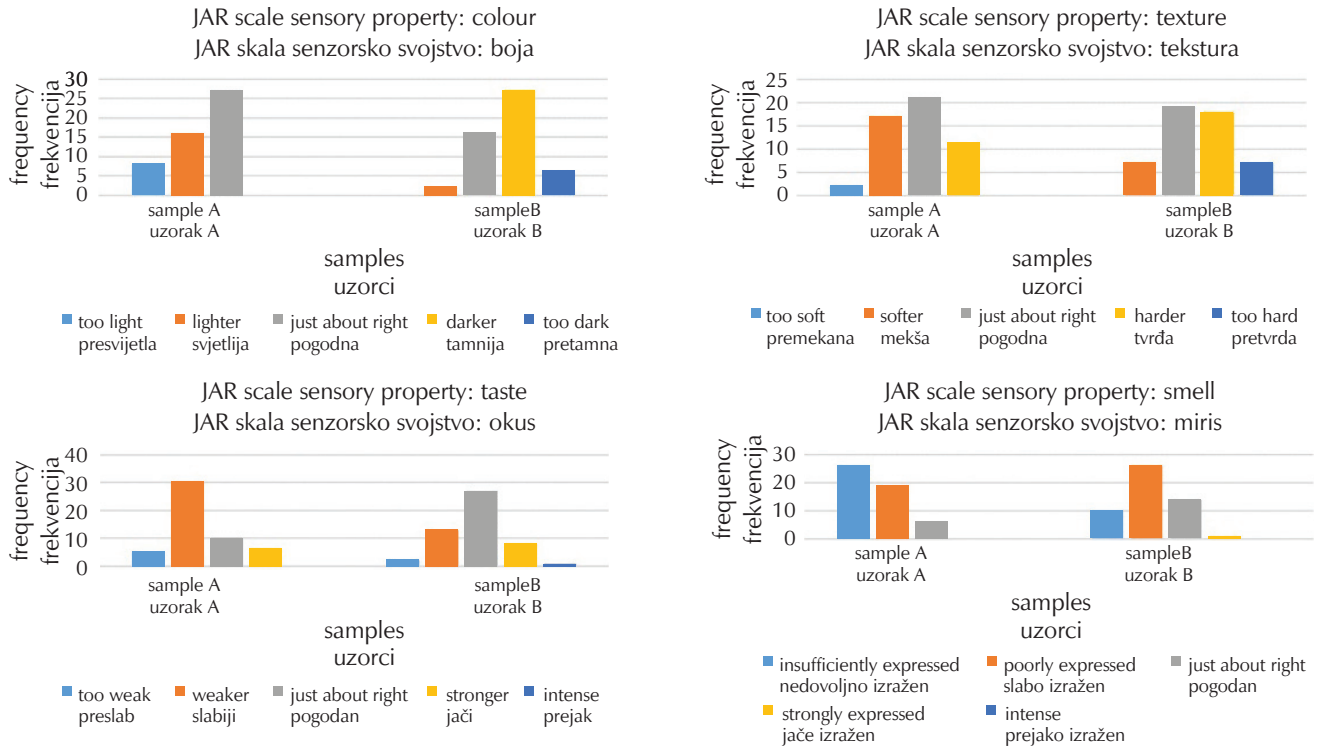

Fig. 4 – Rating of persimmon samples on the JAR scale (J2 – drying at 70 °C/12 h; J3 – drying at 85 °C/10.5 h)
Slika 4 – Ocjena uzoraka japanske jabuke na JAR ljestvici (J2 – sušenje pri 70 °C/12 h; J3 – sušenje pri 85 °C/10,5 h)

ture and colour of these samples were perceived as ideal. However, when subjected to the pair preference test[32], sample J3 scored better.

The taste of dried persimmon was more pleasing than that of the fresh fruit, which is to be attributed to the reduction in tannin content. Consumers favoured the colour and texture of sample J2, which can be attributed to the dehydration process employed during drying. Namely, due to the aforementioned, sample J2 exhibited an appealing orange colour and optimal texture, while sample J3 was darker and had a firmer texture.

4 Conclusion

Japanese persimmon (*Diospyros kaki* L.) was found to possess high nutritional value. The results of the nutritional analysis identified drying at 70 °C as the optimal method. Given that the sensory evaluation of the sample dried at 100 °C was rendered impossible, it was concluded that this high drying temperature led to the deterioration in appearance and taste. Additionally, drying in an autoclave caused water retention in the samples dried at 85 °C and 100 °C, which affected the product. The colour and texture of sample J3 were therefore impaired, while its taste and smell were satisfactory. It was concluded that a device operating on the dehydration principle should be employed for persimmon drying to prevent water retention and product browning. Sugar content significantly increased after drying. The microorganisms in both the fresh and dried samples remained within the limits stipulated under Regulation (EC) 2073/2005. The sample dried at 70 °C received the highest sensory rating for colour and texture, while the sample dried at 85 °C scored better in terms of taste. However, consumer preferences leaned toward the sample dried at 85 °C. With Herzegovina offering favourable agroclimatic conditions for quality production of astringent varieties of both fresh and dried Japanese persimmon, implementing effective drying methods could significantly enhance the fruit's quality, prevent spoilage, and ensure its availability beyond the typical harvest season.

List of abbreviations
Popis kratica

LSD – least significant difference
– najmanja značajna razlika

JAR – just about right
– pogodno

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SAŽETAK

Utjecaj sušenja na nutritivnu, mikrobiološku i senzornu vrijednost *Diospyros kaki* L. (japanske jabuke) koja se konzumira u Hercegovini

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Diospyros kaki L. (japanska jabuka) je iz azijskih zemalja proširena u Hercegovinu, gdje se uglavnom konzumira svježa. U ovom radu ispitane su razlike u nutritivnim, mikrobiološkim i senzorskim vrijednostima japanske jabuke konzumirane u jednoj od hercegovačkih regija i koje su evidentirane nakon sušenja pri 70 °C/12 h, 85 °C/10,5 h i 100 °C/ 5,5 h, zajedno s njihovim utjecajem na teksturu, masu i sastav ploda. Posebno se ističe povećanje udjela šećera, što ukazuje na to da bi sušena japanska jabuka mogla biti zdrav međuobrok. Za sve uzorke nije uočeno znatno povećanje zastupljenosti mikroorganizama. Jabuke sušene u dehidratoru imale su najbolje očuvana nutritivna svojstva i senzorski su najbolje ocijenjene. Zbog visokog sadržaja vode i posmeđivanja uzorak sušen na 100 °C u autoklavu nije upotrijebljen prilikom senzorskog ocjenjivanja.

Ključne riječi
Japanske jabuke, sušenje, nutritivni sastav, senzorska analiza, mikrobiologija

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