

MORPHOLOGICAL CHARACTERISTICS OF CHESTNUT *CASTANEA SATIVA* FROM THE AREA OF UNA-SANA CANTON

MORFOLOŠKE KARAKTERISTIKE PITOMOG KESTENA *CASTANEA SATIVA* SA PODRUČJA UNSKO-SANSKOG KANTONA

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ABSTRACT

Una-Sana Canton (USC) has a large forest areas where chestnut *Castanea sativa* Mill. grows as a self-sprout tree. The aim of this paper was to determine the morphological characteristics of chestnut fruits from four self-sprout locations (Bužim, Bosanska Krupa, Cazin and Velika Kladuša), and plantation where the domestic tree is grafted with Italian Marroni. Number of fruits/kg, the useless fruit, the percentage of kernel, diameter, width, height and weight of fruits were determined. The number of fruit/kg ranged from 160-222.5, percentage of useless fruit varied between 0.88-6.7%. Percentage of kernel ranged from 78.5 to 87.3%. According to the diameter classification, width, height and weight of fruits, chestnuts fruit from USC enters the category of the smallest fruits of the Mediterranean area. Statistical significant differences ($p \leq 0.01$) in the number of fruits/kg and weight of fruits was found between locations, as well in the width of the fruit ($p \leq 0.05$), while there is no difference in the diameter and height of the fruit. For grafted chestnut, all the characteristics provided better quality.

Key words: *Castanea sativa* Mill., morphological analysis, fruit quality, Una-Sana Canton

SAŽETAK

Unsko sanski kanton (USC) ima velike šumske površine na kojima pitomi kesten *Castanea sativa* Mill. raste kao samoniklo drvo. Cilj rada bio je utvrditi morfološke karakteristike plodova pitomog kestena sa četiri šumske lokacije (Bužim, Bosanska Krupa, Cazin i Velika Kladuša) i sa plantaže gdje je pitomi kesten kalemljen sa italijanskim maronom. Istražen je broj plodova/kg, udio neupotrebljivog ploda, udio jezgre, promjer, širina, visina i težina ploda. Rezultati pokazuju da u 1 kg ima od 160 do 222.5 plodova, od kojih udio neupotrebljivih plodova varira od 0.88 do 6.7%, a udio jezgre od 78.5 do 87.3%. Klasifikacijom prema dijametru, širini, visini i težini ploda, pitomi kesten USK ulazi u kategoriju najsitnijih plodova mediteranskog područja. Statistički značajna razlika ($p \leq 0.01$) u broju plodova/kg i masi ploda utvrđena je između lokacija, kao i statistički značajna razlika ($p \leq 0.05$) u širini ploda, dok kod dijametra i visine ploda nema razlika. Što se tiče morfoloških osobina, kalemljeni kesten pokazuje bolji kvalitet u usporedbi s ostalim vrstama.

Ključne riječi: *Castanea sativa* Mill., morfološka analiza, kvalitet ploda, Unsko-sanski kanton

DETALJNI SAŽETAK

Bosna i Hercegovina (B&H) u Europi zauzima sedmo mjesto po površini kestena (*Castanea sativa* Mill.) koji raste uglavnom kao samoniklo drvo, a zbog povoljnih ekoloških uvjeta, najveće su na sjeverozapadu (1 499 ha), na USK (Unsko-sanski kanton). Morfološka svojstva, pored ostalih, obuhvaćaju i broj plodova u kilogramu, udio neupotrebljivih plodova, odnos jezgre i ljuske, boju ljuske, dijametar, širinu, visinu i masu ploda. Podaci o ovim karakteristikama kestena sa područja USK su vrlo oskudni, zbog čega je cilj rada bio utvrditi neke morfološke karakteristike plodova, pri čemu su plodovi (po 10 kg) grupirani prema području općina: Bužim, Bosanska Krupa, Cazin i Velika Kladuša. Reprezentativni uzorak (3 kg) uzet je i sa plantaže na prostoru općine Cazin na kojoj je pitomi kesten kalemljen sa talijanskim maronom. Uzorkovalo se u septembru i oktobru 2005. godine, da se obuhvati rani i kasni kesten, a uzorkovani su samo plodovi koji su sami pali na tlo. Plodovima je određen broj plodova/kg, udio neupotrebljivih plodova, udio jezgre, dijametar, širina, visina i masa. Rezultati su obrađeni deskriptivnom statistikom, dok je analizom varijance utvrđeno postoji li statistički značajna razlika određivanih parametara između lokacija.

Utvrđeni broj plodova/kg za pitomi kesten kretao se između 160-222,5, a za kalemljeni kesten 153,5 ploda/kg. Najviši udio neupotrebljivih plodova imao je uzorak općine Cazin (6,7%), a najniži Bosanske Krupe (0,88%). Kalemljeni kesten imao je 1,97% neupotrebljivih plodova. Udio jezgre kretao se od 78,5% do 87,3%, a kod kalemjenog kestena iznosio je 81,0%. Dijametar plodova pitomog kestena varirao je između 22,11 mm i 23,80 mm, a kod kalemljenog kestena 27,01 mm. Raspon širine plodova kretao se od 23,60 – 24,40 mm, a dužine između 20,62 – 21,50 mm. Kalemljeni kesten imao je nešto više vrijednosti za širinu (26,80 mm) i visinu (24,70 mm). Prosječno najlakši plod imao je uzorak iz Bužima (4,42 g), a najteži iz Cazina (6,33 g), dok je za kalemljeni kesten utvrđena prosječna masa od 6,47 g. Klasifikacijom plodova prema dijametru utvrđeno je da se prosječno 92,5% plodova nalazi u klasi mali plod (<28,6 mm). Kod kalemljenog kestena udio malih plodova je niži u odnosu na pitomi kesten (63,3%), a udio srednjih plodova (28,6-31,75 mm) je viši (33,1%). Statistička značajnost ($p < 0,01$) u broju plodova/kg i masi ploda utvrđena je između lokacija, kao i statistička značajnost ($p < 0,05$) u širini ploda, dok kod dijametra i visine ploda nema razlika. Sudeći prema utvrđenim karakteristikama, plod pitomog kestena USK ulazi u kategoriju najsitnijeg u regionu (zemlje Mediterana). Kalemljeni kesten, općenito ima bolje karakteristike, ali je isto kao i pitomi vrlo sitan.

INTRODUCTION

Chestnut (*Castanea sativa*), the nut from Fagaceae family, is the most prevalent in the Mediterranean area. It is assumed that in Europe this chestnut is autochthon product [14]. According to the surface of chestnut, Bosnia and Herzegovina (B&H) occupies the seventh place in Europe, considering the distribution of chestnut trees on about 22.000 ha [12]. The main distribution of chestnuts in B&H are located in the northwest Una-Sana Canton (USC), east (Bratunac and Srebrenica), and south (Konjic and Jablanica) where chestnut grows within the forest, and it is used for production of wood, while the fruit, for which there is no kind of selection, is a secondary product. At the USC, chestnut is widespread on the 1.499 ha [13]. Due to favourable environmental conditions distribution of chestnut trees in this area is extremely at high level compared to other areas in B&H. However, there is no sufficient available data about this tree in B&H.

Environmental influence and genetic factor can affect chestnut morphological features connected with tree, but also connected with fruit. Chestnut fruit is characterized by brown colour and a good surface. Usually burr of chestnut has one to three fruit of which is the intermediate product of the vertical flat peak, while the rest one are oval with the sides bent inward peak [4,11]. Weight depends on the number of fruits that are formed in the burr. There has been considerable information's published about chestnut fruit weight, who varied depend on country and regions inside the countries. In Spain, Italy and Portugal fruit weight varies from 9.2 to 17.2 g [1,5,9,10,18,19,24]. High variability in mean weight of fruits (2.8–19.1 g) has been reported for 21 Romanian types [2] and the fruits (5.3–15.1 g) from the Samsun vicinity in Turkey [21]. Significant morphological chestnut characteristics is its dimensions (length, width and thickness), which depend on the fruit size [23]. With regard to the mean diameter, length and width of fruit, the chestnut trees from Mediterranean countries do not differ a lot. Fruit diameter ranges from 19 and over 37 mm [22]. The goal of this study was to examine morphological characteristics of chestnut fruit from five locations of USC, four of them are locations of wild chestnut, and one plantation, where the chestnut was grafted with Italian Marroni.

MATERIALS AND METHODS

The samples of sweet chestnut for this study were collected from the four separate geographic localities in northwestern B&H, USC and grouped according to the community (Bužim, Bosanska Krupa, Cazin and Velika Kladuša). Both chestnut varieties, early (maturing in September) and late (maturing in mid-October) were

collected in year 2005. [15]. Sampled were only those burrs that have fall down to the ground and from each locality were taken 10 kg. Grafted chestnuts were taken from plantation near municipality Cazin. The plantation was established in year 2001 at four locations, with area of 100x100 m (the forest area where except chestnut they were located other tree species). It was taken 3 kg grafted chestnut fruits as a representative sample from all four plantations. All samples were transported to laboratory, where they have been grouped in a representative sample.

The following measurements were taken: fruit number/kg, useless fruit (%), percentage of kernel (%), diameter (mm), width (mm), height (mm) and weight (g) of fruit. According to the Principe [20] fruit is categorized in four sizes: small (< 28.6 mm), medium (28.6-31.75 mm), large (31.75-38.1 mm) and jumbo (>38.1 mm). The obtained data were statistically processed by the following methods: total arithmetic mean of base paper, the analysis of variance and comparison with the F statistic [25]. All statistical analysis was conducted using the Microsoft Office Excel 2007 software package.

RESULTS AND DISCUSSION

According to the total number of fruits/kg (Table 1) it has been found that the number of fruit/kg (f/kg) ranged from 160 (Cazin) to 222.5 (Bužim). The fruits from this area are smaller then the fruits from the trees grown in Slovenia where they reach average of 106.9 f/kg. Looking regionally, the eastern part of Slovenia where the number of fruit/kg ranged from 53.8 – 181.8 f/kg, central part of Slovenia where number of fruits/kg ranged from 58.5 – 285.7 f/kg and northwestern Slovenia, where the number of fruits per kilogram ranged from 54.0 – 251.6 f/kg [22], it can be observed that in the USC, according to minimum number of fruits in kilograms, grows smaller chestnut. The fruits of the USC domestic chestnut trees

are also smaller than Spanish chestnut which ranged (by region) from 44-87 f/kg in Andalucia, from 74-119 f/kg in Galicia, and from 72-99 f/kg in Canary Islands [16,17]. Bounous [3] categorize chestnut cultivars in two main groups: ‘marroni’ and chestnut types, and according the Italian region f/kg are grouped from 70-160 f/kg for chestnut, and 70 – 100 f/kg for marroni type, while type marroni with 55 f/kg was recorded only in the province of Toscana. In comparison with domestic sweet chestnut, grafted chestnut had the lowest number of fruits/kg (153.5 f/kg), what was expected, because it was grafted with type marroni whose dimensions are higher.

The highest percentage of useless fruit had sample from Cazin (6.7%) and the lowest was from Bosanska Krupa (0.88%). Grafted chestnut had useless 1.97% of fruit, which is better than average value from 4 domestic sweet chestnut samples (3.62%). The percentage of kernel was ranged from 78.5% (Velika Kladuša) to 87.3% (Bosanska Krupa), and grafted chestnut portion of kernel was 81.0%. In comparison to the European chestnut from ten different areas in Turkey, where percentage of kernel ranged from 75.9 to 86.1% (mean value 82.1%), the chestnut from USC had similar characteristics [7]. Furthermore, if we compared the core ratio of grafted with selected chestnut genotypes from Nazilli district, Turkey where percentage of kernel ranged between 0.79-0.83%, it can be concluded that the ratio of core and shell is not optimum. [6].

The results of average values and descriptive statistical data of four measured chestnut characteristics (diameter, width, height and weight) are shown in Table 2. The mean diameter of chestnut fruits ranged from 22.11 mm (Bosanska Krupa) to 23.80 mm (Velika Kladuša), and grafted sample from Cazin had mean diameter of 27.01 mm. According to the chestnut diameter from Slovenia which ranged from 12-39 mm, and only 10% of nuts are smaller than 22 mm [22]; chestnut from different region of Italy which fruits have smaller diameter (23.0 mm) in the area of Spoleto [10], USC chestnut is the smallest

Table 1. Average values chestnut characteristics for the total number of fruits in 1 kg

Tablica 1. Prosječne vrijednosti karakteristika kestena za ukupan broj plodova u 1 kg

| Measurements | Grafted chestnut (Cazin) | Chestnut | | | |
|--------------------------|--------------------------|----------|----------------|-------|----------------|
| | | Bužim | Bosanska Krupa | Cazin | Velika Kladuša |
| Number of fruits /kg | 153.5 | 222.5 | 185.5 | 160 | 188 |
| Useless fruit (%) | 1.97 | 2.88 | 0.88 | 6.7 | 4.03 |
| Percentage of kernel (%) | 81.0 | 84.9 | 87.3 | 84.4 | 78.5 |

Table 2. Descriptive statistical data of morphological characteristic (diameter, width, height and weight) of chestnuts from Una-Sana Canton

Tablica 2. Deskriptivni statistički podaci o morfološkim karakteristikama (dijametar, širina, visina i masa) kestena sa Unsko-sanskog kantona

| Locations | Statistical data | Morphological characteristic of chestnut | | | |
|--------------------------|------------------|--|-------------------------------|-------------------------------|-----------------------------|
| | | Diameter (mm) | Width (mm) | Height (mm) | Weight (g) |
| Grafted chestnut - Cazin | x_{sr} | 27.01 | 26.80 | 24.70 | 6.47 |
| | s | 0.30 | 0.29 | 0.21 | 2.12 |
| | i | $26.734 \leq \mu \leq 27.298$ | $26.556 \leq \mu \leq 27.106$ | $24.502 \leq \mu \leq 24.892$ | $6.243 \leq \mu \leq 6.671$ |
| Bužim | x_{sr} | 23.70 | 23.65 | 20.62 | 4.42 |
| | s | 0.24 | 0.24 | 0.22 | 1.14 |
| | i | $23.493 \leq \mu \leq 23.863$ | $23.464 \leq \mu \leq 23.838$ | $20.457 \leq \mu \leq 20.791$ | $4.326 \leq \mu \leq 4.503$ |
| Bosanska Krupa | x_{sr} | 22.11 | 24.40 | 21.30 | 5.10 |
| | s | 0.30 | 0.20 | 0.24 | 1.54 |
| | i | $21.260 \leq \mu \leq 22.949$ | $24.139 \leq \mu \leq 24.593$ | $21.104 \leq \mu \leq 21.510$ | $4.972 \leq \mu \leq 5.233$ |
| Cazin | x_{sr} | 25.20 | 25.30 | 21.50 | 6.33 |
| | s | 0.33 | 0.35 | 0.23 | 1.75 |
| | i | $24.899 \leq \mu \leq 25.506$ | $25.017 \leq \mu \leq 25.657$ | $21.339 \leq \mu \leq 21.766$ | $6.169 \leq \mu \leq 6.491$ |
| Velika Kladaša | x_{sr} | 23.80 | 23.60 | 21.10 | 5.04 |
| | s | 0.22 | 0.22 | 0.21 | 2.01 |
| | i | $23.608 \leq \mu \leq 23.982$ | $23.453 \leq \mu \leq 23.823$ | $20.926 \leq \mu \leq 21.280$ | $4.873 \leq \mu \leq 5.213$ |

x_{sr} – mean; s – standard deviation; i – interval arithmetic mean ($\alpha = 0.1$)

Table 3. Classification according to the diameter of chestnut fruit

Tablica 3. Klasifikacija kestena prema promjeru ploda

| Class (mm) | Grafted chestnut | | Bužim | | Bosanska Krupa | | Cazin | | Velika Kladaša | |
|---------------------|------------------|------|-------|------|----------------|------|-------|------|----------------|------|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Small < 28.6 | 195 | 63.3 | 425 | 95.5 | 351 | 94.6 | 265 | 82.8 | 365 | 97.1 |
| Mean 28.6-31.75 | 102 | 33.1 | 19 | 4.27 | 19 | 5.12 | 51 | 15.9 | 10 | 2.66 |
| Large 31.75-38.1 | 11 | 3.57 | 1 | 0.23 | 1 | 0.27 | 3 | 0.94 | 1 | 0.27 |
| Jumbo > 38.1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.31 | 0 | 0 |

No. – number of fruits in the 2 kg sample

chestnut in region.

With regard to the mean width and length of fruit, the chestnut trees do not differ a lot. The mean width of four domestic chestnut samples ranged from 23.60–25.30 mm, but the grafted chestnut shown small variation in width (the mean width was 26.80 mm). According to the length of fruit the mean values ranged from 20.62 – 21.50 mm in the sample taken from Bužim (smaller) and Cazin (bigger). Also, the grafted chestnut has a bigger mean value of 24.70 mm. But, fruit dimensions are smaller

than those reported by authors from Italy [10,18], Spain [8], Turkey [6] or Slovenia [22]. The local chestnut type from USC had the lightest fruit in area of Bužim (4.42 g) and the heaviest fruit in the area of Cazin (6.33 g), and the weight of grafted chestnut is the heaviest between all samples (6.47 g). The fruits from USC area, in general, are the lightest between the Slovenian fruits that has average weight 10.4 g [22], Italian fruit from Spoleto region where the lowest values for length, weight, diameter, and weight ranged from 12.2–17.2 g [10]. The weights of fruit

Table 4. Significant differences of morphological characteristics in the chestnut fruit of Una-Sana Canton between different locations**Tablica 4.** Značajnost razlika morfoloških karakteristika kestena sa Unsko-sanskog kantona između različitih lokaliteta

| Variability source | F value |
|--|---------|
| Number of chestnut fruits/1kg ^a | 27.89* |
| Diameter of chestnut fruits ^b | 1.54 |
| Width of chestnut fruits ^b | 14.47* |
| Height of the chestnut fruits ^b | 2.68 |
| Weight of chestnut ^a | 21.81* |

^a Significant differences with a significance level of $p \leq 0.01$

^b Significant differences with a significance level of $p \leq 0.05$

* Morphological characteristics with statistically significance

from Portugal is heaviest, the average of 10-20 g [9], and from Greek where the weight ranged from 11.1–15.3 g [24]. The weight of USC fruit is only similar to the trees from the western area of Slovenia where not so heavy fruits are growing (3.5–6.5 g) [22].

Related to the diameter, classification of chestnut fruit from USK was conducted and shown in Table 3. It was concluded that the chestnut with four referent area of USC is classified in to the class of chestnut with a small diameter of fruits (< 28.6 mm), because more than approximately 92.5% (for all samples) of the fruit has a measured diameter less than 28.6 mm. Small size of fruit ranged from 82.8 - 97.1 %, but difference was found to grafted chestnut, because 63.3% of fruits were classified in class of fruits with small diameter, and 33.1% of fruits in the middle class (28.6-31.75 mm) of fruit diameter.

The analysis of variance was used to compare morphological characteristic (fruit number/kg, diameter, width, height and weight) from different localities (Bužim, Bosanska Krupa, Cazin and Velika Kladuša) and grafted chestnut from Cazin, and result are shown in Table 4. By comparing results of fruit characteristics from five localities, statistically significant difference was confirmed ($p \leq 0.01$) in the number of chestnuts fruits/kg, and weight of fruit. Number of fruit/kg, as well as weight of fruits from Cazin area with grafted chestnut is different, because the graft was made with Italian Marroni, who has a much larger value of all measured parameters, ie the larger fruit which can be seen from the available literature. Also, the significant difference was observed ($p \leq 0.05$) in the width of chestnut fruit from the same reason. Regarding the diameter and height of chestnut fruit, there is no statistically significant difference ($p \geq 0.05$). Undeveloped diameter and height of chestnut fruit at domestic chestnut is consequences of the fact that the local chestnut is the smallest in the region, but there

are no statistically significant differences in diameter and height of the fruit for grafted chestnut. The reason for this may be the morphological characteristics of the varieties from which was grafted local chestnut, and this is certainly subject for further research investigation for scientists in B&H.

CONCLUSIONS

The results of analysis conducted at four localities of USC, northwestern B&H on domestic chestnut fruit, and one grafted chestnut sample from the same area, shown that the maximum value in total has the grafted chestnut, and the lowest value chestnut in the area Bužim. Based on the obtained results it was concluded that grafted chestnut grown in area of Cazin has the biggest fruit, followed by local chestnut with the area of Cazin, Bosanska Krupa, Velika Kladuša and Bužim, but the chestnut fruit from USC was the smallest one in comparison to the fruits grown up in the Mediterranean area.

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