Fruit Quality of Plum Cultivars 'Elena' and 'Bistrica'

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Summary

In this research dry matter, total acids (TA), total soluble solids (TSS), TSS/TA ratio, pH, vitamin C, total phenols, flavonoids, non-flavonoids, natural and total invert, in fresh and dried plums, of two plum cultivars 'Elena' and 'Bistrica', were investigated. There was significant difference between selected cultivars in fresh and dried fruit. 'Elena' showed higher values of dry matter, TSS, TSS/TA ratio, pH and total invert, while 'Bistrica' had higher values of vitamin C, total phenols, flavonoids and non-flavonoids, total acids and natural invert in fresh and dried fruit. It can be concluded that although 'Elena' obviously has some favorable characteristics, cultivar Bistrica has higher content of antioxidant compounds.

Key words

plum, cultivars, quality

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Introduction

Plum (*Prunus domestica*) growing in Croatia has a long tradition and this species is widely spread throughout country because of favorable ecological conditions. Plum fruits are consummated fresh, dried and also plum brandy is made. The large part of plum production was basically dependent on one cultivar called 'Bistrica', predominantly grown in Croatia. Unfortunately, growing of plums in Croatia over the last few decades has declined. The reason for this is that the most cultivated cultivars were budded onto vigorous seedling rootstocks (*Prunus cerasifera*) and formed trees of large size, which exhibit delayed cropping and their large size added to the high cost of management. In addition, main local cultivar Bistrica is extremely susceptible to plum pox virus and many trees decayed (Čmelik et al., 2007, In Press). Solution of this problem can be found in introduction of new tolerant or resistant cultivars grafted onto semi-vigorous or dwarfing rootstocks which pomological characteristics and fruit quality need to be examined in specific ecological conditions.

Plums fresh and dried are thought to be a big natural source of sugars, acids, vitamins, minerals and phytochemicals such as flavonoids, phenols and other phythochemicals for which is determined that they have antioxidant activity and may help protect cells against the oxidative damage caused by free radicals (Chun et al., 2003; Imeh et al., 2002). In human nutrition they are valued as a rich energetic source with high protective, dietetic and therapeutic value. For this reason when evaluating new cultivars we are especially interested in determining its fruit quality based on physical and chemical analyses.

In our research we examined quality of fresh and dried fruit of plum cultivar Elena which is a new cultivar advised by Hartmann (1998) and compared it to cultivar Bistrica which is commonly grown in Croatia.

Materials and methods

In this research fruit quality of two cultivars 'Elena' and 'Bistrica', for fresh consumption and dried consumption, was analyzed. 'Elena' was grown in "Jazbina" experimental orchard of Faculty of Agriculture, Zagreb and Bistrica was grown in commercial orchard near Zagreb. Fruits were harvested in September of year 2005. Experiment was set as a random design; it was two factorial experiment with two levels. We had two cultivars, 'Bistrica' and 'Elena' and each cultivar had two states of fruit: fresh and dried. That in total makes four treatments: fresh and dried fruit of 'Elena' and fresh and dried fruit of 'Bistrica'. Each treatment had three repetitions. Each repetition had thirty fruits.

Drying was conducted in laboratory oven type Retsch TG1. Surrounding air, which temperature was measured (°C), was used for drying. Speed of air which exited oven was measured by fan anemometer Airflow Developments Ltd. Air temperature in oven was measured by Hg thermometer. Air speed of drying was regulated to approximately 2.0 m s^{-1}.

Following parameters were investigated: dry matter, soluble solids, pH value, total acidity, vitamin C, total phenols, flavonoids, non-flavonoids, and reducing sugars expressed as natural and total invert.

Determination of total dry matter was conducted with etalonic method by drying at 105°C until constant mass (AOAC, 1995).

Determination of total soluble solids was conducted by reading of soluble solids directly from the refractometer scale (AOAC, 1995).

Determination of pH value was conducted using pH-meter, by immersing combined electrode in the homogenized sample and reading the values (AOAC, 1995).

Determination of total acidity was based on potentiometric titration with the solution of sodium hydroxide. This method is used for determination of total acidity of fruits and vegetables and products of fruits and vegetables (AOAC, 1995).

Determination of vitamin C (L-ascorbic acid) was conducted by titrimetric method with 2,6-p-dichlorphenolindophenolom. Method is based on L-ascorbic acid oxidation by 2,6-p-dichlorphenolindophenol into dehydroascorbic acid, until color of reagent turns into colorless leucobasis, so at the same time it serves as indicator of this reaction. This method is used for determination of ascorbic acid in products of fruits and vegetables (AOAC,2002).

Determination of directly reducing sugars by Luff solution was based on the principal that in determined conditions reducing sugars (natural invert) converted $CuSO_4$ from the Luff solution into Cu_2O. Unspent amount of cupric ion was re-titrated with tyosulfate solution. From difference of consumption for blind trail and sample, quantity of sugars was read from tables.

Unreduced disaccharide (sucrose) first had to be inverted, that was hydrolyzed, on reducing monosaccharide by acid, and then it was determined by Luff solution. This is how we got data on total amount of sugar in analyzed sample (total invert). Difference between obtained total invert and natural invert gave quantity of reducing sugars developed by sucrose inversion. (AOAC, 1995).

Total phenolics (TPC), flavonoids (TF), and non-flavonoids (TNF) were determined using the Folin-Ciocalteu colorimetric method described by Amerine and Ough (Amerine and Ough, 1980). Results were expressed as mg of gallic acid equivalents (GAE) per 100 g of fresh weight of edible part of fruit. The formaldehyde precipitation was

Table 1. Basic chemical composition of fresh and dried fruit of cultivars 'Elena' and 'Bistrica'

	Dry matter (%)	Total acids (TA) (%)	Total soluble solids (TSS) (BRIX°)	T.S.S./T.A.	pH	Vitamin C (mg/100 g F.W.)
Fresh 'Elena'	19.29^{a} ±0.02	0.45^{b} ±0.01	15.33^{a}±0.58	33.88^{a}±1.59	3.8 ^{a}±0.01	8.62^{b}±0.34
Fresh 'Bistrica'	17.19^{b}±0.16	0.72^{a}±0.01	14.00^{b}±0.01	19.49^{b}±0.14	3.69^{b}±0.01	9.79^{a}±0.34
Dry 'Elena'	75.11^{a}±0.26	1.07^{b}±0.12	40.73^{a}±0.06	38.29^{a}±4.71	3.90^{a}±0.01	2.45^{a}±0.05
Dry 'Bistrica'	74.27^{b}±0.25	1.42^{a}±0.01	30.20^{b}±0.01	21.27^{b}±0.15	3.84^{b}±0.01	2.59^{a}±0.38

Means followed by the same letter are not statistically different at P=0.05; Values are expressed as means ± SD for n=3

Table 2. Content of total phenols, non-flavonoids, falvonoids, total and natural invert in fresh and dried fruit of cultivar 'Elena' and 'Bistrica'

	Total phenols mg GAE/100 g	Flavonoids mg GAE/100 g	Non-flavonoids mg GAE/100 g	Total invert (%)	Natural invert (%)
Fresh 'Elena'	174.20^{b}±6.18	100.88^{b}±0.55	73.32^{b}±6.27	8.32^{a}±0.28	4.42^{b}±0.01
Fresh 'Bistrica'	231.25^{a}±9.29	125.39^{a}±4.16	105.85^{a} ±5.95	6.40^{b}±0.28	4.67^{a}±0.11
Dry 'Elena'	529.10^{b}±0.46	314.97^{b}±12.10	205.14^{a}±12.02	40.64 ^{a}±0.04	22.95^{b}±0.05
Dry 'Bistrica'	562.17^{a}±9.43	357.03^{a}±7.81	214.13^{a} ±12.29	32.63^{b}±0.25	27.00^{a}±0.44

Means followed by the same letter are not statistically different at P=0.05; Values are expressed as means ± SD for n=3

used to determine flavonoids in fruit samples (Kramling and Singleton, 1969). The content of flavonoids was calculated as difference between total phenolic content and non-flavonoid content. Results were expressed also as mg of gallic acid equivalents (GAE) per100 g of fresh weight of edible part of fruit.

Obtained results were analyzed by two-way factorial analysis of variance using statistical program SAS (SAS Institute, 1997).

Results and discussion

Obtained results are showed in Table 1 and 2. In Table 1 we can see basic chemical composition of fresh and dried fruit of cultivars 'Elena' and 'Bistrica'.

In fresh and dried fruit cultivar Elena had higher content of dry matter (fresh 19.29 %, dried 75.11%), total soluble solids (fresh 15.33 BRIX°, dried 40.73 BRIX°) , total soluble solids/total acidity ratio (fresh 33.88, dried 38.29), pH (fresh 3.83, dried 3.90) than cultivar Bistrica. Cultivar Bistrica in fresh and dried fruit had higher content of total acids (fresh 0.72 %, dried 1.42 %) (Table 1).

In fresh material cultivar Bistrica had higher amount of vitamin C (9.79 mg/100 g). However there was no significant difference in content of vitamin C between cultivars in dried fruit (Table 1). These results are consistent with the work of Ertekin et al. (2006) and Slaughter et al. (2003).

In Table 2 content of total phenols, non-flavonoids, falvonoids, total and natural invert in fresh and dried fruit of cultivars Elena and Bistrica is showed.

Content of total phenols was higher for Bistrica in fresh fruit 231.25 mg GAE/100 g and also in dry fruit 562.17 mg GAE/100 g (Table 2).

'Bistrica' had higher non-flavonoid content in fresh material (05.80 mg GAE/100 g). Although it also had higher amount of non-flavonoids in dry fruit (214.13 mg GAE/100 g), there was no significant difference between cultivars. This was also the case of flavonoids where 'Bistrica' had higher flavonoid content in fresh material (125.39 mg GAE/100 g) and in dry fruit (357.027 mg GAE/100 g) (Table 2).

The work of Kim et al. (2003) showed similar results where total phenols for fresh fruit ranged from 181.3 mg GAE/100 g for cultivar Stanely to 372.6 mg GAE/100 g for cultivar Beltsville Elite. Also in work of Chun et al. (2003), amount of total phenols in fresh fruit ranged from 138.1 mg GAE/100 g for cultivar NY 9 (New York 9) to 684.5 mg GAE/100 g for Beltsville Elite. In the research of Imeh et al. (2002) for cultivar Royal Garnet content of total phenols in fresh fruit was 471.4 mg GAE/100 g. Content of flavonoids and non-flavonoids obtained by these researchers was not comparable with our results because they expressed flavonoid and non-flavonoid content on a fresh weight basis as mg of catechin equivalent (CE) per 100 g, while we expressed it on a fresh weight basis as mg of gallic acid equivalent (GAE) per 100 g.

In research of Cinquanta et al. (2002) content of total phenols in dried plums ranged from 340 to 610 mg GAE/100 g dry weight, which is less than in our research, where if our results are recalculated on dry matter, content of total phenols in dry plums range from 712.40 to 748.46 mg GAE/100 g dry weight.

Total invert was higher in fresh fruit and dry fruit of 'Elena' (fresh 8.32, dried 40.46), while content of natural invert in fresh fruit and dry fruit was higher in 'Bistrica' (fresh 4.67, dried 27.0) (Table 2). Similar result was obtained by Cinquanta et al. (2002).

Conclusions

Cultivar Elena, considering determined chemical parameters, showed good fruit quality for fresh and dry consumption.

In the research 'Elena' showed higher values of dry matter, TSS, TSS/TA ratio, pH and total invert, while 'Bistrica' had higher values of vitamin C, total phenols, flavonoids and non-flavonoids, total acids and natural invert. It can be concluded that although 'Elena' obviously has some favorable characteristics, cultivar Bistrica has higher content of antioxidant compounds.

Further researches are needed, to determine fruit quality of cultivar Elena in different ecological conditions of Croatia and also of other cultivars that are resistant or tolerant to plum pox virus, which could replace susceptible cultivars, so that plum production in Croatia could be improved.

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