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Variability of Oil Content in Fruit of Olive Variety Žutica on Montenegrin Coast

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Abstract

Žutica, the major variety on Montenegrin Coast, belongs to the group of olive varieties for oil production, with oil content in average above 21%. During the research of the properties of Žutica variety, the existence of variability in the oil content was recorded. In order to determine the degree of the variability of oil content within this variety, the fruits of 42 accessions were analyzed. The results confirmed high content of oil as well as the existence of variability of this parameter between the studied accessions. Twenty two accessions had the content of oil of over 20%, while 13 accessions had the oil content greater than 22% in fresh matter. The highest oil content was in fruit of VAL2 (24.3%) and in dry matter in DUB (63.77%). The results suggest Žutica accessions (clones) with higher oil content promising for spread in the new plantations.

Key words: olive accessions, Montenegro, olive oil

Introduction

Olives have been grown on the Montenegrin Coast for more than 2000 years, as evidenced by two exemplars situated in Bar and Budva. The main cultivar that dominates in the olive assortments of Montenegro is Žutica. This cultivar is present with 98% in the southern coastal area or with 65% in relation to other cultivars. During the long period of cultivation and influences of different ecological conditions along the coast, many differences have evolved in the frame of this variety recognizable on the phenotype (Lazović et al., 2002). In general, Žutica is characterized as a variety for oil production, with a small to medium-sized fruit and a high content of oil of more than 21% (Miranović, 1994; Lazović, 2001). This variety is also used for table consumption, prepared in local ways as green and black.

During the research related to morphological and chemical properties of this variety, the existence of variability in the oil content was recorded. With recording of the phenotype differences among individuals of this variety, we considered the possibility to find clones with the valuable morphological traits that can be used in production and/or in breeding programs. In spite of overall opinion that clone selection has not produced much innovation in terms of better genotypes (Bellini et al., 2008), the clones with high oil content can be used to improve olive oil production. The aim of this work was to analyze the range of olive oil content among Žutica individuals/clones and the capacities represented with the most prominent clones for the olive oil production.

Material and Methods

During the three-year period (2009-2011) the study was conducted on 42 individuals /clones of cultivar Žutica. Individual trees /clones were marked according to their original location along the coast of Montenegro (Bar: DAB1, DAB2, DAB3, DAB4, SUS1, SUS2, CSV1, CSV2, DM5, STM1, STM2, KAP1, KAP2, BRI1, BRI2, KUR, ZAVG; Ulcinj: VAL1, VAL2, VALD, VALL, STUL, VALVO; Budva: REZ, PET1, PET2, PET3, PET4, MAES, DIVA, MIRI2; Tivat: GRAB1, GRAB2, GRAB3, KRST; Kotor: KAV1, KAV2, DUB; Lustica: LUS14, LUS15, LUS2, LUS3). Phenological phases (here presented with the end of flowering and beginning of ripening, respectively) were observed and the period of development of fruit was calculated (Baranco et al., 2000). The fruit samples collected in quantity of 1kg per tree were used for the analyses of

moisture and dry matter at 105ºC (drier Memmert UFB400) and olive oil content (Soxtec apparatus with diethyl ether), as well. The data obtained were statistically processed with STATISTIX 7.0 program. The $LSD_{0.05}$ test was used to define the significance of the differences among Žutica individuals/clones. The data were standardized and a dendrogram was constructed using Unweighted pair-group average (UPGMA) method with Squared Euclidean distance in the program STATISTICA 5.0.

Results and Discussion

Flowering in Žutica clones (Table 1) occurred in the last decade of May and the beginning of June. Flowering ended with 9 days of difference among the clones. Flowering intensity was not significantly different. No influence of the location on the clone flowering was noticed.

Tab. 1. Flowering and maturation of 42 clones of cv. Žutica (2009-2011)
Cvjetanje i zrenje 42 klona sorte Žutica (2009-2011)

No. *Br.*	Clone *Klon*	End of flowering *Kraj cvjetanja*	Degree of flowering *Stepen cvjetanja*	Beginning of maturation *Početak zrenja*	Days from the end of flowering to the beginning of maturation *Broj dana od kraja cvjetanja do početka zrenja*
1	DAB1	28th May	1	6th October	130
2	DAB2	27th May	1	6thOctober	131
3	DAB3	30th May	1	16th October	139
4	DAB4	29th May	1.5	16th October	140
5	SUS1	29th May	3	17thOctober	141
6	SUS2	29th May	1	16th October	140
7	CSV1	25th May	1.5	18thOctober	146
8	CSV2	26th May	2.5	12thOctober	139
9	REZ	28th May	3	21th October	146
10	LUS14	2nd June	1.5	15thOctober	135
11	LUS15	2nd June	1.5	15th October	135
12	DM5	23th May	3	14th October	143
13	VAL1	29th May	3	17th October	141
14	VAL2	27th May	4	15th October	141
15	VALD	30th May	3	15th October	138
16	VALL	31st May	2	17th October	139
17	STUL	29th May	2.5	9th October	131
18	VALVO	28th May	3	17th October	142
19	STM1	27th May	1	11th October	137
20	STM2	26th May	2	11th October	138
21	KAP1	25th May	1	8thOctober	136
22	KAP2	25th May	0.5	8th October	136
23	PET1	20th May	2.5	17th October	149
24	PET2	20th May	3	16th October	148

No. *Br.*	Clone *Klon*	End of flowering *Kraj cvjetanja*	Degree of flowering *Stepen cvjetanja*	Beginning of maturation *Početak zrenja*	Days from the end of flowering to the beginning of maturation *Broj dana od kraja cvjetanja do početka zrenja*
25	PET3	20th May	2.5	17thOctober	149
26	PER4	21st May	1	14th October	145
27	BRI1	3rd June	2	13thOctober	132
28	BRI2	2nd June	1.5	13th October	133
29	MAES	26th May	0.5	21st October	148
30	DIVA	25th May	0.5	15th October	143
31	KAV1	27th May	2.0	09th October	135
32	KAV2	27th May	1	10th October	136
33	KRST	28th May	3	10th October	135
34	GRAB1	30th May	2	8th October	131
35	GRAB2	29th May	2.5	8th October	132
36	GRAB3	30th May	3	9th October	131
37	LUS2	30th May	1	13th October	136
38	MIRI2	24th May	5	23th October	152
39	LUS3	29th May	2	10th October	134
40	KUR	29th May	4	17th October	141
41	ZAVG	30th May	1	15th October	138
42	DUB	30th May	3	7th October	130
P-value		0.0002**	0.0941ns	1.0000ns	0.8189ns
$LSD_{0,05}$		5.2062	1.9217	29.848	18.569

Maturation, presented with the beginning of this phase, started in October with a difference of 17 days between the earliest (DAB1 and 2) and the latest (MIR2). Regarding the olive descriptor (Baranco et al., 2000), the early ripening occurred in late October.

The period for fruit to develop and start ripening was differed in 22 days among Žutica clones and it was not significant. The shortest period for fruits to start maturation was 130 days (DAB1 and DUB) and the longest was of 152 days in MIR2. The amount of yield did not influence the maturation beginning. This period is very important for the development of the fruit and in regard of the accumulation of olive oil. It is also in accordance with the previous results (Lazović et al., 2006; Hamidoghli et al., 2008).

The harvesting period is very important since the oil content (in dry and fresh matter) and olive oil quality parameters decreased during ripening (Hamidoghli et al., 2008). Therefore, the data presented in Table 1 are of importance in relation to the oil content and chemical properties of the fruits (Table 2). The chemical properties obtained were significantly different among Žutica clones.

The oil content in fruit of 22 examined clones was over 20% on fresh matter. The range was from the lowest 14.63% (LUS2) up to 24.28% (VAL2). The moisture content in the fruit influenced the oil content which

calculated on dry matter was in range from 33.42% (PET4) to 63.44% (DUB) and it was above 50% in 13 clones, respectively. Similar olive oil values in dry matter were obtained for Turkish varieties (Arslan, 2012), mentioning the conclusion of Tous and Romero (1994) that olive varieties with more than 46% total oil in dry matter are classified as high oil containing varieties. Thus, our results confirm Žutica as high oil containing variety with average of 46.77% oil in dry matter. From the other hand, a high level of variability in olive oil content suggests the presence of even more oily accessions of Žutica.

The influence of ecological conditions of the site cannot be recognized as a rule (Sladonja et al., 2006) since the clones from the same area showed very different oil content. More likely is that differences in oil content is the potential within this variety that should be subject of the deeper research considering the oil qualitative standards (Cantini et al., 1999) to insure more flavoring olive oil production.

The influence of the period end of flowering - beginning of maturation (Table 1) on oil accumulation was not confirmed.

Tab. 2. Chemical properties of fruit in 42 individuals/clones of cv. Žutica
Hemijske osobine ploda 42 individue/klona sorte Žutica

No. *Br.*	Clone *Klon*	Moisture *Vlaga* (%)	Dry matter *Suva materija* (%)	Oil content in fresh matter *Sadržaj ulja na svježu mat.* (%)	Oil content in dry matter *Sadržaj ulja na suvu mat.* (%)
1	DAB1	57.92	42.08	23.90	56.80
2	DAB2	55.06	44.94	22.99	51.15
3	DAB3	55.93	44.07	21.65	49.13
4	DAB4	59.58	40.43	20.31	50.23
5	SUS1	57.69	42.31	17.00	40.17
6	SUS2	55.69	44.32	22.27	50.25
7	CSV1	55.41	44.59	17.96	40.27
8	CSV2	57.62	42.39	19.49	45.97
9	REZ	61.66	38.34	18.46	48.15
10	LUS14	57.41	42.59	17.73	41.62
11	LUS15	55.55	44.45	17.88	40.22
12	DM5	58.44	41.56	20.08	48.32
13	VAL1	56.66	43.34	22.36	51.60
14	VAL2	57.08	42.92	24.28	56.57
15	VALD	58.59	41.41	19.46	47.01
16	VALL	55.23	44.77	21.77	48.63

No. *Br.*	Clone *Klon*	Moisture *Vlaga* (%)	Dry matter *Suva materija* (%)	Oil content in fresh matter *Sadržaj ulja na svježu mat.* (%)	Oil content in dry matter *Sadržaj ulja na suvu mat.* (%)
17	STUL	56.78	43.22	22.40	51.83
18	VALVO	59.33	40.67	18.36	45.14
19	STM1	59.12	40.88	18.67	45.67
20	STM2	61.31	38.69	17.96	46.42
21	KAP1	58.95	41.05	18.14	44.17
22	KAP2	55.50	44.50	20.28	45.57
23	PET1	63.55	36.45	19.46	53.40
24	PET2	63.05	36.95	22.01	59.56
25	PET3	56.44	43.56	21.15	48.57
26	PET4	51.62	48.38	16.17	33.42
27	BRI1	49.72	50.29	23.08	45.90
28	BRI2	53.77	46.23	23.73	51.33
29	MAES	59.75	40.25	19.77	49.11
30	DIVA	53.71	46.29	21.86	47.23
31	KAV1	56.91	43.10	21.99	51.02
32	KAV2	50.16	49.85	23.24	46.61
33	KRST	48.13	51.88	22.00	42.40
34	GRAB1	46.95	53.05	19.90	37.51
35	GRAB2	46.85	53.15	24.20	45.52
36	GRAB3	47.11	52.90	22.04	41.66
37	LUS2	64.33	35.67	14.63	41.01
38	MIRI2	54.65	45.35	19.39	42.76
39	LUS3	58.36	41.64	14.68	35.25
40	KUR	61.11	38.89	20.41	52.47
41	ZAVG	56.09	43.91	19.50	44.41
42	DUB	68.87	31.13	19.75	63.44
Average		56.61	43.39	20.29	46.77
P-value		0.0000**	0.0000**	0.0000**	0.0001**
$LSD_{0,05}$		5.1165	5.1165	3.7196	9.4790

To elaborate further the differences in chemical parameters, the dendrogram was constructed (Fig. 1) dividing Žutica clones into 4 groups. The first group is composed of two subgroups with 12 and 18 individuals. The clones linked in first subgroup have high oil content in fresh and in dry matter. The second group is with the highest dry matter content (51.52%); the third group has the lowest oil content in fresh matter

(15.16%), while the three clones in the fourth group have the highest moisture and oil in dry matter content (65.16% and 56.8%, respectively).

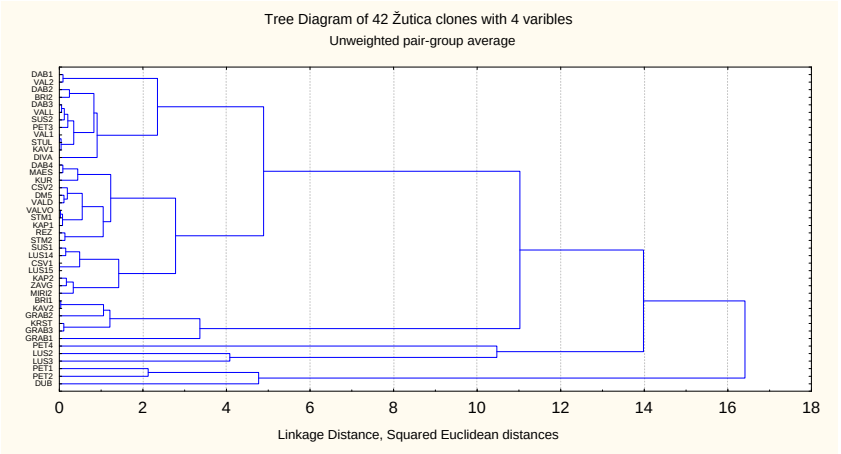

Fig. 1. Dendrogram of 42 Žutica clones derived from UPGMA analysis of chemical properties
Dendrogram za 42 klona sorte Žutica dobijen UPGMA analizom hemijskih osobina

Conclusion

The study of 8 parameters in 42 individuals/clones showed the high level of variability among Žutica variety regarding the olive oil content. The results showed the presence of the clones with high oil content in the fruit, 22 clones with more than 20% and in two clones of over 24% (GRAB2 and VAL2). The clones should be further studied for olive oil quality, while the expressed variability should be confirmed by DNA analysis. The clones with higher oil content are potential for multiplication and growing in new plantations.

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Varijabilnost sadržaja ulja u plodu masline sorte Žutica na Crnogorskom primorju

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Sažetak

Žutica je najvažnija sorta masline na Crnogorskom primorju za proizvodnju ulja, čiji je sadržaj u plodu u prosjeku iznad 21%. Tokom istraživanja osobina ove sorte zapažena je varijabilnost u sadržaju ulja. Za utvrđivanje stepena varijabilnosti sadržaja ulja u plodu analizirano je 42 aksešena (klona) ove sorte. Rezultati su potvrdili visok sadržaj ulja kao i postojanje varijabilnosti ovog parametra između analiziranih aksešena sorte Žutica. Od ukupnog broja ispitivanih, kod 22 aksešena sadržaj ulja u plodu bio je preko 20%, dok je sadržaj ulja veći od 22% u svježoj materiji imalo 13 aksešena/klonova. Najveći sadržaj ulja u svježem plodu bio je kod VAL2 (24,3%), a u suvoj materiji kod DUB (63,44%). Rezultati ukazuju da aksešeni (klonovi) Žutice sa većim sadržajem ulja u plodu predstavljaju potencijal za širenja u novim zasadima.

Ključne riječi: aksešeni, Crna Gora, maslinovo ulje

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