OLIVE OIL QUALITY AND TRACE ELEMENT PROFILE OF SICILIAN VIRGIN OLIVE OILS

FORO DE LA INDUSTRIA OLEICOLA, TECNOLOGIA Y CALIDAD

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ABSTRACT

In this work we report the analytical results related to the chemical composition of two Sicilian cultivars (Cerasuola and Nocellara del Belice). Particularly, these data concern the composition of fatty acids, sterols, total phenols and tocopherols. Also, analyses of trace element profile have been made in order to characterize the geographical origin of the olive oils.

INTRODUCTION

Olive oil represents an important component of the Mediterranean diet whose intake is greatly growing in developed and developing countries. It is valued for its fine, balanced, delicious and unique aroma and flavour, and long shelf-life.[1] Today, its biological, nutritional and healthful effects are universally acknowledged.[2-6] The genuineness and the quality of a virgin olive oil follows certain parameters listed in the Regulation CE 1989/2003 of the European Community. In this study, Sicilian virgin olive oils from Nocellara del Belice and Cerasuola Cultivar have been analysed: single and total phenols, tocopherols, free acidity, peroxide index, UV spectrophotometric indices, fatty acid composition, sterols and aliphatic alcohols have been determined in order to contribute to the optimisation and valorisation of virgin olive oil quality in the olive-producing areas. The quality, in fact, is affected by several factors, such as agronomic techniques, seasonal conditions, sanitary state of drupes, ripening stage, harvesting and carriage systems, method and duration of storage, and processing technology.[7]
Also, analysis of the trace element profile of the oils under investigation was performed in order to see if any difference would appear between the olive oil samples that can allow us to characterize them.[8]

MATERIALS AND METHODS

SAMPLING

Twenty-four organic extra virgin olive oil samples were collected during the year crop 2005/2006 from producers located in two different areas of Sicily: Trapani and Partanna. The oils obtained were stored in dark bottles and transferred in cold dark cell at approximately 4°C until analysis.

REAGENTS

All solvents and reagents were of appropriate grade for spectrophotometric or chromatographic analysis. For trace element analysis, the reagent used were all of analytical-reagent grade certified for the impurities: nitric acid (Normaton ultrapure, VWR Prolabo); single and multi element standard (Certipur, Merk, Darmstadt, Germany). Water was purified with a Milli-Q plus system (Millipore). All glassware was decontaminated with nitric acid (2% v/v) over night, rinsed with ultrapure water and dried. The experimental work was carried out using the following system for the microwave digestion: Milestone MLS-1200 MEGA oven; segmented rotor MPR-600/10M. The determination of the elements of interest in the solutions obtained was carried out utilizing an Elan DRC-e ICP-MS instrument (Perkin-Elmer SCIEX, Canada). Oil samples were introduced by means of a quartz nebulizer. The ICP torch was a standard torch (Fassel type torch) with platinum injector.

ANALYTICAL METHODS

Free acidity, peroxide index, UV spectrophotometric indices, fatty acid composition, sterols and aliphatic alcohols were analysed following the procedures of the Reg. CE 1989/2003, while single and total phenols [9] and tocopherols [10] have been performed following the methodologies developed in the laboratories of the CRA.

RESULTS AND DISCUSSION

Table 1 and Table 2 report the average values related to the fatty acids composition (palmitic, palmitoleic, stearic, oleic, linoleic and linolenic acids) and the relative ratios.

		FATTY ACIDS (%)					
CULTIVAR	**AREA**	**C16:0**	**C16:1**	**C18:0**	**C18:1**	**C18:2**	**C18:3**
Cerasuola	Trapani	9,90	0,32	2,33	76,77	9,26	0,87
Cerasuola	Trapani	10,13	0,31	2,33	76,64	9,14	0,87
Cerasuola	Trapani	10,33	0,37	2,46	75,72	9,50	0,96
Nocellara Belice	Partanna	11,56	0,71	2,72	77,50	6,27	0,74
Nocellara Belice	Partanna	11,61	0,72	2,68	77,26	6,30	0,86
Nocellara Belice	Partanna	11,49	0,70	2,68	77,59	6,22	0,78
Nocellara Belice	Partanna	11,54	0,80	2,29	77,71	6,34	0,80
Nocellara Belice	Partanna	10,72	0,81	2,02	78,67	6,43	0,82
Nocellara Belice	Partanna	11,43	0,82	2,17	77,85	6,42	0,80
Nocellara Belice	Partanna	11,52	0,91	2,22	77,26	6,59	0,90
Nocellara Belice	Partanna	11,45	0,86	2,28	77,56	6,52	0,81
Nocellara Belice	Partanna	11,38	0,84	2,30	77,62	6,53	0,82
Nocellara Belice	Partanna	11,42	0,67	2,66	77,83	6,07	0,78
Nocellara Belice	Partanna	11,23	0,69	2,62	78,05	6,10	0,77
Nocellara Belice	Partanna	11,46	0,62	2,66	77,87	6,08	0,78
Cerasuola	Trapani	10,47	0,29	2,29	76,06	9,37	0,93
Cerasuola	Trapani	10,54	0,30	2,23	76,14	9,33	0,92
Cerasuola	Trapani	9,93	0,29	2,17	76,59	9,42	0,97
Nocellara Belice	Partanna	11,25	0,70	2,76	77,88	6,12	0,78
Nocellara Belice	Partanna	11,59	0,65	2,77	77,41	6,24	0,77
Nocellara Belice	Partanna	10,81	0,70	2,63	78,16	6,31	0,81
Cerasuola	Trapani	10,43	0,38	2,29	77,08	8,35	0,92
Cerasuola	Trapani	10,46	0,36	2,28	76,81	8,46	1,04
Cerasuola	Trapani	9,63	0,36	2,05	77,78	8,62	1,03

Table 1. Fatty acids composition:

CULTIVAR	AREA	omega3/omega6	uns/sat	monouns/polyuns
Cerasuola	Trapani	0,09	6,86	7,61
Cerasuola	Trapani	0,10	6,71	7,69
Cerasuola	Trapani	0,10	6,48	7,28
Nocellara Belice	Partanna	0,12	5,81	11,16
Nocellara Belice	Partanna	0,14	5,77	10,90
Nocellara Belice	Partanna	0,13	5,85	11,19
Nocellara Belice	Partanna	0,13	6,03	11,01
Nocellara Belice	Partanna	0,13	6,59	10,97
Nocellara Belice	Partanna	0,12	6,14	10,91
Nocellara Belice	Partanna	0,14	6,02	10,45
Nocellara Belice	Partanna	0,12	6,07	10,71
Nocellara Belice	Partanna	0,13	6,09	10,68
Nocellara Belice	Partanna	0,13	5,87	11,47
Nocellara Belice	Partanna	0,13	5,99	11,47
Nocellara Belice	Partanna	0,13	5,86	11,45
Cerasuola	Trapani	0,10	6,55	7,42
Cerasuola	Trapani	0,10	6,56	7,46
Cerasuola	Trapani	0,10	6,92	7,40
Nocellara Belice	Partanna	0,13	5,92	11,39
Nocellara Belice	Partanna	0,12	5,74	11,14
Nocellara Belice	Partanna	0,13	6,18	11,08
Cerasuola	Trapani	0,11	6,59	8,36
Cerasuola	Trapani	0,12	6,56	8,13
Cerasuola	Trapani	0,12	7,25	8,10

Table 2. Fatty acid ratios

From the data obtained of the fatty acids composition have emerged that Nocellara del Belice cv has a higher amount of oleic acid (77-78%), while in Cerasuola cv the value is 76-77%. The results underlined a high value of linoleic acid in Cerasuola cv: 0.87-1.04 % that is out of the normal range. Moreover, it was observed a high ratio, between unsatured and satured fatty acids in Cerasuola cv, and a higher value in the ratio between monounsatured and polyunsatured fatty acids in Nocellara del Belice cv.

In the Table 3 are reported the values of total and single tocopherols and total phenols, while in Table 4, are listed the mean values related to the sterols.

		Tocopherols (ppm)					Phenols
CULTIVAR	AREA	α	β	γ	δ	Σ	(ppm)
Cerasuola	Trapani	205,64	2,65	7,87	5,17	221,33	632,23
Cerasuola	Trapani	196,83	2,52	6,24	11,45	217,03	359,98
Cerasuola	Trapani	186,74	1,20	1,26	23,66	212,85	190,11
Nocellara Belice	Partanna	104,70	1,24	1,40	13,61	120,95	168,50
Nocellara Belice	Partanna	105,00	0,89	1,00	16,15	123,04	165,61
Nocellara Belice	Partanna	109,93	1,92	0,99	9,17	122,01	64,43
Nocellara Belice	Partanna	111,83	2,54	1,80	8,92	125,09	52,71
Nocellara Belice	Partanna	86,62	1,30	0,85	19,78	108,54	99,52
Nocellara Belice	Partanna	103,32	3,64	13,27	4,33	124,55	138,00
Nocellara Belice	Partanna	99,24	4,34	10,21	3,31	117,10	37,39
Nocellara Belice	Partanna	102,58	3,84	11,69	3,49	121,59	33,65
Nocellara Belice	Partanna	89,69	1,30	1,06	14,79	106,84	44,31
Nocellara Belice	Partanna	93,11	1,75	3,01	11,67	109,54	154,03
Nocellara Belice	Partanna	87,47	1,04	2,88	5,79	97,18	70,58
Nocellara Belice	Partanna	84,18	0,77	0,78	53,64	139,37	135,25
Cerasuola	Trapani	189,20	2,51	3,67	21,39	216,77	78,13
Cerasuola	Trapani	180,06	2,14	4,21	5,90	192,30	95,92
Cerasuola	Trapani	155,85	2,38	3,88	22,84	184,96	59,63
Nocellara Belice	Partanna	86,74	1,10	2,63	49,75	140,22	50,31
Nocellara Belice	Partanna	107,70	1,16	4,49	11,76	125,11	45,09
Nocellara Belice	Partanna	102,75	1,18	1,42	27,14	132,49	38,10
Cerasuola	Trapani	242,00	3,86	3,25	10,42	259,52	165,61
Cerasuola	Trapani	209,52	2,98	11,50	10,00	234,00	145,98
Cerasuola	Trapani	199,76	4,91	5,57	11,56	221,80	91,62

Table 3. Antioxidants content

The antioxidants content reveals a high amount of total phenols and a strongly high amount of total tocopherols (upper to 200 ppm) in Cerasuola cv.

CULTIVAR	AREA	CHOLESTEROL	BRASSICASTEROL	CAMPESTEROL	STIGMASTEROL	β-SITOSTEROL	Erythrodiol	Uvaol	Σ Erythrodiol-Uvaol	β-SITOSTEROL (Σ)	TOT. STEROLS
Cerasuola	Trapani	0.39	0.03	2.70	0.65	87.18	0.11	0.30	0.41	94.76	9275.71
Cerasuola	Trapani	0.12	0.04	3.99	1.03	83.84	0.04	0.04	0.08	93.61	9477.09
Cerasuola	Trapani	0.21	0.07	3.59	0.95	82.61	0.22	0.08	0.30	93.83	10273.63
Nocellara Belice	Partanna	0.23	0.07	3.50	1.01	84.17	0.10	0.07	0.17	94.00	5667.59
Nocellara Belice	Partanna	0.32	0.03	3.92	1.07	83.82	0.03	0.23	0.26	93.57	6334.52
Nocellara Belice	Partanna	0.33	0.09	3.20	1.03	82.61	0.09	0.14	0.23	94.14	6294.45
Nocellara Belice	Partanna	0.32	0.04	3.01	1.07	82.76	0.13	0.24	0.37	93.27	7851.76
Nocellara Belice	Partanna	0.08	0.09	3.64	1.87	84.99	0.04	0.01	0.05	93.43	7151.51
Nocellara Belice	Partanna	0.33	0.07	3.39	1.11	85.03	0.04	0.14	0.18	94.21	7341.01
Nocellara Belice	Partanna	0.39	0.05	3.45	1.23	83.86	0.04	0.23	0.27	93.82	7569.02
Nocellara Belice	Partanna	0.14	0.02	3.87	1.28	85.02	0.23	0.17	0.40	93.90	6901.41
Nocellara Belice	Partanna	0.37	0.07	3.80	1.24	84.02	0.08	0.02	0.10	93.23	6676.94
Nocellara Belice	Partanna	0.39	0.04	3.43	0.91	85.09	0.06	0.14	0.20	94.01	6291.53
Nocellara Belice	Partanna	0.40	0.02	3.15	0.86	83.16	0.06	0.22	0.27	93.99	5376.71
Nocellara Belice	Partanna	0.33	0.03	3.35	0.87	83.91	0.07	0.22	0.29	94.25	6092.24
Cerasuola	Trapani	0.33	0.06	3.13	0.95	83.71	0.06	0.12	0.18	94.20	11327.28
Cerasuola	Trapani	0.35	0.03	3.29	1.01	84.17	0.05	0.07	0.12	94.23	9793.74
Cerasuola	Trapani	0.29	0.03	2.91	0.95	83.48	0.05	0.20	0.25	94.43	11739.70
Nocellara Belice	Partanna	0.40	0.07	3.31	0.90	83.26	0.13	0.29	0.42	93.73	6915.61
Nocellara Belice	Partanna	0.34	0.07	2.70	1.30	81.05	0.41	0.07	0.48	93.16	8057.11
Nocellara Belice	Partanna	0.13	0.05	3.40	1.04	83.76	0.17	0.21	0.38	93.89	6427.07
Cerasuola	Trapani	0.31	0.03	3.01	0.72	85.33	0.04	0.20	0.24	94.64	10350.84
Cerasuola	Trapani	0.32	0.03	2.95	0.71	85.82	0.05	0.03	0.08	94.75	10283.61
Cerasuola	Trapani	0.39	0.04	2.87	0.75	85.84	0.07	0.04	0.11	94.67	11151.62

Table 4. Sterol mean values

TRACE ELEMENT PROFILE

The statistical treatment performed on the data, V-Parvus 2004,[11] set was principal component analysis (PCA) that gather an overview of data, especially in the preliminary steps of a multivariate analysis. It is a powerful visualization tool and provides a way to reduce the dimensionality of the data. In the present work PCA have been applied to the concentration of 12 elements of each single sample. The scores of the samples, which show 50.60 % of the total variance, and loadings of the variables on the two first

principal components relative to the different treatment performed are plotted in Figure 1. From the available data, the two cultivars appear to be separated considering the different production areas (Trapani and Partanna).
The loading plot provides insights into the discrimination of the variables mainly contributing to PC1. Si, Sc and Cr have the highest absolute loading values on the first component, all of them being positive, and these characterise expecially the oils from Cerasuola cultivar.

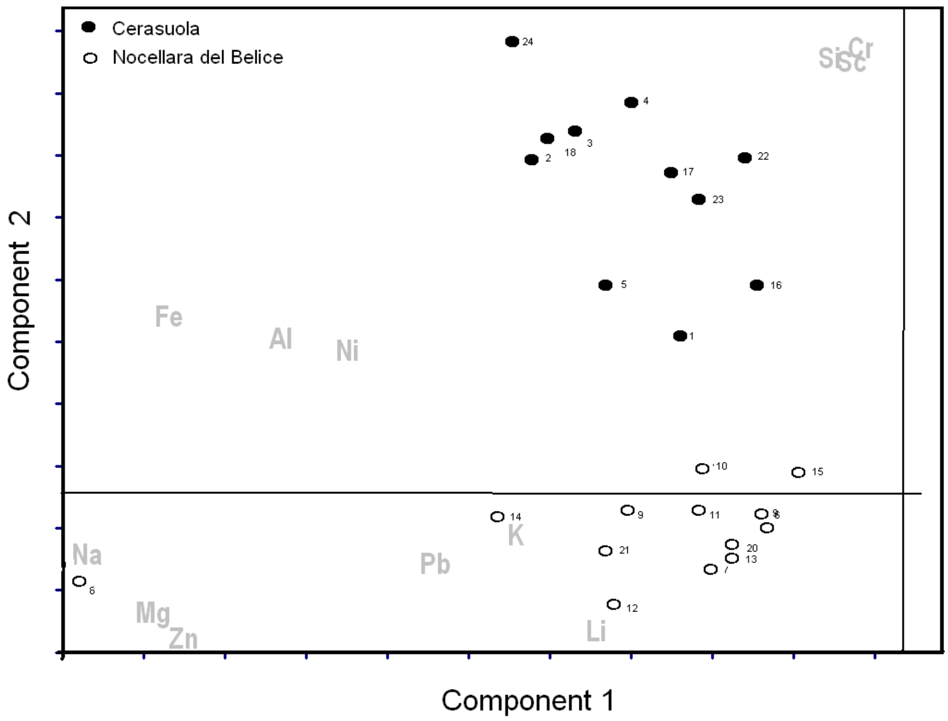

Table 1. Plot of scores of the samples and loadings of the variables on the two first principal components relative to cerasuola and Nocellara del Belice cultivars.

CONCLUSIONS

The results obtained in this study have given an important contribution for the evaluation of qualitative and sensory characteristics of the Sicilian cultivars under investigation. It was, in fact, possible to estimate the differences between oils of the two different cultivars.
Also, a discrimination between the two cultivars was afforded by a simple and rapid method, such as ICP-MS, which allowed a simultaneous determination of 12 elements present in the foodstuff.

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