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Influence of Different Rates of Irrigation to Olive Trees on Fruits Yield, Quality and Sensory Attributes of Olive Oil Output.

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Abstract

An experiment was carried out in olive farm in Wady-El Natron, El Behera governorate, Egypt, to study the influence of deficit rate in different amounts of irrigation water, 96, 64 and 32 liter water / tree per hr.(at rates 80, 53.3 and 26.6 %, respectively) are given to olive trees (Coratina and Dolce vars.), and its compared with 120 liter water / tree per hr. (at rate 100%) as a control on the chemical composition, promological parameters of olive fruits (fruit characteristics) and fruits yield and also on the quality parameters, fatty acids composition, natural antioxidant contents, stability and organoleptic characteristics (sensory attributes**)** of the extracted oils from olive fruits. The results showed that:-

The fruit characteristics of olive trees (Coratina and Dolce vars.) were affected by different amounts of irrigation water whereas, 100- fruit weight, fruit weight, pulp weight and pulp/stone ratio showed statistical variation at a significance level of 5% according to the level of irrigation water applied, generally these parameters gradually decreased with lowering amount water during irrigation for two varieties. Values of FFA, PV, K232, K270 and Δk of olive fruits oil decreased gradually by decreasing the amounts of irrigation water are given to olive trees in both two varieties. Oils from the 32 liter water / tree treatment had higher contents of oleic acid, total polyphenols and O-diphenol, higher oleic / linoleic and TUSFA / TSFA ratios and the highest oxidative stability, despite their lower total tocopherols, carotonids and chlorophyll contents compared with other treatments. Gradual reducing amount of irrigation water caused gradually an increase in fruitiness, bitterness and pungency in virgin olive oils in both two varieties.

Key words: Irrigation, olive trees, fruits yield, olive oil quality, O-diphenols and sensory attributes of olive oil.

Introduction

Olive (*Olea europea* L.) is drought- resistant and has traditionally been cultivated in areas with limited water resources in low density plantations under rainfed conditions. However, it responds positively to irrigation even with low amount of water (Moriana et al., 2003).

The chemical and organoleptic characteristics of olive oil depend on several factors (Salvador et al., 2001). According to Aparicio and Luna (2002), these factors are clustered into four main groups: environmental (soil, climate), cultivation (ripeness, harvesting), technological (fruit storage, extraction procedure), and agronomic factors (fertilization, irrigation). Among these factors irrigation is a major determinant of olive oil quality (Gomez-Rico et al., 2007).

Irrigated agriculture (AI) is shifting the paradigm of irrigation management from the full to partial supply of water needs. Nowadays, deficit irrigation (DI) is a common practice in many areas of the world, especially in dry regions. In these regions it can be more profitable for farmer to maximize crop water productivity than maximize the harvest per unit land (Ruiz-Sanchez et al., 2010).

Regulated deficit irrigation (RDI) improved water productivity, olive oil production, the organoleptic characteristics of the oil and the behavior of the fruits in olive mill (Alegre et al., 2002).

Many experiments have revealed reduction in vegetative growth induced by deficit irrigation (Moriana et al., 2003 and Iniesta et al., 2009). This effect, which is of great interest for controlling canopy size and for reducing the costs associated with specific agricultural practices, many reduce the number of fruits per tree.

In coming olive trees Goldhamer (1999) found that a reduction in water applied during mid summer of 15 to 25% of seasonal application for maximum yield did not have negative impacton yield.

Regulated deficit irrigation (RDI) is an appropriate method of irrigation for olive trees that does not necessarily have any negative impact on fruit or oil yield and quality if applied in the correct amount. RDI level of 65% produces the highest oil content and reaps water savings of 21% with no adverse effects on the quality of olive oil (Talozi and Alwaked, 2016).

Dabbou et al., (2010), in their experiment on olive tree in Tunisia, found that the best oil and fresh fruit production occurred with a 75% RDI scheme.

Ramos and Santos (2010), likewise found the highest oil and fruit yields occurring with a 60% sustaimed deficit irrigation regime within their olive tree test case in Portugal .The olive trees tested by Garcia et al., (2013) in Spain with RDI treatments saw higher oil yields and no difference in quality as compared to control cases.

Gomez-del-Campo (2013) reports that while the control treatment with no RDI on olive trees in Spain

still had the highest oil content, one of the RDI treatments had an oil content very close to the control and just as importantly reaped significant water saving unlike the control group.

Togenetli et al. (2005) have recommended that RDI be applied to olive trees after the pit hardening stage to cover 66% of the crop evapotrans piration.

Oleic acid amount was found to be declined as the increase in water applied in irrigation regime (Berenguer et al., 2006, Gomez-Rico et al., 2007). Additional irrigation increased the palmitic and linoleic acid content and decreased oleic acid. Monounsaturated fatty acids /polyunsaturated fatty acids ratio was also decreased with irrigation supplements (Celil et al., 2009).

Total oil yield also varied with different water amounts and as the water increased about 75%, highest total yield was attained due to increase in fruit number per tree (Motilva et al., 2000, d'Andria et al., 2004).

Gomez-Rico et al.(2007), working with the Manzanilla variety of olives, obtained a yield of 39.2Kg/ tree from unirrigated trees and a maximum yield of 52.7 Kg /tree from irrigated trees.

Intermediate irrigation treatments an olive oil chemical and sensory characteristics provided the best overall balance in oil quality and high oil production (Grattan et al., 2006, Berenguer et al., 2006).

Oil sensory properties of fruitiness, bitterness and pungency all declined in oils made from trees receiving more water. The lowest irrigation levels produced oil that were characterized by excessive bitterness very high pungency and woody, herbaceous flavors. Intermediate irrigation levels (33% to 40% ETC) produced oils with balance complexity and characteristic artichoke, grass, green apple and some ripe fruit flavors. Higher irrigation levels lowered oil extractability and produced relatively bland oils with significantly less fruitiness and almost to bitterness pungency (Maria et al., 2006).

Yield values were not affected by the irrigation treatment. In contrast, 100-fruit weight, pulp ratio, moisture and oil content were affected by irrigation amounts. An increase in the amount of irrigation water given arise in moisture content and reduction in the oil content of olive fruit (Kaya et al., 2017).

Servili et al. (2007) showed that fully-irrigated trees of cv. Leccino yielded oils with a lower concentration of hydrophilic phenols and O-diphenols than either the deficit-irrigated (about 50% water of fully-irrigated trees) or complementary-irrigated ones.

The chemical components influenced by irrigation are the phenolic compounds, which affect both the oxidative stability and the sensory characteristics, especially the bitterness attribute (Gomez-Rico et al., 2007).

The aim of this investigation is to study the influence of different amounts of irrigation water on the yield and olive fruits characteristics and also on the quality of olive oil, to achieve a sustainable balance between water saving, yield fruits, oil production and oil quality.

Materials and Methods

Experimental olive farm: The study was carried out during the 2018 olive crop season in an experimental olive farm of Coratina and Dolce vars. (7 years old) olive trees planted at 6 × 6 m and grown in sandy soil at the experimental farm was in Wady - El-Natron, El-Behera governorate, Egypt. Drip irrigation system was applied using underground water its salinity 1600 ppm. The experiment followed complete randomized block design, with 3 blocks pretreatment and three trees per plot for each varity.

Four treatments**: were applied during season 2018 before commencement of this assay:** 120, 96, 64 and 32 liter water/tree per hr.(Table 1) 120 liter water/tree per hr. was used as the control to compare the results obtained with the three irrigation treatments studied. The following table explain the total water applied to olive trees (Coratina and Dolce vars.) in 2018 (from April to October) for different irrigation treatments (Table 2).

Table 1. Treatments of water applied for olive trees:-

Olive trees of:-	Irrigation treatments (L. water / tree per hr.)	Rates of Irrigation (%)	Water Saving (%)
Coratina	120 (control)	100	-
	96	80	20
	64	53.3	46.7
	32	26.6	73.4
Dolce	120 (control)	100	-
	96	80	20
	64	53.3	46.7
	32	26.6	73.4

Table 2. Total water applied in period from April to October during season 2018 to both olive trees vars.:-

Months	No. hours	Total water applied of treatments in months (L. water / tree)			
		120	96	64	32
April	**6 hr. / week**	2880	2304	1536	768
May	**2 hr. daily/5days/week**	4800	3840	2560	1280
June	**2 hr. daily/5days/week**	4800	3840	2560	1280
July	**2 hr. daily**	7440	5952	3968	1984
August	**2 hr. daily**	7440	5952	3968	1984
September	**2 hr. daily/4 days/week**	3840	3072	2048	1024
October	**2 hr. daily/4 days/week**	3840	3072	2048	1024
Total water applied (Liter/Tree)		**35040**	**28032**	**18688**	**9344**

Fertilization : Fertilization was used to supply mineral before irrigation treatments were put into action, ammonium nitrate (33%) with rat 2 Kg /tree were divided into equal doses from April to September, potassium sulphat with rat 1 Kg /tree/year divided into doses per 15 days, ½ Kg phosphour / tree during winter fertilization on dose in trenches around the tree, it is added liter from sulphoric acid by exchanges with phosphoric acid once per month, the selected trees were sprayed three times/year with solution consist of boric acid plus urea (N) plus calcium nitrate (Ca) during flowering and fruits period.

Harvest olive fruits and oil extraction: Olive fruit samples from irrigation treatments trees were harvested throughout ripening, for each variety whereas Dolce variety harvested in mid October and Coratina var. in end October. Four representative samplings for each variety were gathered in 2018, the samples were collected by hand, then picked at each sampling and bring to the laboratory for oil extraction.

Yield: In order to determine the effect of different amounts irrigation water on yield each tree in the experimental was harvested separately then the olives obtained from each tree were weighed to determine the yield/tree (Kg/tree) (Kaya et al., 2017).

Promological parameters of olive fruits (fruit characteristics): Samples of 20 fruits from each replicate tree i.e. 60 fruits from each of the applied treatments were picked randomly at harvest to determine: Average fruit weight (g), width (cm), length (cm) and pulp/seed ratio fruit were described by (Kaya et al., 2017).

Chemical composition of olive fruit: - Moisture, oil contents, crude protein, ash content and total carbohydrates were determined according to the methods of A.O.A.C (2000). But fiber content was estimated by difference.

Oil extraction: 5 Kg fruits for each treatment olive trees of Coratina and Dolce cultivar were crushed and packed in cheese cloth then pressed using a laboratory hydraulic press. The pressure was 12.000 Ib/in² for 30 min/ one which was reached gradually. The extracted oil was dried over anhydrous sodium sulfate, through a what man filter paper No.1 and kept in brown glass bottles at -5ºC till their analysis.

Physiochemical properties of olive oils:-

- Refractive index of oils (RI), was determined at 25°C according to A.O.A.C. (2012) by using refractometer (NXRL-3 Poland).
- Free fatty acid as oleic acid % (FFA) and peroxide values meq O2 /kg oil (PV) were determined according to the methods of the A.O.A.C. (2012).
- Absorbency in ultraviolet at 232 and 270 nm. (K232 and K270): Ultraviolet and visible spectra were conducted using a pye unicum double beam recording spectrophotometer Model SP 1600, as described by Kates (1972). The oil samples were dissolved in freshly distilled cyclohexane and the absorption were measured at 232 and 270 nm.
- Δk was calculated according to the method in the IOOC (2001) as the following equation:

$\Delta k = A270 - (A266 + A274)/2$

Determination of fatty acid composition: The fatty acids methyl esters were prepared using trans-estrification with cold methanolic solution of potassium hydroxide. The fatty acids methyl esters were identified by GC- capillary column according to the method of IOOC (2001).

Determination of natural antioxidants in olive oils:-

- Determination of total polyphenols was determined in olive oil samples according to the method of Gutfinger (1981).
- Determination of O-diphenols was determined in olive oil according to the method described by Mohamed and Sallanon (2006).
- Determination of total tocopherols was determined according to the method described by Wong et al. (1988).
- Determination of total pigments (chlorophyll and caroteniod contents): The chlorophyll and carotenoid contents of oil samples were determined according to the method of Mosquera et al. (1991).
- Oxidative stability (O.S) was evaluated by the Rancimat method (Mendez et al., 1997). Stability was expressed as the oxidation induction time (hours), measured with the Rancimat 679 apparatus

(Metrohm Co., Switzerland), using 5g oil sample and heated to 100ºC with air flow rate of 20 L/h.

Sensory attributes: The organoleptic assessment of virgin olive oil was conducted according to the method (profile sheet) described by IOC (2007).

Overall Quality Index (OQI):- The overall quality index (OQI) was introduced by the International Olive Oil Council (IOOC) to express virgin olive oil quality numerically (IOOC, 1990). This is a scale from 0 to 10 that considers four quality parameters: the score for sensory evaluation (SE), free acidity (FA), K270 and peroxide value (PV) according to the following equation:

OQI = 2.55 + 0.91SE – 0.78FA – 7.35K270 – 0.066PV.

Statistical analysis: All obtained data during season 2018 were subjected to analysis of variances according to using (CO/STAT). Least significant difference (L.S.D) was used to compare between means of treatments according to (Snedecor and Cochran, 1990) at probability of 5%.

Result and discussion

The effect of different amounts of irrigation water on the yield:

Influence of different amounts of irrigation water applied to olive trees (Coratina and Dolce vars.) on fruits yield are shown in Table (3). There were differences in fruits yield among treatments during harvest year (2018). The lowest yield per tree was obtained as 11 and 23.1 Kg from treatment 32 liter water/tree (per hr.) and the highest with 47 and 43.15 Kg was from treatment 120 liter water/tree (per hr.) for Coratina and Dolce vars., respectively.

Table 3. The effect of different amounts of irrigation on the yield**:**

Treatments (L.water/tree per hr.)	Yield (Kg/ tree)	
	Coratina	Dolce
120	47	43.15
96	43	39.9
64	22	33.9
32	11	23.1

The promological parameters of olive fruits (fruit characteristics):

The values of fruit, pulp, stone weight (gm), pulp / stone ratio, fruit length, width (cm) and fruit shape ratio(promological parameters) and 100- fruit weight obtained from olive trees (Coratina and Dolce vars.) showed statistical variation at a significance level of 5% according to the amounts of irrigation water applied (120, 96, 64 and 32 liter water / tree) in Tables 4 and 5, all previous parameters were affected by treatments and decreased as the amount of irrigation water decreased. This may be due to variation in total fruit load per tree Kaya et al., (2017).

Chemical composition of olive fruits:

The values of moisture, crude oil, protein, crude fiber, ash and total carbohydrates contents of fresh olive fruits from the olive trees Coratina and Dolce vars., irrigated with different amounts of irrigation water 96, 64 and 32 liter water / tree (per hr.) and compared there with 120 Lw./tree (control) are shown in Tables (6 and 7). From the tabulated data it could be noticed that, the previous values of chemical composition of fresh olive fruits were affected by the different deficit irrigation water, such that, as the amount water applied to olive trees (Coratina and Dolce vars.) decreased, the moisture, protein and fiber contents decreased in both two olive fruits, on the other hand, oil, ash and carbohydrate contents recorded gradually increased with decreasing amounts of irrigation water. The increase in oil content in olive fruits may be due to decrease in moisture content by reducing amount irrigation water and that meaning, this increase in oil content is relative increase.

Table 4. Effect of different amounts of irrigation on various promological parameters of Coratina olive fruits:

promological parameters	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
fruit weight (g)	5.55	5.43	3.92	3.72	0.110
pulp weight (g)	4.47	4.35	3.09	2.92	0.119
stone weight (g)	1.08	1.08	0.83	0.80	0.028
pulp /stone ratio	4.14	4.01	3.72	3.65	0.221
Fruit length (cm)	2.76	2.65	2.33	2.09	0.018
Width (cm)	1.57	1.55	1.45	1.35	0.034
fruit shape ratio	1.76	1.71	1.61	1.54	0.049
100-fruit weight (g)	567.480	537.553	379.627	350.493	29.931

Table 5. Effect of different amounts of irrigation on various promological parameters of Dolce olive fruits:

promological parameters	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
fruit weight (g)	4.62	4.42	4.17	3.46	0.119
pulp weight (g)	3.75	3.58	3.35	2.72	0.041
stone weight (g)	0.87	0.84	0.82	0.74	0.037
pulp /stone ratio	4.31	4.26	4.09	3.67	0.398
Fruit length (cm)	3.16	3.03	2.90	2.08	0.039
Width (cm)	1.45	1.40	1.35	1.10	0.045
fruit shape ratio	2.18	2.16	2.14	1.89	0.276
100-fruit weight (g)	440.603	428.667	395.653	392.507	12.873

Table 6. Effect of different amounts of irrigation on chemical composition of Coratina olive fruits (wet / weight):-

Chemical composition (%)	Irrigation treatments (L. water / tree per hr.)			
	120	96	64	32
Moisture	55.44	53.55	52.55	50.80
Oil contents	20.1	23.74	24.82	25.88
Total protein	3.06	2.25	1.86	1.86
Crude fiber	13.89	12.76	12.66	11.80
Ash contents	1.06	1.03	1.07	1.43
Total carbohydrates	6.45	6.67	7.30	8.23

Table 7. Effect of different amounts of irrigation on chemical composition of Dolce olive fruits (wet / weight):-

Chemical composition (%)	Irrigation treatments (L. water / tree per hr.)			
	120	96	64	32
Moisture	63.40	63.12	62.48	57.84
Oil contents	11.46	13.72	14.56	16.61
Total protein	2.47	1.71	1.62	1.70
Crude fiber	17.40	15.69	14.80	15.70
Ash contents	0.79	0.80	0.99	1.27
Total carbohydrates	4.48	4.96	5.55	6.88

The physical and chemical characteristics of olive oils:-

Tables (8and 9) list the physical and chemical characteristics of olive oils (Coratina and Dolce vars.) as affected by the different irrigation treatments (96, 64 and 32 liter water / tree) and compared their with treatment (120 liter / tree) as a control. From the results in these tables, it could be noticed that, FFA, PV, K232 and 270, and Δk decreased as the degree of water deficit increased, but RI was non significantly different between irrigation treatments. The previous all parameters used to evaluate oil quality were only slightly affected by amounts of irrigation (96, 64 and 32 L.w/tree) except peroxide value recorded a higher decreased with decreasing amount water are given to olive trees in Coratina variety comparing with 120 L.w/tree (control). The noticed differences in these parameters of oil quality in both varieties may be due to different amount water of olive fruits that related to change in the activity of enzymes caused hydrolysis and oxidation for oils such as lipas and hydroperoxidase whose activity are more under higher content of moisture in fruits taken from trees irrigated with a higher amount water compared with trees received lower amount water under study. This indicated that, the positive effect of reducing amount irrigation water on the oil quality which important role played by reducing the values of FFA, PV and K232 and K270 nm.

Table 8. Effect of different amounts of irrigation on physical and chemical properties of Coratina olive oils.

Physical and chemical properties	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
RI at 25 °c	1.4675	1.4672	1.4672	1.4667	N.S.
FFA (as oleic acid %)	0.262	0.235	0.225	0.187	0.029
PV (meq O2 /kg oil)	5.57	4.38	3.82	3.77	1.197
K232 nm.	1.817	1.517	1.371	1.294	0.023
K270 nm.	0.382	0.323	0.316	0.309	0.039
Δk	-0.006	-0.006	-0.007	-0.008	0.002

Table 9. Effect of different amounts of irrigation on physical and chemical properties of Dolce olive oils.

Physical and chemical properties	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
RI at 25 °c	1.4680	1.4679	1.4674	1.4671	N.S.
FFA (as oleic acid %)	0.312	0.286	0.243	0.235	0.076
PV (meq O2 /kg oil)	5.72	5.68	5.53	5.39	0.041
K232 nm.	2.011	1.818	1.706	1.665	0.004
K270 nm.	0.368	0.339	0.309	0.302	0.033
Δk	-0.005	-0.007	-0.008	-0.008	0.002

Fatty acid composition of olive oils:-

Data in Tables (10 and 11) illustrated, the fatty acid profile was analyzed in two olive oils varieties (Coratina and Dolce). In each variety there was a trend of increased oleic acid and reduced linoleic and linolenic acids contents with decreasing amount irrigation water. This trend for these major unsaturated fatty acids caused to increase monounsaturated fatty acid / polyunsaturated fatty acid (MUFA / PUFA), total unsaturated fatty acids / total saturated fatty acids (TUFA/TSFA) and $C_{18:1}$/ $C_{18:2}$ ratios with reducing amounts of irrigation water. Also palmitic acid was decreased as a result of decreasing amounts of irrigation water. This indicated positive effect of reducing amount irrigation water on oil quality owing to the important role played by oleic acid in the health properties of olive oil (Bermudez et al., 2011).

Table 10. Effect of different amounts of irrigation on fatty acid composition of Coratina olive oils:-

Fatty acid composition (%)	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05)=
	120	96	64	32	
C16:0	14.99	14.88	13.35	12.95	0.913
C16:1	0.66	0.64	0.62	0.61	0.021
C17:0	0.04	0.04	0.04	0.04	N.S
C17:1	0.05	0.06	0.06	0.06	NS
C18:0	1.94	2.04	2.18	2.27	0.091
C18:1	66.03	67.37	69.32	70.46	0.790
C18:2	14.77	13.48	12.92	12.04	0.570
C18:3	0.79	0.75	0.67	0.67	0.079
C20:0	0.38	0.36	0.43	0.46	0.029
C20:1	0.32	0.38	0.41	0.43	0.024
T.Sat.	17.38	17.32	16.00	15.72	0.761
T.unsat.	82.62	82.68	84.00	84.28	0.287
Monunsat.	67.06	68.45	70.41	71.57	0.734
Polyunsat.	15.56	14.23	13.59	12.71	0.647
T.unsat/ T.sat.	4.75	4.77	5.25	5.36	0.113
Monunsat./polyuns.	4.31	4.81	5.18	5.63	0.004
C18:1/ C18:2	4.47	4.53	5.37	5.44	0.009

Table 11. Effect of different amounts of irrigation on fatty acid composition of Dolce olive oils:-

Fatty acid composition (%)	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05)=
	120	96	64	32	
C16:0	18.03	17.91	17.69	15.67	0.223
C16:1	2.05	2.04	1.87	1.83	0.014
C17:0	0.05	0.05	0.05	0.05	N.S.
C17:1	0.08	0.07	0.07	0.07	N.S.
C18:0	1.96	1.94	1.94	1.92	0.067
C18:1	58.18	59.72	61.33	63.58	0.107
C18:2	18.34	17.14	15.95	15.72	0.489
C18:3	0.74	0.65	0.61	0.56	0.094
C20:0	0.36	0.31	0.31	0.36	0.004
C20:1	0.21	0.17	0.18	0.24	0.046
T.Sat.	20.40	20.21	19.99	18.00	0.147
T.unsat.	79.60	79.79	80.01	82.00	0.969
Monunsat.	60.52	62.00	63.45	65.72	0.053
Polyunsat.	19.08	17.79	16.56	16.28	0.347
T.unsat/ T.sat.	3.90	3.95	4.00	4.56	0.271
Monunsat./polyuns.	3.17	3.49	3.83	4.04	0.052
C18:1/ C18:2	3.17	3.48	3.85	4.04	0.045

Natural antioxidants and stability of olive oils:

Tables (12 and 13) show the effect of amount of irrigation water (120, 96, 64 and 32 liter water / tree) on the natural antioxidants (total polyphenol, tocopherol, O-diphenol, carotenoid and chlorophyll contents) and stability of fruits oil obtained from olive trees (Corotina and Dolce vars.). From the results, the amounts of these previous antioxidant compounds and stability of oils changed significantly according to the amounts of irrigation water given to each treatment. In both varieties the greatest amount from total phenols, O- diphenols and oxidative stability of oils were extracted from the lowest irrigation treatment. The stability was correlated very closely with total phenols content of the oil. Vice versa for total tocopherol, carotenoid and chlorophyll contents. The observed differences in polyphenols concentration in the olive oil could be a consequence of the different water stress level of olives that involve changes in the activity of enzymes responsible for phenolic compound synthesis, such as L-phenyl, alanine ammonia- lyase whose activity is greater under higher water stress conditions (Gomez –Rico et al., 2007). And also the decreased in polyphenol contents of olive oil with increasing the amount of the water employed in the irrigation may be these compounds are mostly water soluble, it is not surprising that the water status of the tree and its fruit have an influence on the amount of polyphenols remaining in the oil after processing (Maria et al., 2006).

Table 12. Effect of different amounts of irrigation on natural antioxidants of Coratina olive oils:-

Natural antioxidants (ppm)	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
Total Polyphenols	458.423	693.763	703.653	747.910	44.267
O-diphenols	76.673	94.307	105.410	147.570	42.169
Total tocophenols	242.603	226.453	222.373	205.660	16.159
Carotenoid contents	0.43	0.32	0.25	0.22	0.117
Chlorophyll contents	0.386	0.320	0.250	0.220	0.068
Oxidative stability (hr.) at100°C	46.50	46.73	50.37	51.41	1.047

Table 13. Effect of different amounts of irrigation on natural antioxidants of Dolce olive oils:-

Natural antioxidants (ppm)	Irrigation treatments (L. water / tree per hr.)				New L.S.D.(0.05) =
	120	96	64	32	
Total Polyphenols	131.510	224.540	405.493	434.353	31.692
O-diphenols	52.500	64.650	69.640	106.283	37.943
Total tocophenols	133.577	113.473	99.483	85.620	21.379
Carotenoid contents	0.520	0.330	0.250	0.207	0.203
Chlorophyll contents	0.987	0.650	0.280	0.120	0.339
Oxidative stability (hr.) at100°C	21.44	21.47	24.33	25.68	2.671

Sensory attributes of virgin olive oils:-

All the virgin olive oils obtained using the different amounts of irrigation treatments (120, 96, 64 and 32 liter water / tree) of the trees in both Coratina and Dolce vars. studied, were classified as extra virgin olive oil by mean of the organoleptic evaluation carried out by an IOOC (International olive oil council) recognized olive oil taster panel as shown in Tables (14 and 15).

Generally sensory attributes affected by different amounts of irrigation water were fruitiness, bitterness and pungency. With regarding the results in the previous Tables (14 and 15), intensity of fruitiness, bitterness and pungency were all higher in fruits oil obtained from trees treated with low amount irrigation water (32 liter water / tree), followed by irrigated with 64 liter water /tree, then trees treated with 96 liter water /tree compared with olive oils obtained from trees treated with 120 liter water / tree for two varieties. An increase in positive attributes especially pungency and bitterness related to higher phenol content in olive oils obtained from olive trees which treated with low amount water under study. Also Overall quality index (OQI) influenced by different amounts of irrigation water. The values of OQI for both Coratina and Dolce vars. recorded a higher increased with decreasing the amount of the water employed in irrigation. This increased in OQI by decreasing amounts of irrigation water for olive tree may be due to reduce in values of FFA, PV, K_{270} and increased the fruitiness in two both olive oils by decreasing irrigation amount water , whereas OQI calculated from four previous parameters (FFA, PV, K_{270} and fruitiness) .

Table 14. Effect of different amounts of irrigation on sensory attributes of Coratina virgin olive oils:-

Sensory attributes	Irrigation treatments (L. water / tree per hr.)			
	120	**96**	**64**	**32**
Fruity	4	5	6.5	7
Bitter	2	2.5	2.5	3
Pungent	2.5	3.5	4	4
OQI	2.81	4.26	5.72	6.25

Table 15. Effect of different amounts of irrigation on sensory attributes of Dolce virgin olive oils:-

Sensory attributes	Irrigation treatments (L. water / tree per hr.)			
	120	**96**	**64**	**32**
Fruity	2.5	3	3.5	4
Bitter	0.5	1	1	1.5
Pungent	0.5	0.5	1	1.5
OQI	1.51	2.2	3.25	3.43

Conclusion

Physical, chemical and organoleptic characteristics of olive fruits oil improved with decreasing amount of irrigation water are given to olive trees (Coratina and Dolce vars.), also deficit irrigation water caused an increase in oleic acid, total polyphenols, O- di phenols, oxidative stability and OQI and also oil content recorded gradually increase with decreasing amounts of irrigation water . On the other hand, yield fruit / tree and promological parameters were decreased as a result reduced amount irrigation water are given to both olive tree varieties.

Recommendation

The findings show that treatment 96 L. / tree (at rate 80%) can be recommended for Coratina and Dolce vars.,application of this recommendation can achieve 20% saving in water and make a significant contribution to the conservation of limited water resources.

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تأثير معدلات الرى المختلفة لاشجار الزيتون على انتاجية الثماروالجودة والخواص الحسية لزيت الزيتون الناتج.

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أجريت هذه التجربة فى مزرعة زيتون بوادى النطرون محافظة البحيرة مصر لدراسة تأثير معدل النقص فى كميات الرى المختلفة 96, 64, 32 لتر ماء / شجرة فى الساعة بمعدل (80, 53.4, 26.6% على التوالى) المعطاه لاشجار الزيتون (صنف كرواتينا ودولسى) ومقارنتهم بالمعاملة 120 لتر / شجرة فى الساعة (بمعدل 100 %) كنترول على التركيب الكيميائى, خواص ثمار الزيتون (قياسات خاصة بالثمرة) والانتاجية و أيضا على قياسات الجودة , تركيب الاحماض الدهنية , ومكونات مضادات الاكسدة الطبيعية , الثبات , الخواص الحسية لزيوت المستخلصة من ثمار الزيتون وأوضحت النتائج الاتى :

تأثرت خواص الثمار لاشجار الزيتون صنف كرواتينا ودولسى باختلاف كميات ماء الرى حيث لوحظ تغيير معنوى لوزن ال 100 ثمرة , ووزن الثمرة , وزن اللحم , نسبة اللحم / البذرة وفقا لمستوى ماء الرى المستخدم . عموما تناقصت هذه القياسات تدريجيا بنقص كمية المياة أثناء الرى فى كلا الصنفين .

تناقصت تدريجيا قيم الحموضة والبيروكسيد والقياس فى المنطقة الفوق البنفسجية على طول موجى 232– 270 نانوميتر و **Δk** بنقص كمية مياه الرى المعطاه لاشجار الزيتون فى كلا الصنفين .

الزيوت الناتجة من المعاملة 32 لتر ماء/ شجرة تحتوى على كميات كبيرة من حمض الاوليك والفينولات الكلية ومركب الارثو داى فينول وأيضا ارتفاع نسبة حمض الاوليك/حمض اللينوليك ونسبة الاحماض الدهنية الغير مشبعة / الاحماض الدهنية المشبعة وكانت هذه الزيوت الاعلى فى الثبات الاوكسيدى على الرغم من انخفاضهم فى مكونات التوكوفيرولات والكاروتينات والكلوروفيل مقارنة بالمعاملات الاخرى.

أدى نقص كمية مياة الرى التدريجى الى زيادة تدريجيه فى صفة الفاكهى والمرارة والحدية فى زيت الزيتون البكر فى كلا الصنفين.