EFFECT OF USING SOME EXTRACTION COADJUVANTS ON EXTRACTION YIELD AND QUALITY OF OLIVE OIL EXTRACTED FROM SOME EGYPTIAN OLIVE CULTIVARS

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Abstract
The use of talc or NaCl at two concentrations (1 and 2%) in addition to water as coadjuvants during extraction of olive oil has been tested at a laboratory scale and compared with those tests which did not use a coadjuvant, using three different Egyptian olive varieties (Olea europaea L. cvs. Maraqi, Moloki and Wattagen)which had a same range of maturity index. Maraqi cv. had the highest oil content and the lowest moisture content. Fatty acid composition of olive oils of the studied olive cultivars were in the range of International olive council standards. Addition of NaCl or talc improves the oil yield and extractability in all olive oil varieties as compared control treatment. On the other hand, water addition to olive paste reduced the oil yield and extractability.Talc or NaCl addition (1%) significantly increased both oil yield and extractability more than addition of talc or NaCl (2%).Results revealed that using of talc or NaCl addition at different ratios during extraction of olive oil from Egyptian cultivars induced improvements on FFA, PV, K_{232} *and* K_{270}*values especially for Maraqi olive oil. Parameters of the virgin olive oils were significantly affected by the use of talc or NaCl at concentration 1% as coadjuvants. However, the total phenols, oxidative stability, pigment content or positive sensory attributes were slightly increased. Finally, it concluded that addition of salt or talc at 1% seems to be a feasible alternative for the improvement of oil extraction.*

Keywords: Maraqi cv., Moloki cv, Nacl, oil yield, olive oil, Talc, Wattagen cv

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1. INTRODUCTION

Extra virgin olive oil – obtained from the olive fruit (*Olea europea* L.) solely by mechanical or other physical means under conditions that do not lead to alteration in the oil (EEC, 2001). It has been widely consumed in the Mediterranean areas. In addition to its sensory quality, among its most appealing traits are its health benefits due to its fatty acid profile and its antioxidant content (Lazzez *et al*., 2008). Composition and characteristics of olive oil depend on several conditions (i.e. olive fruits, processing conditions etc.) (Di Giovacchino *et al*., 2002).
Mechanical processes of olive oil extraction usually include olive fruit crushing, malaxation, and separation by a decanter. Olive oil extractability depends on extraction process variables, but the most important variation source is the cultivar (Beltran *et al*., 2003). During oil extraction water–oil emulsions can appear which decreases oil yield. Coadjuvants (such as talc and water) help to break down water–oil emulsions, which makes oil extraction easer (Clodoveo, 2012).
Different ways can be utilized to improve virgin olive oil yield: (1) acting on time and temperature of the malaxation phase; (2) adopting innovative extraction equipment; (3) using coadjuvants (Caponio *et al*., 2016).
The use of talc as coadjuvant during malaxation, not excluded by EC regulation,was due to its exclusively physical action (Cert *et al*., 1996). It was added during the malaxation step to break down oil/water emulsions and consequently make oil extraction easier, therefore increasing the yield. At the end of the extraction process, the talc ends up in the olive pomace because of its specific weight (2.8 g cm^{-3}), while the oil is free from talc (Caponio *et al*., 2016).
Common salt (sodium chloride), one of the most ancient mineral foods consumed by

humans, is also a powerful emulsion breaker. Its physical action, is based on the repulsion between lipophilic and hydrophilic phases due to the increased ionic charge as well as its density, and it could be very useful for extracting the olive oil from the "difficult pastes" (Cruz *et al*., 2007). The use of common edible salt during oil extraction could improve oil extraction (Perez *et al*., 2008).

Although water addition is not recommended for laboratory test, at industrial scale sometimes water is added to the crushed fruits to increase yield or to the oil before the centrifugation step to clean it. The addition of water to the crushed olive fruits (usual practice with three phase decanters) affects several characteristics and the total phenol content, and in fact the three phases decanter (with a high water requirement) yields oils with a lower total phenol content than those from a two-phases decanter (Carrapiso *et al*., 2013). Clodoveo, (2012) reviewed that warm water can be added to facilitate the oil extraction (usually 50-70 L of water added to 100 kg of olive paste). The additions of water to the paste during malaxation improve oil extractability but also results in lower polyphenol level, hence a shorter shelf life.

Quality of extra virgin olive oil depends on several variables such as cultivar, ripening index and quality, oil extraction, oil storage conditions, etc. However, the coadjuvants used in olive oil extraction can also influence on the characteristics of virgin olive oil. However, almost all the researches until now carried out regard the use of talc and NaCl as extraction coadjuvants on Spanish and Italian olive cultivars, whereas no studies have been made for Egyptian olive cultivars. The aim of this research was to evaluate the effect of using extraction coadjuvants on extraction yield and quality of some Egyptian olive cultivars.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Olive fruits

Olive fruits (*Olea europaea*) cvs. Maraqi, Moloki and Wattagen were harvested during 2017–2018 season in Siwa, Matrouh Governorate, Egypt, and transported within 1-2 days to the laboratory.

2.1.2. Chemicals

Chemicals used in this study were purchased from EL-Gomheria Company for Pharmaceuticals and Chemicals Trading, Cairo, Egypt.

2.2. Methods

2.2.1. Maturity Index

The maturity index (MI) of olive fruits was determined according to the olive skin and pulp color according to Garcia *et al*. (1996).

2.2.2. Moisture and oil content

The moisture content (%w/w) was determined by drying the milled olive at 105ºCto constant weightand the oil content (%w/w) was determined by Soxhlet extraction (AOAC, 2007).

2.2.3. Determination of fatty acids composition

The fatty acids methyl esters were prepared using trans-esterification with cold methanolic solution of potassium hydroxide. The fatty acid methyl esters were injected into Agilent 6890 series GC apparatus provided with a DB-23 column (60 m × 0.32 mm × 0.25 µm) was used. Oven temperatures were 150°C ramped to 195°C at 5°C min $^{-1}$, ramped to 220°C at 10°C min $^{-1}$ and flow rate was 1.5 min $^{-1}$ (IOC, 2016).

2.2.4. Olive oil extraction

The olive fruits of Maraqi, Moloki and Wattagen cultivars were crushed using an experimental crusher mill then olive paste was malaxed using a laboratory mixer for 30 min at room temperature. Talc (1%, 2% w/w), NaCl (1%, 2% w/w) and Lukewarm water (500 mL of water added to 1 kg of olive paste) were added to the paste during malaxation step for 30 min at room temperature, the olive paste was packed in a cheese cloth then pressed by using a laboratory hydraulic press (Carver). The resulting liquid phase was centrifuged (2000 xg) and the upper oil layer was collected and dried over anhydrous sodium sulphate, filtered through a Whatman filter paper No.1 then kept in a brown glass bottles and stored at -5ºC until analysis. Oil yield (%) was calculated by multiplying the oil volume (cm^3) by 0.915 and 100 and dividing it by the weight (g) of the paste. Oil extractability was calculated by multiplying oil yield by 100 and dividing by oil content (Carrapiso *et al*., 2013).

2.2.5. Quality parameters of virgin olive oil

Quality parameters of virgin olive oil (free fatty acids, peroxide value and specific UV absorption characteristics (K_{232}, K_{270}) were determined according to methods described by IOC (2016).

2.2.6. Total phenols

Samples of olive oil were extracted with 10 ml of a methanol/water mixture (60: 40 V/V)three times. The pooled extracts were washed with 10 ml of n-hexane and solvents were removed with a rotary evaporator (Buchi, Switzerland). Total phenols (TP) content of the methanolic extract of olive oil were calorimetrically determined using the Folin-Ciocalteu method (Gamez-Meza *et al.,* 1999).

2.2.7. Determination of Chlorophyll and Carotenoids

Chlorophyll and carotenoids were determined colorimetrically as described by Minguez-Mosquera *et al*. (1991).The chlorophyll fraction at 670 nm and the carotenoid fraction at 470 nm were evaluated from the absorption spectrum of the pigment extract in cyclohexane.

2.2.8. Oxidative stability

Oxidative stability was determined by Rancimat (Gutierrez, 1989). Stability was expressed as the induction time (hours), i.e., the time from the start of the experiment to the intersection point which was automatically determined by the Rancimat 679 apparatus (Metrohm Co., Switzerland), using an oil sample of 5 g heated to 100ºC with air flow of 20 L/h, and then, determining the conductivity variation of water (60 mL) due to the increase in oxidative compounds.

2.2.9. Sensory analysis

Sensory analysis of virgin olive oil samples were done according to the method described by IOC (2016).

2.2.10. Statistical analysis

One-way analysis of variance was carried out on all the data of each oil quality variable studied using a SPSS program (SPSS Statistic 16th version).

3. RESULTS AND DISCUSSION

Table 1 showed maturity index, moisture and oil content of the studied olive fruits varieties. The fruits of the studied olive varieties showed a same range of maturity index. The lowest MI was 4.30 followed by 4.59 and 4.72 for Maraqi, Moloki and Wattagen olive varieties, respectively. There was not a significant difference in MI among varieties. Fruits were different only in the moisture and oil content where Wattagen cv. had the highest moisture content 49.52% and the lowest oil content 15.13%. On the other hand, Maraqi cv. had the highest oil content 19.32% and the lowest moisture content 42.30%.

Table 1. Maturity index, moisture and oil content of olive fruit varieties

Parameters	**Maraqi cv.**	**Moloki cv.**	**Wattagen cv.**
Maturity Index (MI)	4.30±0.30 ^{a}	4.59±0.40 ^{a}	4.72±0.25 ^{a}
Moisture (%)	42.30±1.05 ^{a}	44.44±0.51 ^{b}	49.52±0.51 ^{c}
Oil content (% as wet weight)	19.32±0.32 ^{a}	17.84±0.67 ^{c}	15.13±0.35 ^{b}
Oil content (% as dry weight)	33.47±1.09 ^{b}	32.16±1.49 ^{ab}	29.99±0.99 ^{a}

Means within a raw followed by the same letter are not significantly difference ($p \leq 0.05$).

Table 2. Fatty acids composition of olive oil varieties

Fatty acids	Maraqi cv. olive oil	Moloki cv. olive oil	Wattagen cv. Olive oil
$C_{14:0}$	0.02	0.02	0.02
$C_{16:0}$	12.07	12.44	12.50
$C_{16:1}$	0.42	0.49	0.55
$C_{17:0}$	0.05	0.06	0.07
$C_{17:1}$	0.06	0.07	0.08
$C_{18:0}$	2.75	2.83	2.85
$C_{18:1}$	74.82	73.68	72.73
$C_{18:2}$	8.35	8.95	9.63
$C_{18:3}$	0.63	0.69	0.85
$C_{20:0}$	0.45	0.39	0.42
$C_{20:1}$	0.28	0.30	0.23
$C_{22:0}$	0.10	0.08	0.07
Σ SFA*	15.44	15.82	15.93
Σ USFA**	84.56	84.18	84.07
MUSFA***	75.58	74.54	73.59
PUSFA****	8.98	9.64	10.48
$C_{18:1}$/ $C_{18:2}$	8.96	8.23	7.55
$C_{18:2}$/ $C_{18:3}$	13.25	12.97	11.33
USFA/SFA	5.48	5.32	5.28
MUSFA / PUSFA	8.42	7.73	7.02

*SFA: Saturated Fatty Acids, ** USFA : Unsaturated Fatty Acids, *** MUSFA: Monounsaturated Fatty Acids, **** PUSFA: Polyunsaturated Fatty Acids.

Fatty acid composition of olive oils of the studied olive cultivars were illustrated in Table 2 and all fatty acid compositions were in the range of International olive council (IOC) (IOC, 2016). Fatty acids composition of olive oil as purity parameter is affected by environment (Mousa *et al*., 1996). Maraqi olive oil had the highest contents of $C_{18:1}$, $C_{18:1}$/ $C_{18:2}$, $C_{18:2}$/ $C_{18:3}$, USFA/SFA and MUSFA / PUSFA. On the other side, Wattagen olive oil had the lowest contents of $C_{18:1}$, $C_{18:1}$/$C_{18:2}$, $C_{18:2}$/$C_{18:3}$, USFA/SFA and MUSFA / PUSFA.

The efficiency of using some coadjuvant treatments is presented in Table (3) where the oil yield and extractability of each extraction test is given. The results showed that the addition of NaCl or talc improves the oil yield and extractability in all olive oil varieties as compared control treatment. NaCl addition (1%) was more effective than talc addition (1%). Talc or NaCl addition (1%) significantly increased both oil yield and extractability more than addition of talc or NaCl (2%). These results agreed with Cruz *et al*. (2007).Fernandez *et al*. (2008) and Espınola *et al*. (2009) indicated that the use of talc as coadjuvant improved oil extraction yield. Clodoveo, (2012) reviewed that addition of talc to difficult pastes (from 0.3% to 1%) improves the paste structure, reducing emulsions. However, talc overdose can reduce the process yield. On the side, Water addition to olive paste reduced the oil yield and extractability.

Although the best results were obtained by using talc, the results obtained by the treatment with salt were comparable, with the additional advantage being that common salt is cheaper.

Also, Table 3 showed the effect of using some coadjuvant treatments on FFA, PV, K_{232} and K_{270}. Results revealed that using of talc or NaCl addition at different ratios during extraction of olive oil from Maraqi, Moloki and Wattagen varieties induced improvements on those parameters. The results also show that NaCl or talc addition at 1% had lower acidity, lower peroxide values and finally lower UV extinction coefficients (K_{270} and K_{232}) than those parameters at 2% addition of NaCl or talc. It is important to note that all the oil samples fulfill the quality requirements set for extra virgin olive oil (IOC, 2016). Several studies indicated that talc addition did not influence the amount of FFA (Cert *et al.*, 1996;Cruz *et al.,* 2007; Fernandez *et al.*, 2008;Ben-David *et al.*, 2010; Carrapiso *et al.*, 2013 andCaponio *et al.*, 2014). The obtained results of PV agreed with those obtained by Cruz *et al.* (2007); Ben-David *et al.* (2010); Carrapiso *et al.* (2013) and Caponio *et al.* (2014). There was slight difference in ultraviolet absorption. These results agreed those by Fernandez *et al.* (2008);Moya *et al.* (2010) and Carrapiso *et al.* (2013) for K_{270}, although other studies reported no effect of talc addition on the spectrophotometric indexes (Cert *et al.*, 1996 and Cruz *et al.*, 2007).

As regards the other analytical parameters in Table 4, the use of coadjuvant treatments (talc and NaCl treatment) caused a significant increase of total phenols, probably due to the lower amount of water in the olive paste subjected to extraction, ascribable to the hygroscopic effect of talc..

Table 3. Effect of coadjuvant treatments on oil yield, extractability and olive oil quality

Parameters	Treatments					
	Control	Talc		NaCl		Water
	T0	1% (T1)	2% (T2)	1% (T3)	2% (T4)	(T5)
Maraqi Cv.						
Oil yield (%)	12.11±0.14^{b}	13.76±0.19^{d}	12.93±0.10^{c}	13.85±0.28^{d}	13.18±0.18^{c}	11.77±0.10^{a}
Oil extractability (%)	62.68±0.71^{b}	71.20±0.99^{d}	66.93±0.55^{c}	71.67±1.45^{d}	68.20±0.94^{c}	60.94±0.55^{a}
FFA %(as Oleic acid)	0.16±0.02^{c}	0.13±0.01^{ab}	0.14±0.02^{abc}	0.12±0.00^{a}	0.15±0.01^{bc}	0.15±0.01^{bc}
Peroxide value (meq O_2 / kg oil)	2.42±0.12^{de}	2.09±0.05^{ab}	2.21±0.07^{bc}	1.99±0.04^{a}	2.35±0.15^{cd}	2.56±0.08^{e}
K_{232}	1.36±0.01^{c}	1.32±0.00^{b}	1.35±0.01^{c}	1.29±0.02^{a}	1.34±0.02^{bc}	1.45±0.02^{d}
K_{270}	0.057±0.002 ^{b}	0.050±0.001^{a}	0.056±0.002^{b}	0.050±0.001^{a}	0.056±0.002^{b}	0.057±0.003^{b}
Moloki Cv.						
Oil yield (%)	11.10±0.14^{b}	13.36±0.18^{de}	12.53±0.18^{c}	13.66±0.19^{e}	13.12±0.19^{d}	10.70±0.27^{a}
Oil extractability (%)	62.23±0.78^{b}	74.88±1.02^{de}	70.27±1.02^{c}	76.59±1.07^{e}	73.52±1.07^{d}	60.01±1.54^{a}
FFA %(as Oleic acid)	0.24±0.01^{a}	0.22±0.02^{a}	0.24±0.00^{a}	0.22±0.01^{a}	0.25±0.02^{a}	0.28±0.02^{b}
Peroxide value (meq O_2 / kg oil)	2.96±0.07^{b}	2.54±0.04^{a}	2.95±0.04^{b}	2.53±0.03 ^{a}	3.10±0.09 ^{c}	3.25±0.05^{d}
K_{232}	1.60±0.02^{de}	1.52±0.01^{b}	1.58±0.02^{cd}	1.45±0.03^{a}	1.56±0.00^{c}	1.62±0.02^{e}
K_{270}	0.071±0.002 ^{a}	0.070±0.000 ^{a}	0.080±0.001 ^{b}	0.070±0.001 ^{a}	0.083±0.002^{c}	0.070±0.000^{a}
Wattagen Cv.						
Oil yield (%)	10.40±0.19^{b}	12.32±0.23^{d}	11.50±0.19^{c}	12.60±0.14^{d}	11.65±0.14^{c}	9.52±0.18^{a}
Oil extractability (%)	68.74±1.26^{b}	81.44±1.52^{d}	76.00±1.26^{c}	83.26±0.92^{d}	77.00±0.92^{c}	62.89±1.21^{a}
FFA %(as Oleic acid)	0.35±0.03^{a}	0.32±0.01^{a}	0.34±0.02^{a}	0.32±0.00^{a}	0.33±0.03^{a}	0.34±0.04^{a}
Peroxide value (meq O_2 / kg oil)	3.54±0.04^{c}	3.10±0.08^{ab}	3.19±0.07^{ab}	3.08±0.08^{a}	3.26±0.06^{b}	3.75±0.15^{d}
K_{232}	1.92±0.04^{d}	1.69±0.0^{a}	1.75±0.0^{c}	1.62±0.00^{b}	1.75±0.02^{c}	2.10±0.03^{e}
K_{270}	0.087±0.002^{cd}	0.083±0.000^{ab}	0.085±0.002^{bc}	0.082±0.001^{a}	0.089±0.001^{d}	0.089±0.00 ^{d}

Means within a raw followed by the same letter are not significantly difference ($p \leq 0.05$).

Talc or NaCl addition (1%) significantly increased total phenol content more than addition of talc or NaCl (2%). Consequently, there was increase in oxidative stability of studied oils. Oxidative stability is closely linked to the phenol content (Cert *et al*., 1996; Uceda *et al*., 2006; Cruz *et al*., 2007;
Ben-David *et al*.,2010; Aguilera *et al*., 2015 and Espınola*et al*.,2015). Fernandez *et al*. (2008) indicated that higher phenol contents and increase oil stability in oils when used some coadjuvant treatments. Addition of NaCl during the extraction process was positively correlated with the presence of o-diphenol compounds and the stability of the oils obtained (Clodoveo, 2012).
Data in Table 4 showed that the use of all coadjuvant treatments caused a significant increase of chloropylls and carotenoids content. The results agreed with Criado *et al*. (2007). Caponio *et al*. (2016) cited that the use of talc increased the affinity of chloroplast pigments (chlorophylls and carotenoids) for the oily phase and reduced pigment losses by degradation during the different phases of the oil extraction process. Clodoveo, (2012) mentioned that the use of NaCl resulted in a significant increase in contents of pigments (b-carotene, lutein and chlorophylls a and b) in the oils. The increase of pigment accumulation in the oil induced by the addition of NaCl could be explained by firstly, a high saline concentration could possibly cause a better pigment release from the chloroplast and/or chromoplast by a more effective breaking of their membranes, and secondly an increase in concentration of NaCl could inhibit chlorophylase or lypoxygenase enzymes, which has associated with pigment destruction during olive processing (Luaces *et al*., 2005).

Table 4. Effect of coadjuvant treatments on total phenols, chloropylls, carotenoids and oxidative stability of some Egyptian olive oils

Parameters	Treatments					
	Control	Talc		NaCl		Water
	T0	1% (T1)	2% (T2)	1% (T3)	2% (T4)	(T5)
Maraqi Cv.						
Total phenols (mg/kg)	226.31±0.37ª	235.60±0.50ᵇ	230.36±0.48ᶜ	242.47±0.35ᵈ	232.37±0.38ᵉ	210.53±0.42ᶠ
Chloropylls (mg/kg)	2.75±0.03 ª	2.85±0.01 ᶜ	2.82±0.02 ᵇᶜ	2.91±0.01 ᵈ	2.99±0.03 ᵉ	2.79±0.02 ᵇ
Carotenoids (mg/kg)	1.20±0.01 ª	1.46±0.02 ᶜ	1.45±0.01 ᶜ	1.56±0.01 ᵈ	1.62±0.03 ᵉ	1.25±0.04 ᵇ
Oxidative stability (h)	50.61±0.17 ᵇ	52.69±0.18 ᵉ	51.20±0.20 ᶜ	53.21±0.11 ᵉ	52.13±0.06 ᵈ	48.87±0.65 ª
Moloki Cv.						
Total phenols (mg/kg)	210.67±0.44 ᵇ	225.08±0.39 ᵈ	217.90±0.70 ᶜ	230.38±0.29 ᵉ	217.50±0.50 ᶜ	196.21±0.20 ª
Chloropylls (mg/kg)	2.54±0.02 ª	2.71±0.03 ᶜ	2.65±0.03 ᵇ	2.85±0.04 ᵈ	2.93±0.03 ᵉ	2.60±0.02 ᵇ
Carotenoids (mg/kg)	1.05±0.03 ª	1.27±0.03 ᶜ	1.18±0.29 ᵇ	1.32±0.06 ᶜ	1.40±0.04 ᵈ	1.10±0.02 ª
Oxidative stability (h)	47.30±0.29 ᵇ	49.30±0.20 ᵈ	48.34±0.18 ᶜ	50.21±0.10 ᵉ	48.30±0.20 ᶜ	46.85±0.25 ª
Wattagen Cv.						
Total phenols (mg/kg)	186.32±0.20 ᵇ	196.70±0.30 ᵉ	190.47±0.35 ᶜ	206.70±0.30 ᶠ	192.57±0.50 ᵈ	162.50±0.60 ª
Chloropylls (mg/kg)	1.95±0.02 ª	2.25±0.03 ᵈ	2.17±0.02 ᶜ	2.30±0.04 ᵉ	2.36±0.03 ᶠ	2.05±0.02 ᵇ
Carotenoids (mg/kg)	1.65±0.05 ª	1.82±0.06 ᵇ	1.70±0.04 ª	1.89±0.04 ᵇᶜ	1.95±0.03 ᶜ	1.70±0.02 ª
Oxidative stability (h)	44.11±0.11 ᵇ	45.72±0.18 ᵈ	44.99±0.12 ᶜ	46.23±0.18 ᵉ	45.31±0.21 ᶜ	42.78±0.25 ª

Means within a raw followed by the same letter are not significantly difference (p≤ 0.05).

Table 5. Effect of coadjuvant treatments on sensory analysis of some Egyptian olive oils

Parameters	Control	Talc		NaCl		Water
	T0	1% (T1)	2% (T2)	1% (T3)	2% (T4)	(T5)
Maraqi Cv.						
Defects	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Fruity	6.50±0.10[b]	6.97±0.06[d]	6.77±0.06[c]	6.93±0.06[d]	6.57±0.11[b]	6.07±0.11[a]
Bitter	3.40±0.36[ab]	4.17±0.36[c]	4.03±0.36[c]	4.20±0.26[c]	3.77±0.25[bc]	3.27±0.25[a]
Pungent	2.40±0.20[b]	2.80±0.30[cd]	2.26±0.15[bc]	3.03±0.06[d]	2.80±0.10[cd]	2.07±0.11[a]
Moloki Cv.						
Defects	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Fruity	5.67±0.29[ab]	6.00±0.50[b]	6.17±0.29[bc]	6.67±0.29[c]	6.60±0.17[c]	5.17±0.29[a]
Bitter	3.20±0.26[b]	3.67±0.29[cd]	3.23±0.25[bc]	3.77±0.25[d]	3.57±0.21[bcd]	2.60±0.17[a]
Pungent	2.27±0.11[ab]	2.70±0.20[bc]	2.50±0.20[ab]	3.07±0.11[c]	2.50±0.50[ab]	2.03±0.06[a]
Wattagen Cv.						
Defects	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Fruity	4.77±0.25[b]	5.33±0.29[cd]	5.13±0.11[bc]	5.67±0.29[d]	5.17±0.29[bc]	4.17±0.29[a]
Bitter	2.33±0.29[ab]	2.77±0.25[bc]	2.77±0.30[bc]	3.17±0.38[c]	3.23±0.25[c]	2.07±0.11[a]
Pungent	2.07±0.11[b]	2.53±0.06[cd]	2.33±0.15[bc]	2.73±0.25[d]	2.20±0.20[b]	1.73±0.06[a]

Treatments

Means within a raw followed by the same letter are not significantly difference ($p \leq 0.05$).

Effect of using some coadjuvant treatments on sensory analysis of some Egyptian olive oils illustrated in Table 5. Data showed that no defects were detected in all studied olive oils. Positive attributes (fruity, bitter and pungent) were increased when using talc or NaCl as coadjuvants as compared to control (without coadjuvants). Scores of positive attributes for all studied olive oils belonged to the extra virgin olive oil grade according to IOC (2016), were without any defects. Perez *et al*. (2008) indicated that NaCl treatment could increase of C6 and C5 aldehydes and alcohols that provide the green notes characterising VOO flavor. The increase of polarity of the hydrophilic phase provoked by the presence of dissolved NaCl could facilitate phenols solubility in the oil, consequently increasing oxidative stability and bitterness attribute (Cruz *et al*., 2007). Clodoveo, (2012) cited that the intensity of bitterness was slightly increased. Olive oils were treated with Nacl or talc treatments at (1%) during malaxation had more scores than those treated Nacl or talc treatments at (2%). On the opposite side, treatment with water was led to decrease in scores of positive attribute.

4. CONCLUSIONS

In conclusions, the use of common salt (NaCl) or talc (at concentration 1%) as coadjuvants for the physical extraction of olive oil highlighted a positive effect on oil yield, extractability and quality of olive oil as well as promoting a slight increase in phenols content, oil stability, intensity of bitterness, and pigment content. Salt or talc addition at 1% seems to be a feasible alternative for the improvement of oil extraction.

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