



Enhance the Stability of Traditional Concentrated Yoghurt using Natural Antioxidants Additives

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ABSTRACT

The stability of virgin olive oil (VOO) used as a packing medium for traditional concentrated Yoghurt decreased during time and the product could deteriorate during the storage time. In this investigation, different natural additives such as dried Arum Palaestinum leaves (AP), Tomato Peel (TP) and Chili Pepper (CP) have been used to enhance the quality and stability of packing medium VOO for traditional canned concentrated Yoghurt balls. Parts VOO samples added with natural additives were stored as packing medium for traditional canned concentrated Yoghurt balls. Other part was stored without concentrated Yoghurt in the same storage conditions. All samples were analyzed for their initial quality indexes and during the storage period of six months. At the end of storage, results revealed that the % acidity for all VOO samples used as a packing medium showed a higher value than the samples stored without concentrated Yoghurt balls. On the other side, peroxide values for all stored samples of both parts were less than the control sample without additives. Extinction coefficients (K_{232} , K_{270}) for VOO samples with the natural additives showed increased trend during the storage time, but it didn't exceed the accepted limit for VOO. Total phenol content for all samples were gradually decreased during storage period, whereas samples with the natural additives showed higher values than the controls. All the natural additives (CP, TP, AP) showed a positive trend in enhancing and improving the different VOO quality indexes in our study in particular those samples added with CP during the storage time.

Keywords: Virgin olive oil Traditional concentrated yoghurt, Natural additives, Arum Palaestinum, Tomato Peel, Chili Pepper, Storage stability, Quality indexes.

INTRODUCTION

Virgin olive oil composed mainly of oleic

acid and a balanced amount of polyunsaturated fatty acids, which qualifies it as natural antioxidants. In addition to its contribution to the prevention of several



human diseases, as cardiovascular diseases, VOO found to have a major contribution in cancer disease prevention¹. Secoiridoid molecules are the direct response on the sensory gustative properties of VOOs; pungency, bitterness, and other sensory properties². Additionally, VOO contains more than 230 chemical compounds as minor components that composed around 2% of its weight³.

Oxidative stability is considered useful indicator for the estimation of the potential shelf life of VOO due to the high stability of VOO under normal storage conditions (12 to more than 18 months)⁴. The amount of antioxidants is a key indicator of the quality and stability of VOO, including carotene, phenols, and hydrophilic phenols. Hydrophilic phenols are the most abundant natural antioxidants of VOO⁵. Phenolic compounds concentration ranges from 1.0 to 3.0% (weight/weight) for olive fruits³. The antioxidant content, particularly polyphenols give VOO high resistant to oxidation compared with other edible oils⁶⁻⁸. Natural sources of antioxidants such as tocopherols, ascorbic acid, erythorbic acid or their salts or derivatives have found extensive applications in the food industry⁹. They were characterized by low cost, availability, and recycling without the release of toxic compounds. Other advantages made them environmentally friendly and can be used as natural additives in various foods¹⁰ in order to avoid the adverse health effects of synthetic antioxidants¹¹. The use of different plants in Palestine either in traditional medicine or as edible plants is justified since they are promising sources of natural antioxidants¹². Natural phytochemicals derived from fruits, vegetables, and herbs possess a wide range of biological effects including antioxidant, antimicrobial and anti-inflammatory actions. Addition of different spices, herbs, and olive oil is a traditional practice in Mediterranean gastronomy to enhance the aroma and taste of food¹². One of the well-known plant used as traditional food and possess natural antioxidants found in Palestinian nature is the *Arum palaestinum* (AP). Such plant (locally known as "Luof") contains different active micro-components such as polyphenols, alkaloids, flavone C-glycosides, flavonols, flavones, proanthocyanidins, and polyhydroxy alkaloids. The leaves are considered one of the most edible wild plants in Palestine and one of the medicinal plant utilized for treating various diseases especially cancer¹³. *Arum palaestinum* is commonly preserved by air-drying and then stored

refrigerated or frozen and might be used in many spices mixes¹³. Other natural plants or plant parts that are rich in antioxidants are tomato peels with its content of lutein, lycopene, and b-carotene¹⁴ and chili pepper (CP). CP is a rich source of vitamins C, E and carotenoids¹⁵. Moreover, CP is considered a good source of flavonoids such as quercetin and luteolin¹⁶. CP could be added to olive oil to prevent it from oxidations¹⁷. On the other hand, CP play clear rule in exhibiting the strongest ferrous chelating activity and scavenging activity against free radicals¹⁶.

The content of phenolic compounds and ascorbic acids, β -carotene, α -tocopherol, and lycopene, play an important role in increasing total antioxidant activity of such natural antioxidants¹⁸.

This investigation is based on the use of a traditional fermented dairy product (Concentrated Yoghurt). Concentrated Yoghurt is a semisolid fermented dairy food produced by removing part of the whey from yogurt to reach total solid levels between 23 and 25 g/100 g concentrated Yoghurt balls are immersed in VOO olive oil as a packing medium to preserve it and to increase its shelf life at the same time. It may be kept in the refrigerator for up to 2 months. Dairy products as many other food products are perishable by nature and require protection from spoilage during their preparation, storage and distribution to give them desired shelf life¹⁹. The objectives of this work is therefore to study the (*Arum palaestinum*, Tomato peel, and Chili Pepper) on the quality of VOO which is used as packing medium for Concentrated Yoghurt balls.

MATERIALS AND METHODS

Samples

Virgin olive oil of the cultivar "Nabali Baladi" from Salfet region-West Bank was extracted in November 2016. Leaves of *Arum palaestinum* plant were collected from the mountainous area near Ramallah/Palestine. Tomato and green fresh pepper were obtained in the same period from markets. Leaves of *Arum palaestinum*, tomato peel and green pepper were dried at room temperature. The dried natural additives were then packaged and stored at $20 \pm 2^\circ\text{C}$ in the dark until used. Traditional concentrated Yoghurt balls were prepared from fresh and pasteurized milk.

Samples Preparation

The VOO was enriched with natural additives according to Table 1 and divided into two parts. The first part was stored in a hermetically sealed glass bottle in dark at room temperature. The other part was added as packing medium to traditional concentrated Yoghurt balls in a hermetically sealed glass jars. Control samples were prepared for each

part without any additives. All samples were stored at room temperature ($20 \pm 2^\circ\text{C}$) in dark for a period of 6 months. Olive oil samples were analyzed initially at time zero and each respective time of analysis during the period of storage for their free acidity, peroxide value, UV absorption coefficients, and total phenols. Each sample was obtained from separate sealed bottles and jars and was analyzed in triplicates.

Table 1: Distribution of natural additives in VOO samples

Natural Additives	Concentration%	(g) of natural additives in 85 g of VOO samples	(g) of natural additives in 185 g of VOO & 255 g Concentrated Yoghurt
Control		-----	-----
Arum Palaestinum	2%	1.7	3.7
	5%	4.25	9.25
	10%	8.5	18.5
Tomato Peel	2%	1.7	3.3
	5%	4.25	9.25
	10%	8.5	18.5
Chili Pepper	1%	0.85	1.85
	2%	1.7	3.7
	3%	2.55	5.55

Chemical quality indexes

Acidity and peroxide values were expressed as g oleic acid per 100 g oil and as milliequivalent O₂ per Kg oil, respectively, both indicators were analyzed according to the methods described in AOAC, 2000. Extinction coefficients K_{232} and K_{270} were performed according to the methods described in IOOC. Total polar phenols were extracted following the procedure by Georgios *et al.*, and the results were expressed as mg gallic acid per Kg oil.

Statistical analysis

All chemical analyses were carried out in triplicate. The software XLSTAT 7.5.2 version (Addinsoft, USA) was used to elaborate the data by analysis of variance (ANOVA, Fisher LSD, $p < 0.05$). Significant differences (at p -level < 0.05) among medians at different storage time was used. The same letters (a-d) represent no significant differences throughout the storage time, within the same sample ($P < .05$).

Chemicals

All chemicals used in this study are of analytical grade and purchased from Fluka (Buchs, Switzerland) or Sigma-Aldrich (Steinheim, Germany). The list of, chemicals include: Acetic acid,

Chloroform Potassium Iodide, Sodium Thiosulfate, Starch Ethanol 95%, Potassium Hydroxide, Phenol Phethalein, Hydrochloric Acid, Cyclohexane, Sodium Carbonate, Folin-Ciocalteu Reagent).

RESULTS AND DISCUSSION

VOO enriched with natural additives

Acidity percent

Results (Fig. 1-3) showed significant increase in acidity % of VOO for the control samples compared with those with AP, TP and CP during six months of storage. On the other hand, the samples enriched with CP contain less free fatty acid percent than other samples. This could be explained by the action of various antioxidants contained in, such as polyphenols and alkaloids with flavone glycosides, flavonols, flavones, proanthocyanidins, and polyhydroxy alkaloids as main classes in (AP)²⁰. These results are in agreements with²¹ who found that enrichment of VOO with carotenoids and lycopene from (TP), caused decrease in acidity during storage time compared with the control sample. Besides, Borel and his coworkers²² explained this decline in acidity by the solubility of carotenoids from (TP) in the olive oil. In addition, the lower values of acidity in VOO samples contained CP reflects improvement

effects of CP on the oxidative stability of VOO (Fig. 3). In VOO samples with (AP) and (TP), 2% concentration was more efficient than the higher 5% and 10% in keeping stable oil with acceptable acidity %. Nevertheless, all stored control samples have remained within the limits of EU regulations (EU Re.1348/2013) at the end of the storage period.

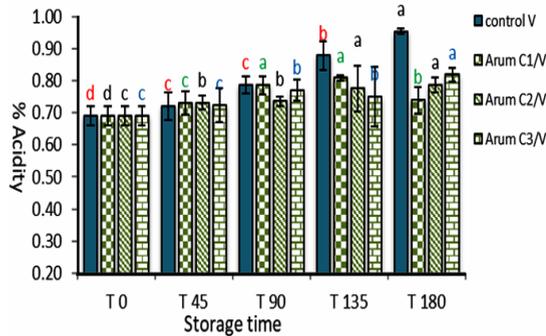


Fig. 1. Influence of storage time (days) on % acidity for VOO samples with (2%, 5%, & 10%) of (AP)

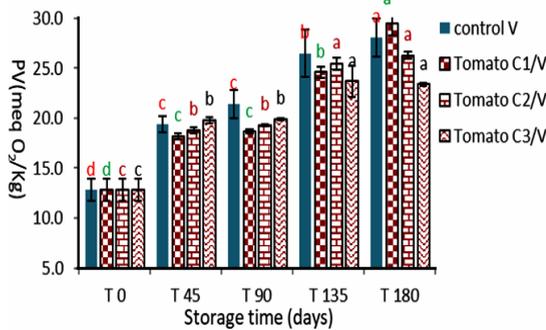


Fig. 2. Influence of storage time (days) on %acidity for VOO samples with (2%, 5%, & 10%) of (TP)

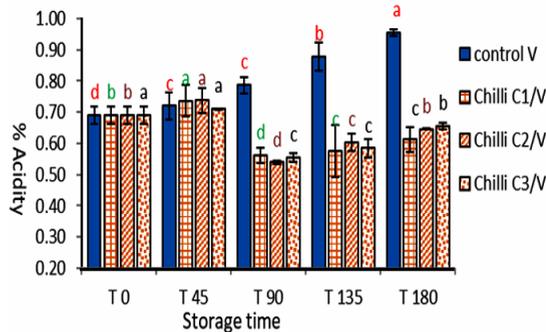


Fig. 3. Influence of storage time (days) on acidity for VOO samples with (1%, 2%, &3%) of (CP)

Peroxide Value for VOO

Peroxide Value results (Fig. 4-6) indicated significant increase in Peroxide value during storage. However, control sample showed generally

significantly higher increase in PV with respect to natural additives enriched samples throughout the storage time.

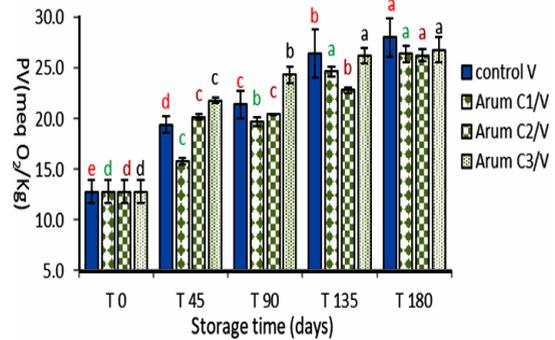


Fig. 4. Influence of storage time (days) on peroxide value for VOO samples with (2%, 5%, & 10%) of (AP) additives

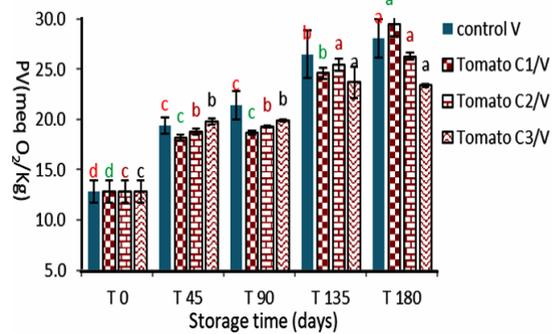


Fig. 5. Influence of storage time (days) on peroxide value for VOO samples with (2%, 5%, & 10%) of (TP) additives

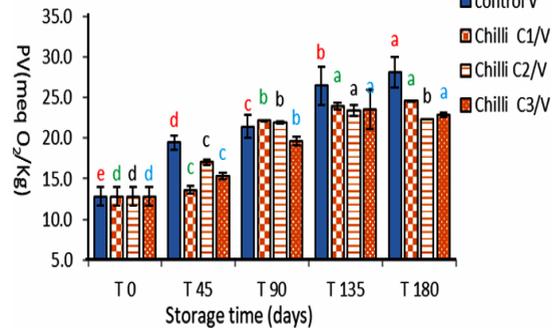


Fig. 6. Influence of storage time (days) on peroxide value for VOO samples with (1%, 2%, &3%) of (CP) additives

These results emphasize the positive effect of natural additives (CP, AP and TP) on the oxidative stability of VOO. The results also indicated that higher concentrations of natural antioxidant have better effects on oxidative stability than lower concentrations. These results were in agreement with²³⁻²⁴.

Extinction Coefficients (K_{232} , K_{270})

A significant increase in K_{232} and K_{270} values were observed for all samples with different concentrations of natural additives in addition to

the control sample (Table 2 and 3). However, all the samples remained within the accepted limits by EEC Reg. 2568/1991 and the following amendments for VOO category.

Table 2: Influence of natural additives on the extinction coefficients (K_{232}) value indicators for the pure VOO during 6 months of storage

Sample	Type	$K_{232} \pm S.Dat$ T0	$K_{232} \pm S.Dat$ T45	$K_{232} \pm S.Dat$ T90	$K_{232} \pm S.Dat$ T135	$K_{232} \pm S.Dat$ T180
Control	V	2.21±0.04c	2.31±0.02c	2.397±0.17b	2.52±0.04a	2.58±0.14a
V-O.O	C1(2%)	2.21±0.04b	2.31±0.14ab	2.09±0.03c	2.35±0.06a	1.45±0.05d
With	C2(5%)	2.21±0.04c	2.36±0.24b	2.11±0.18c	2.33±0.08a	1.48±0.06d
Arum	C3(10%)	2.21±0.04b	2.33±0.01a	2.17±0.01c	2.29±0.17ab	1.5±0.06d
V-O.O	C1(2%)	2.21±0.04c	2.42±0.14c	2.36±0.08b	2.41±0.0a	1.88±0.08d
With	C2(5%)	2.21±0.04b	2.48±0.09bc	2.30±0.22b	2.50±0.11a	1.98±0.04c
Tomato	C3(10%)	2.21±0.04c	2.48±0.05b	2.30±0.28bc	2.48±0.11a	01.81±0.11d
V-O.O	C1(1%)	2.21±0.04c	2.5±0.21ab	2.391±0.03b	2.46±0.0a	1.30±0.16d
With	C2(2%)	2.21±0.04bc	2.47±0.17b	2.41±0.01a	2.49±0.11a	1.36±0.03c
Chili	C3(3%)	2.21±0.04c	2.59±0.07a	2.37±0.14b	2.51±0.11a	1.89±0.17d

Table 3: Influence of natural additives on the extinction coefficients (K_{270}) value indicators for the pure VOO during 6 months of storage

Sample	Type	$K_{270} \pm S.Dat$ T0	$K_{270} \pm S.Dat$ T45	$K_{270} \pm S.Dat$ T90	$K_{270} \pm S.Dat$ T135	$K_{270} \pm S.Dat$ T180
Control	V	2.355±0.14e	2.63±0.13c	2.75±0.13b	2.59±0.18d	2.87±0.05a
V-O.O	C1(2%)	2.355±0.14d	2.478±0.19c	2.55±0.19b	2.17±0.06e	2.68±0.16a
With	C2(5%)	2.355±0.14c	2.522±0.12b	2.61±0.12ab	2.18±0.07d	2.66±0.12a
Arum	C3(10%)	2.355±0.14c	2.538±0.14b	2.56±0.14b	2.19±0.23d	2.63±0.19a
V-O.O	C1(2%)	2.355±0.14d	2.51±0.02b	2.17±0.02e	2.45±0.17c	2.73±0.11a
With	C2(5%)	2.355±0.14d	2.521±0.02b	2.18±0.02e	2.46±0.09c	2.680±0.06a
Tomato	C3(10%)	2.355±0.14d	2.55±0.04b	2.189±0.04e	2.508±0.05bc	2.76±0.24a
V-O.O	C1(1%)	2.355±0.14d	2.47±0.01c	2.70±0.01a	1.92±0.14e	2.54±0.08b
With	C2(2%)	2.355±0.14c	2.49±0.01b	2.71±0.01a	2.502±0.03b	2.50±0.29b
Chili	C3(3%)	2.355±0.14c	2.56±0.03b	2.74±0.03a	2.07±0.13d	2.56±0.21b

indicators for the pure VOO during 6 months of storage

The increase in K_{232} values is caused by the formation of primary oxidation products (hydroperoxide) while that for K_{270} could be attributed to the accumulation of secondary oxidation products²⁵. Such secondary products include aldehyde, ketones and others trienes containing product²⁶.

Total Phenolic Content for virgin olive oil

Figures 7-9 represent the behavior of total phenolic compounds contents throughout the storage period for VOO samples added with the three natural antioxidants in comparison with the control sample. The results showed that total polar phenolic content for all samples decreased during storage, where samples with the natural additives had lower values at the end of storage period compared

with control VOO sample. These results were in agreement with Montesano and his coauthors²⁴.

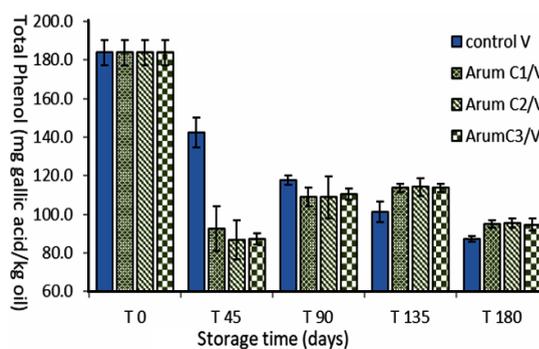


Fig. 7. Influence of storage time (days) on total phenols content for VOO added with (2%, 5%, & 10%) of *Palestinium Arum* (AP)

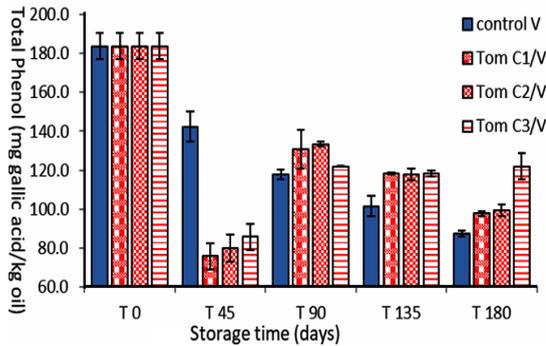


Fig. 8. Influence of storage time (days) on total phenols content for VOO with (2%, 5% & 10%) of Tomato Peel (TP)

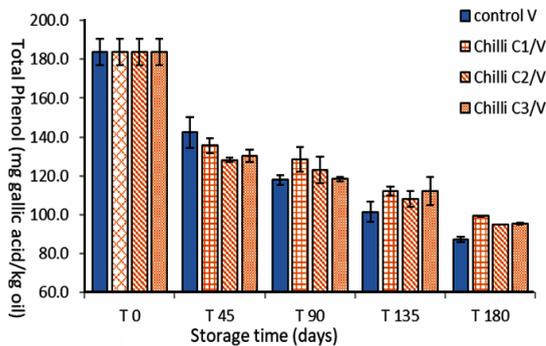


Fig. 9. Influence of storage time (days) on total phenols content for VOO with (1%, 2%, & 3%) of (CP)

The results of this research highlighted the protective effect of the natural additive on the phenolic compounds and the stability of virgin olive oil.

Virgin olive oil as a packing medium for traditional concentrated Yoghurt

Acidity percentage

A significant increase in the free acidity values up to the end of storage period was observed while the control sample showed less increasing trend compared with those packed the concentrated Yoghurt balls in sealed glass jars (Fig. 10-12). In addition, samples for packing VOO with 1%, 2%, & 3% of dried (AP), (TP), and (CP) were used. In addition, packing VOO samples showed similar trend as the samples stored without food matrix (Fig. 1-3). The results showed also that lower concentration of the natural additives (1%, 2%) used as packing medium showed lower acidity % than those added with 3%. However, all samples added with natural additives showed less acidity % than control samples at the end of storage period which indicate the positive effect of such additives on retarding hydrolytic degradation of virgin olive oil.

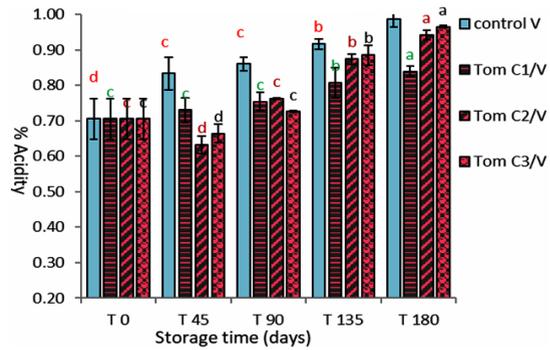


Fig. 10. Influence of storage time (days) on acidity for (VOO) samples with (2%, 5%, & 10%) of (AP) used as a packing medium for concentrated Yoghurt balls

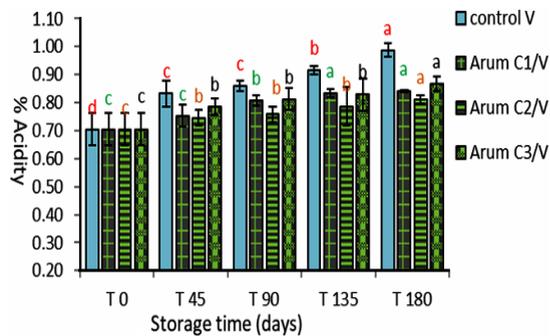


Fig. 11. Influence of storage time (days) on acidity for (VOO) samples with (2%, 5%, & 10%) of (TP) used as a packing medium for concentrated Yoghurt balls

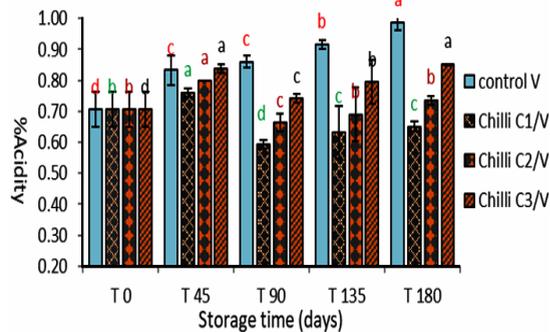


Fig. 12. Influence of storage time (days) on acidity for (VOO) samples with (1%, 2%, & 3%) of (CP) used as a packing medium for concentrated Yoghurt balls

Comparing the samples of VOO stored with and without concentrated Yoghurt balls, results showed that VOO samples used as packing medium had slightly higher acidity value, which could be explained by the humidity in concentrated Yoghurt (food matrix) which in turn increases the rate of the hydrolysis³.

Peroxide Value

Figures 13-15 showed the results for VOO samples used as a packing medium for traditional

concentrated Yoghurt with the natural additives (AP, TP, and CP). Results showed significant increase in PV for all samples during storage with respect to the initial values. Moreover, it was clear that peroxide values for VOO samples with natural additives had lower values than the control sample. The results emphasize the positive effect of these natural additives in enhancing the oxidative stability and quality of VOO used as a packing medium for traditional concentrated Yoghurt.

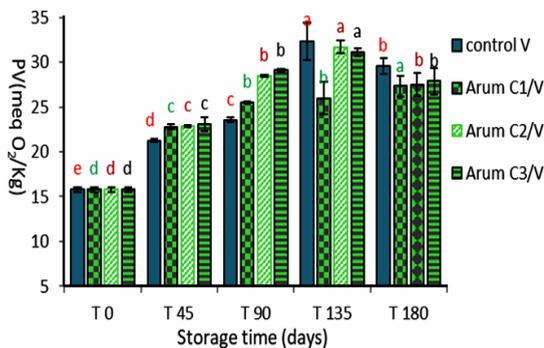


Fig. 13. Influence of storage time (days) on peroxide value for VOO with (2%, 5%, & 10%) of (AP) used as a packing medium for concentrated Yoghurt balls

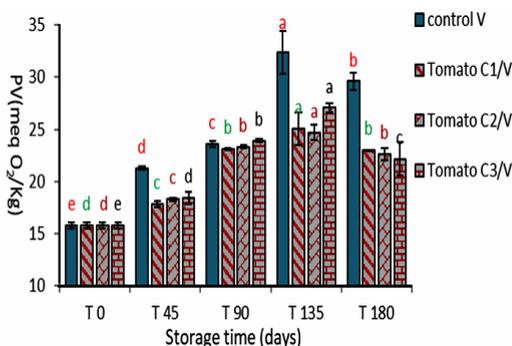


Fig. 14. Influence of storage time (days) on peroxide value for VOO with (2%, 5%, & 10%) of (TP) used as a packing medium for concentrated Yoghurt balls

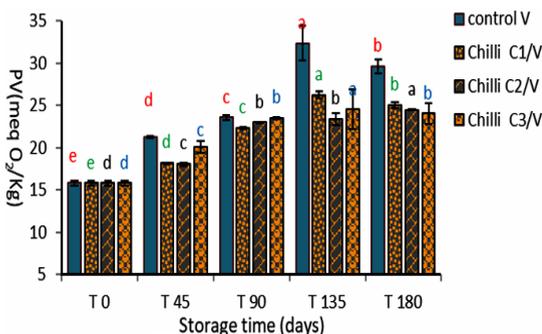


Fig. 15. Influence of storage time (days) on peroxide value for VOO with (1%, 2% & 3%) of Chili Pepper used as a packing medium for concentrated Yoghurt balls

These results were in accordance with Montesano *et al.*, 2006 who reported that VOO samples with lycopene showed PV remarkably lower than the reference sample. In addition, Caporaso and his group also reported that capsaicinoids and aroma compounds found in pepper had a high antioxidant capacity, that cause a decrease in (PV) and other oxidation parameters during VOO storage^[12].

By comparing the activity of the different natural additives in view of peroxide value, results showed that the lowest recorded values of PV were for (TP) followed by (CP), then (AP) respectively.

Extinction Coefficients (K_{232} , K_{270}) for VOO with natural additives used as a packing medium for traditional concentrated Yoghurt

Results showed in Tables 4 and 5 indicated that K_{232} and K_{270} values exceeded the accepted limit by EEC Reg. 2568/1991 after 45 days of storage for all stored samples. In this regard, the sample with Chili pepper showed higher stability than other samples, where these results agreed with Caporaso *et al.*, 2013. However, the increase in oxidation rate during storage of VOO used as a packing medium for concentrated Yoghurt might result from the presence of high humidity in concentrated Yoghurt. Besides, the presence of water in contact with oil considered responsible for the oxidation of double bonds in fatty acids, leading to an extreme increase in K_{232} and K_{270} .

Total Phenolic Content

The results presented in Table 4 showed generally a significant and dramatic degradation of phenolic compounds in VOO samples, for all samples. These results indicated that an ultimate oxidation resistance was involved because of the presence of food (concentrated Yoghurt) in contact with VOO used in this study. A loss of about 50% was recorded after the end of storage time.

The results Table 5 for VOO with AP samples showed more stability in total phenol during storage, and it had higher values at the end of storage than the control samples. Moreover, results showed that phenolic substances seem to be involved more than other antioxidants in the protection of the oil from oxidation during storage²⁷. The tomato peel and chili pepper additives, as shown in Table 6, showed an increase

in total phenols after 45 days of storage as a result of degradation of complex phenolic compounds⁷.

These results could be explained by the fact that there was progressive oxidation during the period of storage. Caporaso *et al.*, 2013 reported that polyphenols play an important role in protecting olive oil against oxidation especially if olive oil is stored in dark conditions.

Comparing between total phenol content of VOO samples with natural additives with those VOO used as a packing medium for concentrated Yoghurt balls Table 6, it was clear that the packing VOO had lower total phenol content. These results revealed the higher autoxidation which accelerated by the presence of humidity in concentrated Yoghurt balls³.

Table 4: Influence of natural antioxidants additives on the extinction coefficients (K_{232}) Value Indicators for the pure VOO used as a packing medium for traditional concentrated Yoghurt during 6 months of storage

Sample	Type	$K_{270} \pm S.D$ at T0	$K_{270} \pm S.D$ at T45	$K_{270} \pm S.D$ at T90	$K_{270} \pm S.D$ at T135	$K_{270} \pm S.D$ at T180
Control	V	0.195±0.04d	0.234±0.04c	0.237±0.04c	0.247±0.04b	0.277±0.01a
V-O.O	C1(2%)	0.195±0.04d	0.224±0.06c	0.238±0.03b	0.234±0.0b	0.245±0.01a
With	C2(5%)	0.195±0.04e	0.226±0.05d	0.231±0.05c	0.242±0.02b	0.249±0.03a
Arum	C3(10%)	0.195±0.04e	0.2252±0.01d	0.239±0.01c	0.246±0.03b	0.251±0.04a
V-O.O	C1(2%)	0.195±0.04d	0.224±0.03c	0.237±0.01b	0.250±0.02a	0.256±0.01a
With	C2(5%)	0.195±0.04d	0.229±0.02c	0.233±0.04b	0.251±0.07a	0.253±0.05a
Tomato	C3(10%)	0.195±0.04c	0.23±0.04b	0.235±0.04b	0.253±0.02a	0.255±0.01a
V-O.O	C1(1%)	0.195±0.04c	0.238±0.07b	0.234±0.01b	0.247±0.06a	0.248±0.04a
With	C2(2%)	0.195±0.04c	0.237±0.05b	0.233±0.0b	0.243±0.01a	0.244±0.0a
Chili	C3(3%)	0.195±0.04d	0.239±0.02c	0.236±0.02c	0.254±0.01a	0.247±0.03b

Table 5: Influence of natural antioxidants additives on the extinction coefficients (K_{270}) value Indicators for the pure VOO used as a packing medium for traditional concentrated Yoghurt during 6 months of storage

Sample	Type	$K_{270} \pm S.D$ at T0	$K_{270} \pm S.D$ at T45	$K_{270} \pm S.D$ at T90	$K_{270} \pm S.D$ at T135	$K_{270} \pm S.D$ at T180
Control		0.245±0.01c	0.268±0.05bc	0.357±0.03b	0.45±0.04ab	0.480±0.01a
VOO	C1(2%)		0.245±0.01c	0.251±0.01bc	0.274±0.02b	0.279±0.01b
With	C2(5%)		0.245±0.01d	0.252±0.06c	0.269±0.06b	0.28±0.0b
Arum	C3(10%)		0.245±0.01d	0.251±0.05ac	0.273±0.04b	0.27±0.02b
VOO	C1(2%)		0.245±0.01c	0.258±0.0bc	0.262±0.05b	0.31±0.04b
With	C2(5%)		0.245±0.01d	0.261±0.05c	0.263±0.06c	0.31±0.02b
Tomato	C3(10%)		0.245±0.01d	0.265±0.01c	0.266±0.04c	0.31±0.03b
VOO	C1(1%)		0.245±0.01c	0.257±0.0b	0.259±0.02b	0.314±0.02a
With	C2(2%)		0.245±0.01e	0.259±0.02d	0.265±0.02c	0.322±0.01a
Chili	C3(3%)		0.245±0.01e	0.259±0.01d	0.272±0.02c	0.32±0.01a

Table 6: Influence of natural antioxidants additives on the total phenols for of pure VOO and VOO that used as a packing medium covering the concentrated Yoghurt balls stored in hermetically sealed glass jars during 6 months of storage time

Sample	media T.Ph±S.D at T0	media T.Ph±S.D at T45	media T.Ph±S.D at T90	media T.Ph±S.D at T135	media T.Ph ±S.D at T180	
VOO with natural additives	Control	183.74±6.76a	172.34±7.77b	117.85±2.49c	101.45±5.26d	87.28±1.50e
	C1/A	183.74±6.76a	92.46±11.49c	109.05±4.98b	113.70±2.26b	94.95±1.88c
	C2/A	183.74±6.76a	86.73±10.14c	108.80±11.02b	114.23±4.51b	95.48±2.63c
	C3/A	183.74±6.76a	87.21±2.70d	110.56±2.84b	113.70±2.26b	94.68±3.01c
	C1/T	183.74±6.76a	75.74±6.76e	130.67±9.95b	118.22±0.38c	97.61±1.13d
	C2/T	183.74±6.76a	79.80±7.10e	133.43±1.07b	117.95±3.01c	99.4634±1.50d
	C3/T	183.74±6.76a	85.77±6.76d	121.87±0.36b	118.48±1.50b	99.47±3.01c
	C1/Ch	183.74±6.76a	135.568±3.72c	128.60±6.40b	112.11±2.26b	99.27±0.30c
	C2/Ch	183.74±6.76a	128.23±1.01b	122.85±6.75b	108.12±4.14c	95.05±0.0d
	C3/Ch	183.74±6.76a	130.19±3.04b	118.35±1.07c	112.12±7.14c	95.40±0.49d
VOO with natural additives for packing Labneh	Control	154.59±8.79a	119.76±2.70b	100.756±8.89c	83.929±3.76d	75.42264±1.50e
	C1/A	154.59±8.79a	129.411235±5.41d	89.41±6.75b	85.58±1.50d	100.53±2.26b
	C2/A	154.59±8.79a	130.17±0.71b	87.0183±0.71b	83.797865±6.77d	100.80±1.13b
	C3/A	154.59±8.79a	132.18±4.27b	89.41059.18±4.27b	84.5958±1.88d	101.60±3.01b
	C1/T	154.59±8.79a	65.70±2.03e	97.49±7.11c	73.56±0.38d	105.58±4.89b
	C2/T	154.59±8.79a	67.14±2.70c	101.01±2.84b	74.36±8.27c	99.20±4.89b
	C3/T	154.59±8.79a	67.14±4.73c	101.76±11.73b	74.95±2.18c	100.53±3.76b
	C1/Ch	154.59±8.79a	63.79±3.38d	103.52±1.42b	78.88±4.14c	106.65±4.14b
	C2/Ch	154.59±8.79a	66.66±7.43d	108.05±10.66b	79.14±3.76c	101.60±0.75b
	C3/Ch	154.59±8.79a	68.33±2.37d	110.31±3.91b	80.47±5.64c	103.72±2.26b

CONCLUSION

The principal causes of deterioration of the virgin olive oil during storage are the oxidation reactions and their products as well as the loss of natural antioxidants. Acidity in all VOO samples with the different additives, whether, those used as a packing medium for traditional concentrated Yoghurt balls or the others without concentrated Yoghurt balls, were less than the acidity of the control sample. In addition, values of peroxide values exceed the limited value of Palestinian standard for all samples with the natural additives for VOO, but less than the control at the end of storage time. For Tomato Peel and Chili Pepper additives, the lower concentration of natural additives gives better results than the higher concentration. K_{232} and K_{270} for VOO values didn't exceed the legislation limit accepted for VOO during 6 months of storage time for all samples of VOO with the natural additives. For VOO samples used for packing traditional concentrated Yoghurt, K_{232} and K_{270} values exceeded the official limit for

Arum and tomato peel added samples. On the other hand, K_{232} for the chili pepper additives remained lower than the accepted limit for VOO. At the end of the storage period of six months, the total phenol content for samples used as a packing medium for the traditional concentrated Yoghurt was lower than the samples of olive oil with the natural antioxidants stored without concentrated Yoghurt balls. However, all natural additives used in this investigation showed a positive trend for improving the quality of olive oil used as a packing medium for traditional concentrated Yoghurt in different rates.

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Conflicts of Interest

The authors declare no conflict of interest.

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