The Effect of Adding Fig Leaf Extracts by Thermal Method on the Physicochemical Properties and Oxidative Stability of Virgin Olive Oil

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***Abstract*—Given the importance of olive oil and vulnerable against oxidative spoilage, can be used fig leaf extract as an antioxidant to prevent corruption in the olive oil. This study examined the effect of adding fig (ficuscarica) leaf extract by thermal method to virgin olive oil on the physicochemical properties and oxidative stability it, in a randomized complete block design with three replications deals. Treatments include virgin olive oil contains fig leaf extract 5% extracted by thermal method at 80 ℃ for one hour and control of virgin olive oil (no fig leaf extract), respectively. The results showed that the addition of fig leaf extract as antioxidants in virgin olive oil by thermal method thereby increasing total amount of polyphenol compounds, chlorophyll content and oxidative stability compared with virgin olive oil (Control). The polyphenolic compounds with peroxide and TBA inverse relationship, thus increasing the amount of polyphenol compounds can reduce peroxide and TBA are fig leaf extract containing samples compared to control samples.**

***Index Terms*—oxidative stability, thermal method, olive oil, fig leaf extract**

I. Introduction

Olive tree Olea of the genus and the family Oleaceae is more than thirty are known species in the world. Common species in gardens and large parts of olive cultivation is to be named Olea europaea [1]. Two main products of the olive fruit, canned olives and olive oil are produced. Olive oil for nutritional value and health benefits of the old times is known. Most important products of olive cultivation, oil is almost 93 percent of global production is used exclusively to produce oil. Olive evolved, about 30 percent its oil. The oil is a mixture of oleic acid, linoleic acid and palmitic acid. Dietary linoleic acid will be leaded to synthesis of eicosanoids which can prevent fatty deposits and the formation of platelets. By comparing the amount of saturated fatty acids and monounsaturated olive oil with other oils can be realized to its biological and quality value. Olive oil contains many chemical compounds such as polyphenols, which distinguishes it from other vegetable oils. Vitamin E found in olive oil of high biological value because it contains 85-80% of alpha-Tocopherol, 6% beta-Tocopherol and 15% gamma-Tocopherolis [1]. Olive oil phenolic compounds are a gr in kg. Virgin olive oils contains large amounts of phenolic compounds that have a direct effect on the taste of olive oil against oxidation stability and through induction of a hydrogen atom to fat radicals created block the oxidation process are [2]. Tyrosol, hydroxytyrosol, oleuropein, simple phenolic acids and derivatives esterified tyrosol and Hydroxy-tyrosol including the most popular is olive polyphenol compounds these compounds, in addition to its lasting influence on oil and chemical parameters, as well as increase the nutritional value and prevent many diseases are [3].

Fig fruit is nutritious and flavor. Fig fruit contains sugary materials, material that nitrogen, fats, minerals, amino acids, different enzymes and carotene. That leaves about 0.6% of bitterness such as Ficusin and there Bergaptene. Fig leaves contains moisture content of 67.6%, 4.3% protein, 1.7% fat, 4.7% fiber, 5.3% ash, 3.6% Pentose, Carotene, Bergaptene, Sigma sterol, Sitosterol, Tyrosine, Ficusin, Oleanolic, Taragzasterol, Betasitosterol, Sapogenine and compounds are biologically active [4]. Given the importance of olive oil and vulnerable against oxidative spoilage and also high consumption of this product in the diet of Iranian families, used the fig leaf extracts as an antioxidant to prevent corruption in olive oil [5]. Antioxidants can inhibit or delay oxidation, but does not improve the quality of a product enhances the oxidized reactions corruption is irreversible. Antioxidant compounds through various reactions such as the publication and beginning of the process control catalysts, sustain hydroperoxides, destruction or the combination of the radicals, depending on their structure, slow the rate of oxidation reactions, but it seems that most of the antioxidants through a combination with proxy radicals that are created in the process of release or the decomposition of hydro peroxides reduce speed Autoxidation [6]. There are many

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ways to transport flavorful Materials to oil. The importance of this issue because of the impact of extraction on the acceptance and oxidative stability of oil is flavor ful. Methods transfer flavorful materials and antioxidants in olive oil traditional method, heating at specific temperatures, adding condensed extract the oil, microwave, flooding method, Supercritical Fluid Extraction (SFE), cold pressed olive with vegetables and spices, and is extracted with ultrasonic waves [7]. The method used in this study is specific heating methods in this method vegetable oil in contact with material containing the flavor, the dropped to 80 to 200℃ temperature [8]. Migoel *et al.*, (2003) the effect of powder and extracts of spices and thermal method (75℃) on the olive oil and other edible oils refined in order to increase the oxidative stability studied and the results showed that the oxidative stability of oil samples by adding (fig leaf extract and Menthapiperita L.) to olive oil, fig leaf extract and basil to refined oil and basil to vegetable oil mixed were increased [9]. In this regard, the study effect of adding fig leaf extract by thermal method to virgin olive oil on the physicochemical properties and oxidative stability of those deals.

II. Materials and Methods

A. The Results of Chemical Tests on the Basic Components of Virgin Olive Oil

Chemical characteristics of the virgin olive oil used to flavor shown in Table I. Natural olive oil features and is as follows.

TABLE I. Chemical Characteristics Was Purchased Virgin Olive Oil

Chlorophyll	Chlorophyll	Oxidative stability	Acidity	Peroxide
11.01±0.38	1.33±0.026	14.16±0.89	277.18±0.89	1.32±0.04

B. The Results of Chemical Analysis of Fig Leaves Extract

Table II shows the results of the compounds in the fig leaf extract. The results showed that the major components of the extract are glycoside. To prepare treatments crushed fig leaves than 5% was added to virgin olive oil then, at 80℃ for one hour with three replications were prepared and control is virgin olive oil. The total amount of polyphenol compounds samples using the Folin-Kaltv was measured. These samples, along with control (no fig leaf extract) were placed in glass bottles, after closing the glass door and wrapping aluminum foil around them, were placed at room temperature, away from direct light and changes in measurements at the end of each month for 5 months, were studied. The methods of measuring these factors are as follows:

- Total phenolic content test by Folin-Ciocalteu reagent was conducted [10].
- Measure acidity (mg KOH needed to neutralize free fatty acids per gram of fat called acid number) according to the National Standard No.4178 was conducted.
- Measuring the peroxide (This factor represents the entire content of hydro peroxides and fats oxygen peroxide or fat-containing substances) according to the National Standard No. 4179 was conducted.
- Test the level of malondialdehyde (Thiobarbituric TBA) to measure lipid peroxidation, which is carried out in accordance with the National Standard No.10494.
- Colorimetric test: the chlorophyll and pigments in the oil typically by spectrophotometer at 360, 670 and 710nm is measured. Virgin olive oil is different from yellowish green to golden. The main pigments found in olive oil are: 1. chlorophyll a, b and pheophytina, b 2- carotenoids, in this study, used to measure chlorophyll content of the AOCS standard in Cc13i-96number [10].
- The time resistance to oxidation: using rancimat (at a temperature of 110℃ with air flow of 20 liters per hour) was measured [10].

Data analysis: an experiment in a completely randomized block design and test mean Duncan test was conducted using SPSS software.

TABLE II. Results of the Analysis Chemical Compounds Fig Leaf Extract

Peak numbers	Total polyphenol compounds	Oxidative stability	Acidity	Peroxide
1	Cyanidin 3 & 5 D-galactoside	5.02	611	449.287
2	cyanidin-3-galactoside	7.11	449	287
3	Cyanidin 3 Rotinoside	7.98	595	449.287
4	Pelargonidin 3-glucoside	9.82	433	271

III. Result and Discussion

A. The Test Results of Total Phenolic Content

The results showed that the total amount of polyphenol compounds, olive oil samples containing fig leaf extract by thermal extraction with control sample is statistically significant at 1%. Most of the polyphenol compounds extracted from samples containing fig leaf extract value of 264.50mg Tannic acid/kg oil and the lowest polyphenol compounds in the control sample were in the fifth month (Fig. 1). The results indicated that a polyphenol compound in virgin olive oil contains extracts of fig leaf in the fifth month more than the amount of these compounds in the second month control samples (Fig. 1). Bubonja-Sonje (2011) in their study found that fig leaf extracts phenolic compounds and antioxidant activity stronger than the phenolic extracts of cocoa and olive. The results of this study are equal [11]. Jafarian *et al.*, (2012) examined the effect of three spices including fig leaf extract, mint and thyme on oxidative stability and fatty acid profile of olive oil to by thermal method began. The results showed that the oxidative stability of virgin olive oil containing fig leaf extract treatments and mint increased [12].

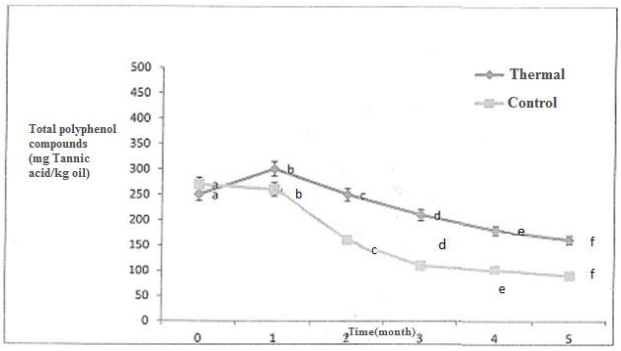

Figure 1. Comparison of total polyphenol compounds, based on adding fig leaf extract thermal method and control interaction on their storage

B. Test Results of the Determination of Acidity

According to data from Table III Comparison of the interaction of treatment with fig leaf extract in olive oil, control and maintenance of the acidity value was significant ($P<0.01$).

Based on the results of the Table III in all samples was increased acidity number. The increase was faster in the control sample. Fig leaf extract samples during the maintenance period were significantly lower compared to control is the acidity number. Due to acidity increase faster in the control sample, can be attributed to the presence of the enzyme lipase in virgin olive oil because the treatment is not performed during the production of virgin olive oil operation and therefore does not apply thermal thus, the enzyme still remains active in oil and by the action of enzymes, free fatty acids are formed to continue the process of oxidation, oil are converted to aldehydes and ketones and this increases the number of acidity are in control. Increasing the percentage of free fatty acids increased during heat as a result of various chemical reactions, especially hydrolysis of triglycerides. Fig leaf extract in olive oil can further prevent the formation of FFA (free fatty acids) is. The process is quite regular, not be considered for this index. The findings of this study were matches by the results of Mohammadi *et al.*, (2007), which examines the relationship between fatty acid compositions of oil stability in mixed Sunflower oil and canola were involved.

TABLE III. THE FIG LEAF EXTRACT PRODUCED BY THERMAL METHOD AND CONTROL OF ACIDITY VALUE

Time Keeping	Thermal method	Controls	Interaction of ultrasonic methods in acidity
1	1.0 ± 0.12^{a}	1.5 ± 1.2^{a}	2.3 ± 0.03^{a}
2	1.2 ± 0.14^{b}	1.75 ± 0.03^{b}	2.45 ± 0.05^{ab}
3	1.4 ± 0.19^{bc}	1.9 ± 0.41^{c}	2.65 ± 0.4^{b}
4	1.6 ± 0.71^{c}	2.3 ± 0.57^{d}	2.72 ± 0.16^{bc}
5	1.8 ± 0.24^{d}	3.5 ± 0.09^{e}	2.83 ± 0.23^{c}

C. Test Results Peroxide

Based on the results from the Fig. 2, fig leaf extract samples produced in zero time (immediately after the production 16.73 mqo2/kg oil), significantly higher than the control sample containing peroxide (11.41 mqo2/kg oil), respectively. After a month of preparation of samples, peroxide fig leaf extract significantly reduced at the same time. The highest peroxide value during maintenance of control in the third month and the lowest peroxide value of the samples in the fifth month was a fig leaf extract (Fig. 2). At time zero (immediately after heating) heating the catalyst oxidation reaction is accelerated. As is clear separation of hydrogen bound to a carbon adjacent to the carbon with double bonds needs less energy. The reason is that hydrogen under resonance or flipping the double bond electrons is for this reason this hydrogen than other hydrogen the situation is volatile. In the case of oleic acid, hydrogen is separated from the carbon number 8 or 11 in each case leads to the formation the two free radicals in the resonant (or actually four free radicals) occurs. These radicals then combine with oxygen, are converted to hydro peroxides. During the formation of hydroperoxides, large amounts of Cis bonds to during transport are becoming to Trans form the amount of depends on the temperature. The increase in temperature increases the rate of formation of hydro peroxides formed in Trans [10]. Low-temperature oxidation of fatty acids hydro peroxides produce more relevant responses in the case of unsaturated compounds are not reduced, but the high-temperature oxidation of the double bonds are saturated so the stability of oil against oxidation at high temperatures is important [13]. As a direct correlation between the number of peroxide and temperature, at zero time then there is production and the increase peroxide value at zero time thermal treatment compared to control for this reason. Peroxide thermal treatments after five months there was a significant difference compared to control and peroxide less shows (Fig. 2). The reason could be because of the heat of formation of polar compounds consists mainly of oxidized triglycerides and polymerization triglycerides increased. Yoshida *et al.*, (2010) reports were consistent with the results obtained in this study, that a significant difference in peroxide fig leaf extract oil sample over time [14].

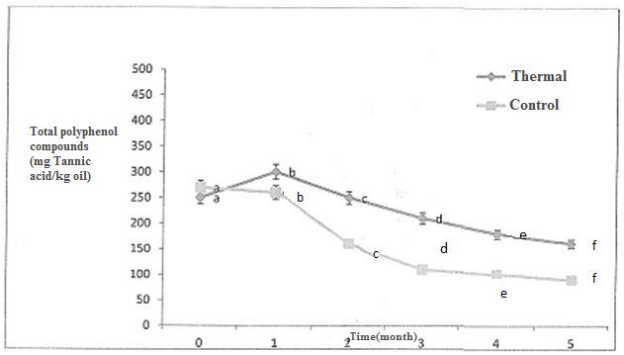

Figure 2. Comparison of peroxide-based interaction add extract in virgin olive oil by thermal method and control of storage time

D. Test Results of Thiobarbituric Acid

Alone Peroxide is not characteristic of oil sample oxidation because this number is an indicator of oxidation

of primary products and secondary oxidation products not specify. Therefore, such a test to determine the number of TBA (Malone aldehyde content in one kilogram of oil) as an indicator of the level of oxidation and secondary products of this is reaction, it seems necessary. Therefore, in this study, this test was conducted. The results of the analysis of variance show the effects of fig leaf extract in virgin olive oil and control in during storage on the number of TBA was significant ($P<0.01$). In control, because over time, and achieve specified levels of peroxide, peroxide decomposition will start, thus, the production of aldehyde, ketone and increasing TBA which is resulting in a reduction in the amount of peroxide at the end of the fifth month (Fig. 3). But the fig leaf extract in olive oil treatments Due to compounds with antioxidant properties prevent it from increasing too fast the TBA. In the final months of testing the speed of formation of oxidation primary products declined. Presumably, part of the hydro peroxides formed in the publication began to disintegrate and secondary oxidation products such as Malone aldehydes are converted (Fig. 3). Dramatic increase in the number of TBA in the final months of testing, the observed decline in the rate of formation of hydro peroxides acknowledges this month. Tahanejad *et al.*, (2011) that trials on the assessment of lavender essential oil anti-oxidation in the soybean oil system have, also seen an increase in TBA value with overtime of treatments were tested [15].

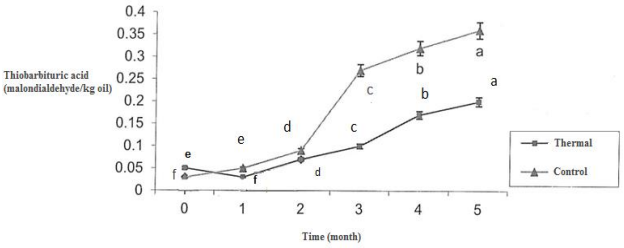

Figure 3. Comparison of thiobarbituric acid value based on the interaction add the fig leaf extract thermal method and control sample at the time of their maintenance

E. Colorimetric Test Results (Chlorophyll Color Index)

As the results obtained effect of fig leaf extract in virgin olive oil in storage compared to control the color of chlorophyll have significant difference in the level of one percent. The optimum temperature for the Chlorophylase of 82.2 to 60 ℃ has been reported. The higher the temperature, the enzyme activity is reduced. Olive oil contains a fig leaf extracts by thermal method treatment because of the conditions (80 ℃) Chlorophylase enzyme activity, resulting in the hydrolysis of the ester bond was Phytol and after separation of the chlorophyll Phytol is converted to Chlorophyllide. So this is not observed differences in the treatment green color. But during the process of thermal a lipoprotein attached to chlorophyll that chlorophyll has the protective role and barriers separating magnesium from it, denatured and can no longer play such a role and hence, chlorophyll easier and open to expose to acid and change the color of it is [5]. So in addition to the Chlorophylase active in the thermal process at 80 ℃ is caused Chlorophyllide. Below this temperature, the denaturation of lipoprotein and Chlorophyllide magnesium atoms separate into Pheophorbideis, color and spectral characteristics it is like pheophytin and the in the thermal treatment is becoming green to olive color that reduce the amount of chlorophyll in the thermal treatment may for this reason (Fig. 4). Changes the colors of chlorophyll in the sample have fig leaf extracts to diminish from the first month until the fifth month was 1.99 mg/kg oil (Fig. 4). Trend of a decrease in the control treatment with a higher severity of the thermal treatment occurred. In the thermal process, the removal of the enzyme is done and green discoloration can be at least partly related to the oxidizing effects of free radicals produced of fat is due to thermal damage. In the control treatment that is not added plant, the loss of chlorophyll content of virgin olive oil could be the result of oil oxidation and the increase in virgin olive oil acidity is (Fig. 4).

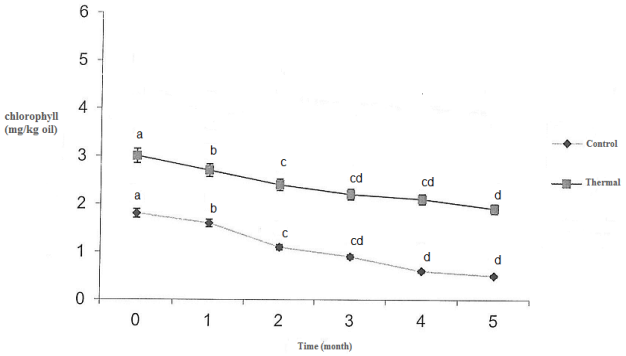

Figure 4. Comparison of chlorophyll content based on the interaction of adding fig leaf extracts by thermal method and controls their storage

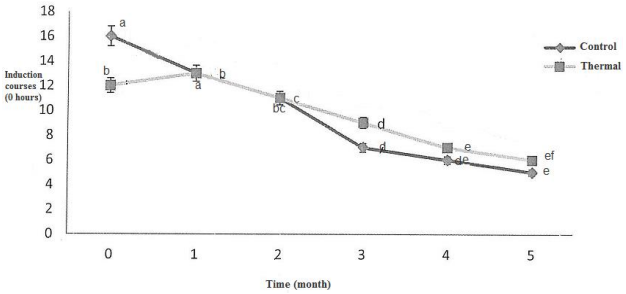

Figure 5. Comparison of rancimat number based on the interaction of adding fig leaf extracts by thermal method and controls their storage

F. Oxidative Stability Test Results

The ability of the oil against oxidation is expressed oxidative stability of oil. Oxidation status was measured at 110 ℃ when resistance to oxidation is terminated as a result of decomposition carboxylic acids from oxidation of lipids and absorbing it in deionized water, special guidance will show a rapid increase. At the same time have been thermal processes treatments due process and increasing the amount of peroxide, lower oxidative stability are at zero time (12.44 hours). Over time, also increasingly the oxidative stability in thermal treatment and in the fifth month treatments fig leaf extract have a higher oxidative stability (13.7 hours) than in controls (28.6 hours) (Fig. 5). Control sample the absence of a fig leaf extract antioxidants and special profile of fatty acids,

the less time there. The results were compatible by the results of Miguel (2003) and Bouaziz *et al.*, (2008) [9], [16]. Bubonja-Sonje (2011) in their study concluded the fig leaf extract phenolic compounds can be used as a food additives for prevent corruption and pollution [11]. Those results of this study are equal.

IV. Conclusions

Consuming further of antioxidants whether natural or synthetic type buildings are phenolic. Antioxidants in autoxidation by reacting the free radicals interfere with their proxy antioxidants, free radical production cannot start the next oxidation and construction is stabilized the resonance hybrids and so the autoxidation mechanism prevents. In this study also adding a fig leaf extracts as antioxidants in virgin olive oil the extracting thermal at 80 ℃ for 1 hour, thereby increasing total amount of polyphenol compounds, chlorophyll content and oxidative stability compared with virgin olive oil (Control). The poly phenolic compounds with the peroxide and TBA inverse relationship, so increasing the amount of polyphenol compounds can reduce peroxide and TBA are fig leaf extract containing samples compared to control samples.

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