INVESTIGATION THE THERMAL RESISTANCE CHARACTERISTICS OF OLIVE OIL

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ABSTRACT

Olive oil has more anti-oxidant and heat resistance than many other oils. The heat resistance stability of extra virgin olive oils varies slightly and depends on various factors. But in general, extra virgin olive oil is suiFigure for cooking and frying. Compared to other oils such as soybean oil or sunflower oil, this oil tolerates higher temperatures and is less susceptible to obvious changes such as cracking, oxidation and neutralization. For this reason, extra virgin olive oil can be used for cooking and frying.

Heating oils at high temperatures causes extensive changes in their chemical properties, and due to the importance of oils in health, it is necessary to study and research more in choosing the type of oil to be used and its quality. Extra virgin olive oil is considered one of the best oils due to its beneficial nutritional effects. Therefore, this study was conducted with the aim of comparing the thermal stability of extra virgin olive oil and normal olive oil. In this research, eight types of extra virgin olive oil were tested. In order to evaluate the thermal stability, the oils were heated at 120°C for 4 hours and sampling was done at 2-hour intervals. The composition of fatty acids, acid number, peroxide number, anisidine number, totox number and oxidative stability with Rancimet were performed according to standard methods. According to all the researches that have been done so far, it is clear that oleic acid is the main fatty acid of olive oil, and its amount is between 69 and 74%. Based on the results, it can be seen that extra virgin olive oils have more favorable properties than the normal type and are more resistant to heat. It is recommended that if olive oil is consumed raw, it is better to use normal oils, but if it is used in cooking, extra virgin oils should be used as much as possible.

Keywords: extra virgin olive oil, edible oil, heat resistance, regular olive oil.

INTRODUCTION

The thermal resistance of olive oil is about 190 degrees Celsius. This means that if a high temperature is applied to the olive oil and its temperature reaches above 190 degrees Celsius, during frying, cooking or other thermal processes, the olive oil may oxidize and spoil and create substances harmful to health. To use olive oil, it is better to use a lower cooking temperature and store it at room temperature to extract the best quality and health benefits from it.

Fats and oils are important components of food, during the reaction with food ingredients, they leave favorable organoleptic characteristics, on the other hand, during frying, factors such as moisture, heat and oxygen cause the oxidation of frying oil, which This causes the quality of the product to drop [1]. Heating oils at high temperatures causes extensive changes in physical and chemical properties, fatty acids as the most important components of oils have an important position in changing the chemical and physical properties of oils [2]. Due to the importance of oils in health, it is necessary to study and research more in choosing the oil to use and choosing its type and quality. Most researchers in the field of edible oils, among oily fruits, introduce olive as one of the most important sources of oil. Olive oil is one of the important components of the Mediterranean diet, which is obtained by extracting the fruit of the Olea europaea tree. Due to the fact that the properties of olive oil depend on its quality and the price of olive oil is also related to its quality, for this reason, the best oil should be chosen in terms of quality [3]. The nutritional benefits of olive oil depend on the composition of their fatty acids. Olive oil contains high amounts of natural antioxidants that are effective in preventing many diseases [4,5]. Olive oil improves the fat profile by reducing the amount of low-density lipoprotein and increasing the amount of high-density lipoprotein, improving vascular oxidative damage, improving vascular function, reducing blood cholesterol, improving blood pressure control and favorable changes in body homeostasis [5, 6]. Compared to other vegeFigure oils, olive oil is resistant to oxidation, which is due to the composition of its fatty acids, especially the ratio of monounsaturated and polyunsaturated fatty acids and other partial compounds [7]. Among the classifications of olive oil, natural olive oil has numerous nutritional, therapeutic and economic benefits[8]. Antioxidants, like phenolic compounds, prevent oil spoilage and at the same time create a good taste [9]. Based on previous studies, it can be found that heat changes the oxidative stability and degradability of olive oil[10]. Thermal process in oils activates free radicals and increases oxidation [11]. Heating increases free fatty acids, decreases tocopherols and isomerization of fatty acids [12]. The most important factors that have the most effects on oils during heat treatment are oil structure, heating time and temperature [13].

Baluryan and his colleagues in the study of thermal resistance and efficiency of palm olein and rapeseed oil mixtures in frying potato chips showed that after 5 consecutive days of heating at 180 degrees Celsius, it increased the amount of polar compounds, acidity, and peroxide value of the oils. During frying, the presence of free fatty acids reduces the smoke point of the oil [14]. In a research conducted to investigate the stability of fatty acids in frying oils and liquid oil during frying, it was shown that the stability of frying oils during frying is low and they cannot be used for frying several times. In addition, these studies showed that liquid oils are not suiFigure for frying [15]. In the studies conducted regarding the investigation of phenolic compounds and oxidative stability of olive oil during storage, it was shown that increasing the storage time increases the acidity and peroxide and decreases the phenolic compounds in the oil, and this can cause the oil's low resistance to oxidation [16]. In 2013, by investigating the characteristics of two varieties of yellow and oil olives in the cities of Shiraz and Kazeroon, Hamapour and his colleagues found that the quality of olive oil depends on the type of variety and the climate of its cultivation[17]. Also, in 2013, Alavi Rafi and his colleagues, by studying the properties of olive oil, concluded that climatic and agricultural conditions affect the composition of olive oil[18]. Due to the fact that nowadays natural and untouched products are highly welcomed and extra virgin olive oil is considered one of the natural products and statistics have shown that 90% of consumed oils are oils that are almost virgin. And people use them in cooking and it is effective in people's health, especially cardiovascular diseases, diabetes and cancer. Therefore, the quality control of these oils is considered one of the most important issues in health and food safety. For this reason, this study was carried out with the aim of comparing the thermal resistance of extra virgin olive oil with the normal type and investigating the changes in chemical compounds during the heating period and providing recommendations for the correct use of extra virgin olive oil.

2- MATERIALS AND METHODS

Solvents and chemicals used in this study were of analytical grade and were purchased from Merck.

2-1. SAMPLING

Extra virgin olive oils including 10 types from border markets in the west of the country and Iranian extra virgin olive oils including 8 types from local stores in Qazvin province. were purchased, all the samples had been produced for at least 4 months at the time of testing.

2-2. THERMAL STABILITY TEST

Some oil was removed from each sample and heated at 120°C for 4 hours. Sampling was done with time intervals of 2 hours, and after cooling down and reaching the ambient temperature, the samples were transferred to closed tubes and kept in the freezer until the test.

2-3- ANALYSIS OF PARAMETERS

In this research, the profile of fatty acids with a gas chromatography device (Varian CP-3800) equipped with a flame detector (FID) based on the Iranian national standards number 4090 and 4091 [19, 20], acid number according to standard number 4178 [21], peroxide index with standard number 4179 [22], anisidine index with standard number 4093, totox index was calculated and from the total of twice the number of peroxide and anisidine index [23] and also to determine the oxidation resistance of olive oil samples Ransimet model 743 device was used [24].

2-4- STATISTICAL ANALYSIS

To perform statistical analysis, the average of three repetitions was considered, and analysis of variance was used for repeated data in SPSS-16 software. The graphs were drawn with Excel 2010 software.

3- FINDINGS

Figure 1 shows the composition and percentage of fatty acids of olive oil. Oleic acid is the main fatty acid of studied olive oils. After that, palmitic acid, linoleic acid, stearic acid, palmitoleic acid and linolenic acid are in the next ranks. In Figure 2, the results related to acid, peroxide, anizidine and totox indices are presented. The results indicate that in most of the tested samples, the amount of acid number before heating corresponds to the standard amount of IOC (International Olive Council), which is less than 1% in terms of oleic acid for extra virgin olive oils[25]. But in samples 1 and 4, this amount is higher than the determined limit. In the second hour, the heat changes it, which is accompanied by a decrease in its value in the fourth hour. The amount of indic peroxide of all the samples before the heat process is consistent with the amount of IOC standard and Iran's internal standard 1446, which is determined for extra virgin olive oils, less than or equal to 20 [22].

In the second hour, the amount of peroxide in all the tested oils was found, and in some of these samples, its amount reached higher than the standard range. From the second hour onwards, peroxide failure is observed. The amount of anisidine in all the tested samples before heating is within the standard range, which is based on the Iranian National Standard No. 4152, the maximum amount of anisidine in frying oils is set at 6, but in the second and fourth hours, this amount It increases and in some samples it rises to more than several times compared to the standard range. Standard totox index of total oxidation is calculated from the sum of two times of peroxide index and anisidine index. At first, the amount of this index is low, but due to heat, its amount increases in the second and fourth hours. In order to investigate the oxidative stability, 3 grams of oil samples were tested at a temperature of 120°C. The ventilation speed was also set at 20 liters per hour [24]. Figure 3 shows the duration of oxidative stability of the samples, based on which it can be seen that sample 2 has the highest and sample 4 has the lowest oxidative stability.

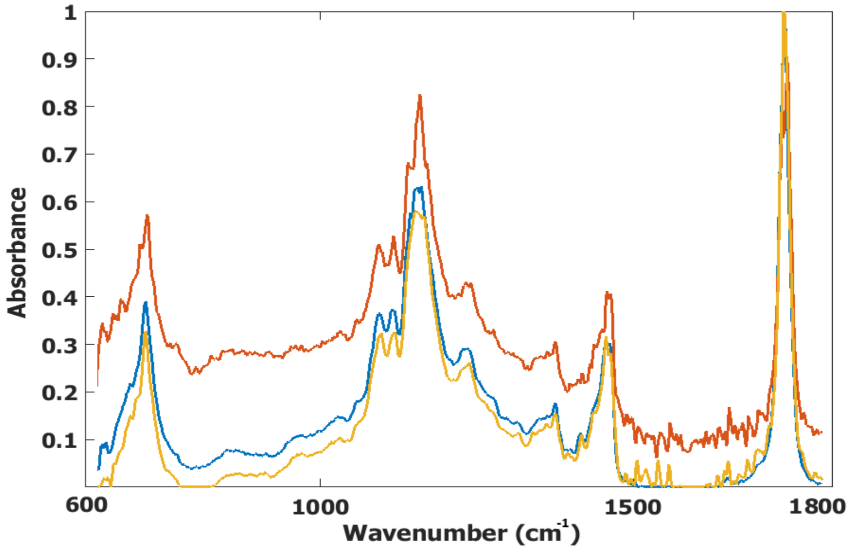

figure 1. Comparison of acid index changes during thermal process

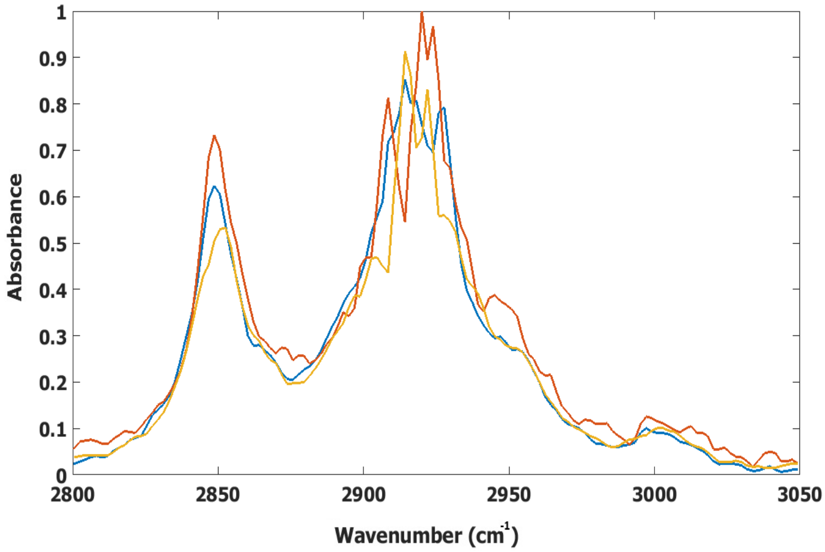

figure 2. Comparison of anisidine index changes during thermal process

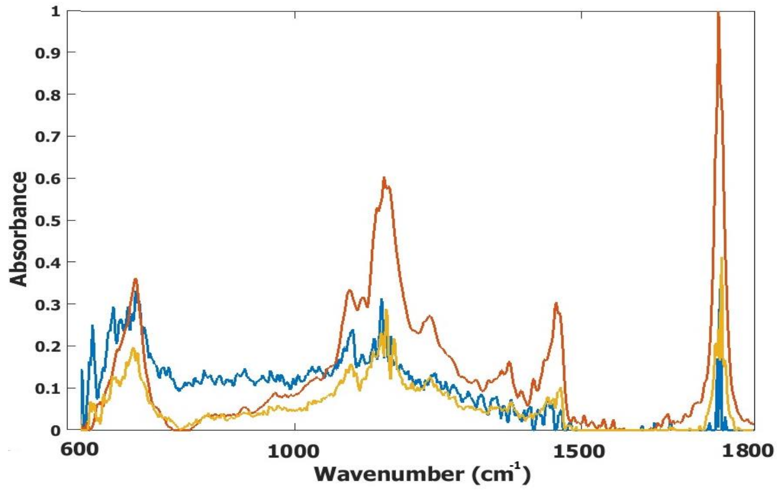

Figure 3. Comparison of Totox index during the thermal process

4- RESULTS AND DISCUSSION

The results of this research showed that each type of oil mainly contains monounsaturated fatty acids, especially oleic acid, saturated fatty acids, especially palmitic acid, and polyunsaturated fatty acids, especially linoleic acid. The percentage of two unsaturated fatty acids in Iranian extra virgin olive oils, i.e. oleic acid and linoleic acid, was 69-74 and 8-9% respectively, and in foreign oils it was 73-79 and 3-8% respectively. , which results show that both extra virgin olive oils are consistent with the results of the study conducted in 1996 [26], as well as the findings of Khorazy et al. and Fashi found that their dominant fatty acid is oleic acid [27]. The results of Pokorny and Sakurai's research in 2002 showed that both types of oil mainly contain high oleic acid and a lower percentage of monounsaturated fatty acids, especially oleic acid and linoleic acid. They are superior both in terms of storage and thermal processing.[28] In 2003, Pinelli et al. studied virgin olive oils in Italy and concluded that the high amount of polyunsaturated fatty acids increases the oxidizability of the oils and thus decreases their stability[29], based on Figure 1. It can be seen that foreign samples have higher oleic acid than domestic samples, but the amount of linoleic acid in domestic oils is higher than in foreign oils.

It can be said that based on the structure of fatty acids, foreign oils have more favorable reduction stability. However, Iranian samples are in a more favorable nutritional condition due to the high amount of linoleic acid, which is considered a part of essential fatty acids, which is confirmed by the research conducted by Alavi Rafiei and colleagues[30].

In Figure 2, the results of the acid index show that samples 1 and 4 have values higher than the standard. The high percentage of free fatty acids in these samples indicates inappropriate olive storage conditions, such as high humidity and temperature [31]. Due to the hydrolysis of triglycerides, heat causes an increase in acidic andes [32]. But the results of Figure 1 showed that in both types of oil, with increasing time, the amount of acid base does not increase much. Because one of the first factors that trigger hydrolysis is the presence of water from frying material[33] and because there is no frying material in this study, the amount of hydrolysis will decrease and the amount of acidity will not increase much, and the second hour after the amount It decreases, this decrease is due to the volatility of free fatty acids at high temperatures [34]. Since the rate of oxidation of free fatty acids is higher than the fatty acids participating in the structure of triglycerides, the lower the amount of free fatty acids, the more the amount of acid andes decreases, and the oil is less resistant to oxidation. It will be higher. By comparing the average acid index in Figure 1, it can be seen that foreign oils have a favorable condition compared to Iranian oils during the thermal process.

The amount of oil peroxide can change under the influence of various factors. One of these factors can be the amount of unsaturated fatty acids, as the amount of polyunsaturated acids in the oil increases, the amount of peroxide increases. Also, other factors such as oil extraction conditions, water temperature used, type of olive variety and climatic conditions of growth can affect the peroxide level [35]. In figure number 2, it is evident that in the second hour onwards, the hydrogen peroxide will fail, that is, its amount will decrease. In 1994, in a study by Neff and colleagues, they heated frying oil with a formulation of 1:1 palm olein and soy without antioxidants and reported the breakdown of peroxide after 5 and 6 hours[36], due to the high level of unsaturated fatty acids. In these oils, at high temperatures, the rate of formation and transformation of free radicals in them is faster, and therefore the peroxide concentration quickly reaches the breaking point and their amount is reduced, that is, in this case, hydroperoxide turns into secondary oxidation compounds such as aldehydes. And ketones are converted. That is, after the failure of oxidation, it continues [37]. This article shows that peroxide has an unsFigure structure chemically and breaks at high temperatures[38]. In Figure 2, it is clearly seen that foreign oils have better characteristics than Iranian types. The presence of natural antioxidants in olive oil increases the oil's resistance to oxidative spoilage, and as a result, it reduces the amount of peroxide increase [39, 40].

Anisidine index indicates the level of secondary oxidation, which is more sFigure than primary oxidation products, i.e. peroxides [41]. Previous studies show that as a result of increasing temperature and time, Anisidine also increases [1, 37]. Baiano and colleagues in 2005 stated that the lower the amount of this index, the lower the secondary oxidation rate. The antioxidant properties of phenolic compounds are mostly related to the secondary compounds of oxidation [42]. It is evident in Figure 3 that in the second hour by applying the heat process, the amount of secondary compounds increases, the result of which is an increase in anisidine, and this increase in oxidation can be due to the destruction of existing antioxidants such as phenolic compounds in olive oil, but in the fourth hour It will be reduced a bit.

In 1992, Tsimidou and his colleagues, by studying the phenolic compounds in olive oil, showed that increasing the amounts of these compounds in olive oil increases its stability and durability[43]. This low stability can be related to the high content of polyunsaturated fatty acids such as linoleic acid (which quickly oxidizes and turns into secondary compounds) [39] and the degradation of phenolic compounds over time [42].

Due to the fact that peroxide alone is not considered a reliable indicator for the oxidation of oils, the Totox index for oils is calculated based on this [1], which is a measure of total oxidation. The calculation of Totox index showed that heat causes a change in the total oxidation rate, which leads to an increase in the number of peroxide, anisidine and Totox. The previous studies also confirm this[1, 45-47]. Figure 3 shows the difference between Iranian and foreign oils. In Iranian oils, the amount of this index is higher, which indicates that total oxidation is higher than foreign oil. Abdulkarim and his colleagues showed in the comparison of the thermal stability of vegeFigure oils that the high content of polyunsaturated fatty acids such as linolenic and linoleic acids increases the amount of TOTOX number [48].

In 2010, Susana Casal and her colleagues showed that extra virgin olive oil has the longest oxidation resistance time by evaluating the oxidative stability with Rancimet method in different edible oils [45]. The highest oxidation resistance time indicates the high stability of the oil during heating. In 2004, Aranda and colleagues showed that the high oxidation resistance of two Spanish olive cultivars, Cornicabra and Picol, was due to the high amount of oleic acid and low amounts of linoleic acid and linolenic acid [49]. Susana Casal and colleagues in 2010 showed that extra virgin olive oil has more phenolic compounds than other vegeFigure oils, these compounds have high antioxidant and antimicrobial effects, the amount of phenolic compounds has a direct relationship with the amount of oxidative stability. [45]. Among the tested samples, sample No. 2 with a time of 13.68 hours has the highest and sample No. 4 with a time of 2.70 hours has the lowest oxidation resistance. In their study, Haqi Kharazi and colleagues stated that the low oxidation stability of the oil Fishi variety olive is because of the low amount of oleic acid and high linoleic acid in it [27], which can be a justification for the high oxidative stability of sample number 2 compared to the rest. Among the studied samples, no significant difference was observed between sample 6 and sample 8 at the 5% level, but there was a significant difference at the 5% level in other samples. Based on Figure 4, it can be stated that extra virgin olive samples have higher oxidative stability than normal olive oil samples. It can be seen that extra virgin olive oils have higher amounts of phenolic compounds of monounsaturated fatty acids such as oleic acid and a lower amount of linoleic acid than normal samples, also other factors such as growth and climatic conditions can be It is involved in the stability of olive oil.

5- CONCLUSIONS

Based on the results obtained from the thermal stability of the oil during heating and the results of the oxidation resistance with Rancimet machine, it can be concluded that extra virgin oils have more favorable conditions in terms of thermal stability than normal oils. which can be attributed to the presence of high monounsaturated fatty acids and low polyunsaturated fatty acids and antioxidants such as phenolic compounds. In general, it can be concluded that due to the fact that oils with poor initial quality are oxidized sooner, it is better to use high quality oils for cooking, due to the fact that olive oil changes its composition due to heat. occurs and causes its quality to decline, it is recommended that if extra virgin olive oil is consumed raw, it is better to use normal oils due to the higher polyunsaturated fatty acids and also due to the availability And the lower cost of their consumption will be more economical, but if they use extra virgin olive oil for cooking, it is better to use normal oils because of their higher thermal and oxidation stability.

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