Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XVI, Issue 1- 2017, pag. 29 - 33

OXIDATIVE STABILITY OF REFINED SUNFLOWER OIL AT ROOM TEMPERATURE AND DURING CONVENTIONAL FRYING

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Received January 30th 2017, accepted March15th 2017

Abstract: *The aim of this stady was to assess the oxidative stability of refined sunflower oil both at room temperature and during conventional frying in a pan. For this purpose, the refined sunflower oil was heated for 10 minutes in a fryer pan. Under these conditions, the Wheeler method was used to determine the peroxide number. Oven test was used to determine the oil stability. Peroxide number of the oil fried from 0 to 10 minutes at a temperature from 27ºC to 200ºC continuously increases from 0.357 mmol/kg to 6.4762 mmol/kg. Peroxide number of the oil analyzed by the Oven test increased from 2.41 mmol/kg for 24 hours to the value of 16.67 mmol/kg for 96 hours. The oil that has been fried for 10 minutes and reached a temperature of 200ºC should not be used as food. The oil which is kept in an open bottle at room temperature can be used up to 24 days.*

Keywords: sunflower oil, peroxide number, Oven test, frying

1. Introduction

Sunflower oil is one of the most used oils. The first oil produced from sunflower was patented in England in 1716. Sunflower seeds contain 40-60% oil and it depends on the type, location and method of cultivation of the sunflower [1].
Sunflower oil contains essential fatty acids, polyphenols, phosphatides and vitamins A, D, E and K [2-4]. Among the fatty acids, the most represented are linolenic acid 50-65% and oleic acid 30-40% [5].
The oil that is obtained by pressing is called cold pressed oil, while the oil obtained by extraction is refined oil. Cold pressed oils have greater antioxidant activity due to higher content of polyphenols, but they are less stable and the oxidized more easily [6]. Oils oxidize after longer standing, at a temperature higher than that of room temperature and in case of frying [7-9]. The oxidation of products depends on temperature, availability of oxygen, surface oil exposed to oxygen, light, and the presence of metals [9-10]. The most important factors for the oxidative stability of oils are: contact with oxygen, temperature, metals as catalysts and light. When the temperature increases by 10ºC the oxidation of products increases doubly [11-12].
Oxidation of fats and oils that are present in food products today are a major problem in food technology. Oxidation products in oil are reduced if antioxidants are added. Today, aromatic herbs, fruits and vegetables are used as natural antioxidants, being added to oil and food with high content in fats and oils [13-16].
Oxidation products in fats and oils are toxic and harmful to human health. Experiments on animals have shown a decline in nerve cells, memory and attention [17]. They are carcinogenic,

hepatotoxic and can contribute to the development of Alzheimer and Parkinson disease [18-19].
There are several physical and chemical methods for the determination of the oxidation products of fats and oils. Peroxides and hydroperoxides which are the main oxidation products in oil are characterized by the peroxide number. The type of oxidation products is determined by various instrumental methods [20].
The stability of oils and fats except of external factors depends on the type and composition of oils and fats.The methods used to determine the stability are based on the accelerated oxidation of sample under the influence of one or more factors that accelerate this process. In practice, most applications are methods in which the oxidation is accelerated by increasing the temperature. The mostly used methods for determining the stability of fats and oils are: Oven test, Swift test and the Rancimat test [21-22].
The purpose of this study is to evaluate the stability of sunflower oil "Kristal" at room temperature and to determine the oxidation products occurred during conventional frying of oil in a pan.

2. Materials and methods

The refined sunflower oil "Kristal"was analyzed. 10 bottles of 1l packages were purchased from supermarkets in Macedonia. For each experiment oil from each bottle is analyzed individually. The results from our experiments are mean of 10 measurements of oil from 10 different bottles.
The stability of oil is determined by Oven test at a temperature of 63ºC for 4 days (96 hours). The oil temperature was maintained constant using a drying oven Instrumentaria ST-05. Every 24 hours, a sample was taken for analysis and the peroxide number was determined by the method of Wheeler [23]. Oven test is performed to determine how long the oil can be stored in an open bottle at room temperature. It has been proven that one day of Oven test corresponds to a real stability of the oil of 6 to 12 days at room temperature [24].
To see how the oil gets oxidized during conventional frying in a pan, the following analysis was conducted. 100 ml oil was placed in a pan with a diameter of 24 cm and heat on hot plate at half of its maximum power of 2 500 W. The sample is heated for 10 minutes. After 2, 4, 6, 8 and 10 minutes the temperature of the oil is measured and the peroxide number is determined by the method of Wheeler. The temperature is measured with Barbecue high thermometer TBT - 08H which has a range of -50^{o}C to +300^{o}C, with a tolerance of +/- 1°C.
All chemicals for the determination of peroxide value were of analytical grade and purchased from Merck (Germany) and Sigma (USA).

3. Results and discussion

The results of the determination of the Oven test are given in Fig. 1.

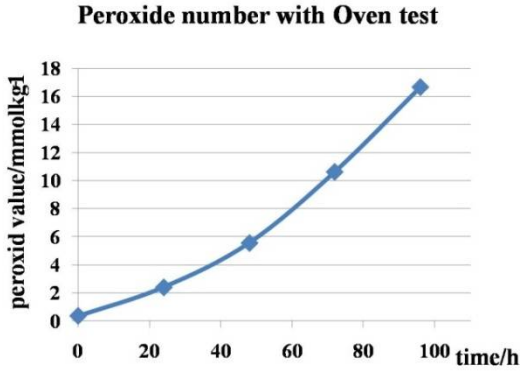

Fig. 1. Peroxide number in the analyzed oil with Oven test

After 24 hours the peroxide number is 2.41 mmol/kg and it is within the allowed limits according to the rules of the Republic of Macedonia [25].

Peroxide number after 48 hours is 5.567 mmol/kg, which is above the maximum value (5.00 mmol/kg) according to the Official Journal of R. Macedonia No.127/12.

If 48 hours in drying oven at temperature of 63°C corresponds to maximum 24 days at room temperature, that means that after 24 days an open bottle of oil stored at room temperature (about 25°C) has a large amount of oxidation products and it is not recommended for use.

After 72 hours in a drying oven at a temperature of 63°C or 36 days at room temperature, peroxide number of the oil is 10.635 mmol/kg and it is two times higher than the maximum which is allowed.

As expected, the oxidation increases constantly, and the peroxide number increases considerably. After 96 hours at 63°C or 48 days at room temperature, the peroxide number is 16.67mmol/kg. This value is more than three times higher than the maximum allowedand cooking oil in this case is too harmful to use.

The second experiment was made to determine the oxidation products in the oil during frying. For this purpose, the temperature is measured and the peroxide number of oil after 2, 4, 6, 8 and 10 minutes is determined. The dependence of the peroxide number on the heating time is shown in Fig. 2, and its dependence on the temperature is shown in Fig. 3.

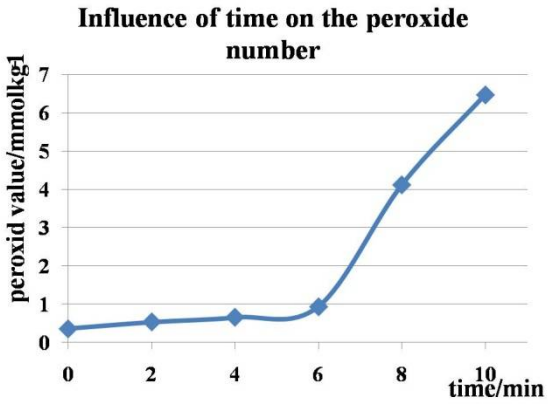

Fig. 2. Influence of time on the peroxide number

The initial value of the peroxide number is 0.357mmol/kg and it increases as the heating time is increased. After just two minutes of heating it increases to the 0.5376 mmol/kg, after 4 minutes it is of 0.6558 mmol/kg, and after 6 minutes it is of 0.9375 mmol/kg. In the next 2 minutes there is a rapid increase of peroxide number to 4.1202mmol/kg. However, all these values of peroxide number are smaller than the maximum allowed values of 5.00mmol/kg according to the Official Journal of R. Macedonia No.127/12 [25]. When the oil is heated for 10 minutes the peroxide number exceeds the maximum value and is 6.4762 mmol/kg. This means that the prepared food, in which the oil is heated more than 10 minutes at this temperature, contains a high concentration of oxidation products and it is not recommended for use.

When the oil is heated its temperature increases. The initial oil temperature is 27°C and then it increases continually. After 2 minutes the oil temperature is 66°C, after 4 minutes 91°C, after 6 minutes 127°C, after 8 minutes 147°C, and after 10 minutes, it reaches even 200°C. At this temperature the oil starts smoking and this oil, as shown by peroxide number is not suitable for use (Fig. 3).

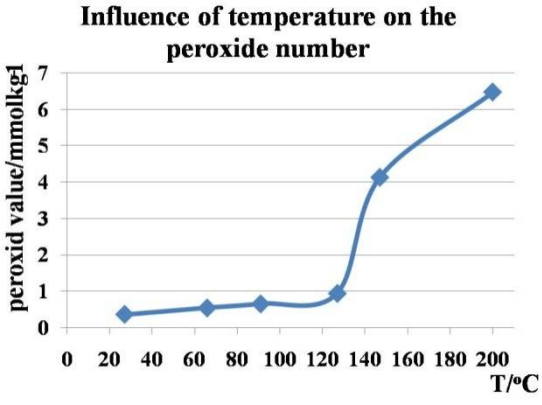

Fig. 3. Influence of temperature on the peroxide number

4. Conclusions

The results of our study show that the stability of refined sunflower oil "Kristal" evaluated on the base of Oven test is significantly affected during storage in a drying oven at a temperature of 63°C. After 48 hours, the peroxide number of the oil corresponds to that of the oil stored at room temperature not exceeding 24 days. For oil samples kept in a drying oven at a temperature of 63°C, for 72 and 96 hours the peroxide number was two, respectively three times higher than the allowed upper limit.Our data highlight that the cooking oil "Kristal" can be safely used up to 24 days, if it is kept open at room temperature.As regards the peroxide number of the fried oil samples, the obtained results reveal that in the frying time there were recorded increased values of peroxide number with the increasing of temperatures from 27°C to 200°C.
When the oil is fried for 8 minutes the peroxide numbers were in acceptable range while the oil fried for 10 minutes contains peroxide amounts over the allowed value.

5. References

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