ASSESSING THE QUALITY OF SUNFLOWER OIL USED FOR FRYING DOUGHNUTS

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ABSTRACT

Fats and oils play important functional and sensory roles in food products. They are responsible for carrying, enhancing, and releasing the flavour of other ingredients, as well as for interacting with other ingredients to develop the texture and mouth-feel characteristics of fried foods. Man has enjoyed fried foods for thousands of years, the main reason being that these foods have unique and delicious sensory characteristics. Recent consumer requirements are directed towards improving the quality of foodstuffs expecting that certain processed foods and the ones prepared by frying will exhibit in addition to sensorial attributes nutritional qualities as well. The efficiency of the frying oils quality control depends on objective analytical methods compatible with the needs of fried food processors. In this respect, our experiment refers to quantification of toxic compounds formed during the frying process of doughnuts in a Romanian fast food unit. The experiment was conducted in such a way to determine the quality of sunflower oil submitted to frying process over a period of time. Quantification of toxic compounds formed in oils was done every day of the experiment from physical and chemical point of view.

INTRODUCTION

The frying process is one of the oldest food preparation processes. For decades, consumers have preferred fried products due to the specific combination between aroma and texture which they present. Process technology was first developed in the Mediterranean area due to the cult of olive oil (Varela *et al.,*1988).

Traditionally, this is the way various products can be prepared depending on their specific volume as follows:

i) products containing moisture, covered in crust as fries, donuts, fried chicken fingers, etc.
ii) products completely dry crisp products , such as chips (Vitrac *et al .,* 2000).

Sunflower oil is the fourth most widely consumed edible oil in the world (Veldstra and Kler, 1989). Is obtained from the seeds of *Helianthus annuus* plants which are containing oil in an amount of 22-36 % (Sonntag, 1979). The oil is characterized by a high concentration of linoleic acid and a moderate level of oleic acid, a very low level of linolenic acid and containing less than 15 % saturated fatty acids (Veldstra and Kler, 1989). The content of fats and oils play an important role in both aroma and functionality of food. The efficiency of quality control used for frying oils depends on objective analytical methods compatible with the needs of fried food processors. In this respect, our experiment refers to the quantification of toxic compounds formed during frying donuts in a Romanian fast-food operation unit.

MATERIALS AND METHODS

The experiment was conducted over a period of 24 hours of continuous frying, or 3 working days, 8 hours of frying each day at 180 ^{0}C ± 1^{0}C. The purpose of this experiment was to determine the quality of sunflower oil subjected to frying process over a period of time. Type of fried food: Romanian donuts. At the end of each working day experimental samples of oil used in deep-fat fryers in the processing unit were withdrawn. Quantification of toxic compounds formed oil was made from chemically and physically point of view.

The methods used for quality evaluation of the oils are the AOAC standard methods for refractive index, acidity, a sensor for polar compounds (FOM-Food oil monitor). Fritest and Oxifrit, rapid methods, were used to asses qualitatively the oils as far as the total oxidation compounds are concerned. Oxifrit - test is a colorimetric test kit, marketed by Merck which contains redox indicators that react with the total amount of oxidized compounds in the sample. Fritest is also a colorimetric test sensible to carbonyl compounds.

RESULTS AND DISCUSSIONS

At the end of each experimental day sunflower oil samples were taken and were analyzed from physical and chemical point of view. Some analyzes were performed at time 0 of the experiment, control samples, some after 8h (Sample 1) of frying and after 24 hours (Sample 2) of continuous frying process of doughnuts. The results of these analyses represent the quality of the sunflower oil used in the frying process throughout the experiment period.

Table 2.

The results obtained from the analysis of refractive index and the percentage of soluble solids of sunflower oil samples used in frying Romanian doughnuts.

Sample	nD	nD-TC	Brix	Brix-TC
Control	1,4719	1,4735	72,5	73,3
Sample 1	1,4727	1,4744	72,9	73,6
Sample 2	1,4735	1,4753	73,3	73,9

The refractive index was determined using a digital refractometer AR Reichart 200. IR increase has been attributed to conjugation which, as is known, happens prior to the formation of hydroperoxides (Table 2). IR continues to grow in the third stage of the peroxides decomposition, but not as much as in the second stage. Polymerization of partially oxidized fats is found responsible for IR changes (Gray, 1978).

The IR results of the experiment had an increasing trend, the values grow from an index of 1.47 in fresh oil at a rate of 1.48. The results are comparable to those obtained by Yoon et *al.,(*1987), Al -Harbor (1993), Al-Kahtani (1991) and indicate that the IR of oils which have been used for frying are higher than those oils fresh. IR values change in relation to the three stages of autooxidation. During induction period the peroxide formation is low, the refractive index remains constant. During the 2nd stage of oxidation when more peroxides are formed, IR rapidly increases.

The results of the experiment as far as toxic compounds are formed during the frying process reveals that in terms of both the development of the free acids formed-acid value, expressed as mg NaOH per gram of oil and the percentage of oleic acid expressed as g oleic acid per 100 g of oil samples of sunflower oil, have increased proportionally with the time of exposure to temperatures of $180^0C \pm 1^0C$, as shown the table 3.

Table 3.

The results obtained from the analysis of acidity value and oleic acid percent of sunflower oil samples used in frying Romanian doughnuts.

Sample	**Acidity Value** **(** mg NaOH per gram of oil sample)	**Oleic acid percent** (g oleic acid per 100 g of oil sample)
Control	5.7	2.86
Sample 1	9.25	4.65
Sample 2	23.6	13.39

Total polar compounds are the ideal method or instrument used to determine when the frying oils must be replaced. Total polar compounds (CTP) are a measure of overall oil change in the sense of degradation, in frying process. For this reason, it is considered to be generally a good indicator for monitoring the change caused in the frying process (Quiles *et al.,*2002).

In our experiments, we used FOM (Food Oil Monitor) 310 Ebro to determine accurately the quality of the frying oil as far as the TPC percentage is concerned. FOM measures TPC in percentages from 0 to 40 %. A percentage of 25 to 27 % is the regulation limit in many European countries (Romero *et al .,* 1999 ; Andrikopoulos *et al .,* 2002) .

The results obtained are exhibited in table 4, where we can see the increasing trend of the percentage of total polar compounds (TPC) in sunflower oil samples used in continuous frying process of doughnuts. The initial content of polar compounds was 4.25 %, after 8 hours of frying to 180^{0}C the polar compounds content was 9.25 % and after 24 hours of frying, the CTP increased to 12%.

Table 4.

The results obtained from the analysis of Total Polar Compounds of sunflower oil samples used in frying Romanian doughnuts.

Sample	Total polar compounds %
Control	4.25
Sample 1	9.25
Sample 2	12

Although the content of CTP was highest after 24 hours of frying, about 3 times higher compared to control samples the oil is considered acceptable in terms of legal regulations since the European level the maximum acceptable levels of total polar compounds is 25-27 %.

The Oxifrit test is a colorimetric method which contains a redox indicator that reacts with the total quantity of oxidized compounds in the oil sample. The color evolving from contact between the sample and reagent is compared with a color scale featuring four qualitative indicators: 1 good, 2 still good, 3 intermediate quality and 4 poor. The Fritest provides a colorimetric measurement of carbonyl compounds. The mixture of the sample and reagents is compared to a three color scale 1 good quality, 2 intermediate, 3 replace oil, 4 bad.

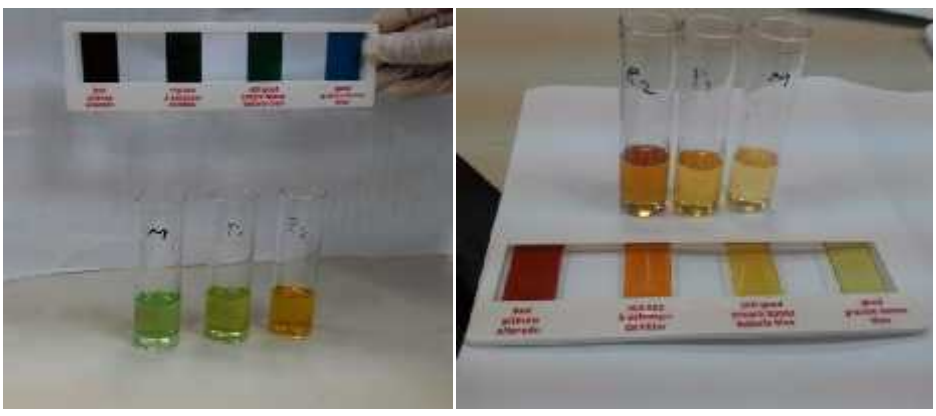

Figure 1. Evaluation of total oxidation compounds by the test Oxifrit and Fritest

The results obtained from the use of the colorimetric kit tests Oxifrit and Fritest, after comparing the mixture of sample and reagents with the choice of four colors scale showed that after 24 hours experiment of frying, the samples registered a value of 2-3, which means that the oil was still good in sample 1 but had to be replaced in sample 2 (Fig 1). A value greater than 3 at Fritest indicate that oil should be replaced.

CONCLUSIONS

The refractive index increased with exposure to high temperatures sunflower oil, this increase was attributed to conjugation which as is known, prior to the formation of hydroperoxides.

Another conclusion is that, Oxifrit, the quick test, can be used to determine the quality of the oil samples resulting from the frying process, but the ability to discriminate is not as precise as to the determination of total polar compounds.

The content of TPC was the highest after 24 hours of frying, about 3 times higher compared to control samples, however the oil is considered acceptable in terms of legal regulations, as at European level acceptable maximum total polar compounds is 25-27%.

The percentage of total polar compounds may be used as a complementary method to the determination of the acid value to control the quality of the vegetable oil during continuous frying as is the most accurate method of determining the quality of frying oil.

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