DETERMINATION OF FATTY ACID COMPOSITION FOR FRYING SUNFLOWER OIL USING GAS CHROMATOGRAPHY

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ABSTRACT

Frying of sunflower oil has been carried out for 7 running days at 175°C±2 in this study. The aim of this study is to determine fatty acid composition of sunflower oil under real domestic frying conditions. In the frying processes, potato has chosen for food and the processes have continued during seven days. The composition, trans fatty acid (TFA) amount and average molecular weight of sunflower oil have been determined by gas chromatography (GC) technique. This work focuses on finding changes in free fatty acid after repeated batch potato frying. Unsaturated fatty acid (UFA) contents of sunflower oil have been decreased and saturated fatty acids (SFA) have also been increased during frying process. When the frying times run on, the analysis of oil samples have showed that trans fatty acids such as elaidic and linoelaidic acids occur quite slowly. At the end of the repeated frying series, the elaidic acid (C18:1 trans) has been determined in oils for sunflower 1.5%. And also linoelaidic acid (C18:2 trans) has been detected 0.3%. At the end of the seventh day of frying, the relative contribution of oleic acid has been decreased.

Key words: Sunflower, frying, fatty acid composition

INTRODUCTION

Today, frying is one of the most popular methods for the preparation of food stuff, because the method is fast and relatively cheap and results in yellow brown products with a typical taste and smell, preferred by the consumer. The oil plays a critical role as a heat transfer and impregnation medium, and it is the crucial component of the frying process. For the quality of products being fried the quality of the frying medium is very important, because during frying the food takes up the oil becoming a significant part of the product. (Taha et al., 2014). Many factors affect the deterioration of a frying oil, such as the presence of unsaturated fatty acids, the oil temperature, oxygen absorption, the presence of metals, and the type of food (Arroyo et al. 1992). During frying, oil or fat is subjected to high temperatures in the presence of air and water from the food, thus producing a wide range of compounds resulting from thermal, oxidative, and hydrolytic reactions (Chatzilazarou et al. 2006, Dobarganes et al. 2013). As a result of the deterioration, the oil sustains some physical changes: the colour darkens, the viscosity increases, and smoke appears (Paul and Mittal, 1997).

The fatty acid composition of the frying oil is an important factor affecting fried food flavor and its stability; therefore, it should be low level of polyunsaturated fatty acid such as linoleic or linolenic acids and high level of oleic acid with moderate amounts of saturated fatty acid (Kiatsrichart et al., 2003, Mehta and Swinburn, 2001). Partial hydrogenation decreases polyunsaturated fatty acid but increases saturated fatty acid and trans-fatty acid to produce more stable frying oil. However, trans-fatty acids (TFA) adversely effects on cardiaovascular health (Rehab and Anany 2012). One approach to increasing the stability of unsaturated oil is partial hydrogenation (Li et al., 2008; Bysted et al., 2009), but hydrogenation also results in the formation of SFA and trans fatty acids. Trans isomers of fatty acids have been reported to increase the ratio of low-density-lipoprotein (LDL) to high-density-lipoprotein cholesterol (HDL) in the plasma and increase the risk of coronary heart disease (CHD), and play a part in atherosclerosis development (Willett et al., 1993; Dalainas and Loannou, 2008). Low levels of trans fatty acids and saturated fatty acids that are basis of nutritional and diet physiological aspects also play important roles in selecting a frying oil. Since the fatty acid composition alone is not enough to explain the stability of oils, a variety of minor components, such as tocopherols, polyphenols, phospholipids, caretonoids and certain sterols are also beneficial to oil stability during frying (İnanç and Maskan 2012).

Oil and fats are one of the important components of human diet and ingredients of food industry. Oils and fats are preferred as carriers of fat soluble vitamins (A, D, E and K) and source of essential fatty acids and energy (Öğütcü et al., 2015). Vegetable oils are recognized as important compounds of our life. Sunflower is between the five biggest oilseeds in world production (Anwar et al., 2008). Sunflower oil contains a wide range of unsaturated fatty acids and is rich in essential fatty acids. Sunflower oil is considered nutritious due to high content of polyunsaturated fatty acids (PUFA), mainly linoleic acid (18:2). However, due to high PUFA, it is more susceptible to oxidative degradation leading to rancidity, off-flavors, and discoloration (Gordon 1991). And also sunflower oil is characterized by high content of tocopherols (up to 935 ppm) higher than those of other oils such as soybean and peanut. It is considered an oil of high stability due to its high content in natural antioxidants (Bramley et al., 2000; Shahidi, 2005). The nutritional aspects of edible oils associated with the presence of minor and major components play an important role in preventing diseases and improving health. It is important to formulate vegetable oil blends with special composition in order to enhance their stability and nutritional value (Frankel et al., 1994; Shiela et al., 2004).

The objective of the present study was to obtain the fatty acids combination of refined sunflower oil under normal frying conditions. Frying processes were done with potato repeating seven days.

MATERIALS AND METHODS

Frying Process

At the beginning of frying, the fryers have been stuffed with 2 L of fresh oil samples, and then oils have been heated to 175 ± 2 °C. The frying temperature has been controlled using a probe joined to the thermometer. An electrical domestic deep-fat fryer has been used for frying experiments. Prior to frying, potato slices have been dried on both sides on filter paper to remove any excess water. The frying process started 30 minutes after the temperature reached at 175 ± 2 °C. The frying time has been 6 minutes for potato slices. One frying has been done per day for seven consecutive days. All physical and chemical analyses of oils have been performed immediately after the frying. During frying process, fresh oil has not been added to frying pans.

Determination of Fatty Acids Composition

Gas chromatography has been used for the qualitative and quantitative determinations of the fatty acids reported in relative area percentages. Fatty acids have been methylated prior to analysis by gas chromatography. Analysis have been performed on Agilent 9C 6890N gas chromatograph (CA, USA) equipped with a DB-23 capillary column (60 m, 0.32 mm, 0.25µm film thickness) and a flame ionization detector. The oven temperature has been arranged from 160°C to 185°C at a rate of 7 minutes, later programmed from 195°C to 220°C for 3 minutes, finally kept 20 minutes at the last temperature. The injector and detector temperatures have been 230°C and 255°C, respectively. Nitrogen has been used as carrier gas at a flow rate of 1.0 ml/min. FAME has been identified by comparing their retention time with known commercial standard mixtures.

RESULTS AND DISCUSSION

The fatty acid compositions of sunflower oils are shown in Table 1. Composition of fatty acid in sunflower oil contained palmitic acid (7.1 %), stearic acid (4.3 %), oleic acid (19.0 %), linoleic acid (67.5 %) and linolenic acid (0.8 %). These results belong to before starting fryings. Linoleic acid (C18:2) is determinated the most abundant unsaturated fatty acid in the sunflower oil. Linolenic acid (18:3) is highly sensitive to oxidation because it contains three double bonds, while oleic acid (18:1) is less reactive as it contains only one double bond. At the end of the frying processes, composition of fatty acid in sunflower oil contained palmitic acid (11.4 %), stearic acid (4.9 %), oleic acid (9.1 %), linoleic acid (47.9 %) and linolenic acid (0.0 %). It is observed that there is a decrease in polyunsaturated fatty acids and resulting increase in the saturated acids content. When the frying times run on, the analysis of oil samples have showed that trans fatty acids such as elaidic and linoelaidic acids occur quite slowly. The elaidic acid ($C18:1_{trans}$) has been determined in oils for sunflower %1.5. And also linoelaidic acid ($C18:2_{trans}$) has been detected 0.3%. At the end of the seventh day of frying, the relative contribution of oleic acid has been decreased for sunflower oils.

Table 1 Changes in fatty acid composition (%) during frying processes.

Fatty Acids	Fresh oil	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
$C_{14:0}$	0.1982	0.2472	0.4000	0.5772	0.7579	0.9120	1.0700	1.2035
$C_{15:0}$	-	-	-	0.1859	0.3580	0.4727	0.5674	0.6498
$C_{15:1\ cis}$	0.2683	0.2037	0.1229	0.0680	0.0391	0.0253	0.0157	0.0102
$C_{16:0}$	7.0560	7.4007	8.0065	8.4157	9.2316	10.0710	10.8954	11.3895
$C_{16:1\ cis}$	0.1731	0.1710	0.1698	0.1687	0.1654	0.1619	0.1559	0.1463
$C_{16:1\ trans}$	-	-	-	-	-	-	-	-
$C_{17:0}$	-	-	-	-	-	-	-	-
$C_{17:1\ cis}$	-	-	-	-	-	-	-	-
$C_{18:0}$	4.3061	4.4458	4.5834	4.7435	4.8403	4.9146	4.9414	4.9502
$C_{18:1\ cis}$	18.9617	18.1325	17.2031	16.3104	15.1967	13.5689	11.2314	9.1256
$C_{18:1.\ trans}$	-	-	0.139	0.4793	0.7193	0.9486	1.2546	1.4876
$C_{18:2\ cis}$	67.5091	63.1032	59.9364	56.0213	53.4558	51.0132	49.0135	47.9356
$C_{18:2\ trans}$	-	0.0601	0.1147	0.1625	0.2053	0.2421	0.2748	0.3059
$C_{18:3\ cis}$	0.7778	0.5364	0.4915	0.3221	0.2287	0.2032	0.0913	-
$C_{18:3\ trans}$	-	-	-	-	-	-	-	-
$C_{20:0}$	0.2939	0.3192	0.3605	0.3989	0.4408	0.4854	0.5073	0.5231
$C_{20:1\ cis}$	0.1552	0.1187	0.0983	0.0812	0.0706	0.0567	0.0364	0.0286
$C_{20:1\ trans}$	-	-	-	-	-	-	-	-
$C_{20:2}$	-	0.0102	0.0243	0.0411	0.0618	0.0825	0.1026	0.1168
$C_{20:3}$	-	-	0.0306	0.0052	-	-	-	-
$C_{20:5}$	0.062	0.0245	0.0056	-	-	-	-	-
$C_{22:0}$	0.6325	0.6726	0.7094	0.7532	0.7831	0.8029	0.8203	0.8316
$C_{22:1}$	0.0153	0.0102	0.0044	-	-	-	-	-
$C_{23:0}$	0.0447	0.0635	0.0976	0.1368	0.1732	0.2123	0.2419	0.2604
$C_{24:0}$	-	0.1201	0.2032	0.2713	0.3404	0.3941	0.4402	0.4657
$C_{24:1}$	-	0.0223	0.0445	0.0614	0.0727	0.0802	0.0889	0.0901

Poor frying stability in sunflower oil comes primarily from the high level of linoleic acid. Therefore, sunflower oil must also be hydrogenated to reduce its linoleic acid content to 35% or lower for industrial frying. On the other hand, fatty acid compositions do not fully explain frying stability of oils. For understanding of the frying stability of oil, there are so many parameters. Stability of oil indicates that the oil must be low in free fatty acids, peroxide value, conjugated dienes, anisidine value, monoacylglycerols, diacylglycerols, and trace impurities, such as iron, phosphorus, calcium, and magnesium. All of these quality parameters have specific significance in influencing the performance of the frying oil.

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