CHARACTERISTICS OF THE PROCESS OF FRYING IN OIL BATH

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Abstract: The technology of frying is one of the most - important and popular methods of cooking food, widely used in restaurants, companies engaged in catering and in many other food industries. The main principles of deep frying in oil bath are as follows: fresh oil - delivered and inspected by a licensed provider, the amount of fried items, load the cooking trays for hours and days; multiplicity of adding fresh oil, form, structure and capacity of professional fryers used in the restaurant and food industry, chemical changes that occur in fat; principle effects of heat and moisture transfer during frying; fast and objective methods to control the oil. The main purpose of our book review was to investigate previous researches in this area and to present our knowledge about oxidative degradation processes in fat during frying in the cooking product. The study of these processes is of great importance for our time, because it defines the quality of fried foods and semi-finished products, as they can be a potential risk to human health.
Keywords: deep-fat frying, oil bath, hydrolysis, oxidation, polymerization

Introduction

Frying is a heat process of food preparation up to finished culinary production by contact of the oil with the food as fat is used for heat transfer. Part of the oil enters the food product and causes different reactions that lead to the appropriate mode of culinary product. During the process of frying different complex reactions occur, causing physical and chemical changes in the fat-hydrolytic, oxidative and thermal reactions (Frankel, 1998, Chang, 1978). These reactions lead to processes of polymerization and the formation of hydroperoxides.

Decomposition products are obtained as a result of interactions between food and vegetable oils for frying, they affect the taste, texture and aroma of the finished culinary product (Dobarganes et al., 2000). Fat oxidation during heat treatment plays a significant role in changing the flavor and organoleptic properties are decreased by the formation of oxidized products which may cause a health hazard (Katan et al., 1984; Willett & Ascherio, 1994). The problem of objective methods to control the cooking fat repeated frying food in oil bath is discussed at the Sixth International Symposium in Hagen, Germany (22-24 May 2011). An analysis and evaluation of vegetable oils and animal fats has been made. As the most reliable indicators of the cooking fat are used chemical analysis to determine the polar and polymeric triglycerides. Chemical indicators, such as free fatty acids is a measure for determining the primary and secondary products of fat digestion. These parameters vary depending on the type of vegetable oils for frying and the conditions under which it is used [29]. For better control of the fat can be used determining chemical parameters such as: anizide - number including the FFA-value. For fresh oil the acid value (free fatty acids) and peroxidase value is usually used as a selective factor for oxidative degradation status. Determination of the point of smoking is an important indicator and a potential tool for determining the degradation of thermally treated oil [7]. The purpose of this experiment is

to determine the products of degradation, the polymers and polar compounds by frying different types of food products [24].

The sensory evaluation of vegetable oils and fried foods are one of the most - important methods of quality control in the food industry, as well as the color of the oil and free fatty acids are not an appropriate indicator of the quality of fried food and the cooking oil. The main goal of all scientific experts is finding fast and harmonic methods, criteria and constraints. The conference[24] a recommends using rapid tests for monitoring the quality of the cooking oil with recommendations to be corresponding to following characteristics: to correlate with recognized international standard methods, to provide an objective index, to be easy to use, safe to use in the restaurant and food – industry.

Chemical reactions occurring during the frying process

Choe § Min [4] in their detailed studies investigate in details the chemical changes that occur during the process of frying food in oil bath, and which can be used for quality control of the oil.

1. Hydrolysis of oil

When food products are fried in heated oil, moisture evaporates in the form of steam and boiling solution and then gradually subsides. Water vapor and oxygen are involved in chemical reactions in frying oil and food. Water as a nucleophile, attacks esters associated with triglycerides and produces di-and mono-glycerides, glycerol and free fatty acids. The free fatty acids included in the oil for frying increase proportionally with increasing the numbers of frying with the time [Chung and col., 2004] (6) as shown in Figure 1.

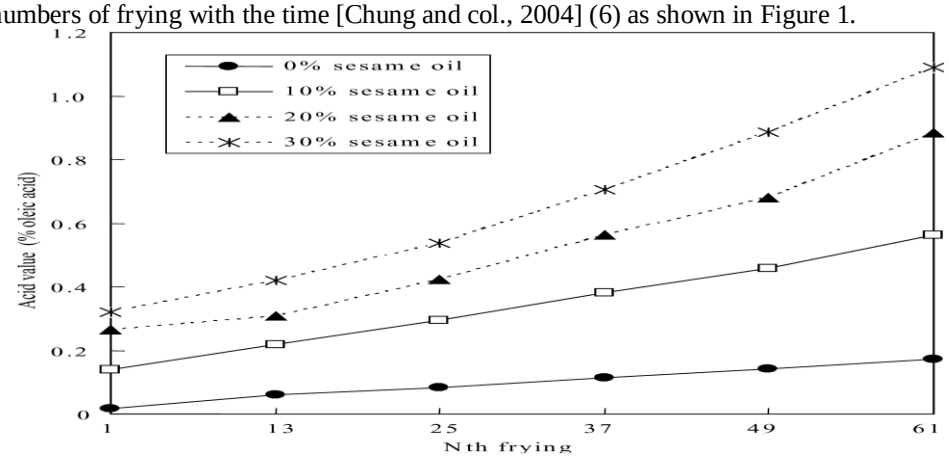

Fig. 1. Free fatty acids formed in a mixture of soy and sesame oil during prolonged frying flour dough products at 160 ° C (Chung and col. 2004)

Determination of acid value is used for monitoring the quality of heat treated oil. Large amounts of water hydrolyze faster the oil (Dana and others 2003) (9). Water hydrolyzes faster than oil steam (Pokorny 1989) (20). Frequent change of frying oil with fresh new oil slows down the hydrolysis of the cooking oil for frying (Romero and others 1998) (23).

In their research (Naz et al., 2005) (18) found that frying does not affect hydrolysis of fat. Di-and mono-glycerides, glycerol and free fatty acids accelerate the further hydrolytic reactions of heating oil (Frega and others 1999) (11).

Glycerol evaporates at 150 ° C and the remaining glycerol in oil promotes the formation of free fatty acids by hydrolysis (Naz and others 2005) (18). Stevenson and col, (1984) (26) suggest that the maximum content of free fatty acids in olive oil for frying is from 0.05% to 0.08%.

2. Oxidation of oil

Oxygen reacts with the oil during the process of deep oil frying (Houhoula and col., 2003) (12). The chemical mechanism of thermal oxidation is in fact the mechanism of auto-oxidation. Thermal oxidation occurs faster than auto-oxidation, but detailed scientific information and comparison between the oxidation rates between thermal oxidation and auto-oxidation are not available. The mechanism of thermal oxidation is shown in Figure 2.

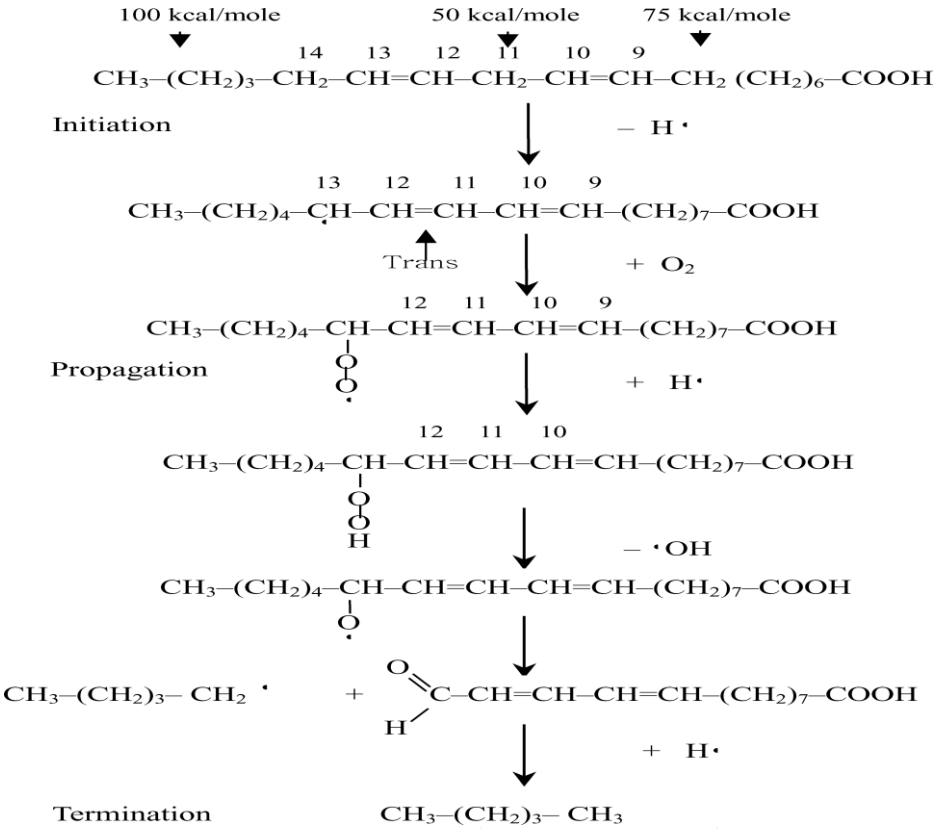

Fig. 2. Beginning, development and completion of the thermal oxidation of the oil, Choe and Min, 2007

Carbon-hydrogen bonds in saturated hydrocarbons are without any double bonds to the next and it is approximately 100 kcal / mol (Min and Boff 2002) (17). Double bond in the carbon -9 and carbon- 12 reduces carbon-hydrogen bond at carbon 11 by removal of

electrons. Carbon - hydrogen bond in carbon - 8 or 11, which is α to the double bond of oleic acid is about 75 kcal / mol. Carbon - hydrogen bonds in saturated hydrocarbons is without any double bond to it and it is about 100 kcal / mol (Min and Boff 2002) (17). Different strengths of carbon-hydrogen bond of fatty acids can be explained by the difference of the percentages of oxidized in stearic, oleic and linoleic acids during thermal oxidation or auto-oxidation (Figure 2).

3. Polymerization of oil

Volatile compounds are very important to the taste of frying oil and heat treated products in it. The main products of degradation of oil are non-volatile polar compounds, dimers and polymers of triacylglycerols. The amount of cyclic compounds is relatively small compared to the polar non-volatile components, dimers and polymers (Dobarganes § col., 2000) (10). Dimers and polymers are large molecules with a molecular weight of 692 to 1600 D (Daltons) and are formed by the combination-CC-,-COC-, and-COOC-links (Stevenson § col., 1984; Kim § col., 1999) (26, 14). Dimers or polymers are linear or cyclic depending on the reaction process and the type of fatty acids contained in the oil (Tompkins and Perkins 2000). Dimerization and polymerization in the process of deep-frying are radical reactions. Allyl radicals are formed in the preferred methylene hydrocarbons to double bond. Dimers are formed by reaction of allyl radical C-C connection. Triglycerides react with oxygen to produce alkyl hydroperoxides (ROOH) or dialkyl peroxides (ROOR).

Free fatty acids increase the thermal oxidation of oils during heat treatment and their saturation.

The aroma of the oil produced in deep frying food in oil is described as fruity, grassy, burnt, fish and toasted nuts. It depends on the type of oil and the number of fryings, the temperature of the heat treatment does not affect the flavor changing (Prevot and others 1988) (21). Oxidation of linoleic acid during deep frying in fat increases the smell of fish and fruits and reduces the smell of nuts (21). Typically desired flavor of frying occurs at the optimum oxygen concentration (Pokorny 1989) (20). Aromatic components, created during the frying process and formed in fried foods are mainly volatile compounds from linoleic acid and are mainly dienes, alkenes, lactones, hydrocarbons, and other cyclical components (Pokorny1989) (20).

Some of the volatile compounds formed during deep frying in oil products such as 1, 4 - dioxane, benzene, toluene and heksylbenzene do not contribute to desired taste and are toxic compounds. Carbonyl compounds formed in lipid oxidation can react with amino acids, especially with asparagine forming acrylamide which accordingly reduces the nutritional value and safety of fried food products. Acrolein formed in heat treated oil reacts with asparagine pending acrylamide (Yasahura and others 2003) (29). The formation of acrylamide requires temperature heating above 100 ° C, as well as by increasing the temperature, the amount of acrylamide increases too. (Becalski and others 2003) (7), (Kim and others 2004; Pedreschi and others 2005) (15, 19).

Naturally presented or added oils and antioxidants in food affect the quality of oil during deep frying in oil. Tocopherols, butylhydroxytoluene (BHT), propyl gallate (PG) and tertiary butylhydroksyquinone (TBXQ) slow down the oxidation of the oil at room temperature. However, they become less active under temperature of frying. (Boskou 1988; Choe and Lee 1998), (2, 5). Carotene do not protect oil from thermal oxidation in the absence of other antioxidants. The combination of carotenes and tocotrienols reduces

simultaneously the oxidation of oil during frying of potato slices(Schroederand others 2006) (25).

CONCLUSIONS:

1. This study shows, that deep frying of food products in oils causes hydrolisys, oxidation and polymerization in oil, while hydrolysis increase quantity of free fatty acids, mono , diglycerides and glycerides in oils, but oxidation occur by greater percentage during frying process. Polymers and dimmers forms in oil from radicals, during the frying process.
2. Adding of fresh oil, during the process of frying, technological circumstances byf frying of food froducts, quality and type of oil, type of food products, concentration of oxygen, type of fryer, type of using antioxidants, affects of quality, taste and aroma of oil, during the process of deep frying.
3. Of major importance is discover of fast tests for control of thermal treated oils and their application in restaurants and centralized manufacture of ready for use culinary production.

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