Hazards associated with fried fast food products

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Abstract

Frying fats or oils are one of the most common and oldest method used by mankind for the preparation of food. Recent consumer interest in “healthy eating” has raised awareness of the need to limit the consumption of fat and fatty foods.

Although fried fast foods are becoming more and more popular, increased consumer awareness has been witnessed concerning the safety of those foods. Guidelines have been drawn up in most of the countries and the HACCP system has been implemented in food service systems as an ultimate quality control measure.

In this paper we present a review of hazards associated with frying, highlighting the control measures that must be taken and also the critical limits of this hazards.

Keywords: frying, guidelines, fast food products, quality control

Introduction

Fat or oil frying is one of the most common and the oldest methods developed and used by man for the preparation of food. Recent consumer interest in “healthy eating” has raised awareness of the need to limit the consumption of fat and fatty foods (Brian and Lyon [1]).

Frying processes are carried out at temperatures of between 140-200°C, far higher than can be reached when boiling water, but lower when roasting food in a circulating hot airflow. The complex reactions taking place under frying process conditions have been extensively studied for frying oils. Fats and oils used for the preparation of foods are exposed to elevated temperatures in the presence of water and oxygen, thus causing chemical changes (Gertz [2][3]). These reactions are causing deterioration of the frying fat and oils, the degree of deterioration depends on the nature of the frying oils and many other circumstances as the fryer design, the kind of food that is fried and the frying method (deep-fat frying or shallow-frying) etc. (Gertz et al.[4]). Research has revealed a variety of compounds namely hydrocarbons, aldehydes, cyclic monomers, dimmers, trimmers and polymers that are formed during the oxidation, polymerization and hydrolysis of frying oil (Gertz and Klostermann [5]; Bryan [6]) Many studies focused on the safety of thermally oxidized frying fats and oils that are based on feeding experiments with laboratory animals have demonstrated that the consumption of oxidized fats is harmful for our health.

It is true that most of these studies were carried out under unrealistic frying conditions that yielded non nutritional compounds. The resulting products of heated oils and fats from frying foodstuff are not always detrimental to the metabolic processes in the human body especially at the concentrations normally encountered in food. Furthermore the polymeric
compounds are absorbed at a very low rate in intestine, and thus will have no practically influence upon metabolic processes.

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When frying is performed under controlled frying conditions for example, using oils such as high oleic soybean oil, corn oil canola or sunflower oil developed by plant breeding or transgenic manipulation oxidation occurs at a lower rate. Continuous frying leads to oils with a low level of degradation and results in a fairly constant quality of the fried product when the process is adequately controlled (Dobarganes et al., [22]); Navas et al. [23]). Also, one can optimize frying conditions and monitor oil quality by measuring changes in the oil during frying to help inhibit the formation of decomposition products. The oils have to be discarded after certain duration of use because of the harmful effects of the degradation products forming and accumulating in the oil. The level of Total Polar Compounds (TPC) and Polymerized Triglycerides (PTG) are by far the most reliable parameters in this matter. Limits of 24-26% of TPC and 12-13% PTG are accepted in most European Countries, following the recommendations made by German Society for Fat Research. A recommended daily turn over is 15-25% of the fryer capacity (Gertz and Kochhar [7]; Gertz [8]). The frying temperature recommended varies from 160 to 200°C, with the optimal frying temperature depending on the type of the food, its size, fat turnover, the size of the frying vat and the number of the frying vats used. The internal temperature of the product is of concern regarding the microbiological safety of the finished products. A suitable time temperature schedule aims at reducing the survival of resistant microorganisms, spores and toxins. Guidelines for good frying practices should be implemented in all restaurants, including fast food chains and should be accompanied by personnel training and inspection on a regular basis (Williams [9]).

**Frying oil quality**

The necessity of using a good quality frying medium becomes obvious when one considered that some of the fat is absorbed by every piece of food fried in it. The choice of frying fat depends on many factors such availability, price, frying performance, flavor and stability of product during storage (Sulieman et al. [25]).

Edible oils used for food frying are subjected to the formation of compounds, such as enzyme inhibitors, vitamin destroyers, lipid oxidation products, gastrointestinal irritants, potential mutagens that are harmful to human health and can therefore become a chemical and physical hazard. For this reason, regulations have been drawn up in several countries to control the use of frying fats in restaurants and food processing establishments (Soriano et al. [10]). The requirements for the oil in processing plants center on handling and resistance to breakdown at the frying temperatures, during which the product undergoes textural changes and water is driven off. The finished product should be bland flavor and the shelf life should not be adversely affected (Burdon [11]). An ideal frying fat should be inexpensive, have long frying life and fatty acid profile that is low in saturated and trans fatty acids. It should also be resistant to gumming, rancidity and uniform in quality and ease of use (transporting, pouring heating) (Mehta and Swinburn [12]).

Deep-frying, as well as pan-frying, is a very complicated procedure that is not only influenced by the quality of fat or oil being used, but also by several other factors (Gertz and Kochhar [7]; Blumenthal et al.[13]).
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Type of food that is fried

The type of food being fried affects the frying life of the oil. Food, when fried, can introduce various components such as carbohydrates, phosphates, sulfur compounds, trace metals, to the oil and these will contribute to color formation and other changes that may be deleterious in the frying medium by reacting with the oil or its breakdown products (Kochhar [14]).

Moisture in foods creates a steam blanket over the fryer and reduces contact with air (Choe and Min, [27]; Dana et al. [28]; Kochhar and Gertz [29]).

The higher the moisture content of the food is, the higher the moisture transfer, and hence hydrolysis (Stevenson et al. [15]; Paul and Mittal [16]).

Frying foods that contain high levels of egg solids can contribute to early foaming due to the leaching of lecithin into the frying fat. The frying oil may also become contaminated with fats from foods, such as meat or chicken, which diffuse into the fat during the frying process. Foods that are breaded or battered may result in particles of the surface being coated to the fat, resulting in burning and off flavors. Strongly favored foods such as fish and onions can also contribute to off-flavors in the frying medium (Stevenson et al. [15]).

Continuous deep frying of snack foods appears to be a simple operation. However, the continuous production of high quality products with a crispy texture and appropriate flavor and shelf life is complex (Hammond, [24]).

The frying equipment design

The frying oils should be handled with great care during storage and processing because any abuse will result in reduced product shelf life (Burdon [11]). The fast food industry is adopting various methods designed to maintain the quality and increase the useful life of frying oils. They include the use of active and passive filters, antioxidants, and the proper maintenance of frying equipment (Paul and Mittal [16]). Sophisticated fryers with indirect heating systems, automatic filtration, balanced steam stacks, control oil flow, efficient controls and instrumentation that aim at keeping the oil in good condition (Burdon [11]).

The design features should eliminate known factors of heat degradation/oxidation in the oil, while maintaining an output of fried products of consistent quality. For instance, pro-oxidant catalyst copper or brass valve fittings must not be employed (Kochhar [14]). A fryer should ensure the required throughput of food for the minimum amount of fat volume, and it should have a heating element capable of rapidly returning the temperature of the fat. Also, the ratio of volume of fat to the volume of food is of great importance. The larger the surface area of the vat is, the larger the area of fat exposed to the air and the faster the rate of oxidation (Mehta and Swinburn, [12]). Using fryers designed with a small surface to volume ratios will prevent aeration of the oil; air in the hot oil is the greatest contributor to oil breakdown (Stevenson et al. [15]).

Cleanliness of the fryer is another factor to be considered in controlling oil breakdown (Stevenson et al. [15]). Deposits of gum or polymer around the fryer hood or utensils promote oxidation, and are difficult to remove if left for long periods (Mehta and Swinburn [12]). Regular cleaning of the frying equipment should be carried out with special attention being paid to rinsing, to ensure that all the traces of soap and detergent are removed (Stevenson et al. [15]). Water or detergent remaining after cleaning will cause foaming and aeration. Failure to remove alkaline cleaning compounds is a prime cause of fat degradation because the compounds react with water and free fatty acids to form alkaline soaps (Blumenthal [13]).

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**Turnover rate**

The turnover rate is probably the most important factor in maintaining oil quality (Paul and Mittal [16]). The rate of color darkening or any other change in the characteristic of the frying oil depends on the turnover rate of the oil, which is the ratio of the total amount of oil in the fryer to the rate of which fresh oil is added to the kettle. The higher the rate of replacement, the lower the level of oil darkening. (Soriano et al. [10]). Also, the higher the turnover rate, the slower the production of free fatty acids (Kochhar [14]). A recommended daily turnover is 15-25% of the fryer capacity. Proper turnover will keep the level of free fatty acid low. In large-scale commercial operations, in which frying is continuous, this turnover period can be as low as 12 hours, and fat degradation is minimal (Stevenson et al. [15]). The frequent addition of fresh fat throughout the deep-frying process minimizes thermo-oxidative and hydrolytic changes in frying oils and extends the frying life of the oils. Various factors may account for this phenomenon, for example the addition of fresh oil after each use dilutes the concentration of alteration compounds formed during frying, while the addition of unaltered fatty acids and antioxidant compounds from the fresh oil helps to maintain the initial composition of the frying oil (Romero et al. [18]). In most fast food outlets the rate of turnover varies from 3 to 5 days. The rate of turnover may be low, if the food being fried is less absorbent or if the frying process is not continuous. A high turnover (fewer than 2 days) means that fat never has to be discarded. When turnover extends 5 days, fat deteriorates faster than it can be replaced. In such a situation, smaller frying vats should be used and some fat should be removed each day to allow the addition of fresh makeup fat (Mehta and Swinburn [12]).

**Frying Temperature**

The frying temperature recommended for specific foods in different studies varies from 160 to 200 °C, with the optimal frying temperature depending on the type of food, its size, the fat turnover, the size of the frying vat, the number of the frying vats used (Mehta and Swinburn [12]). Higher temperatures, especially over 200°C, accelerate oxidative and thermal alterations and increase the rate of formation of decomposition products (Soriano et al. [10]).

**Heating Time**

The intermittent heating and cooling of oil shows a greater rate of polar compound formation than that occurring during continuous frying. This is due to the increase in fatty acyl-peroxides as the oil cools and their decomposition upon heating causing further damage to the fat. This is repeated with each heating and cooling cycle (Clark and Serbia [19]). Therefore, intermittent heating is much more destructive than continuous heating (Paul and Mittal [16], Stevenson et al. [15]).

**Microbiological hazards associated with the frying of food**

Two hazards have been detected concerning frying from the microbiological point of view. One is microbial survival, mainly of spore forming bacteria, due to insufficient heating and the survival of resistant microorganisms; the other is the presence of preformed toxins, such as staphylococcal toxins, which are not destroyed by heat (Bryan [20]). Proper finished internal temperature based on time/temperature schedule aims at reducing the risk of pathogen survival (USDA [21]). In the geometric center of food the temperature should reach 80°C for 5 minutes during frying, while the frying oil temperature should range from 160-180°C in frying operations (Soriano et al. [10];[26]).
Conclusions

Deep- and pan-frying depends on several factors such as: fat or oil quality used, type of food that is fried, the frying equipment design, turnover rate, frying temperature and heating time. An ideal frying fat should be inexpensive, have long frying life and fatty acid profile that is low in saturated and trans fatty acids. It should also be resistant to gumming, rancidity and uniform in quality and ease of use (transporting, pouring heating). The design features should eliminate known factors of heat degradation/oxidation in the oil, while maintaining an output of fried products of consistent quality. A recommended daily turnover is 15-25% of the fryer capacity. Proper turnover will keep the level of free fatty acid low. The frying temperature recommended for specific foods in different studies varies from 160 to 200 °C, with the optimal frying temperature depending on the type of food, its size, the fat turnover, the size of the frying vat, the number of the frying vats used. Regarding the heating time, intermittent heating is much more destructive than continuous heating.

The microbiological hazards associated with frying of food are: microbiological survival and the presence of preformed toxins, such as staphylococcal toxins. A temperature of 80°C for 5 minutes during frying is reducing the risk of pathogen survival in the geometric center of food, while the frying oil temperature should range from 160-180°C in frying operations.

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References