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THE EDIBLE OIL USED TO FRY FOOD PLAYS AN IMPORTANT ROLE WHEN PRODUCING HIGH QUALITY FRIED PRODUCTS

Deep fat frying: science or art?

Fried food is popular in nearly all cultures across the world due to its quick cooking speed and the taste of the final product. Although it appears simple, deep fat frying is a complex process and many factors need to be taken into account to protect flavour and ensure health concerns are addressed as far as possible. Christian Gertz, Bertrand Matthäus and Richard Stier write

Deep fat frying is one of the most popular food preparation techniques in today's world. Even though there are health issues, it remains a large and expanding industry. Fried products are enjoyed by consumers of all ages and in virtually all cultures because they are quick and easy to prepare and taste and smell good. Additionally, since frying is done at such high temperatures, fried foods are generally microbiologically safe and, depending on the type of product being manufactured, can be stored at ambient temperatures. This allows industrial processors to easily package fried foods whether they are snacks or coated products for storage and retail distribution.

Although the process itself appears relatively simple, deep fat frying is a dynamic process with many pitfalls that must be taken into consideration in order to produce high-quality tasty products that are attractive to consumers.

Frying oils

The frying medium, edible oil, is a very important part of the equation when it comes to producing high quality fried foods. Not only is the food fried in the oil but it is also taken up by the food, becoming a significant part of the end product. In recent years the selection of suitable frying oils has changed due to health concerns, decreased availability of vegetable oils suitable for frying and the placing of regulatory limitations on *trans*-fatty acid content in frying oils and fried food in Canada, the USA and some European countries. The end result is that many producers are looking for *trans*-free alternatives that have the high heat stability of *trans*-fats.

In addition, frying oils should be free of synthetic antioxidants or other additives such as dimethylpolysiloxane (E900, antifoam) and should not be manufactured from sources that are genetically modified (GM). Finally, oils used for deep fat frying must be free from food allergens.

Since most oils used for industrial and restaurant frying are refined, bleached and deodorised, the oils will not contain allergens or GM organisms.

Today, there are several alternative oils with healthier fatty acid profile and no trans-fatty acids available to food processors and restaurant operators that have good oxidative and heat stability. Examples are oils from rapeseed or sunflower with modified fatty acid composition showing a high content of oleic acid and reduced amounts of polyunsaturated fatty acids such as linoleic or linolenic acid.

Minimising degradation

The heating of edible oils and fats results in both thermal and oxidative degradation of the frying oil. Fried foods such as potato chips have up to 40% oil that is absorbed during frying. Thus, it is extremely important to minimise the degree of oil degradation during frying to ensure the quality of fried foods. The composition of the fat in fried products has nearly the same composition as that of the used frying fat. Therefore, the quality of the frying oil will strongly affect the flavour, aroma, appearance, storage stability and content of potentially harmful degradation products in the fried product.

The minimisation of degradation during deep fat frying is a real challenge for the fryer operator with respect to the minimisation health risks. During frying, a constant formation of polar components from triacylglycerols can be observed. About 50% of the polar fraction (= total polar compounds) is oxidised monomeric triacylglycerols. These compounds are absorbed in the human stomach and intestinal tract due to their more hydrophilic property. Oxidised products may react with amino acid like lysine following the Maillard reaction. These advanced lipoxidation end products (ALE) and advanced glycation end products (AGE) have been shown to play an important role in the development and progression of different oxidative-based diseases including cardiovascular disease, diabetes and neurological disorders. Also the formation of heat-induced contaminants such as 3-MCPD-esters in fried fish products, heterocyclic aromatic amines in meat as well as acrylamide in French fries has to be taken into consideration. Therefore, it is important to optimise the frying process in order to minimise the potential for oil degradation and the formation of heat-induced

contaminants. This includes utilising temperature control and managing oil quality through the use of treatments, good frying processes and proper training of restaurant and food plant workers.

To understand oil degradation and the development of mitigation strategies, it is necessary to understand the mechanisms of thermal-oxidative degradation during processing and storage. Proper processing and stability of vegetable oils are the critical factors for quality during frying. Oxidation is the predominant mechanism of degradation below 140°C due to better solubility of oxygen in oil. At higher temperatures (>140°C), other mechanisms of degradation take place. Many phenomena such as the ineffectiveness of some antioxidants under frying conditions cannot be explained only by autoxidation. New mechanisms have to be discussed which might help to develop heat-stabilising agents based on natural sources and their role in optimising the frying processing. It is especially important for industrial food producers to understand the different thermo-oxidative changes occurring in frying operations. The formation of undesirable oxidation products has to be avoided since it may result in the formation of off-flavours and can reduce shelf life, even in frozen foods.

To properly evaluate what happens in the deep-fat frying process and the suitability of vegetable oils or stabilising ingredients and additives used in deep fat frying, a systems approach to the process including detailed chemical analyses of the changing frying oil is essential. Utilising a single test, such as Rancimat, is not recommended since simply not enough information is provided.

Oil uptake and heat transfer

Studies show that, in general, only 20% of the total fat of a product being fried is absorbed during the frying process. The major part (80%) is taken up while food cools down. In this phase, a vacuum is formed in the capillaries of the crust that will suck the oil from the surface into the interior of the food. Therefore, it is important to understand the frying process and the impact of deep fat frying on the product. Finished product quality is a function of the frying process and the quality of the oil. Degraded oils contain higher levels of surfactant materials, which adversely affect heat transfer and ultimately the quality of the product.

POTATO CHIPS HAVE UP TO 40% OIL THAT IS ABSORBED DURING FRYING *(PHOTO: PAULISTA/DOLLARPHOTOCLUB.COM)*

The first seconds of the frying process are crucial for the development of flavour and textural characteristics of the fried food. These characteristics include crust formation and oil pick-up during the later cooling phase. The structural characteristics (porosity) directly affect the heat-mass transfer between oil and food. Heat energy is transferred from the oil to the food, while moisture is released from the food to the oil. Excessive temperatures may cause a non-uniform crust with less, but larger pores, so that moisture is released in a rapid and uncontrolled way. If moisture release decreases too fast, the temperature in the boundary zone increases resulting in an increased rate of acrylamide formation. For instance, moderate temperatures at the beginning of deep fat frying encourage the development of a more structured crust through controlled heat-mass-transfer.

Analytics and quality assurance

Polar compounds and polymeric triacylglycerols are the most reliable chemical indicators for the assessment of used frying oils and fats. Other analytical criteria such as content of free fatty acids or anisidine value are not representative and the changes depend strongly on the type of oil. These analyses do, however, add to the overall understanding of the frying process. A more detailed analysis of the level of polar compounds, polymerised triacylglycerols, monomeric oxidised triacylglycerols and colour index helps to detect the critical points during the production of fried foods. In this context, Near Infrared Spectroscopy (NIR) is a valuable tool as this system rapidly provides all this information within a few seconds. Validated standard methods are available today.

In fast food restaurants where the products are prepared for direct consumption, it is possible to monitor oil degradation by measurement of the dielectric constant which is related to the degree of degradation. Results are expressed using a value that roughly corresponds to the amount of polar material present in the frying oil. It is necessary to validate these quick tests with other validated standard methods. Be aware, however, that it is very difficult to implement and maintain a monitoring programme such as this in the restaurant environment.

Building the bottom line

Today, food processors and restaurant operators working in the area of fried food and suppliers to these industries – which includes oil producers, food and ingredient suppliers, equipment manufacturers and the service trade – must understand that the foods they manufacture or serve must not only be safe and wholesome, but also tasty and palatable, in order to remain in business. The pressure on the industry is great and the competition is tough, but understanding the science and technology of frying as well as the markets and demands is essential and helps to build the bottom line. ●

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Congress gives new information on deep fat frying

The 8th International Symposium on Deep Fat Frying will be held on 15-17 September 2015 in Munich, Germany.

"The aim of the symposium is to provide participants with new information on frying and discuss the latest findings in order to make the market of fried products fit for the future," says the organiser of the event, the European Federation for the Science and Technology of Lipids (Euro Fed Lipid).

"Although the process of deep fat frying has been known for nearly 4,000 years, the complex process taking place at the surface of the food – and also in the oil – is still not understood comprehensively.

"Since a remarkable part of oil is taken up by food, the focus of interest also has to be on aspects important for maintaining the oil quality."

"In this context, new mechanisms taking place during the frying process have to be discussed. This may help to develop heat stabilising agents based on natural sources and to optimise the frying process."

The symposium is aimed at food producers, official and commercial laboratories and those involved in producing fried food, researching the frying process, assessing used frying oils or interested in deep fat frying in general.

The programme will cover all aspects necessary for a better understanding of the frying process and features six sessions:

- Theory of Frying
- Contaminants and Degradation Products
- Quality and Analytics
- Stabilisation
- Modelling of the Frying Process
- Industrial Frying

The symposium will take place in the MOC Veranstaltungscenter München, parallel to the oils+fats trade fair taking place on the same dates. Euro Fed Lipid has negotiated a joint deep-fat frying exhibition space within the main oils+fats trade fair. This space will host all social/networking events of the symposium.

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