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Frying

Improving quality

Edited by J. B. Rossell

WOODHEAD PUBLISHING LIMITED

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Preface

Pan-frying and deep-frying have been very popular and ancient methods of food preparations for more than 4000 years. Pre-fried and fried food products like potato crisps, fish fingers or French fries have become a main component of our diet. It is estimated that the total usage of frying fats and oils in restaurants, commercial frying and households is about 20 million tons a year.

During the last international symposium on Deep Fat Frying in Germany in March 2000, experts reaffirmed that there are no health concerns associated with consumption of frying fats and oils that have not been abused during normal frying conditions. In contrast, used cooking oils, containing high levels of degradation products, lead to a loss of organoleptic quality and a decrease in the nutrition value in fried foods, and cause strong foaming. Consumers also sometimes suffer from gastrointestinal distress after consuming food fried with such oils. Attempts by some frying establishments to bring about savings in frying oil costs have resulted in various improper practices such as the over use of frying oils, frying for too long a time, and recovery and reprocessing of spent frying oil for use in animal and poultry feeds which led indirectly to the Belgian catastrophe in which animal feed based on spent frying oil became accidentally contaminated with industrial transformer oil containing PCBs and dioxin.

The chemistry of oils and fats at frying temperatures is rather complex. More than 500 different chemical compounds have been detected as a result of oxidation, pyrolysis, polymerisation and hydrolysis. The kind and quantity of these reaction products also vary from one frying process to the other. It is impossible to identify any one compound or a group of compounds as a key indicator of the deterioriation process. Only a combination of different physical parameters may offer a solution of this problem. The March symposium *recommended* the combination of *two* tests like the determination of polar

materials and the determination of the polymer triglycerides as the best way of analysing suspect frying fats and oils. Many countries have official or informal guidelines or legal regulations for assessing the quality of frying fats and oils as a way of protecting the consumer. However, these regulations are usually based only on one method and need correction.

In the past, research on deep fat frying has concentrated mostly on health, regulation and analytical aspects of the subject. The theory of deep frying and its application to industrial frying processing have been relatively neglected. The March symposium identified a number of new areas for research such as the use of natural ingredients with stabilising properties and new ideas about the acid catalysed polymerisation of triglycerides which acts in tandem with the acid catalysed dehydration of sterols, squalenes and others natural compounds. The symposium therefore identified the need to:

> Encourage and support basic research focused on understanding the dynamics of deep fat frying and the frying process. Research should be cross-disciplinary encompassing oil chemistry, food engineering, sensory science, food chemistry and nutritional sciences.

The present book will help us to get a better understanding both of current research on frying oil quality and of the nature of deep frying itself. Such an understanding is necessary to produce good fried products more economically with an optimum flavour and a better shelf-life.

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Introduction

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Frying is one of the fastest, oldest and simplest methods of food cooking, since it involves heating an edible oil or fat and simply using the hot oil to cook the food. It was probably invented by the ancient Chinese but became so popular that it is now used throughout the world in domestic, restaurant and industrial establishments. The popularity relates to the speed with which the food can be cooked as well as the pleasant attractive properties of the cooked food. Frying cooks the food through to the middle and while so doing generates a 'crust' on the surface of the food as well as a distinctive fried food flavour.

Frying is useful in cooking all types of food, viz. meat, fish and vegetables. In fact, a single vegetable, the potato, is probably the food most closely associated with frying, since potatoes are used to generate both French fries and crisps (chips in US parlance). Banks (1996) relates that the introduction of crisps can be traced back to an event in 1853, when Commodore Cornelius Vanderbilt was vacationing in Saratoga Springs, where he ordered French fries for his evening meal. He complained that the potatoes were sliced too thick and sent them back to the kitchen. The chef, George Crum, was angered and prepared some paper thin slices of potato and fried these until they were golden brown, fully crisp and dehydrated. This was no doubt intended as a riposte to the unreasonable demands of the self-opinionated restaurant guest, but, to his surprise, the Commodore found the crisp slices to his liking. This led to a new food, initially called 'Saratoga Chips', afterwards chips in the USA and crisps in the UK. They were initially available only as a restaurant item, but, just before the turn of the century, crisps were introduced as a snack food by frying in open kettles and serving loose over the counter in paper bags from a bulk stock. As popularity increased, small factories began to produce pre-packaged crisps, which could be sold in garages and other retail outlets.

In 1929, the J.D. Ferry Company introduced a continuous fryer, which provided a commercial boost to the development of industrial frying as we now know it. In today's world, huge installations are totally dedicated to crisps production, manufacturing different types, such as traditional, salted, and a variety of flavoured types. The crisps industry has now become a major part of the food manufacturing industry and it is not unusual for a crisps-making factory to consume over 400 tonnes of frying oil per week.

The French fries industry has also progressed, and several factories world-wide now manufacture pre-fried products in a variety of forms. These include not only 'pre-fried chips' which just need finish frying, but also 'oven ready' chips, which need simple re-warming, and low-fat chips, all produced to a variety of thicknesses and shapes to suit the palate of the consumer or the fashion of the day.

These developments with two distinct forms of fried potato have run alongside the development of the ready meals trade. Many types of fried food are now produced and sold retail. Frying is a very attractive way of 'setting' a batter on the surface of a food such as fish fingers or battered and breaded turkey legs. The coating generates added value to the food, and provides a pleasing appearance. It has, for instance, been claimed that children find golden fish fingers far more visually attractive than boiled white fish, and are then more easily persuaded to eat this nutritious food. In addition, frying also helps protect the food from microbial attack. The initial frying effectively sterilises the surface of the food and, provided the food is initially of good quality, a sterilisation of the surface is sufficient to ensure a good shelf life, especially if the fried product is subsequently frozen.

A contrast arises, however, between the initially prepared Saratoga chips and the crisps, etc., that we now consume. This is because the crisps, pre-fried frozen foods and ready meals that we now eat are cooked in a large-scale industrial plant and then transported to retail outlets, where they may be displayed for several weeks before they are purchased and consumed. They are not eaten hot straight out of the kitchen. This entails a long period of time between production and consumption, during which oxidation and deterioration reactions can continue to take place. A consequence of this is that frying oils for the industrial frying sector must withstand not only the stress of frying at 180°C but also the subsequent storage, and still be of good flavour.

Although frying is one of the simplest cooking methods for the chef, it is, in contrast, one of the least well understood for the food scientist. This is due to the fact that both oxidation and hydrolysis take place during the frying operation. Above all, an understanding of oxidation is confounded by the fact that a variety of different frying oils and fats is used, each having a profusion of different constituent fatty acids. Even experiments in which oil is heated on its own to the frying temperature of about 180°C involve a complex series of oxidation reactions, but this becomes even more complicated when food is introduced into the hot oil. The constituent fatty acids are oxidised initially to hydroperoxides, but these are unstable at the frying temperature, breaking down quickly to secondary

oxidation products, such as aldehydes and ketones. Some of these are 'steam distilled' out of the oil by the steam liberated from the food as it cooks, but sufficient remain to form pro-oxidants, assisting further oxidation of the oil. On the other hand, some of the oxidised components react with protein in the food to generate the flavours that we find so attractive. Other decomposition products act as surface-active agents, breaking down the interfacial tension between the oil and the food, assisting heat transfer between the hot oil and the food and thus in turn assisting the cooking process. Furthermore, some components escape from the food, catalysing, inhibiting, or otherwise participating in the reactions in the oil. It is for these reasons that a fresh oil needs to be 'broken in' before the optimum fried products can be produced. Although these aspects can be explained in general terms, the devil is in the detail, preventing a full understanding and full optimisation of the frying process. This book sets out to correct this lack of understanding of the frying process.

The book therefore covers the market for fried foods, in which the range of different fried foods is reviewed together with the size of the market in the UK and other European countries. This general section of the book also covers regulatory issues in the EU and the USA, two of the main markets for industrially fried foods. Health issues are next discussed, since there are conflicting issues. One the one hand, consumers want a diet containing polyunsaturated fatty acids free from food additives such as antioxidants, but on the other hand they also want foods that are free of oxidised fats and the rancid and perhaps deleterious oxidation products that result when polyunsaturated oils are used with insufficient care and attention.

The oil or fat used in the frying operation becomes part of the food we eat and is, of course, the major factor in the quality and nutritional value of the food we eat. A large section of the book is therefore devoted to the properties and use of this important raw material. There are therefore chapters on the composition of frying oils, factors influencing the quality of frying oils and measurement of fat quality during and at the end of frying. The actual frying process is, of course, also important, and the book therefore concludes with chapters on effective process control, measures that need to be taken in order to maximise flavour, texture and colour, as well as the production of pre-fried foods and potato crisps.

Reference

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