Recent Advances in Food Frying Processes

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Frying is defined as a process of cooking and drying through contact with hot oil. It is intended to make food more palatable and tasteful, but at the same time makes food safer and provides a preservative effect that results from thermal destruction of microorganisms and enzymes, and a reduction in water activity at the surface or throughout the food. The shelf life of fried products is mostly determined by the moisture content after frying.

This frying condition allows physical and chemical changes such as starch gelatinization (larger starch granules), crust formation (drying of the fried product's surface), taste component formation (which makes fried foods distinctive), shrinkage, and swelling.

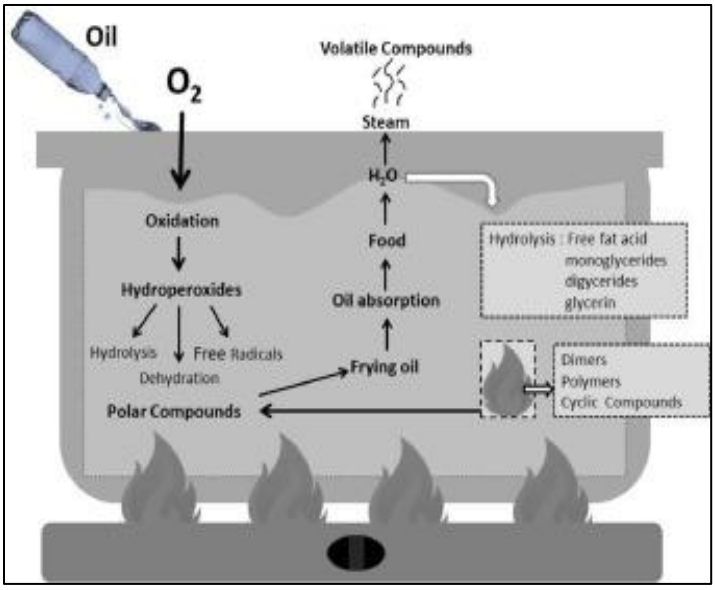

Fig. 1. Mechanisms of frying (Faruq et al., 2022)

High temperatures and the presence of air during the frying process can initiate chemical reactions such as oxidation, hydrolysis, and polymerization in fried oil. During the oxidation process, oxygen binds to the double bonds of the oil structure and produces the primary oxidative product, such as hydroperoxides. Hydrolysis is a high-energy reaction (between 160 to 190 °C) that is replaced by water in the form of steam produced by frying food and reacted with triglyceride and free fatty acid (FFA), monoglyceride, diglyceride, and glycerol.

Innovative frying processes

Vacuum frying (VF)

Vacuum Frying is a patronizing frying technique as a perfect substitute for traditional frying processes, delivering the desired quality fried product and adapting to new health trends. The vacuum is a term that defines states where the pressure is below that of the atmosphere. In this process, products are fried under lower atmospheric pressure in a closed-door system, usually below 6.65 kPa. The vacuum condition 'thus helps to lower the boiling point of water and enables the products to fry at a lower temperature than conventional frying.

The Vacuum Frying process can be broken down into five distinct stages: depressurization, frying, de-oiling, cooling, and pressurization. In the depressurization process, the samples are placed in the headspace of the frying chamber and have to wait for the pressure value to go down at a specified point. The frying process is carried out at each temperature at different frying times. In this step, heat and mass transfer happen, and the products are fried.

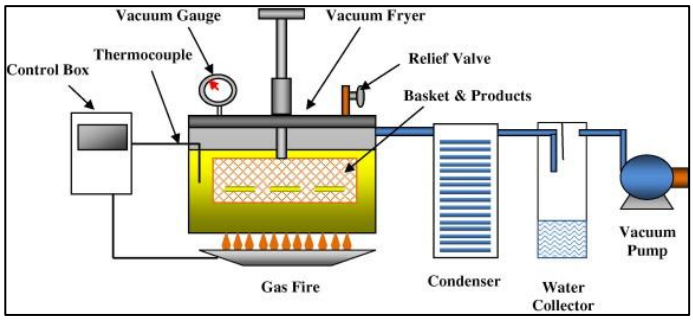

Fig. 2. Mechanisms of Vacuum frying (Faruq et al., 2022)

Microwave frying

Microwave heating has numerous applications in the food industry, including pasteurization, sterilization, tempering, dehydration, blanching, baking, gelatinization, and roasting. MW are electromagnetic waves with frequencies between 300 MHz and 300 GHz. Within this range of the electromagnetic spectrum, the International Telecommunications Union has recommended a specific range for the use for domestic

and industrial purposes. Generally, the home MW frequency is 2.45 GHz, while the industrial MW frequency is 915 MHz or 2.45 GHz.

Microwave energy can be used to heat many foods efficiently and quickly; substantial research has been conducted on the use of Microwave heat for fried purposes. Microwave frying uses two types of energy to fry food, such as dipolar rotation and ion conduction.

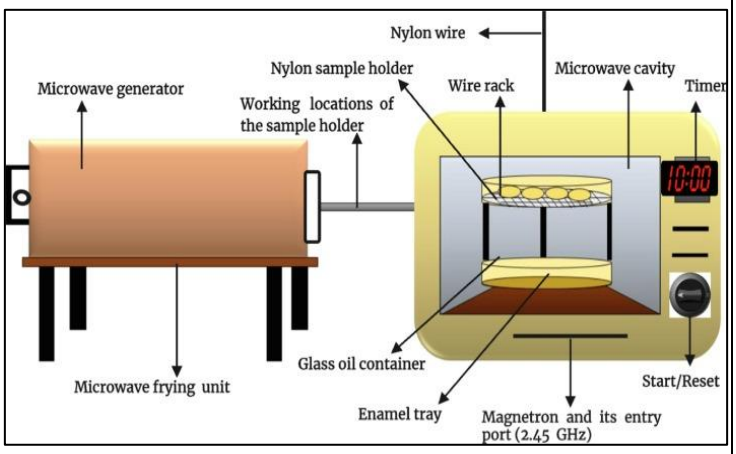

Fig. 3. Mechanisms of Microwave frying (Faruq et al., 2022)

Microwave vacuum frying (MVF)

In recent years, Microwave Vacuum Frying has gained popularity by achieving high heating rates, more uniform heating, proper handling, easy operation, and minimal cost. In this method Microwave energy is coupled with the Vacuum Frying process and provides additional power for the water molecules to diffuse outwardly and make fewer pathways possible for moisture diffusion. In the pressurization and cooling steps, these moisture pathways create less porous spaces for the interaction between dry portion and oil compared to Vacuum Frying. A limited amount of porous area in the Microwave Vacuum Frying process prevents oil absorption in the fried product.

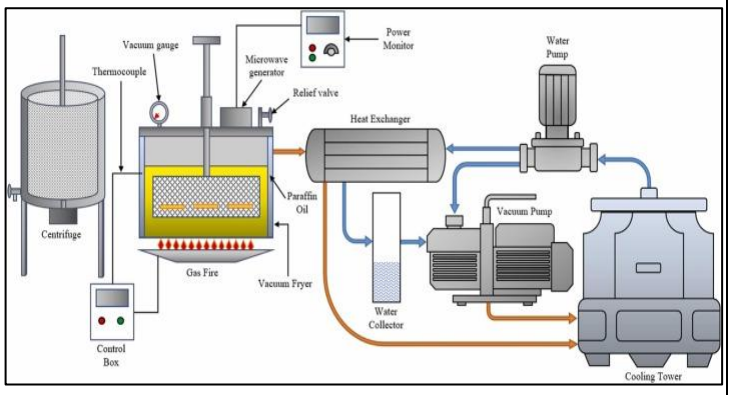

Fig. 4. Mechanisms of Microwave vacuum frying (Faruq et al., 2022)

Ultrasound combined with microwave vacuum frying (UMVF)

Modern food companies are always looking for innovative technologies to produce high-quality and safe foods while improving production efficiency and lowering energy consumption. Ultrasound is a promising technology that can reduce the processing time, increase quality, and ensure the safety issue of food products. In the food industry, ultrasound has been utilized for homogenization, extraction, filtration, crystallization, dehydration, fermentation, and the inactivation of microbes and enzymes. In addition, the use of ultrasound as a pretreatment process prior to drying or frying has shown a remarkable impact on moisture evaporation and colour preservation.

While ultrasound energy (20-100 kHz) passes through a medium and generates a series of compression and rarefaction, producing extreme shear forces that can disintegrate the medium. When ultrasonic waves hit the surface of a material, they generate energy that accelerates the sequence of compression (positive pressure) and rarefaction (negative pressure), similar to how a sponge is squeezed and released (sponge effect). The sponge effect created by ultrasound waves facilitates the formation of microscopic channels in porous materials and makes it easy to remove moisture.

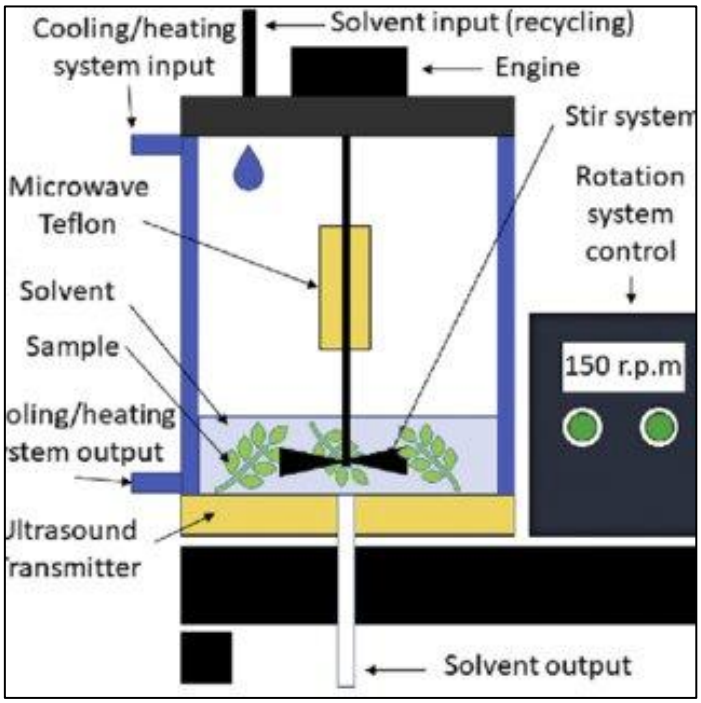

Fig. 5. Mechanisms of Ultrasound combined with Microwave vacuum frying (Faruq et al., 2022)

Air frying

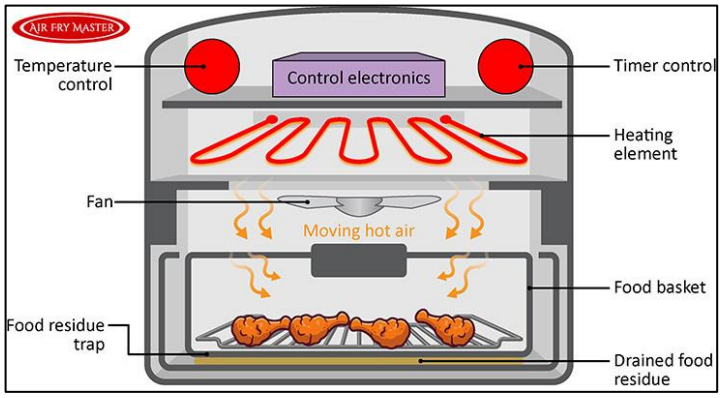

Fig. 6. Mechanisms of Air frying (Faruq et al., 2022)

Air frying is an innovative method of preparing fried foods and is considered an alternative to the conventional frying process since it produces fried foods with little or no oil. Generally, food products are fried with hot air circulation rather than oil immersion, and the frying chamber radiates heat from the heat source for more effective frying. In this process, the foods are fried by direct interaction between the external emulsion of oil droplets in hot air and the food item in the frying chamber. The heat transfer rate is remarkably high and uniformly spread throughout the food item, resulting in the production of high-quality fried products. In addition, a considerably lower amount of oil needs to be used in this frying process than the conventional frying process, which results in low oil content food.

Conclusion

This article on innovative frying processes intended to provide high-quality fried foods with low oil absorption and retain more nutritional properties than conventional frying. This article conclude that the limitations of the deep fat frying method could be overcome by adopting novel frying technologies, such as VF, microwave frying, MVF, UMVF, air frying, and radiant frying.

References

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