

# Advancement in Food Processing and Preservation Techniques

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In a world where the focus is on achieving environmental sustainability and ensuring food security, the food industry's continuous growth relies heavily on innovation. Moreover, responding to the demand for intricate and varied food products requires constant product innovation. Contemporary food technology offers a range of fresh processing possibilities to consider, potentially leading to a broader array of food industry products and processes that are both more competitive and resource-efficient. Numerous of these inventive technologies present novel avenues for creating new food items and enhancing the safety and quality of traditionally produced foods using gentler processing methods.

Novel processing technologies come with several challenges that must be tackled throughout their journey from conception to practical implementation. Specifically, ensuring the correct utilization, advancement, and fine-tuning of appropriate machinery and procedural parameters demand a substantial increase in knowledge and comprehension. Food processing technologies cover a wide array of methods and approaches used to transform raw agricultural resources into safe, nutritious, and easily consumable food items. These technologies encompass a range of procedures including cleaning, sorting, categorizing, heating, cooling, drying, fermentation, extraction, packaging, and preservation. These techniques not only improve

the taste and extend the shelf life of food but also guarantee adherence to safety regulations.

Food safety guarantees that food items are devoid of impurities, harmful microorganisms, poisons, and any other dangers that might endanger consumers' well-being. Quality pertains to the sensory qualities, nutritional composition, and overall superiority of food products, encompassing factors such as flavor, visual appeal, consistency, fragrance, and nutritional significance. Moreover, sustainability concentrates on diminishing the environmental consequences of food manufacturing, curbing waste, conserving resources, and advocating ethical procedures across the entirety of the food distribution network. Through preventing spoilage, decreasing microbial presence, and maintaining the nutritional integrity of food, these processing technologies play a vital role in enhancing worldwide food security and public health.

## **Overview of Food Processing and preservation Technologies**

Food processing technologies involve a diverse set of methods, procedures, and machinery employed to convert raw agricultural resources into safe, user-friendly, and enhanced food products with added value. The emergence of new and contemporary trends in food processing methods stems from the consumer desire for foods that promote health and offer elevated nutritional and nutraceutical benefits. Throughout history, the food industry's primary focus was on

creating safe products with extended shelf-lives. However, in today's landscape, meeting consumer demands goes beyond mere safety. Consumers now expect food products to offer substantial nutritional benefits, bioactive compounds, and pleasing sensory characteristics. The desirable qualities of food, including its taste, texture, appearance, and nutritional content, are heavily influenced by the methods of food processing employed.

Microorganisms have long been the primary culprits behind food spoilage and contamination, prompting various preservation techniques to combat them. Industrial food processing methods generally involve either eliminating these microorganisms or impeding their growth. Conventional heat-based approaches like thermization, pasteurization, and in-container sterilization have the downside of potentially compromising taste, nutritional value, and appearance. In response to consumer demands for higher quality and more tailored food products, the industry has shown keen interest in non-traditional methods of food processing. These innovative techniques, often referred to as "novel" or "emerging," aim to overcome the limitations of traditional thermal processing, ensuring that food products maintain their integrity and better cater to consumer preferences.

### Novel Food Processing Technologies

Thermal treatment is a widely employed method for prolonging the shelf life and ensuring the microbiological safety of food items due to its capability to deactivate microorganisms and spoilage enzymes. However, this approach can have adverse impacts on the excellence and nutritional aspects of fruit-based consumer goods. The components responsible for color, flavor, and taste are generally sensitive to heat, making thermal processing capable

of significantly altering the caliber of commercial fruit products and influencing consumer acceptance. As a result, the quest for alternative approaches to thermal food processing, which can yield safer products with enhanced quality, nutritional value, and sensory characteristics, prompted food scientists to explore alternative methods of deactivation.

Presently, there are two primary categories of food processing technologies being investigated: non-thermal methods, which rely on physical barriers like pressure, electromagnetic fields, and sound waves to deactivate harmful elements, and innovative thermal processing methods that primarily harness energy from sources such as microwaves and radio frequencies. However, inactivating microorganisms and enzymes in food by using such novel technologies is not enough. Ensuring product safety also involves eliminating toxic substances and preventing any contact between food and specific materials during the processing phase. Thus, evaluation of the overall quality of food products processed by innovative technologies is an essential requirement before a product can be commercialized.

**Table 1: Novel food processing technologies**

Thermal technologies	Non-Thermal Technologies
Microwave	High hydrostatic pressure
Radio Frequency	Pulsed electric fields
Ohmic - Heating	Irradiation
Inductive Heating	Ultrasound
	Inductive heating
	Cold plasma
	Ozone
	Supercritical water

### A) Advancements in thermal processing methods

Thermal processing plays a critical role within the food industry by offering efficient solutions for

transferring heat in a range of food processing tasks. Modern advancements in food processing technologies have introduced novel thermal methods that bring notable advantages in enhancing food safety, quality, and sustainability.

Microwave processing involves the utilization of electromagnetic waves within the microwave frequency spectrum to heat and cook food items. This approach presents numerous benefits, including quick and even heating, retention of sensory characteristics and nutritional integrity, as well as reduced processing durations in comparison to established techniques. Microwave processing has effectively been employed across diverse food categories, encompassing fruits, vegetables, meats, and baked goods. Nonetheless, addressing obstacles related to heat transfer constraints in specific products, managing moisture movement, and ensuring the use of suitable packaging materials is necessary to promote broader adoption of this method.

Ohmic heating, also referred to as Joule heating or electrical resistance heating, encompasses the application of alternating electric current through food items to generate heat. This approach presents merits such as accurate and manageable heating, decreased processing durations, and enhanced product excellence attributed to minimal temperature differences. Ohmic heating has effectively found application in diverse food categories, including soups, sauces, and beverages. Nevertheless, addressing issues like electrode fouling, regulating electrical conductivity in varying food compositions, and enabling scalability for industrial usage remain areas requiring attention.

Radio frequency (RF) heating entails the utilization of high-frequency electromagnetic waves to

generate heat within food items via molecular friction. This technique provides benefits like swift and thorough heating, energy efficiency, and heightened product quality and safety. RF heating has effectively found application in a variety of food products, ranging from grains, nuts, seafood, to confectionery goods. Nonetheless, addressing hurdles such as uneven heating, managing moisture retention, and the necessity for specialized machinery and packaging materials is essential to facilitate wider adoption of this approach.

### **B) Advancements in non-thermal processing technologies**

Alternative to conventional thermal processing, non-thermal processing technologies have garnered notable interest within the food industry. These groundbreaking methods provide a range of advantages concerning food safety, quality, and sustainability.

Ultraviolet (UV) light treatment is a non-thermal approach that utilizes UV-C radiation to deactivate microorganisms present on the surfaces of food items. It presents merits such as brief treatment durations, efficacy against a wide range of pathogens, and its non-thermal character. UV light treatment has been effectively employed in a variety of food items, spanning fruits, vegetables, juices, and water. Nevertheless, addressing obstacles connected to depth of penetration, inconsistent treatment, and potential alterations in sensory qualities and nutritional content is necessary to broaden its application.

Cold plasma technology entails the utilization of ionized gases at low temperatures to create reactive species capable of deactivating microorganisms and altering the surface characteristics of food items. This non-thermal technique offers benefits like quick

treatment durations, adaptability to both solid and liquid foods, and its non-thermal nature. Cold plasma has found application in diverse food items, spanning fruits, vegetables, meats, and packaging materials. Yet, addressing challenges like intricate equipment requirements, management of plasma parameters, and the necessity for extended research on its enduring impacts is crucial for its broader incorporation.

Ultrasound processing employs high-frequency sound waves to disturb cellular structures, improve mass transfer, and streamline diverse food processing tasks. This non-thermal method presents advantages such as limited influence on sensory characteristics and nutritional content, enhanced extraction effectiveness, and its non-thermal characteristic. Ultrasound processing has effectively been employed in numerous food operations, encompassing extraction, emulsification, and preservation. Nevertheless, addressing issues like fine-tuning process parameters, managing cavitation effects, and ensuring scalability for industrial usage is essential for wider implementation.

### **C) Advancements in preservation techniques**

Ensuring the safety, excellence, and sustainability of food products relies heavily on preservation methods. Recent progress in food processing technologies has introduced inventive preservation approaches that bring noteworthy advantages compared to conventional methods.

High-pressure processing (HPP) involves subjecting food items to elevated pressures, typically between 100 and 900 mega pascals, effectively deactivating spoilage microorganisms and extending product shelf life. HPP presents several benefits, including minimal impact on sensory qualities and nutritional content, as well as the capacity to neutralize pathogens without resorting to

heat or chemicals. It has found successful application across a diverse array of food products, including juices, meats, seafood, and ready-to-eat meals. However, addressing issues like equipment expenses, limited penetration in larger items, and potential alterations in product texture and appearance is essential for its widespread adoption.

Pulsed electric field processing (PEF) encompasses the application of brief, high-voltage electrical pulses to food items, leading to the disruption of cellular membranes and microbial structures. PEF provides benefits such as limited heat production, preservation of sensory and nutritional attributes, and suppression of enzymatic activity. It has effectively been utilized in an array of products, spanning fruits, vegetables, dairy, and liquid foods. However, addressing issues such as restricted implementation on an industrial scale, refining process parameters, and managing electrode fouling is crucial for its broader acceptance.

Hurdle technology integrates a range of preservation methods, such as regulating temperature, adjusting pH, reducing water activity, and applying antimicrobial treatments, to collectively create a synergistic impact that retards microbial proliferation and extends the lifespan of food items. This approach provides versatility in customizing preservation factors to suit individual food products, guaranteeing safety while upholding quality traits. Hurdle technology has been effectively utilized across different product types, including processed meats, sauces, and ready-to-eat meals.

### **Implication and Future Scope**

The progress in food processing technologies carries notable consequences for how consumers perceive products, the direction of market preferences,

regulatory evaluations, and the overall uptake of these innovative methods. The evolution of food processing technologies significantly shapes how consumers perceive products and steer market trends. Consumers are progressively recognizing the significance of food safety, excellence, and sustainability. The integration of pioneering processing techniques that elevate these dimensions holds the power to sway consumer choices in the marketplace. Approaches like high-pressure processing, novel preservation methodologies, and intelligent packaging systems have the capacity to offer consumers safer and superior food items. Moreover, incorporating sustainable practices into food processing, including the adoption of energy-efficient machinery and environmentally friendly packaging, aligns with the escalating consumer desire for products that reflect environmental responsibility. The potential for future advancements and areas of extended research and development within food processing technologies is substantial. Sustained exploration and inventive efforts are imperative to tackle emerging hurdles and maximize the potential of these innovations. A notable realm for exploration lies in crafting integrated strategies that amalgamate various technologies to attain synergistic outcomes in the realms of food safety, quality, and sustainability.

### Conclusion

These pioneering processing technologies have played a significant role in elevating the quality, safety, viability, and bioactivity of functional elements in food. The adoption of novel and inventive processing methods is expanding extensively due to their positive influence on health, resulting in fewer consumer grievances. In the foreseeable future, traditional thermal processing is anticipated to be entirely substituted by innovative food processing techniques,

as these methods are swiftly gaining traction on the global stage. These technologies are of utmost importance in fulfilling consumer expectations, molding market dynamics, and steering the trajectory of the food industry moving forward.

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