Publications by Prof. Arun S. Mujumdar during 2019-2023

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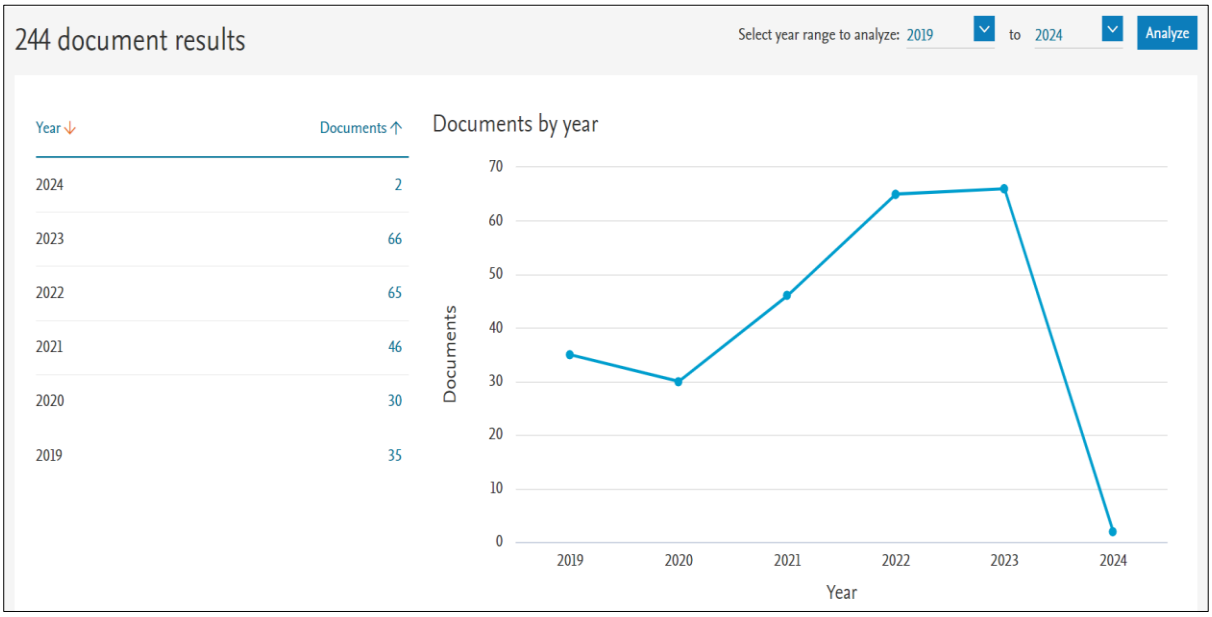

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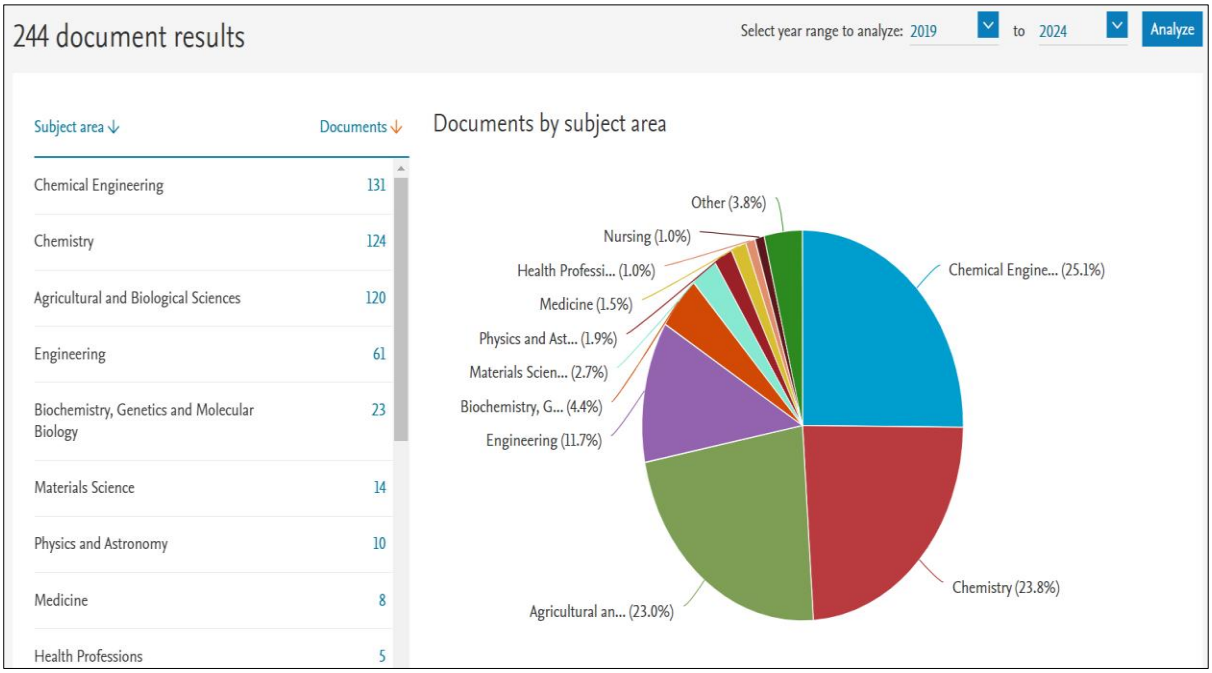

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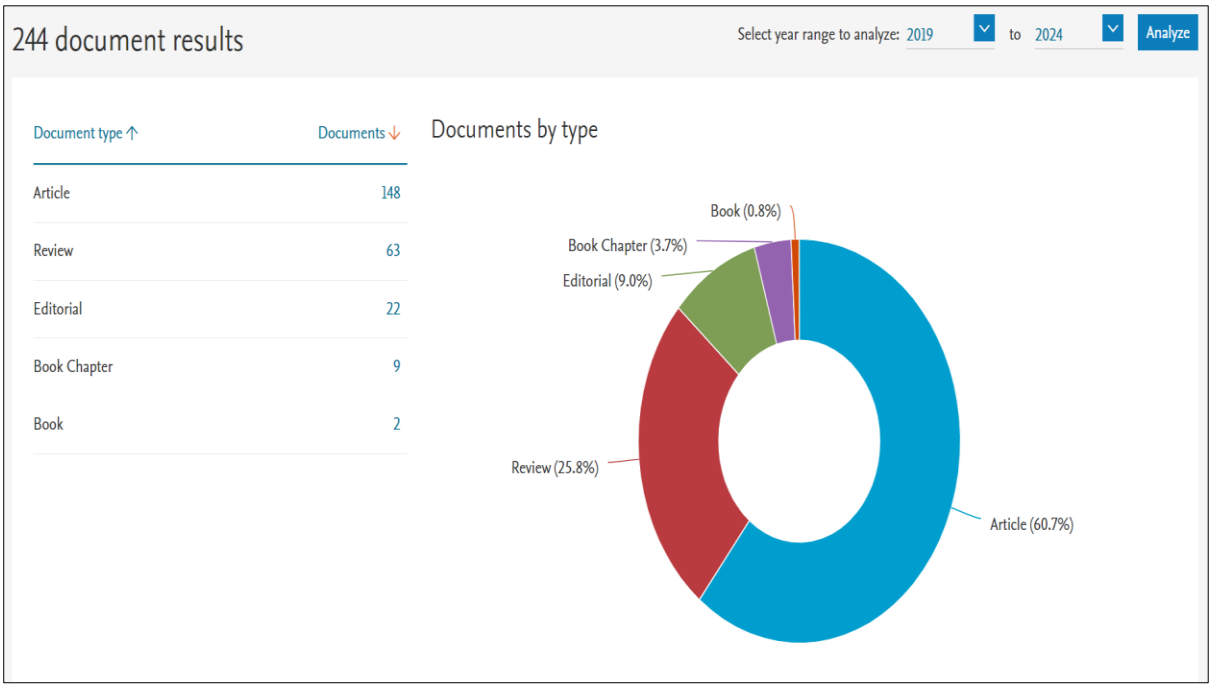

List of Publications with Abstracts:

1. ***Zhang, L., et al., Intermittent high voltage electrostatic field and static magnetic field assisted modified atmosphere packaging alleviate mildew of postharvest strawberries after simulated transportation by activating the phenylpropanoid pathway. Food Chemistry, 2024. 434.***

   The mildew is a typical symptom of strawberries during storage. The effectiveness of intermittent high voltage electrostatic field combined with static magnetic field (HVEF-SMF) technique in inhibiting the mildew of strawberries (before and after simulation of transport vibrations) was investigated. Intermittent HVEF, SMF and HVEF-SMF treatments inhibited spoilage fungal growth on the surface of strawberries by increasing the membrane permeability and leakage of intracellular materials of spoilage fungal. The HVEF-SMF alleviated mildew in strawberries, which probably via the increase of antifungal compounds (total phenolics and lignin), phenylpropanoid biosynthetic enzyme activities (Phenylalanine ammonia-lyase, 4-coumarate-CoA ligase) and pathogenesis-related proteins enzymes activities (chitinase and β-1,3-glucanase). Overall, HVEF-SMF contributed to alleviating the mildew and disease incidence of strawberries, improving the levels of antimicrobial activity, as well as extending their

shelf life from 6 d to 12 d. Therefore, HVEF-SMF treatment is a promising technology for alleviating postharvest mildew in strawberries after transportation. © 2023 Elsevier Ltd

2. ***Chen, K., et al., Development of quinoa (Chenopodium quinoa Willd) protein isolate-gum Arabic conjugates via ultrasound-assisted wet heating for spice essential oils emulsification: Effects on water solubility, bioactivity, and sensory stimulation. Food Chemistry, 2024. 431.***

Quinoa protein isolate-gum Arabic (QPI-GA) conjugates were developed by ultrasound-assisted wet heating to improve the water solubility and bioactivity of spice essential oils (EOs) in this study. The optimal conditions for QPI-GA conjugates preparation were found to be: heating temperature of 72 ℃, ultrasound power of 450 W, and reaction time of 46 min. QPI-GA conjugates displayed significantly higher emulsifying efficiency and stronger tolerance to pH variation, high salt concentration, and storage than raw materials. The emulsifying efficiency of emulsions was also influenced by the pH and viscosity of EOs, zeta potential of the emulsion as well as the relative density and lipid/water partition coefficient (P) of EOs were the possible factors impacting the stability of EO emulsions. The water solubility, antioxidant ability, and antibacterial ability of tested EOs were improved after emulsification. Meanwhile, encapsulation with QPI-GA conjugates played a good effect on reducing the sensory stimulation of EOs. © 2023 Elsevier Ltd

3. ***Zhu, Y., et al., Application advantages of new non-thermal technology in juice browning control: A comprehensive review. Food Reviews International, 2023. 39(7): p. 4102-4123.***

Fruit juices are a rich source of the bioactive compounds. Most fruit juices are rich in vitamins and organic acids that are easily absorbed by the human body. However, improper processing methods will weaily lead to stored juice suffers adverse browning reactions, which has been an important problem faced by the juice processing industry. Increasing consumer demand for safer, more nutritious products has made it difficult for traditional browning control technologies to meet the need of consumers, this has contributed to the rapid development of non-traditional processing technologies. In this paper, the traditional browning prevention and control methods are briefly summarized,

and several emerging non-thermal processing techniques are detailed reviewed along with an assessment of their commercialization potential and their application advantages. © 2022 Taylor & Francis.

4. ***Zhou, Y.H., et al., Nanotechnology for Food Safety and Security: A Comprehensive Review. Food Reviews International, 2023. 39(7): p. 3858-3878.***

Food safety and food security are subjects of great concern around the world. Ensuring a sustainable supply of nutrient-dense and safe food is a grand challenge. Nanotechnology will bring great opportunities to improve food safety and enhance agricultural productivity in a sustainable way. This study presents a critical concise overview of the basic principles and applications of diverse nanotechnologies in solving food safety and security issues. Following an overview of recent work relevant to food safety issues, several key applications of nanotechnology in food packaging and contaminant detection are outlined. The important role of nanotechnology in addressing agricultural production, water resource management (such as nanofiltration and nanosterilization), harmful substance adsorption, and nutrient delivery is discussed. Finally, opportunities for further research and development in nanotechnology for food safety and security are identified. It is noteworthy that large scale industrial applications of nanotechnology are not commonplace yet as major issues of cost and potential adverse effects on human health continue to remain impediments to be overcome. © 2021 Taylor & Francis.

5. ***Zheng, Z., et al., Maillard reaction products of pea protein hydrolysate as a flavour enhancer for beef flavors: Effects on flavor and physicochemical properties. Food Chemistry, 2023. 417.***

This study evaluated the effects of Maillard reaction products of pea protein hydrolyzates (MRPs-PPH) as salt-reducing and umami-enhancing components on the flavor and physicochemical properties of beef flavors. The addition of MRPs-PPH reduced the brightness of beef flavors, increased the redness and yellowness, as well as changed the texture characteristics of beef flavors. With the addition of MRPs-PPH, the apparent viscosity, storage modulus and loss modulus of beef flavors decreased. Finally, the relationship between taste attributes and flavor compounds of the samples was analyzed by Partial Least Squares Regression (PLSR), and flavor compounds with

significant positive contributions to different taste attributes were found. This study showed that MRPs-PPH could be used as a flavor enhancer derived from biomacromolecules with salt reduction and freshness enhancement. © 2023 Elsevier Ltd

6. ***Zhao, L., et al., Application of carbon dots in food preservation: a critical review for packaging enhancers and food preservatives. Critical Reviews in Food Science and Nutrition, 2023. 63(24): p. 6738-6756.***

Carbon dots (CDs) have two unique advantages: one is ease of synthesis at low price, the other is desirable physical and chemical properties, such as ultra-small size, abundant surface functional groups, nontoxic/low-toxicity, good biocompatibility, excellent antibacterial and antioxidant activities etc. These advantages provide opportunities for the development of new food packaging enhancers and food preservatives. This paper systematically reviews the studies of CDs used to strengthen the physical properties of food packaging, including strengthen mechanical strength, ultraviolet (UV) barrier properties and water barrier properties. It also reviews the researches of CDs used to fabricate active packaging with antioxidant and/or antibacterial properties and intelligent packaging with the capacity of sensing the freshness of food. In addition, it analyzes the antioxidant and antibacterial properties of CDs as preservatives, and discusses the effect of CDs applied as coating agents and nano-level food additives for extension the shelf life of food samples. It also provides a brief review on the security and the release behavior of CDs. © 2022 Taylor & Francis Group, LLC.

7. ***Zhang, W.K., et al., Hot-air impingement roast drying of beef jerky: Effect of relative humidity on quality attributes. Drying Technology, 2023. 41(2): p. 277-289.***

To mitigate encrustation of beef jerky and improve quality during hot-air impingement roast drying (HIRD) process, the effect of different relative humidity (RH) conditions (NO (about 2.3%), 10%, 15%, 20%) at a constant roast drying temperature of 120 °C on “encrustation” thickness, cooking yield, microstructure, tenderness, color, myoglobin, lipid oxidation, flavor and sensory quality of beef jerky were explored. Results indicate that improving RH decreased the “encrustation” thickness of beef jerky significantly ($p < 0.05$) as the moisture distributed more evenly shown by magnetic

resonance imaging analysis. Microstructure observation showed that the number of gaps between muscle bundles decreased and muscle bundles become plumper at both cores and edges of beef jerky with an increase of RH. Meanwhile, humidification could improve the color quality of beef jerky, decline the content of malondialdehyde (MDA) as well as enhance the flavor of beef jerky. The findings in this work indicate that humidification enhances the quality of beef jerky by alleviating surface encrustation, improving color, reducing lipid oxidation, and enhancing roast drying flavor during HIRD processing. © 2022 Taylor & Francis Group, LLC.

8. ***Zhang, L., et al., Drying technology development for future starchy staples food processing: Research process, challenges, and application prospects. Drying Technology, 2023.***

Starchy staples are the main source of energy for most of the global population, and future growing populations and limited arable land areas dictate that reducing post-harvest losses of produce and conserving energy consumption are critical. With the increased prevalence of chronic non-communicable diseases (such as cardiovascular disease) and the implementation of the Sustainable Development Goals, the benefits of grains for human health are being rethought. Drying, as a significant and energy-intensive unit operation in post-harvest handling and storage of grain, has been extensively studied by scholars. This paper describes several common types of starchy staple foods and their drying and pretreatment technologies in recent years, focusing on some auxiliary drying technologies to improve drying efficiency and energy-saving aspects, while pretreatment technologies not only improve drying efficiency but also help to retain nutrient content. And with the increasing pursuit of nutrition, personalized food is essential in the future. This paper also introduces the application prospects of starchy staples, including 3D printing, the aerospace field, and special medical food. © 2023 Taylor & Francis Group, LLC.

9. ***Zhang, L., et al., Potential nano bacteriostatic agents to be used in meat-based foods processing and storage: A critical review. Trends in Food Science and Technology, 2023. 131: p. 77-90.***

Background: Nano bacteriostatic agents have attracted substantial attention of researchers and industry because of their unique properties. Meat-based foods (including fresh meat and meat product) have short shelf life due to risk of microbial growth resulting in rapid deterioration. Consumer demand for meat-based foods with long shelf life and of high quality has led to meat processors seeking new cost-effective and reliable methods to inhibit the growth of microorganisms in various types of meat. Scope and approach: This paper provides a concise yet comprehensive review of recent research on several common nano bacteriostatic agents, e.g., nano silver, nano zinc oxide, nano carbon quantum dots, and nano-scale essential oils, suitable for foods from the aspect of antibacterial properties. Also covered is discussion of various newly developed preparation methods for such agents. The application and development prospects for nano bacteriostatic agents in processing and low-temperature storage of meat-based foods are reviewed critically. Key findings and conclusions: Nano bacteriostatic agents have an excellent ability to inhibit the growth of foodborne pathogens. With the development of the concept of green chemistry, more nanoparticles are synthesized by the synthesis method of green biology under the reduction and stabilization of active substances in microorganisms, plants, and their extracts. In the storage of meat-based foods, nano bacteriostatic agents are widely used in the forms of edible coatings and active packaging to prolong shelf life. Furthermore, nano zinc oxide is often used in combination with radio frequency (RF) to improve the sterilization effect of RF heating, maintain the flavor of meat products, and prolong shelf life. This review contributes to a deeper understanding of the preparation of nano bacteriostatic agents and their application in meat-based foods. © 2022 Elsevier Ltd

10. Zhang, L., et al., Novel multilayer chitosan/emulsion-loaded syringic acid grafted apple pectin film with sustained control release for active food packaging. Food Hydrocolloids, 2023. 142.

The clove essential oil (EO) emulsions were prepared using syringic acid grafted apple pectin (SAAP) and soy protein isolate (SPI). This emulsion was used to improve properties of pullulan film (inner layer), which can be used for active packaging. Furthermore, chitosan was employed as the outer layer of the multilayer film prepared to address the limitations of existing pullulan films. Mechanical, optical, and functional properties of multilayer films were determined. The emulsions produced by SAAP

display better emulsifying properties, smaller and uniform droplet size distribution. In comparison with AP-SPI-Pul, water vapor and oxygen permeabilities of SAAP-SPI-Pul were lower, while antioxidant, antimicrobial properties and barrier properties to UV were improved. Chitosan film can be used as the outer layer to modify the hydrophilicity/hydrophobicity of films with water contact angle of 98.4°. SAAP-SPI-Pul-Chit film has characteristics of high-performance films with favorable optical and mechanical properties. Furthermore, antioxidant and antimicrobial properties, as well as fruit preservation properties of the SAAP-SPI-Pul-Chit films were strengthened, which is attributed to the sustained release of clove EO in films. © 2023

11. Zhang, L., et al., Preparation of sodium-containing coacervates via high-voltage electrostatic field treatment: Saltiness perception of prefabricated chicken patties. Food Hydrocolloids, 2023. 142.

Sodium-containing soy protein isolates (SPI)/apple pectin (AP) coacervate dispersion were prepared via high-voltage electrostatic field (HVEF) application to inhomogeneous spatial distribution of sodium as a strategy for reduction of salt content and enhancing the saltiness of prefabricated chicken patties. SPI/AP coacervates were prepared by HVEF processing at pH of 4.0, HVEF voltage of 32 kV, and ratio of SPI: AP to 5:1 which was optimized according to Artificial neural network (ANN)-coupled with genetic algorithm. Fluorescence intensity and FTIR analysis demonstrated that the HVEF treatment caused alteration of protein conformation, improved hydrogen bonding and electrostatic interactions between SPI and AP. At the NaCl concentration of 100 mM, HVEF treated sodium-containing SPI/AP coacervates achieved maximum phase separation as well as coacervate yield (85.23 ± 0.51%). HVEF treated sodium-containing SPI/AP coacervates displayed increased sodium fluorescence intensities, higher sodium concentration difference between coacervate phase and supernatant, and smaller particle sizes. Furthermore, HVEF treated coacervate dispersion showed higher sodium release in vitro during oral digestion. The saltiness of prefabricated chicken patties prepared using HVEF treated coacervates dispersion allowed a reduction in the sodium content of 43.59%. The increase of saltiness perception and sodium release in prefabricated chicken patties is attributed to enhanced water mobility in the matrix and distribution of inhomogeneous sodium. © 2023 Elsevier Ltd

12. Zhang, L., M. Zhang, and A.S. Mujumdar, Terahertz Spectroscopy: A Powerful Technique for Food Drying Research. Food Reviews International, 2023. 39(3): p. 1733-1750.

Due to its major advantages such as broadband capability, coherence, low photon energy, water absorption characteristics, high penetration ability and fingerprint spectrum, terahertz time domain spectroscopy (THz-TDS) is being applied extensively in the field of food science and technology. The application of terahertz is a promising technology for monitor and detection of chemical components during drying foods. In this paper, a concise overview of the important features of THz spectrum and imaging are described. In addition, the latest advances in the application of THz technology to monitor the variation of water content during drying along with the possibility for quantitative detection of sugar, protein, amino acid and foreign-objects are summarized. Also, potential problems and limitations in the application of terahertz technology are summarized for further development. © 2021 Taylor & Francis.

13. Zhang, L., M. Zhang, and A.S. Mujumdar, Technological innovations or advancement in detecting frozen and thawed meat quality: A review. Critical Reviews in Food Science and Nutrition, 2023. 63(11): p. 1483-1499.

Frozen storage is one of the main storage methods for meat products. Freezing and thawing processes are important factors affecting the quality of stored foods. Deterioration of texture, denaturation of protein, decline of water holding capacity etc. are among the major quality issues during freezing that must be addressed. A number of advanced technologies are now available to detect the quality changes that can occur during freezing and/or thawing. This paper presents an overview of the techniques commonly used for the detection of meat product quality; these include: advanced microscopy, molecular sensory science and technology, nuclear magnetic resonance, hyperspectral technology, near infrared spectroscopy, Raman spectroscopy etc. These direct and indirect measurement techniques can characterize the quality of meat product from many different angles. The objective of this review is to provide an in-depth understanding of possible quality changes in meat products during freezing and thawing cycle so as to improve the quality of frozen and thawed meat products in industrial practice. © 2021 Taylor & Francis Group, LLC.

14. Yu, Q., et al., Evaluation of antioxidant, antimicrobial and bacterial labeling capacities of four plant byproduct carbon dots. Food Bioscience, 2023. 56.

The comprehensive utilization of food resources has been an issue of interest. In this study, carbon dots (CDs) were prepared by green hydrothermal method using four plant byproducts, and then the preparation of fluorescent CDs was verified by particle size, Fourier transform infrared spectroscopy, X-ray diffraction, thermogravimetric analysis as well as UV and fluorescence spectroscopy. The results showed that all four CDs had particles smaller than 50 nm and at a concentration of 128 μg/mL, CDs had similar ability to scavenge DPPH free radicals as vitamin C. Also, all four CDs had extensive fluorescence properties. In addition, CDs showed good antibacterial properties and fluorescence properties against Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa. These findings suggest that these four CDs have a promising future in the field of food detection and preservation, and provide useful information for the thorough utilization of food resources. © 2023 Elsevier Ltd

15. Xu, L., et al., Thermal-hydraulic performance of flat-plate microchannel with fractal tree-like structure and self-affine rough wall. Engineering Applications of Computational Fluid Mechanics, 2023. 17(1).

Inspired by the natural bifurcating structures, tree-like microchannels have been applied for microelectronics cooling. In order to understand the thermal-hydraulic performance of a flat-plat tree-like microchannel, successive branching ratios of tree-like structure are optimized based on minimization of flow resistance. It is shown that the optimal successive diameter ratio of symmetrical and dichotomous structures under volume constraint follows Murray's law, while the optimal successive length ratio under the constraint of fixed channel area follows the power law 2−2/3. A mathematical model of convection in disc-shaped heat sink composed of a tree-like microchannel with self-affine rough surface is developed by the fractal geometry and finite element method. The flat-plate tree-like micro-channel with optimal successive diameter and length ratio shows enhanced thermal-hydraulic performance. The Nusselt number of the flat-plat tree-like micro-channel increases with the inlet Reynolds number and the self-affine fractal dimension of the rough wall. The present optimization method and mathematical model for the flat-plate tree-like microchannel shed light on the design of flat-plate micro-channel heat sinks and flow channel in fuel cell among other potential cooling

applications. © 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

16. Wu, S., et al., Fresh Food Quality Deterioration Detection and Labeling: a Review of Recent Research and Application in Supply Chain. Food and Bioprocess Technology, 2023.

The demand for fresh food has become a frequent high demand commodity in everyday living and accounts for a larger share of the retail consumer market. As the quality of fresh foods deteriorates from harvest to consumption due to internal or external factors, it is important to label or mark fresh products or their package directly on the surface or on the top. In recent years, there has been a growing demand for labels to monitor the quality of various fresh food products. Sellers and consumers can easily determine whether a product is edible by observing visual changes in the detection label without opening the package for visual or olfactory inspection. This review summarizes the latest research findings on advances in fresh food quality deterioration and the application of suitable detection labels in the supply chain. It highlights diverse detection labels, modification of label functionality, and several latest shelf-life prediction systems. Finally, recommendations and prospects for future research in the development of fresh detection labels are provided. This paper allows relevant researchers to quickly obtain information on food quality inspection labels and their problems to be solved. © 2023, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

17. Watson, A.G., et al., A simple solar crop drying and pasteurizing system appropriate for smallholder and subsistence farmers in tropical and subtropical regions. Drying Technology, 2023.

Open sun drying is the predominant process used for food preservation by smallholder and subsistence farmers (SHSFs), and their families, globally constituting about 2 billion people on about 475 million farms. The major problems with this process are the slow, unreliable speed of completion, rain-caused loss of vital food sources, risks from mycotoxin accumulation, environmental contamination, and loss of nutritional quality. SHSFs represent the poorest and least educated human demographic, whose survival is largely ignored by Governments, untouched by international aid programs,

and with limited access to basic utilities. Solar drying systems can greatly improve the preservation of safe and nutritious food, but current systems deployed put this technology beyond the reach of the demographic which needs it most. Here, our objective was to develop the technology for the simplest low-cost drying system, which would minimize all risk factors, particularly eliminate mycotoxin accumulation, and which could be practically deployed by SHSFs. © 2023 Taylor & Francis Group, LLC.

18. Wang, X., et al., Improvement of the Flavor of Powder-Form Meal Replacement: a Review of Relevant Technologies. Food and Bioprocess Technology, 2023. 16(3): p. 492-509.

Powder-form meal is now a common type of meal replacement product for busy consumers. The flavor of such meals in dry powder form as replacement for conventional meals is an important quality indicator, which directly affects consumer preference. As expected, powder quality is closely related to the processing it undergoes. Therefore, it is necessary to carefully consider the process and processing technology used to produce high-quality powder-form meal replacement products. This article introduces the processing characteristics of powders for meal replacement, which vary due to differences in the properties of the raw materials used. This article also reviews the development of key processing technologies of powders for meal replacement, including drying, ultra-micro pulverization, and blending technologies. The application of these technologies has greatly improved the flavor quality of powder-form meal replacement. In addition, future trends in relevant powder technologies for meal replacement are discussed. © 2022, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

19. Wang, X., et al., Easy-to-swallow mooncake using 3D printing: Effect of oil and hydrocolloid addition. Food Research International, 2023. 164.

3D printing is a promising technology for food production, capable of producing and developing personalized food products. In recent years, research on the application of 3D printing technology to create easy-to-swallow foods for the elderly with dysphagia has received extensive attention. In this study, we applied dual nozzle 3D printing technology to develop an easy-to-swallow mooncake food using a traditional Chinese food, mooncake, as a model system. We optimized the printing dough ink formulation

by setting up soybean oil gradient experiments and Arabic gum gradient experiments, and then we applied the optimized dough ink as the crust of the mooncake to produce easy-to-swallow mooncakes. The experimental results show that the addition of 2.5 g of soybean oil and 0.125 g of Arabic gum could improve the texture of the dough product and reduce its hardness and adhesiveness. The mooncake produced with this crust dough ink was rated in the IDDSI texture level four, which met expectations. Therefore, this work provides insights into the development of easy-to-swallow food products. © 2022 Elsevier Ltd

20. Wang, D., et al., Novel drying techniques for controlling microbial contamination in fresh food: A review. Drying Technology, 2023. 41(2): p. 172-189.

Fresh foods such as fruits, vegetables, grains, nuts, and meats are generally rich in water and are susceptible to microbial contamination. Drying and dehydration processes can reduce water content, but low water activity foods may not be microbiologically safe. Several novel drying techniques have demonstrated varying degrees of effectiveness in microbial inactivation, including supercritical CO2 drying, low-pressure superheated steam drying, microwave drying, radio frequency drying, infrared drying, vacuum drying, freeze drying, etc. Some typical microorganisms used as indicators of microbial inactivation including natural present microorganisms (e.g., mesophilic bacteria and their spores, yeast and mold) and various pathogens (e.g., Escherichia coli O157:H7, Listeria monocytogenes and Salmonella spp.). This paper reviewed novel drying techniques for controlling microbial contamination of fresh foods and analyzed their advantages/disadvantages and microbial inactivation capabilities. These novel drying techniques have the potential to ensure microbiological safety during drying and have the prospect of shortening the food processing chain by integrating drying and sterilization/decontamination into the same process. © 2022 Taylor & Francis Group, LLC.

21. Tunçal, T. and A.S. Mujumdar, Modern techniques for sludge dewaterability improvement. Drying Technology, 2023. 41(3): p. 339-351.

Since sludge mitigation requires new strategies for enhanced dewaterablity, several scientific and technological advancements in conditioning, dewatering and drying technologies for a variety of sludges are being developed continuously. Grappling with

the problem of ever-increasing sludge volume, it is important to critically assess the new concepts to assist in rapid technological developments in this area. This paper provides a concise state-of-the-art discussion focused on the effects of the key parameters including affected dewatering performance according to the sludge type, source and its physicochemical characteristics, rheological factors, particle size distribution, floc surface charge and endogenic polymeric substances (EPS), on the dewatering performance. Since initial conditioning is highly critical on the following dewatering and drying steps, innovative methods, e.g., physical conditioning, sonication, hydrodynamic cavitation, thermal treatment, microwave, electrical treatment, photocatalytic treatment and chemical coagulation/flocculation have been included in this review. Furthermore, latest developments in dewatering and drying technologies are also discussed in terms of their advantages/disadvantages and energy demands. This paper includes a capsule discussion of control of industrial sludges and the application of advanced oxidation processes (AOP(s)) in sludge conditioning and dewatering. © 2022 Taylor & Francis Group, LLC.

22. Teng, X., M. Zhang, and A.S. Mujumdar, Phototreatment (below 1100 nm) improving quality attributes of fresh-cut fruits and vegetables: A review. Food Research International, 2023. 163.

The emerging area of phototreatment technology has shown a significant potential to enhance the quality of fresh-cut fruit and vegetable products (FFVP). This review critically evaluates relevant literatures to address the potential for phototreatment technology (Red, blue, green, ultraviolet and pulsed light) applied to FFVP, outline the key to the success of phototreatment processing, and discuss the corresponding problems for phototreatment processing along with research and development needs. Base on photothermal, photophysical and photochemical process, phototreatment displays a great potential to maintain quality attributes of FFVP. The operating parameters of light, the surface properties and matrix components of the targeted material and the equipment design affect the quality of the fresh-cut products. To adapt current phototreatment technology to industrial FFVP processing, it is necessary to offset some limitations, especially control of harmful substances (For example, nitrite and furan) produced by phototreatment, comparison between different phototreatment

technologies, and establishment of mathematical models/databases. © 2022 Elsevier Ltd

23. Tang, T., et al., Novel strategies for controlling nitrite content in prepared dishes: Current status, potential benefits, limitations and future challenges. Food Research International, 2023. 170.

Sodium nitrite is commonly used as a multifunctional curing ingredient in the processing of prepared dishes, especially meat products, to impart unique color, flavor and to prolong the shelf life of such products. However, the use of sodium nitrite in the meat industry has been controversial due to potential health risks. Finding suitable substitutes for sodium nitrite and controlling nitrite residue have been a major challenge faced by the meat processing industry. This paper summarizes possible factors affecting the variation of nitrite content in the processing of prepared dishes. New strategies for controlling nitrite residues in meat dishes, including natural pre-converted nitrite, plant extracts, irradiation, non-thermal plasma and high hydrostatic pressure (HHP), are discussed in detail. The advantages and limitations of these strategies are also summarized. Raw materials, cooking techniques, packaging methods, and storage conditions all affect the content of nitrite in the prepared dishes. The use of vegetable pre-conversion nitrite and the addition of plant extracts can help reduce nitrite residues in meat products and meet the consumer demand for clean labeled meat products. Atmospheric pressure plasma, as a non-thermal pasteurization and curing process, is a promising meat processing technology. HHP has good bactericidal effect and is suitable for hurdle technology to limit the amount of sodium nitrite added. This review is intended to provide insights for the control of nitrite in the modern production of prepared dishes. © 2023 Elsevier Ltd

24. Tang, T., et al., Novel drying and pretreatment methods for control of pesticide residues in fruits and vegetables: A review. Drying Technology, 2023. 41(2): p. 151-171.

Presence of pesticide residues on fruits and vegetables is a serious safety issue for consumers. Efforts are being made to utilize drying technology to turn fruits and vegetables with high pesticide residues into dehydrated products with minimal or no pesticide residues are clearly conducive to ensuring safety and international fresh food

commodity trade. This paper attempts to summarize the latest developments in drying technologies and pre-drying treatments for controlling pesticide residues in fruits and vegetables, with emphasis on sun-, oven-, freezing-, vacuum-, and microwave-drying technology, as well as non-thermal pretreatment methods such as ultrasound, non-thermal plasma (NTP), pulsed electric field (PEF), high hydrostatic pressure (HHP), and irradiation. © 2022 Taylor & Francis Group, LLC.

25. Singh, P., et al., New strategies on the application of artificial intelligence in the field of phytoremediation. International Journal of Phytoremediation, 2023. 25(4): p. 505-523.

Artificial Intelligence (AI) is expected to play a crucial role in the field of phytoremediation and its effective management in monitoring the growth of the plant in different contaminated soils and their phenotype characteristic such as the biomass of plants. This review focuses on recent applications of various AI techniques and remote sensing approaches in the field of phytoremediation to monitor plant growth with relevant morphological parameters using novel sensors, cameras, and associated modern technologies. Novel sensing and various measurement techniques are highlighted. Input parameters are used to develop futuristic models utilizing AI and statistical approaches. Additionally, a brief discussion has been presented on the use of AI techniques to detect metal hyperaccumulation in all parts of the plant, carbon capture, and sequestration along with its effect on food production to ensure food safety and security. This article highlights the application, limitation, and future perspectives of phytoremediation in monitoring the mobility, bioavailability, seasonal variation, effect of temperature on plant growth, and plant response to the heavy metals in soil by using the AI technique. Suggestions are made for future research in this area to analyze which would help to enhance plant growth and improve food security in long run. © 2022 Taylor & Francis Group, LLC.

26. Shirkole, S.S., A.S. Mujumdar, and G.S.V. Raghavan, Drying of foods: principles, practices and new developments, in Drying Technology in Food Processing: Unit Operations and Processing Equipment in the Food Industry. 2023, Elsevier. p. 3-29.

Food is consumed fresh as well as in dried form for preservation as well as for use in numerous consumer products. The goal is to provide nutritious products with micro-

and macronutrients safely for the population. This chapter provides an overview of the drying of food, the role of moisture content in food preservation, the principles of drying kinetics, and the selection of dryers for various types of food products. The effects of drying conditions on drying kinetics and the quality parameters of the dried food commodities are discussed briefly. Finally, the role of drying technologies for the long-term preservation of food products has also been highlighted, along with suggestions for future research and development. © 2023 Elsevier Inc. All rights reserved.

27. Shen, J., et al., Schemes for enhanced antioxidant stability in frying meat: a review of frying process using single oil and blended oils. Critical Reviews in Food Science and Nutrition, 2023. 63(21): p. 5414-5429.

Deep-fried meat products are widely popular. However, harmful compounds produced by various chemical reactions during frying have been shown to be detrimental to human health. It is of great necessity to raise practical suggestions for improving the oxidation problem of frying oils and frying conditions in some aspects. Vegetable oils are not as thermally stable as saturated fats, and blended oils have higher thermal stability than single oil. In this review, we discussed the oxidation problems frying oils and meats are subject to during frying, starting from the oil oxidation mechanism, the effects of different oils and fats on the quality of different fried meats under different conditions were concluded to alleviate the oxidation problem, to highlight the necessity of applying blended oils for frying, and effective antioxidants added to frying oils are also introduced, that would provide more convenient and practical options for obtaining higher quality of fried meat products and offer better understanding of the potential of blended frying oils for frying meat products. © 2021 Taylor & Francis Group, LLC.

28. Shen, J., et al., Effect of particle size on quality of crab meatballs using enzymatically deproteinized crab by-products. Advanced Powder Technology, 2023. 34(1).

The production of crab meatballs generates large amount of crab shell waste, it is therefore necessary to develop a green, economical and environmentally friendly process to vaporize the waste. This study was aimed at investigating the applicability of microwave heating combined with ultrasonic field-assisted alkaline protease (MUSED) (50 ℃, pH = 9.0, 14025.67 U/g, 4.21 h and liquid/material = 14.41:1) for

pretreatment of ball-milled crab shells. The ball milling efficiency of the crab shell powder pretreated by MUSED was observed to increase by 50 % compared to the control group, with the final average particle size of D4 = 4.88 ± 0.20 um. High calcium solubility and low energy consumption of the ball-milled powder increased dietary calcium bioavailability and reduced the potential for high calorie intake. The addition of 6 % (w/w) crab shell powder treated by MUSED improved the texture of the crab meatballs (CM-D4) and gave the product enhanced crab flavor relative to the control group. Moreover, the lower cooking loss of CM-D4 resulted in significant retention of nutrients (p < 0.05). The crab shell powder treated by MUSED method was more efficient in ball milling, which improved the quality of crab meatballs while relieving environmental pressure. © 2022 The Society of Powder Technology Japan

29. Shen, D., et al., Consumer-oriented smart dynamic detection of fresh food quality: recent advances and future prospects. Critical Reviews in Food Science and Nutrition, 2023.

Since fresh foods include a significant amount of water, fat, and protein, it is more likely to become infected by microorganisms causing a major loss of quality. Traditional detection techniques are less able to meet customer expectations owing to the limitations of high cost, slow response time, and inability to permit dynamic monitoring. Intelligent non-destructive detection technologies have emerged in recent years, which offer the advantages of small size and fast response at low cost. However, dynamic monitoring of fresh food quality based on intelligent detection technologies on the consumer side has not been rigorously evaluated yet. This paper discussed the application of intelligent detection technologies based on the consumer side in the dynamic monitoring of fresh food freshness, microorganisms, food additives, and pesticide residues. Furthermore, the application of intelligent detection technologies combined with smartphones for quality monitoring and detection of fresh foods is evaluated. Moreover, the challenges and development trends of intelligent fresh food quality detection technologies are also discussed. Intelligent detection technologies based on the consumer side are designed to detect in real-time the quality of fresh food through visual color changes in combination with smartphones. This paper provides ideas and recommendations for the application of intelligent detection technologies

based on the consumer side in food quality detection/monitoring and future research trends. © 2023 Taylor & Francis Group, LLC.

30. Shen, D., et al., Advances and application of efficient physical fields in extrusion based 3D food printing technology. Trends in Food Science and Technology, 2023. 131: p. 104-117.

Background: 3D printing technology, also known as additive manufacturing technology, has the advantages of customization, digitization and personalization. At present, researchers have made significant progress in the exploration of printable materials and the improvement of printing precision in food 3D printing technology, while the use of efficient physical fields in changing printing properties of materials and improving the quality of printed products has not yet been rigorously evaluated. Scope and approach: This paper discusses applications of efficient physical fields for improving the printability and precision of printed food materials. At the same time, efficient physical fields and the combination of efficient physical fields to induce the conversion of 3D printing of products into 4D printing (color, flavor, nutrition, shape changes) are discussed. Moreover, this paper also emphasizes the importance of efficient physical fields for drying and sterilization of 3D printed products. Key findings and conclusions: Pretreatment of printed materials with efficient physical fields can improve their printability and printing accuracy. Meanwhile, the combination of efficient physical fields and efficient physical fields combined with 3D printing technology can quickly realize 4D printing technology. Moreover, efficient physical field drying not only maintains the shape stability of the printed samples, but also protects the active components of the printed samples. Unfortunately, there are few studies on the sterilization of 3D printed samples by efficient physical fields. This paper provides a new ideas for the future study of physical fields combined with 3D food printing technology. © 2022 Elsevier Ltd

31. Patil, A., et al., Combined microfluidics and drying processes for the continuous production of micro-/nanoparticles for drug delivery: a review. Drying Technology, 2023. 41(10): p. 1533-1568.

Drug nanonization and encapsulation efficiency enhancement are prerequisites for hydrophobic and hydrophilic drugs to be delivered at the targeted site. Microfluidic

technology has emerged as an efficient technique to achieve these objectives due to its ability to provide intensive mixing and yield relatively uniform nanosized particles. Furthermore, microfluidic technology has been established as a promising method to develop novel drug delivery systems with uniform particle size and distribution, reducing batch variation with controlled drug delivery capabilities. This extensive review introduces various applications of microfluidic systems for synthesizing controlled-sized organic and inorganic nanoparticles, followed by a discussion on micromixers and their recent advancements in drug delivery systems. We have reviewed the vital role of spray and freeze-drying in nanoparticle production. In addition, we have highlighted the concept and compared a microreactor-assisted spray and freeze dryer for developing a new innovative drug delivery platform. Finally, a critical discussion is presented on several recent patents on microfluidics along with applicable drying technologies. © 2023 Taylor & Francis Group, LLC.

32. Pani, A., S.S. Shirkole, and A.S. Mujumdar, Expert reviews for assessment of recent developments and future prospectives of global drying R&D. Drying Technology, 2023. 41(3): p. 335-338.

33. Okaiyeto, S.A., H.W. Xiao, and A.S. Mujumdar, Understanding the coffee ring effect: how it has led to advanced applications. Drying Technology, 2023. 41(7): p. 1083-1084.

34. Niu, H., et al., Sensing materials for fresh food quality deterioration measurement: a review of research progress and application in supply chain. Critical Reviews in Food Science and Nutrition, 2023.

Fresh food are consumed in large quantities worldwide. During the supply chain, microbial growth in fresh food can lead to the production of a number of metabolites, which make food highly susceptible to spoilage and contamination. The quality of fresh food changes in terms of smell, tenderness, color and texture, which causes a decrease in freshness and consumers acceptance. Therefore, the quality monitoring of fresh food has become an essential part in the supply chain. As traditional analysis methods are highly specialized, expensive and have a small scope of application, which cannot be

applied to the supply chain to realize real-time monitoring. Recently, sensing materials have received a lot of attention from researchers due to the low price, high sensitivity and high speed. However, the progress of research on sensing materials has not been critically evaluated. The study examines the progress of research in the application of sensing materials for fresh food quality monitoring. Meanwhile, indicator compounds for spoilage of fresh food are analyzed. Moreover, some suggestions for future research directions are given. © 2023 Taylor & Francis Group, LLC.

35. Niu, D., et al., Investigation of 3D printing of children starch gummies with precise and special shape based on change of model parameters. Journal of Food Engineering, 2023. 356.

The practicability of using corn starch and erythritol as initial printing inks for manufacture to children printed products (with high accuracy and special shape) with addition of gelan gum (GG) was investigated. Materials properties and model parameters were applied to improve the printability and printing accuracy of special shape. The results showed that compared with the control group, all materials with hydrophilic colloid additions showed higher hardness, viscosity, rigidity and self-supporting ability. The results had shown that materials with higher GG additions possessed higher obvious viscosity and hardness, while printing inks with 1.5% GG concentration displayed best printing performance. Hydrophilic colloid additions attenuated the syneresis of samples. 3D printed objects using Ink-D (printing ink with GG addition of 1.5%) shown high printing precision with great self-supporting performance and smooth surface texture. Printing experiments revealed that model parameters (such as height and wall thickness) could significantly influence the printing precision and success rate of model with special shape. © 2023 Elsevier Ltd

36. Niu, D., et al., Research on Microwave-Induced Bidirectional Deformation of Coix Seed Compound Materials in 4D Printing. Food and Bioprocess Technology, 2023. 16(11): p. 2400-2415.

The traditional 4D deformation of 3D printed objects has certain limitations, because the deformation they achieve is often singular. Unlike previous 4D deformation studies, we proposed a new method to achieve bidirectional 4D deformation of 3D printed objects and explored the principles that lead to this change. We chose the paste made

of coix seeds and purple potato powders as the printing ink, and tested its rheological properties, moisture distribution, and dielectric properties to predict and explain the characteristics of the 4D printing process. A model-based structural design was performed to study the conditions needed to achieve bidirectional 4D deformation. Experiments showed that the local expansion of the microwave-induced printed object was the driving force that led to the deformation. The structure of the deformable component in the model changed the role of this driving force. Different 4D deformation effects can be achieved by adjusting the structure of the model. The experiment also proved that the composition of the printing ink did affect 4D deformation. The purpose of this research is to provide a method to accentuate the 4D deformation effect, so that users can obtain a more appealing visual experience, and such deformation will attract children to consume, which can then be applied to the manufacture of cold food dishes and the production of food for children. © 2023, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

37. Niu, D., et al., Investigation of 3D printing of toddler foods with special shape and function based on fenugreek gum and flaxseed protein. International Journal of Biological Macromolecules, 2023. 253.

The practicability of using corn and flaxseed protein as printing inks for manufacture of printed products specifically designed for toddlers as a dysphagia diet with high precision and special shapes with addition of fenugreek gum (FGG) was investigated. 3D printing was used to process grains and dysphagia-compatible food (corn) into a dietary product with attractive appearance which was also easy to swallow. Rheological measurements shown that appropriate amount of flaxseed protein (FP, 0–10 %) can reduce the stickiness and yield strength of printing material. Based on FTIR measurements, FP weakened the hydrogen bond strength of inks, but it was still an important gradient for the formation of the ink suitable for precision 3D printing. The TPA results shown that the addition of FP (0–10 %) remarkably reduced both the stickiness and hardness of the ink. These results shown that compared with the control group, materials with FGG additions possessed higher printing accuracy and self-supporting ability. Ink with 5 % FP content exhibited the best printability and swallowability, while ink with 10 % FP content had the lowest viscosity and hardness,

but it was not suitable for 3D printing. 3D printing of objects printed using Ink-C (5%FP and 0.8 %FGG) showed high support characteristic and attractive appearance. According to the international IDDSI testing standards, Ink-C (5%FP and 0.8 %FGG), Ink-E (15%FP and 0.8 %FGG), and Ink-F (20%FP and 0.8 %FGG) were defined as level 5-minced and moist foods. © 2023 Elsevier B.V.

38. Mujumdar, A.S., 40th anniversary commemorative issue of Drying Technology. Drying Technology, 2023. 41(6): p. 805-807.

39. Mujumdar, A.S., Second special issue commemorating four decades of Drying Technology. Drying Technology, 2023.

40. Mujumdar, A.S., Advances in Drying Science and Technology. Particulate Drying: Techniques and Industry Applications, 2023: p. vii.

41. Mandpe, S., et al., Design, development, and evaluation of spray dried flurbiprofen loaded sustained release polymeric nanoparticles using QBD approach to manage inflammation. Drying Technology, 2023. 41(15): p. 2418-2430.

Spray-dried Flurbiprofen (FLB) loaded polymeric nanoformulation using Eudragit L 100 and Ethylcellulose. They were optimized and evaluated. This study determined drug release (%) and encapsulation efficiency (%) by developing a nanoparticulate system using the design of experiment (DoE) approach. FLB is slightly soluble in water; it dissolves slowly and has a low oral bioavailability. FLB-loaded polymeric nanoparticles were produced by solvent evaporation and Spray drying technology. In this research, nanoparticle formulation was prepared by screening and optimization by approaching two different statistical methods (Plackett-Burman and Central composite Designs). The polymeric nanoparticles were evaluated for various characteristics, including drug release, percentage of encapsulation efficiency, X-ray diffraction (X-RD), surface morphology, and Fourier transform infrared (FTIR) spectroscopy. Based on the X-RD analysis, it was found that the drug was successfully incorporated into the polymeric nanoparticles. As a result of nanoparticles containing FLB, % Drug release values were found to be nearly 85-90% increased while % EE was observed in the range

of 79-89%. An excellent sustained release, i.e., 14 h, is possible by combining Ethylcellulose (EC) and Eudragit L 100 (ED-100) polymers. The results are beneficial in identifying the ideal formulation parameters for effective encapsulation. Abbreviations: FLB: Flurbiprofen; API: Active pharmaceutical ingredient; DR: Drug release; EE: Encapsulation efficiency; DoE: Design of experiment; X-RD: X-ray diffraction; FTIR: Fourier transform infrared spectroscopy.; PVA: Polyvinyl alcohol; EC: Ethylcellulose; EUGD: Eudragit L 100; NPs: Nanoparticles; PBD: Placket-Burman Design; CCD: Central Composite Design; CMV: Critical method variables; GIT: Gastrointestinal track; SLN: Solid lipid nanoparticles; NLC: Nanostructured lipid carriers; NSAID: Nonsteroidal anti-inflammatory drug; BCS: Biopharmaceutical classification system; PS: Particle size; PDI: Polydispersity Index; ZP: Zeta potential; FE-SEM: Field emission scanning electron microscopy; 2D: 2 Dimensional; 3D: 3 Dimensional. © 2023 Taylor & Francis Group, LLC.

42. Liu, Y., et al., Improvement in the quality of frozen dough for fried flour products by electrostatic field-assisted freezing. Journal of the Science of Food and Agriculture, 2023.

BACKGROUND: With the development of the food industry, frozen dough technology has gradually become an indispensable part of dough processing but its quality is often reduced due to freezing during the production process. Electrostatic field-assisted freezing (EF) technology, a key research project in recent years, reduces the physical damage to food materials by reducing or changing the size of ice crystals in frozen products. RESULTS: In this study, different intensities of electrostatic fields were used to assist in the repeated freezing and thawing of dough. The effects of electrostatic fields on the freezing nucleation process were evaluated by measuring dough freezing curves, low field nuclear magnetic resonance, and melting enthalpy. It was found that the freezing time of frozen dough added with electrostatic field-assisted freezing processing was shortened, the rate at which hardness, viscosity, and elasticity decreased was reduced, and the indicators of water distribution and protein secondary structure components were closer to those of fresh dough. CONCLUSION: This experiment used electrostatic field-assisted freezing to reduce the damage to the dough structure during the freezing process, improve the quality of frozen dough and fried products, and improve the freezing efficiency of frozen dough. It provides a new idea for the study of

frozen dough. © 2023 Society of Chemical Industry. © 2023 Society of Chemical Industry.

43. Liu, W., et al., Role of dehydration technologies in processing for advanced ready-to-eat foods: A comprehensive review. Critical Reviews in Food Science and Nutrition, 2023. 63(22): p. 5506-5520.

Advanced ready-to-eat foods, which can be consumed directly or only need simple processed before consumption, refer to the products that processing with cutting-edge food science and technology and have better quality attribute. Cold chain and chemical addition are commonly used options to ensure microbial safety of high moisture advanced ready-to-eat foods. However, this requires freezing/thawing processing at high cost or has undesirable residue. Dehydration treatment has the potential to compensate those shortcomings. This article reviewed the positive effects of dehydration on advanced ready-to-eat foods, current application status of dehydration technologies, novel dehydration related technologies and the pathogenic bacteria control of products. It is observed that dehydration treatment is receiving increasing attention for ready-to-eat foods including space foods, 3 D-printed personalized foods and formula foods for special medical purposes. Recently developed drying technologies such as pulsed spouted microwave freeze-drying and infrared freeze-drying have attracted much interest due to their excellent drying characteristics. Finally, intelligent drying, dehydration-nano-hybridization and dehydration-induced multi-dimensional modification technology are some of the emerging R and D areas in this field. © 2021 Taylor & Francis Group, LLC.

44. Kong, D., et al., New drying technologies for animal/plant origin polysaccharide-based future food processing: Research progress, application prospects and challenges. Food Bioscience, 2023. 56.

Natural polysaccharides of plant and animal origin include polysaccharides with nutritional effects but no pharmacological activity, and bioactive polysaccharides with pharmacological activity. Using polysaccharides and their derivatives as additives can impart unique consistency, structure and texture to food products to facilitate individualized design. Appropriate drying technologies will not only help preserve the inherent biological activity and physicochemical properties of polysaccharides, but also

to enhance the potential of polysaccharide-based materials for new applications; these include polysaccharide-based microencapsulation and food gel systems for encapsulating bioactive compounds and simulation of texture of future foods. In this review, we start with the applications of plant and animal-derived polysaccharides in future food products followed by discussion of conventional and innovative drying technologies used for different origin bioactive polysaccharides. Secondly, we analyze the drying technologies used for polysaccharide-based micro- and nanocapsules encapsulating bioactive compounds. Furthermore, we summarize prospects of innovative drying technologies for polysaccharide-based food gel systems -mainly oleogels and aerogels-involved in the development. Finally, we look at the opportunities and challenges of drying technology innovation for polysaccharide-based food packaging in anticipation of the development of superior packaging technologies for future foods based on polysaccharides. © 2023 Elsevier Ltd

45. Kong, D., et al., Feasibility of hydrocolloid addition for 3D printing of Qingtuan with red bean filling as a dysphagia food. Food Research International, 2023. 165.

Glutinous rice flour, the main component of Qingtuan, has increased adhesiveness after gelatinization and hardness after aging; this results in great challenge in swallowing if for patients with dysphagia. Dual nozzle 3D printing has great potential for developing innovative Chinese pastries with fillings that conform to dysphagia diets. In this experimental study, the gelatinization and retrogradation behavior of glutinous rice starch was improved by designing printing inks of optimal properties made with different soluble soybean polysaccharide (SSPS) additions (0%, 0.3%, 0.6%, 0.9%). The internal structure of Qingtuan was modified by adjusting different filling densities (75%, 100%) in combination with the dual nozzle 3D printing. The objective of these tests was to enhance the texture of Qingtuan so that it meets the requirements of International Dysphagia Diet Standardization Initiative (IDDSI). The experimental results showed that 0.9% SSPS addition could effectively reduce the hardness and adhesiveness of the Qingtuan, which met the Level- 6 -soft & bite-sized standard while lower filling density lowers both hardness and adhesiveness. © 2023 Elsevier Ltd

46. Kole, E., et al., Prospects for the Development of the Industrial Process for Drying Nanoformulations, in Particulate Drying: Techniques and Industry Applications. 2023, CRC Press. p. 131-150.

Drying is a method of removing volatile components thermally to produce a dry product. Drying can aggravate nanoparticle aggregation upon evaporation, resulting in an initial reduction in the dissolution advantages provided by nanonization. Water-soluble or insoluble composite formers have been used in the drying process to reduce drying-cause agglomeration. The nano-spray drying technique is effective for forming submicron polymer powders containing bio-active ingredients. In nano-spray drying, several organic solvents are used, each chosen according to its solubility and ability to incorporate wall materials. Surface analysis methods with multiple sources are underutilized for the characterization of nanostructured materials. Nano-spray drying has been used effectively in various drug delivery applications, including raising the solubility and bioavailability of hydrophobic drugs through nanonization and structural modification and encapsulating nanoparticles in biocompatible polymers for prolonged drug release. A nano-spray dryer has primarily been used in pharmaceutical and material science applications. © 2024 selection and editorial matter, Sachin Vinayak Jangam, Chung Lim Law, and Shivanand Shankarrao Shirkole.

47. Jiang, Q., et al., Non-destructive quality determination of frozen food using NIR spectroscopy-based machine learning and predictive modelling. Journal of Food Engineering, 2023. 343.

Non-destructive testing for the quality of frozen food is of great interest. A model food product was developed as the test material for this study. Different modeling methods were applied to establish the relationship between the near-infrared (NIR) spectra of the frozen samples and quality indicators of drip loss, texture parameters including hardness, chewiness, gumminess and gel strength, respectively. Principal component analysis (PCA) and hierarchical clustering analysis (HCA) analysis results show that the collected NIR spectra of the model food prepared based on different moisture content were well distinguished. The modeling results show that principal component regression (PCR), support vector machine regression (SVR), partial least squares regression (PLSR) and back-propagation artificial neural network (BP-ANN) algorithms could be used to predict the quality indicators of frozen samples. By

comparison, the BP-ANN modeling approach performed better with higher R2 and lower root mean squared errors (RMSE). © 2022 Elsevier Ltd

48. Jiang, Q., et al., Effects of magnetic field-assisted liquid carbon dioxide spray freezing on the quality of honeydew melon. Food Chemistry, 2023. 417.

The effectiveness of static magnetic fields with different intensities (5, 10, 15 mT) combined with liquid carbon dioxide spray freezing (LCSF) technique in improving the quality of frozen honeydew melon was investigated. The results showed that LCSF with magnetic fields above 10 mT significantly improved ice nucleation and quality of frozen melons compared to conventional −20 °C freezing, −80 °C freezing and LCSF method without magnetic field assistance ($P < 0.05$). 15 mT strength static magnetic field assistance suggested the best results, with a 15.0% reduction in total freezing time, 17.7% increase in average freezing rate, 26.6% reduction in drip loss, and better maintenance of sample quality compared to LCSF. These findings demonstrate that LCSF with static magnetic field assistance is promising in improving the quality of frozen foods. © 2023 Elsevier Ltd

49. Jiang, Q., et al., Effects of electric and magnetic field on freezing characteristics of gel model food. Food Research International, 2023. 166.

The novel freezing technologies including electrostatic field assisted freezing (EF), static magnetic field assisted freezing (MF), electrostatic field combined with static magnetic field assisted freezing (EMF) were conducted on model food to facilitate comparing their application effect. The results show that the effect of EMF treatment was best, which significantly changed the freezing parameters of the sample. Compared with the control, the phase transition time and total freezing time were shortened by 17.2% and 10.5%, respectively; the proportion of the sample free water content detected by low-field nuclear magnetic resonance was significantly decreased; the gel strength and hardness were significantly improved; the protein secondary and tertiary structures were better maintained; the ice crystal area was reduced by 49.28%. Inverted fluorescence and scanning electron microscopic results indicated that the gel structure of EMF treatment samples was better than MF and EF. MF was less effective in maintaining the quality of frozen gel model. © 2023 Elsevier Ltd

50. Jiang, Q., M. Zhang, and A.S. Mujumdar, Application of physical field-assisted freezing and thawing to mitigate damage to frozen food. Journal of the Science of Food and Agriculture, 2023. 103(5): p. 2223-2238.

Freezing is an effective technique to prolong the storage life of food. However, the freeze-thaw process also brings challenges to the quality of food, such as mechanical damage and freeze cracks. Increasingly, physical fields have been preferred as a means of assisting the freezing and thawing (F/T) processes to improve the quality of frozen food because of their high efficiency and simplicity of application. This article systematically reviews the application of high-efficiency physical field techniques in the F/T of food. These include ultrasound, microwave, radio frequency, electric fields, magnetic fields, and high pressure. The mechanisms, application effects, advantages and disadvantages of these physical fields are discussed. To better understand the role of various physical fields, the damage to food caused by the F/T process and traditional freezing is discussed. The evidence shows that the physical fields of ultrasound, electric field and high pressure have positive effects on the F/T of food. Proper application can control the size and distribution of ice crystals effectively, shorten the freezing time, and maintain the quality of food. Microwave and radio frequency exhibit positive effects on the thawing of food. Dipole rotation and ion oscillation caused by electromagnetic waves can generate heat inside the product and accelerate thawing. The effects of magnetic field on F/T are controversial. Although some physical field techniques are effective in assisting F/T of food, negative phenomena such as uneven temperature distribution and local overheating often occur at the same time. The generation of hotspots during thawing can damage the product and limit application of these techniques in industry. © 2022 Society of Chemical Industry. © 2022 Society of Chemical Industry.

51. Huang, Y., et al., Dehydrated fruits and vegetables using low temperature drying technologies and their application in functional beverages: a review. Drying Technology, 2023. 41(6): p. 868-889.

Although people's perception of fruits and vegetables is green, healthy and nutritious, the consumption of fruits and vegetables for most people around world still does not meet the WHO’s recommendations for a healthy diet. Functional foods and beverages containing functional ingredients with health-improving properties, are gaining

increasing popularity among consumers and the food industry. Either hydrous or dried fruit and vegetables formulated into beverages can promote the daily intake and is a splendid delivery approach for nutrients and bioactive compounds to human body. Drying is the good method to preserve fruit and vegetables characterized by high moisture content and perishability. However conventional drying processes are strongly associated with high temperature, which is detrimental to their nutritional and sensory qualities. This work aims to review low temperature drying technologies for fruits and vegetables to better maintain the qualities and expand their application in functional beverages. © 2022 Taylor & Francis Group, LLC.

52. Huang, J., et al., Technological advances in protein extraction, structure improvement and assembly, digestibility and bioavailability of plant-based foods. Critical Reviews in Food Science and Nutrition, 2023.

Plant-based foods are being considered seriously to replace traditional animal-origin foods for various reasons. It is well known that animals release large amounts of greenhouse gases into the environment during feeding, and eating animal-origin foods may also cause some health problems. Moreover, animal resources will likely be in short supply as the world population grows. It is highly likely that serious health problems ascribed to insufficient protein intake in some areas of the world will occur. Studies have shown that environmentally friendly, abundant, and customizable plant-based foods can be an effective alternative to animal-based foods. However, currently, available plant-based foods lack nutrients unique to animal-based foods. Innovative processing technologies are needed to improve the nutritional value and functionality of plant-based foods and make them acceptable to a wider range of consumers. Therefore, protein extraction technologies (e.g., high-pressure extraction, ultrasound extraction, enzyme extraction, etc.), structure improvement and assembly technologies (3D printing, micro-encapsulation, etc.), and technologies to improve digestibility and utilization of bioactive substances (microbial fermentation, physical, etc.) in the field of plant-based foods processing are reviewed. The challenges of plant-based food processing technologies are summarized. The advanced technologies aim to help the food industry solve production problems using efficient, environmentally friendly, and economical processing technologies and to guide the development of plant-based foods in the future. © 2023 Taylor & Francis Group, LLC.

53. Huang, J., et al., Technological innovations enhance postharvest fresh food resilience from a supply chain perspective. Critical Reviews in Food Science and Nutrition, 2023.

Fresh food is rich in nutrients but is usually seasonal, perishable, and challenging to store without degradation of quality. The inherent limitations of various preservation technologies can result in losses in all stages of the supply chain. As consumers of fresh foods have become more health-conscious, new technologies for intelligent, energy-efficient, and nondestructive preservation and processing have emerged as a research priority in recent years. This review aims to summarize the quality change characteristics of postharvest fruits, vegetables, meats, and aquatic products. It critically analyzes research progress and applications of various emerging technologies, which include: the application of high-voltage electric field, magnetic field, electromagnetic field, plasma, electrolytic water, nanotechnology, modified atmosphere packaging, and composite bio-coated film preservation technologies. An evaluation is presented of the benefits and drawbacks of these technologies, as well as future development trends. Moreover, this review provides guidance for design of the food supply chain to take advantage of various technologies used to process food, reduce losses and waste of fresh food, and this improve the overall resilience of the supply chain. © 2023 Taylor & Francis Group, LLC.

54. Hajji, W., et al., Coupling Interval Hyper-Active Drying (IHAD) with Instant Controlled Pressure Drop (D.I.C.) to define new swell-drying processes. Drying Technology, 2023.

To respond to the various issues of conventional drying (textural defects of collapse-shrinkage and case hardening, microbiological contamination, poor rehydrability, degradation of active molecules caused by high wet-bulb temperature, weak drying kinetics, and marketing difficulty), swell-drying has proven high relevance in combining conventional drying processes with the Instant Controlled Pressure Drop (D.I.C.). The international team of "Research & Engineering Platform for intensifying Drying Processes (REPID)" has studied phenomenological models and experimental trials combining D.I.C. with new Interval Hyper-Active Drying (IHAD) processes. Currently, IHAD includes interval starting accessibility drying (ISAD), interval infrared airflow drying (IIRAD), and interval microwave airflow drying (IMAD). All

these "interval operations" are sandwiched into cycles, each comprising double separate independent mechanisms; a short, hyper-focused active period (that generates and sweeps out vapor to the surrounding environment) alternated by a passive period of internal water diffusion/moisture homogenization. Since surface evaporation is highly intensive, the wet-bulb temperature stays low, although highly effective drying kinetics. Thus, the operation results in avoiding biochemical damage risks. Coupled with the D.I.C. texturing-decontamination, these drying operations are very effective in terms of drying kinetics, energy consumption, and product quality of heat-sensitive solids. It has led to the manufacturing of effective drying equipment. © 2023 The Author(s). Published with license by Taylor & Francis Group, LLC.

55. Ghazal, A.F., et al., Progress in 4D/5D/6D printing of foods: applications and R&D opportunities. Critical Reviews in Food Science and Nutrition, 2023. 63(25): p. 7399-7422.

4D printing is a result of 3D printing of smart materials which respond to diverse stimuli to produce novel products. 4D printing has been applied successfully to many fields, e.g., engineering, medical devices, computer components, food processing, etc. The last two years have seen a significant increase in studies on 4D as well as 5D and 6D food printing. This paper reviews and summarizes current applications, benefits, limitations, and challenges of 4D food printing. In addition, the principles, current, and potential applications of the latest additive manufacturing technologies (5D and 6D printing) are reviewed and discussed. Presently, 4D food printing applications have mainly focused on achieving desirable color, shape, flavor, and nutritional properties of 3D printed materials. Moreover, it is noted that 5D and 6D printing can in principle print very complex structures with improved strength and less material than do 3D and 4D printing. In future, these new technologies are expected to result in significant innovations in all fields, including the production of high quality food products which cannot be produced with current processing technologies. The objective of this review is to identify industrial potential of 4D printing and for further innovation utilizing 5D and 6D printing. © 2022 Taylor & Francis Group, LLC.

56. Gao, Y., et al., Influence of thermal cycling on stability and thermal conductivity of nanofluid ice slurry. International Journal of Thermal Sciences, 2023. 185.

Nanofluid ice slurry has the advantages of large phase change latent heat, high energy storage density and cooling rate. In this article, a two-step approach was used to prepare water-based graphene oxide (GO), Al2O3, and GO-Al2O3 hybrid nanofluids. The effects of thermal cycling on the stability and thermal conductivity of nanofluid ice slurry were also investigated. Moreover, thermal conductivity model considering thermal cycling and mass fraction was proposed. Results show with the increase of the number of phase change cycles, the stability of nanofluids decreases gradually, and tends to be stable after 6 cycles. The lower the minimum temperature of the thermal cycling, the more serious the segregation of nanoparticles, the worse the stability of nanofluids after thermal cycling. In addition, multi-cycle of phase change has less influence on thermal conductivity of GO nanofluid than that of non-phase-change, although the influence is a little larger at the dilute concentration range. The thermal conductivity of GO-Al2O3 hybrid nanofluid ice slurry is between that of GO and Al2O3 aqueous single nanofluid after phase change thermal cycling. The influence of the phase change cycles on thermal conductivity decreases with the increase of concentration, however, the smaller the concentration, the larger the thermal conductivity reduction. The hybrid nanofluid ice slurry can ensure the dispersion stability and thermal conductivity of the fluid, and its comprehensive performance is better than that of nanofluid with one type of nanoparticle. © 2022 Elsevier Masson SAS

57. Gao, Y., et al., Experimental investigation of producing ice slurry with water using opposed-nozzle impinging jet method. Applied Thermal Engineering, 2023. 219.

In order to improve the efficiency of producing ice slurry, an experimental device of opposed-nozzle impinging jet was established. Deionized water of 2.5–10.5 °C was jet impinged with chilled air in an ice-making tank. The spray and performance of impinging and non-impinging jet was evaluated. The results show the temperature around the water nozzle is higher, which is benefit for preventing ice blockage. The impinging jet makes the water droplets smaller, more evenly distributed and longer residence time, which strengthens the turbulence flow and heat transfer, as well as reduces supercooling degree of water, while increasing the production of ice particles. The ice packing factor (IPF) decreases with the rise of the water initial temperature, but the corresponding reduction rate is smaller at the higher initial temperature. Meanwhile,

the maximum IPF and the utilization rate of cooling capacity of impinging jet are about 4 times than that of the traditional non-impinging jet as the initial water temperature is in the range of 2.5–10.5 °C. The refrigeration coefficient of the ice-making system increases with the initial water temperature. The impinging flow can greatly improve the refrigeration coefficient of the ice-making system. The average refrigeration coefficient of impinging flow system is about 1.6 times that of non-impinging flow system in the range of 2.5–10.5 °C of the initial water temperature. Moreover, the impinging flow improves the refrigeration coefficient of the system more significantly under the condition of lower initial water temperatures. © 2022 Elsevier Ltd

58. Gan, S., et al., Advances in processing, encapsulation, and analysis of food flavor compounds. Journal of Food Process Engineering, 2023. 46(10).

In recent years, the market for edible flavor has become larger and the demand for edible flavor has become more diverse. Customers are paying more attention to natural, healthy, and functional flavors. This article reviews some new technologies about flavors in recent years, including processing technology, encapsulation, and detection of flavors. The synthetic technologies of flavor include thermal reaction technology, enzymatic hydrolysis technology, and microbial fermentation technology. The encapsulation technology includes nano-emulsion and filled soluble hydrogel, as well as the new carrier materials used in packaging, such as β-cyclodextrin, 2-acetyl-1-pyrroline (2AP), yeast cell, and jackfruit seed starch (JM) are also hot spots in recent years. Finally, the detection of flavor components and the monitoring of characteristic flavor substances and harmful flavor substances are very important for flavor quality control. There are many detection techniques, such as chromatographic analysis techniques, solid-phase microextraction, electronic nose and electronic tongue, sensor arrays, and fluorescence detection with DNA barcoding techniques and (quantitative) conformational relationships. © 2023 Wiley Periodicals LLC.

59. Feng, T., et al., Extraction of functional extracts from berries and their high quality processing: a comprehensive review. Critical Reviews in Food Science and Nutrition, 2023. 63(24): p. 7108-7125.

Berry fruits have attracted increasing more attention of the food processing industry as well as consumers due to their widely acclaimed advantages as highly effective anti-

oxidant properties which may provide protection against some cancers as well as aging. However, the conventional extraction methods are inefficient and wasteful of solvent utilization. This paper presents a critical overview of some novel extraction methods applicable to berries, including pressurized-liquid extraction, ultrasound-assisted extraction, microwave-assisted extraction, supercritical fluid extraction, enzyme-assisted extraction as well as some combined extraction methods. When combined with conventional methods, the new technologies can be more efficient and environmentally friendly. Additionally, high quality processing of the functional extracts from berry fruits, such as refined processing technology, is introduced in this review. Finally, progress of applications of berry functional extracts in the food industry is described in detail; this should encourage further scientific research and industrial utilization. © 2022 Taylor & Francis Group, LLC.

60. Feng, T., et al., Effect of a magnetic field/electrostatic field on the quality attributes of green bell peppers during cool chain transportation. Sustainable Food Technology, 2023. 1(4): p. 582-589.

Electric field and magnetic field preservation technologies are pollution-free, safe, and healthy physical means that have been widely used in recent years. The aim of this study is to evaluate the effects of different intensities of electrostatic fields and static magnetic fields on the quality of cold chain transportation of green bell peppers. During the cold storage period of green bell peppers, different intensities of an electrostatic field (3 kV cm-1 and 5 kV cm-1) and magnetic field (2 mT, 5 mT, and 8 mT) were applied, and quality testing was conducted at 0, 3, 6, 9, 12, and 15 days of cool storage. The quality of green bell peppers based on physical and chemical indicators was evaluated and was compared with that of the blank group. The results indicated that the application of electrostatic and magnetic fields is beneficial for improving the quality of green bell peppers during refrigeration. Based on various indicators, the optimal treatment conditions for this study are 4 °C and 5 kV cm-1, which can effectively improve the quality and nutrition of cold chain transportation of green peppers. © 2023 The Author(s).

61. Feng, M., et al., Comparative evaluation of chemical substances and sensory properties of postharvest rose (Rosa rugosa cv. Plena) and tea infusion prepared by five drying techniques. Drying Technology, 2023. 41(4): p. 523-535.

The growing awareness of the health benefits of edible roses has attracted researchers to explore different rose products. In this study, fresh roses were dried using different techniques including vacuum freeze, hot air, heat pump, relative humidity and catalytic infrared drying. The influence of drying techniques on rehydration kinetics and quality attributes were evaluated. Results showed that the Weibull model provided the best fitting for each rehydration curve. Total phenolic content (TPC), total flavonoid content (TFC), total anthocyanin content (TAC) and antioxidant activity of rose infusion increased while the sensory score decreased with brewing time increasing. Amongst dried products, vacuum freeze drying combined with 5 min brewing had higher TPC (33.97 ± 0.83 mg GAE/g DW), TFC (13.77 ± 0.26 mg RE/g DW), TAC (8.81 ± 0.20 mg CGE/g DW), and antioxidant activity (DPPH IC50: 1.36 ± 0.03 mg/mL and ABTS IC50: 1.16 ± 0.05 mg/mL) along with the highest evaluation score (8.54). The present findings will offer more information in selecting the best drying technique for rose brewing as a tea beverage. © 2022 Taylor & Francis Group, LLC.

62. Fang, J., et al., Superheated steam processing: An emerging technology to improve food quality and safety. Critical Reviews in Food Science and Nutrition, 2023. 63(27): p. 8720-8736.

Heat processing is one of the most efficient strategies used in food industry to improve quality and prolong shelf life. However, conventional processing methods such as microwave heating, burning charcoal treatment, boiling, and frying are energy-inefficient and often lead to inferior product quality. Superheated steam (SHS) is an innovative technology that offers many potential benefits to industry and is increasingly used in food industry. Compared to conventional processing methods, SHS holds higher heat transfer coefficients, which can reduce microorganisms on surface of foodstuffs efficiently. Additionally, SHS generates a low oxygen environment, which prevents lipid oxidation and harmful compounds generation. Furthermore, SHS can facilitate development of desired product quality, such as protein denaturation with functional characteristics, proper starch gelatinization, and can also reduce nutrient loss, and improve the physicochemical properties of foodstuffs. The current work provides a

comprehensive review of the impact of SHS on the nutritional, physicochemical, and safety properties of various foodstuffs including meat, fruits, and vegetables, cereals, etc. Additionally, it also provides food manufacturers and researchers with basic knowledge and practical techniques for SHS processing of foodstuffs, which may improve the current scope of SHS and transfer current food systems to a healthy and sustainable one. © 2022 Taylor & Francis Group, LLC.

63. Du, Y., et al., Double-nozzle 3D-printed bean paste buns: Effect of filling ratio and microwave heating time. Journal of Texture Studies, 2023. 54(5): p. 671-680.

With the aggravation of the global aging process, more and more elderly people are facing the problem of dysphagia. The advantages of three-dimensional (3D) printing in making chewy food are increasingly prominent. In this study, the two-nozzle 3D printer was used to explore the effects of different proportions of buckwheat flour, printing filling ratio, microwave power, and time on the quality of bean-paste buns. The results showed that the bean paste filling containing 6% buckwheat flour had the best antioxidant and sensory properties. When the filling ratio was 21.6%, the microwave power was 560 W, and the time was 4 min, the obtained sample was the most satisfactory. Compared with the microwave-treated and steamed traditional samples, the chewiness of the samples was reduced by 52.43% and 15.14%, respectively, and the final product was easier to chew and swallow. © 2023 Wiley Periodicals LLC.

64. Chen, K., et al., Encapsulation of different spice essential oils in quinoa protein isolate-gum Arabic coacervates for improved stability. Carbohydrate Polymers, 2023. 300.

A fully plant-based wall material, quinoa protein isolate-gum Arabic (QPI-GA) complex coacervate, was developed for stability improvement of different spice essential oils (EOs): Sichuan pepper EO (SPEO), ginger EO (GEO), and star anise EO (SAEO). The optimum pH and QPI-to-GA ratio to form QPI-GA coacervates were experimentally confirmed to be 3.6 and 4:1. IF, FTIR, and XRD analyses (shown in supplementary information) indicated that complex coacervation generated electrostatic interactions between QPI and GA molecules and caused a more ordered structure of QPI-GA coacervates. The QPI-GA coacervates exhibited high encapsulation efficiency for SPEO (82.53 ± 1.59 %), GEO (88.19 ± 2.37 %), and SAEO

(84.68 ± 1.51 %). The encapsulated EOs showed substantially higher stability in comparison to free EOs, while some differences in each type of stability among encapsulated EOs were observed. Additionally, the QPI-GA coacervate wall materials made EOs stable in oral and gastric stages and sustainably release in intestinal stage, which contributed to the excellent absorption of EOs in simulated digestion. © 2022 Elsevier Ltd

65. Chen, K., et al., Quinoa protein isolate-gum Arabic coacervates cross-linked with sodium tripolyphosphate: Characterization, environmental stability, and Sichuan pepper essential oil microencapsulation. Food Chemistry, 2023. 404.

Quinoa protein isolate-gum Arabic coacervates (QPI-GA coacervates) was cross-linked with sodium tripolyphosphate (STPP) to enhance their physicochemical properties. The optimum concentration of STPP for cross-linking was determined experimentally to be 0.2 g/g of QPI-GA mixture. After cross-linking, QPI-GA coacervates changed to the more ordered structure, and showed higher pH, ionic, and thermal stability. The STPP cross-linked coacervates were used as wall materials for Sichuan pepper essential oil (SPEO) encapsulation with encapsulation efficiency of 87.25 %. Compared with uncross-linked microcapsules, cross-linked microcapsules showed higher SPEO retention at high temperature, different pH, and high ionic concentration. Meanwhile, STPP cross-linked microcapsules improved the stability of SPEO during oral and gastric digestion as indicated by the lower SPEO release, which guaranteed the higher release and absorption in intestinal digestion of SPEO. Consequently, STPP cross-linked QPI-GA coacervates can be an ideal carrier for flavors or active ingredients, protecting them against harsh environment conditions during food processing and digestion. © 2022 Elsevier Ltd

66. Chen, B., et al., Freezing of green peppers assisted by combined electromagnetic fields: Effects on juice loss, moisture distribution, and microstructure after thawing. Journal of Food Process Engineering, 2023. 46(5).

The combination of electric and magnetic field assisted freezing has potential as a new means of improving the freeze–thaw quality of green peppers. In this work, the quality of the freeze–thawed product was assessed in terms of thawing juice loss, moisture profile, ascorbic acid content, antioxidant activity, flavor, and microstructure. Juice loss

was reduced by 16%–68%, freezing time was shortened by 15%–26%, and the nutrient retention rate was higher in the physical field-assisted case compared to the no-physical field case. Interestingly, the combined freezing of the two physical fields showed better freezing results compared to a single electric or magnetic field, with juice loss reduced to 3.04%, retention of 82% of calcium ions, retention of ascorbic acid increased by 6%–15%. In addition, the content of hexenal and methyl salicylate and other aromatic substances increased, showing a good flavor quality such as increased umami. The results suggest that combined electric and magnetic field assisted freezing is better in improving the quality of frozen products and may be a potential alternative to freezing and thawing of fruits and vegetables. Practical application: This research provides a simple and novel method for improving the speed and quality of frozen products. These steps combine electric and magnetic fields to explore, improve the quality of frozen products, but also provide a new idea for freezing research. © 2023 Wiley Periodicals LLC.

67. Chen, B., et al., Progress in smart labels for rapid quality detection of fruit and vegetables: A review. Postharvest Biology and Technology, 2023. 198.

Smart labels are an effective way to provide timely feedback to consumers on the quality of fruit and vegetables and have great potential for development and market application. This paper reviews the types and research progress of smart labels. It also summarizes the classification of various smart labels according to the factors affecting the quality of fruit and vegetables. Based on the characteristics of fruit and vegetables, smart labels suitable for fruit and vegetable quality inspection are collated, including ethylene-sensitive, color-sensitive and temperature-sensitive types. Finally, the future development and new applications of smart labels are foreseen. © 2023 Elsevier B.V.

68. Barani, Y.H., et al., Effect of chemical and natural product additives on anthocyanins, color, total antioxidant properties of rose powder and stability of anthocyanins during storage. Drying Technology, 2023. 41(5): p. 735-745.

The present study was undertaken to determine the effect of natural colorants and combination with select chemical products on anthocyanins, total phenolics (TPC) and total flavonoids content (TFC) of rose powder, and on the stability of anthocyanins (ACNs) during storage. Moreover, the color property of rose juice in holding period of

0-1hr at room temperature was also studied. Rose powder was mixed with three chemicals (citric CA; ascorbic AA; tartaric acid TTA) and natural colorants powder (Anthocyanin; Hibiscus; food-grade Vitamin-C) at different levels viz. 0.1%, 1%, 5% and 10% (w/w), respectively. AA addition at 1% retained the highest anthocyanins content among the chemical groups, while Hibiscus 1% addition resulted in the highest amount of anthocyanins retention (56.02 ± 1.86 mg/g, cyanidin 3- glucoside equivalent). In addition, the degradation rate of anthocyanins increased significantly with storage time and temperature except for 1% Hibiscus flowers at 25 °C. TPC of chemical additions showed no significant change in rose powder. However, natural colorant additions resulted in distinct TPC and TFC compared to the control sample except for Vitamin-C addition. All the additive-mixed samples exhibited a lighter color and lowered the redness value after a period of time. © 2022 Taylor & Francis Group, LLC.

69. Zhou, Y.H., et al., Conventional and novel peeling methods for fruits and vegetables: A review. Innovative Food Science and Emerging Technologies, 2022. 77.

This review explores the effects of various peeling technologies on the peeling performance of fruits and vegetables and peeled product quality. The peeling methods include conventional peeling approaches using hot-water, steam and lye and novel peeling techniques employing infrared radiation heating, ohmic heating and power ultrasound. The working principles, technology characteristics, the major factors affecting the processing efficacy, and limitations of conventional and novel peeling approaches are identified and discussed. Infrared radiation heating, ohmic heating and ultrasound-assist peeling methods have been successfully used to the peeling of tomatoes and other fruits and vegetables. The novel technologies can reduce the use of lye and can improve peeling performance and peeled product quality compared to conventional peeling. The process conditions and food properties are the major determinants affecting the processing efficacy. Future research needs are proposed to scaling-up the technology and exploring other technology used for peeling. Industrial relevance: As a key operation in the fruits and vegetables processing industry, peeling not only directly affects product quality, but also influences the processing cost and the management cost of waste generated by peeling. An unsuitable peeling process may result in low peeling efficiency and quality, high water and energy consumption, and

high discharge of waste liquid, leading to the decline of economic benefits and environmental issues. The current work provides important information for selecting suitable peeling methods for high quality and safe products. © 2022

70. Zhao, L., et al., Monitoring of free fatty acid content in mixed frying oils by means of LF-NMR and NIR combined with BP-ANN. Food Control, 2022. 133.

The free fatty acid (FFA) is an essential indicator to determine the discard point of frying oils, however, the current detection method of FFA in oil is laborious. This research established two non-destructive approaches based on low field nuclear magnetic resonance (LF-NMR), near Infrared (NIR) spectra, and back-propagation artificial neural network (BP-ANN) algorithm for monitoring the FFA content of fried oil samples. 105 used frying oils, representing various frying degree, were detected using LF-NMR, NIR and reference method. HCA and PCA were used for natural clustering of LF-NMR parameters (S21, S22, S23, T21, T22, and T23) and NIR spectroscopy. Finally, the value of the correlation coefficient (R2) manifested that the accuracy of LF-NMR model and NIR model reached 0.850, 0.963, respectively. The R2 value of NIR model was 0.113 higher than that of LF-NMR model, indicating NIR spectroscopy of used frying oil could be a more accurate method for monitoring the FFA content in the oil using the BP-ANN model. © 2021 Elsevier Ltd

71. Zhao, L., et al., Preparation of a Novel Carbon Dot/Polyvinyl Alcohol Composite Film and Its Application in Food Preservation. ACS Applied Materials and Interfaces, 2022. 14(33): p. 37528-37539.

Carbon dots (CDs) were synthesized with the facile hydrothermal method to produce CDs/polyvinyl alcohol (PVA) active food packaging films. The CDs had a diameter ranging from 2.01 to 5.61 nm and were well-dispersed. The effects of different concentrations of CDs on mechanical strength, water resistance, morphology, optical, and thermal performance of the CDs/PVA films were discussed. The incorporation of CDs in the PVA film improved its mechanical properties, water resistance properties, UV blocking properties, and thermal stability and endowed the composite film with antioxidant and antimicrobial properties. The maximum scavenging rates of 2,2-diphenyl-1-picrylhydrazyl and ABTS free radicals by the 0.50% CDs/PVA film were 72.81 and 97.08%, respectively. The inhibition zone diameters of the 0.50% CDs/PVA

solution against Staphylococcus aureus (S. aureus), Bacillus subtilis (B. subtilis), and Escherichia coli (E. coli) were 9.52, 8.21, and 9.05 mm, respectively. Using the 0.50% CDs/PVA film as active packaging, the shelf life of banana, jujube, and fried meatballs was observed to be extended significantly. These results demonstrate the viability of the CDs/PVA composite film as a promising active food packaging material. © 2022 American Chemical Society. All rights reserved.

72. ***Zhang, X., et al., Light-emitting diodes (below 700 nm): Improving the preservation of fresh foods during postharvest handling, storage, and transportation. Comprehensive Reviews in Food Science and Food Safety, 2022. 21(1): p. 106-126.***

In order to maintain the original taste, flavors, and appearance, fresh foods usually do not go through complex processing prior to sale; this makes them prone to deterioration due to external factors. Light-emitting diodes (LEDs) have many unique advantages over traditional preservation technologies leading to their increasing application in the food industry. This paper reviews the luminescence principles of LED, the advantages of LED compared with traditional lighting equipment, and its possible preservation mechanism, and then critically summarizes the beneficial effects of LED irradiation on the ripening and aging process of various fruits and vegetables (climacteric and non-climacteric). The activity changes of many enzymes closely related to crop development and quality maintenance, and the variation of flavor components caused by LED irradiation are discussed. LED illumination with a specific spectrum also has the important effect of maintaining the original color and flavor of meat, seafood, and dairy products. For microorganisms attached to the surface of animal-derived food, both 400–460 nm LED irradiation based on photodynamic inactivation principle and UV–LED irradiation based on ultraviolet sterilization principle have high bactericidal efficacy. Although there is still a lack of useful standards for matching optimal LED irradiation dose with wavelength, perhaps in the near future, the improved LED irradiation system will be applied extensively in the food industry. © 2021 Institute of Food Technologists®

73. ***Zhang, W.P., et al., The influence mechanism and control strategy of relative humidity on hot air drying of fruits and vegetables: a review. Drying Technology, 2022. 40(11): p. 2217-2234.***

Drying temperature, air velocity, material thickness during hot air drying usually have a significant influence on drying kinetics and quality attributes of fruits and vegetables. However, under constant drying temperature, the influence of relative humidity (RH) of hot air on heat and mass transfer is often ignored in drying practice. On the other hand, the current literature about the influence of relative humidity of drying medium on drying kinetics and quality of fruits and vegetables are inconsistent or even contradictory. Usually, the relative humidity is roughly controlled based on experience. Therefore, it is necessary to summarize and reveal the influence mechanism of relative humidity of drying medium on drying kinetics and quality of fruits and vegetables. The RH effect mechanism on drying kinetics is analyzed in two aspects including heat transfer and mass transfer. Increasing RH intensifies heat transfer process while decreasing RH intensifies mass transfer process. Applied high RH in the initial drying stage and then decreasing RH can improve drying efficiency compared to the continuous dehumidification RH drying method. Additionally, step-down RH drying strategy method helps to mitigate the formation of casehardening on product surface and promote pore network, which is benefit for moisture transfer and diffusion. High RH during hot air has the potential to improve the pore network of materials, which is helpful for rehydration ratio. Additionally, low RH increases drying rate so that material surface generates a rigid crust or shell that fixes the volume. Low temperature but high RH drying medium can preheat the sample as soon as possible so as the energy which was used to heat the drying air can be saved. The applicable of step-down RH drying strategy is suitable for those food materials drying, whose β value is more than 1 in Weibull distribution model and Bi value in Bi-Di model is more than 0.1. In other circumstances, continuous dehumidification drying is suitable for food material drying. The auto RH control adjustment drying strategy has been investigated based on material temperature. Such RH control drying strategy provides theoretical foundation for enhancing drying efficiency and quality of fruits and vegetable materials. © 2021 Taylor & Francis Group, LLC.

74. Zhang, L., et al., Antibacterial mechanism of ultrasound combined with sodium hypochlorite and their application in pakchoi (Brassica campestris L. ssp. chinensis). Journal of the Science of Food and Agriculture, 2022. 102(11): p. 4685-4696.

BACKGROUND: In order to prolong the storage and inhibit microorganisms of pakchoi, the antibacterial activity and mechanism of ultrasound combined with sodium hypochlorite (NaClO-US), the efficiency of NaClO-US in reducing Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa as well as preserving quality of pakchoi were investigated. RESULTS: Ultrasound treatment could significantly reduce the usage of NaClO solution from 800 ppm to 500 ppm. NaClO-US decreased the counts of E. coli, S. aureus and P. aeruginosa, which disrupted the bacterial cell membrane with cytoplasmic leakage. In addition, NaClO-US significantly increased cell membrane permeability, while cell membrane integrity decreased, the secondary structure of bacterial proteins showed several obvious changes, such as the increase of random coil content, as well as the decrease of α-helix content. The bacterial counts, E. coli, S. aureus and P. aeruginosa population in pakchoi treated with NaClO-US reduced by 1.89, 1.40, 1.60, 1.72 log CFU g−1, respectively compared to control sample after storage for 15 days. NaClO-US resulted in minimum chlorophyll depletion, flavor and sensory deterioration. CONCLUSION: NaClO-US solution treatment inhibited microorganisms and prolonged storage of pakchoi. © 2022 Society of Chemical Industry. © 2022 Society of Chemical Industry.

75. Zhang, L., et al., Synergistic antibacterial mechanism of different essential oils and their effect on quality attributes of ready-to-eat pakchoi (Brassica campestris L. ssp. chinensis). International Journal of Food Microbiology, 2022. 379.

The mixture of garlic essential oil (GEO), ginger essential oil (GIEO) and litsea cubeba essential oil (LCEO) was prepared and its effect on the antibacterial activity of E. coli, S. aureus and P. aeruginosa, as well as properties of ready-to-eat pakchoi during storage were assessed. GEO, GIEO or LCEO treatment significantly enhanced the accumulation of reactive oxygen species (ROS) levels, resulting in disruption of the permeability of cell membrane, the leakage of cytoplasmic contents, and the alteration of the secondary structure of bacterial proteins. Meanwhile, GEO, GIEO or LCEO treatment repressed the key enzyme in tricarboxylic acid (TCA) and Hexose monophosphate pathway (HMP) cycle of E. coli, S. aureus and P. aeruginosa. Essential oil treatments ($p < 0.05$) could significantly prolong the shelf life of pakchoi, total bacterial count (TBC) values and chlorophyll content of GEO/GIEO/LCEO sample were 3.47 log cfu/g and 0.82 mg/g, respectively, after storage for 7 days. E. coli, S.

aureus and P. aeruginosa counts in GEO/GIEO/LCEO samples decreased by 56.76 %, 70.10 %, 73.95 % compared to CK (no essential oil) samples. The comprehensive results from the sensory (flavor and color) and microbial analysis (especially TBC) showed that GEO/GIEO/LCEO could extend the shelf life of ready-to-eat pakchoi from 4 d to 7 d. As compared with GEO, GIEO or LCEO individually, the combination of GEO, GIEO and LCEO exhibited synergistic effect and more pronouncedly antibacterial activity to improve quality of ready-to-eat pakchoi. © 2022 Elsevier B.V.

76. Zhang, L., et al., Recent advances in essential oil complex coacervation by efficient physical field technology: A review of enhancing efficient and quality attributes. Critical Reviews in Food Science and Nutrition, 2022.

Although complex coacervation could improve the water solubility, thermal stability, bioavailability, antioxidant activity and antibacterial activity of essential oils (EOs). However, some wall materials (such as proteins and polysaccharides) with water solubility and hydrophobic nature limited their application in complex coacervation. In order to improve the properties of EO complex coacervates, some efficient physical field technology was proposed. This paper summarizes the application and functional properties of EOs in complex coacervates, formation and controlled-release mechanism, as well as functions of EO complex coacervates. In particular, efficient physical field technology as innovative technology, such as high pressure, ultrasound, cold plasma, pulsed electric fields, electrohydrodynamic atomization and microwave technology improved efficient and quality attributes of EO complex coacervates are reviewed. The physical fields could modify the gelling, structural, textural, emulsifying, rheological properties, solubility of wall material (proteins and polysaccharides), which improve the properties of EO complex coacervates. Overall, EOs complex coacervates possess great potential to be used in the food industry, including high bioavailability, excellent antioxidant capacity and gut microbiota in vivo, masking the sensation of off-taste or flavor, favorable antimicrobial capacity. © 2022 Taylor & Francis Group, LLC.

77. Yu, Q., et al., Advances in prepared dish processing using efficient physical fields: A review. Critical Reviews in Food Science and Nutrition, 2022.

Prepared dishes are increasingly popular convenience food that can be eaten directly from hygienic packaging by heating. Physics field (PF) is food processing method built

with physical processing technology, which has the characteristics of high efficiency and environmental safety. This review focuses on summarizing the application of PFs in prepared dishes, evaluating and comparing PFs through quality changes during processing and storage of prepared dishes. Currently, improving the quality and extending the shelf life of prepared dishes through thermal and non-thermal processing are the main modes of action of PFs. Most PFs show good potential in handing prepared dishes, but may also react poorly to some prepared dishes. In addition, the difficulty of precise control of processing conditions has led to research mostly at the laboratory stage, but as physical technology continues to break through, more PFs and multi-physical field will be promoted for commercial use in the future. This review contributes to a deeper understanding of the effect of PFs on prepared dishes, and provides theoretical reference and practical basis for future processing research in the development of various enhanced PFs. © 2022 Taylor & Francis Group, LLC.

78. Xu, B., et al., Multi-frequency power ultrasound as a novel approach improves intermediate-wave infrared drying process and quality attributes of pineapple slices. Ultrasonics Sonochemistry, 2022. 88.

This study evaluated the effect of mono-frequency ultrasound (MFU, 20 kHz), dual-frequency ultrasound (DFU, 20/40 kHz), and tri-frequency ultrasound (TFU, 20/40/60 kHz) on mass transfer, drying kinetics, and quality properties of infrared-dried pineapple slices. Pretreatments were conducted in distilled water (US), 35 °Brix sucrose solution (US-OD), and 75% (v/v) ethanol solution (US-ET). Results indicated that ultrasound pretreatments modified the microstructure of slices and shortened drying times. Compared to the control group, ultrasound application reduced drying time by 19.01–28.8% for US, 15.33–24.41% for US-OD, and 38.88–42.76% for US-ET. Tri-frequency ultrasound provoked the largest reductions, which exhibited time reductions of 6.36–11.20% and better product quality compared to MFU. Pretreatments increased color changes and loss of bioactive compounds compared to the control but improved the flavor profile and enzyme inactivation. Among pretreated sample groups, US-OD slices had lower browning and rehydration abilities, higher hardness values, and better retention of nutrients and bioactive compounds. Therefore, the combination of TFU and osmotic dehydration could simultaneously improve ultrasound efficacy, reduce drying time, and produce quality products. © 2022 The Authors

79. Wang, X., et al., Impact of internal structural design on quality and nutritional properties of 3D printed food products during post-printing: a critical review. Critical Reviews in Food Science and Nutrition, 2022.

3D food printing (3DFP) provides an excellent opportunity to deposit layers of multiple food materials to create unique complex structures of products with more engaging visuals, specific textures, and customized nutritional properties. Many printed products require post-printing processing which can result in sensory variance, texture changes, and even nutritional modification. Hence it is necessary to implement the design of the complex internal structure to ensure the desired quality of the printed products following post-printing. 3-D printing of various types of food products, for example, chocolate, cheese, meat, vegetables, fruits, fish, eggs, cereal-based products, and so on, has been examined with regard to post-printing requirements. This review aims to summarize the current work on the latest developments in 3DFP technology concerning the internal structure design of 3D printed products and its effect on quality during post-printing. The quality parameters include: textural, physical, morphological, and dimensional characteristics as well as nutritional properties. Furthermore, post-printing modifications such as 4D are also analyzed. © 2022 Taylor & Francis Group, LLC.

80. Wang, J., et al., Effect of high-humidity hot air impingement blanching and pulsed vacuum drying on phytochemicals content, antioxidant capacity, rehydration kinetics and ultrastructure of Thompson seedless grape. Drying Technology, 2022. 40(5): p. 1013-1026.

A new pretreatment method using high humidity hot air impingement blanching (HHAIB) followed by pulsed vacuum drying (PVD) was employed for Thompson seedless drying. The effect of this dehydration technique on phytochemicals content (ascorbic acid, total phenols and chlorophyll), antioxidant capacity (tetraethylammonium chloride, TEAC, ferric ion-reducing antioxidant power, FRAP and 2,2-diphenyl-1-picrylhydracyl, DPPH) and rehydration kinetics of Thompson seedless grape was explored. Results revealed that both HHAIB and PVD had a significant influence on phytochemicals composition and antioxidant capacity. After blanching for 150 s, the ascorbic acid and total chlorophyll content reduced by about 33% and 51%, respectively, while the total phenols and antioxidant capacity increased

significantly ($p < 0.05$). Ultrastructure observations explained why the total phenols and antioxidant capacity increased even as the ascorbic acid and total chlorophyll decreased. The findings indicate that HHAIB can enhance the total phenols content and antioxidant capacity of seedless grapes during blanching process and after drying. This information could be useful to change the general believed hypothesis that thermal processes lower the nutritional value of fruits and vegetables. © 2020 Taylor & Francis Group, LLC.

81. Wang, D., et al., Advanced Detection Techniques Using Artificial Intelligence in Processing of Berries. Food Engineering Reviews, 2022. 14(1): p. 176-199.

Berries are delicious and nutritious, making them among the popular fruits. There are various types of berries, the most common ones include blueberries, strawberries, raspberries, blackberries, grapes, and currants. Fresh berries combine high nutritional value and perishability. The processing of berries ensures high quality and enhanced marketability of the product. Sorting, disinfection, and decontamination are essential processes that many types of fruits such as citrus fruits, berries, pomes, and drupes must undergo to ensure improved quality, uniformity, and microbiological safety of the product. Drying and freezing are excellent processing methods to extend the shelf life of berries which also provide new options to the consumer of a wide variety of berries. With the demand for high quality and automatic high-throughput detection of the quality of fruit products, intelligent and rapid detection of various parameters during processing has become the development direction of modern food processing. Therefore, this paper reviews the application of advanced detection technologies, artificial intelligence-based methods for detection and prediction during berry sorting, drying, disinfecting, sterilizing, and freezing processing. These advanced detection techniques include computer vision system, near infrared, hyperspectral imaging, thermal imaging, low-field nuclear magnetic resonance, magnetic resonance imaging, electronic nose, and X-ray computed tomography. These artificial intelligence methods include mathematical modeling, chemometrics, machine learning, deep learning, and artificial neural networks. In general, advanced detection techniques incorporating artificial intelligence have not yet penetrated into all aspects of commercial berry processing, which include drying, disinfecting, sterilizing, and freezing processes. ©

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82. Tiliwa, E.S., et al., Comparative study of intermediate-wave and catalytic infrared drying on the kinetics and physicochemical properties of pineapple rings. Drying Technology, 2022. 40(12): p. 2568-2580.

This comprehensive study examined the effects of two infrared drying modes: intermediate-wave infrared drying (IWD) and catalytic infrared drying (CID), on drying kinetics and various quality parameters of pineapple rings at 60–80 °C. Hot-air drying (HAD) was the control drying operation. CID showed the highest drying rates and coefficients of moisture diffusivity (3.05 × 10−8 m2/s to 5.12 × 10−8 m2/s), resulting in drying times (1.88–3.15 h) that were about half that of HAD (3.57–7.25 h) and 10–34% less than that of IWD (2.08–4.75 h). Compared to IWD, CID exhibited minor color changes and a stronger flavor profile and enzyme inactivation potential. However, it resulted in a hardened product surface, thus reducing the rehydration ability. Overall, CID exhibited higher bioactive retention rates, especially at 60 °C (56–87%), followed by IWD at 70 °C (50–80%) and 80 °C (35–90%). Based on the results of this study, CID produces superior quality dried pineapples in a significantly shorter drying time, which is of potential industrial interest. © 2022 Taylor & Francis Group, LLC.

83. Thorat, B.N., A. Sett, and A.S. Mujumdar, Drying of Vaccines and Biomolecules. Drying Technology, 2022. 40(3): p. 461-483.

Vaccines are the most important life-saving prophylactic medicines administered in maintaining global health. In a pandemic situation, the manufacturing, formulation followed by preservation of vaccine are challenging areas of concern looking at the dire need of administering it to several billion people on the planet in a pandemic like situation. An important area of major concern is the potential loss of vaccine activity during storage and transportation. Scientists have developed several innovative ideas to store vaccines for a longer period of time. This article focuses on a critical overview of various methods of vaccine storage in dry powder form. Conventional vaccine drying processes, such as freeze drying under different conditions, spray drying along with the upcoming novel technologies such as spray freeze drying are described in detail for the

application in vaccine drying. Some other emerging methods, such as, microwave freeze drying and atmospheric freeze drying techniques are also discussed; these could be the game changers in the future. Several drying techniques make use of protective agents during the process of drying and storage. This review also highlights a comparative study of various technological challenges in drying of vaccines in support of the current global health scenario affected by COVID19. © 2020 Taylor & Francis Group, LLC.

84. Teng, X., et al., Garlic essential oil microcapsules prepared using gallic acid grafted chitosan: Effect on nitrite control of prepared vegetable dishes during storage. Food Chemistry, 2022. 388.

In order to lower the nitrite content in prepared vegetable dishes (PVDs) within a week, microcapsules loaded with garlic essential oils (GEO) were prepared using modified chitosan (CS) with different mass ratios of gallic acid (GA) to CS, and their physicochemical properties were determined. The effects of GEO alone and of microcapsules made using native CS and GA-CS (GA-grafted CS) with the highest conjugation degree on the nitrite content in PVDS were measured quantitatively. Also, the reasons for the differences were identified. The results showed that the microcapsules prepared using GA-CS (at a mass ratio of 0.5:1) presented the best physicochemical properties, including antioxidant activity, encapsulation efficiency, sustained release, etc. GA-CS microcapsules enhanced growth inhibition of bacteria producing nitrites, thus showing its excellent ability to inhibit nitrites, compared to GEO alone and microcapsules made using native CS. GA-CS encapsulation is a new option to lower the nitrite content in PVDs. © 2022 Elsevier Ltd

85. Teng, X., et al., Inhibition of nitrite in prepared dish of Brassica chinensis L. during storage via non-extractable phenols in hawthorn pomace: A comparison of different extraction methods. Food Chemistry, 2022. 393.

The objective of this study was to investigate whether non-extractable phenols (NEP) prepared by acid, enzymatic and alkaline hydrolysis in hawthorn pomace could reduce the nitrite content in prepared vegetable dishes (PVDs), analyzed through ultraviolet spectrophotometry and high performance liquid chromatography. The results showed that on the seventh day of storage, compared with the control group, the nitrite content of the samples added with acid, enzymatic and alkaline hydrolyzed NEP decreased by

40%, 28% and 19%, respectively, depending on different contents and chemical compositions of the recovered NEP. The nitrite reduction caused by NEP was mainly attributed to the growth inhibition of microorganisms producing nitrite (e.g., Escherichia coli and Pseudomonas aeruginosa) and the direct scavenging effect on nitrite, rather than affecting the activities of nitrate reductases and nitrite reductases in plant tissues. Use of hawthorn pomace is potentially a promising option to reduce nitrite in PVDs. © 2022 Elsevier Ltd

86. Teng, X., M. Zhang, and A.S. Mujumdar, Strategies for controlling over-puffing of 3D-printed potato gel during microwave processing. LWT, 2022. 153.

Starch-based printed foods are very sensitive to rapid heating using microwaves because microwave energy accelerates gelatinization of starch and formation of the gel network, which enhances the ability of foods to hold water vapor, resulting in the over-puffing problem of printed samples. Insoluble dietary fiber extracted from soybean residue (SIDF, soybean insoluble dietary fiber) and modification of the internal structure provided a solution to the over-puffing problem. Experimental results showed that incorrect addition and particle size of SIDF caused excess puffing or hardening. SIDF addition of 10% (w/w) and particle size of 150–180 μm provided better crispness while maintaining the product shape. The effect of SIDF on expansion rate was attributed to reduced mobility of moisture, enhanced mechanical strength, and declined deformation ability of potato gel. Internal structures with parallel lines and high porosity should be selected and the maximum internal filling density was generally less than 70%. Besides controlling deformation, it added value of soybean residue by incorporating into 3D-printed puffed potato chips. © 2021 Elsevier Ltd

87. Teng, X., et al., Progress in Extrusion-Based Food Printing Technology for Enhanced Printability and Printing Efficiency of Typical Personalized Foods: A Review. Foods, 2022. 11(24).

Three-dimensional printing technology enables the personalization and on-demand production of edible products of individual specifications. Four-dimensional printing technology expands the application scope of 3D printing technology, which controllably changes the quality attributes of 3D printing products over time. The concept of 5D/6D printing technology is also gradually developing in the food field. However, the functional value of food printing technology remains largely unrealized

on a commercial scale due to limitations of printability and printing efficiency. This review focuses on recent developments in breaking through these barriers. The key factors and improvement methods ranging from ink properties and printer design required for successful printing of personalized foods (including easy-to-swallow foods, specially shaped foods, and foods with controlled release of functional ingredients) are identified and discussed. Novel evaluation methods for printability and printing precision are outlined. Furthermore, the design of printing equipment to increase printing efficiency is discussed along with some suggestions for cost-effective commercial printing. © 2022 by the authors.

88. Tang, T., et al., 3D printed white radish/potato gel with microcapsules: Color/flavor change induced by microwave-infrared heating. Food Research International, 2022. 158.

The feasibility of using microwave-infrared heating (MIR) to stimulate color/flavor changes of 3D-printed white radish and potato gels containing lipid-soluble natural pigment and essence microcapsules was investigated. Natural red gromwell pigment and rose essence were microencapsulated using gum Arabic/maltodextrin/β-cyclodextrin as the wall materials and spray drying as the drying method. The microcapsules were incorporated into white radish and potato powder at different mass ratios (0, 0.3, 0.7, 1, and 2%, w/w) and the mixture were used as 3D printing ink. The storage modulus and loss modulus of printing paste were decreased with the increasing microcapsule addition; however, the viscosity was not significantly affected. The texture properties (hardness, springness, chewiness, and gumminess) of printed samples after MIR were increased significantly. The color and flavor of the samples changed in a microcapsule concentration- and heating time-dependent manner. With the prolongation of heating time, the brightness value (L*) of the printed sample added with microcapsules was decreased, while the redness (a*) and yellowness value (b*) were significantly increased. The results of electronic nose showed that the flavor of 2% (w/w) microcapsule samples was significantly different before and after heating, and the signals of sensors S1, S4, S5, S9, S11, S14, S16, S17 increased significantly after heating. This research has provided insights for the development of novel 3D printed foods with bright colors and unique flavors. © 2022 Elsevier Ltd

89. Tang, T., M. Zhang, and A.S. Mujumdar, Intelligent detection for fresh-cut fruit and vegetable processing: Imaging technology. Comprehensive Reviews in Food Science and Food Safety, 2022. 21(6): p. 5171-5198.

Fresh-cut fruits and vegetables are healthy and convenient ready-to-eat foods, and the final quality is related to the raw materials and each step of the cutting unit. It is necessary to integrate suitable intelligent detection technologies into the production chain so as to inspect each operation to ensure high product quality. In this paper, several imaging technologies that can be applied online to the processing of fresh-cut products are reviewed, including: multispectral/hyperspectral imaging (M/HSI), fluorescence imaging (FI), X-ray imaging (XRI), ultrasonic imaging, thermal imaging (TI), magnetic resonance imaging (MRI), terahertz imaging, and microwave imaging (MWI). The principles, advantages, and limitations of these imaging technologies are critically summarized. The potential applications of these technologies in online quality control and detection during the fresh-cut processing are comprehensively discussed, including quality of raw materials, contamination of cutting equipment, foreign bodies mixed in the processing, browning and microorganisms of the cutting surface, quality/shelf-life evaluation, and so on. Finally, the challenges and future application prospects of imaging technology in industrialization are presented. © 2022 Institute of Food Technologists®.

90. Sun, Q., et al., Research on the Vegetable Shrinkage During Drying and Characterization and Control Based on LF-NMR. Food and Bioprocess Technology, 2022. 15(12): p. 2776-2788.

Shrinkage is a common phenomenon during the drying of fruits and vegetables. The research aimed to study the mechanism of drying shrinkage and investigate the potential use of low-field nuclear magnetic resonance (LF-NMR) for online monitoring changes in shrinkage. The effects of drying parameters (temperature, power, and vacuum) on shrinkage of three types of materials banana (fruit), carrot (vegetable), and Pleurotus eryngii (an edible fungus) were studied in the different drying processes of hot air drying (HAD), microwave vacuum drying (MVD), infrared drying (IRD), and infrared freeze-drying (IFD). During drying, material shrinkage mainly occurred in the early and middle drying stages with different characteristics of retention volume and shrinkage equilibrium point of moisture content. The drying shrinkage was significantly

related to the change of MC in vacuolar compartment (p < 0.05). Reducing the drying time from drying beginning to the LF-NMR A23/A22(1), i.e., when the water content between vacuolar compartment and cytoplasm was equal, was beneficial for reducing shrinkage, and the volume retention rate increased by 39.13%. The shrinkage model of BP-ANN based on LF-NMR had a high prediction accuracy of shrinkage more than 95% and was excellent with the R2 of 0.9989 and RMSE of 0.0087. The shrinkage control strategy based on LF-NMR provided a reference for the development of artificial intelligence drying equipment. © 2022, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

91. Shirkole, S.S., A. Pani, and A.S. Mujumdar, Role of expert reviews for assessment of current developments in global drying R&D. Drying Technology, 2022. 40(2): p. 227-229.

92. Shen, J., et al., Investigation on the discoloration of freeze-dried carrots and the color protection by microwave combined with coating pretreatment. Drying Technology, 2022. 40(16): p. 3568-3579.

The color of freeze-dried carrots tends to be lighter than that of fresh ones, and the degree of color fading becomes more evident with longer storage time, thus affecting the sensory quality. To investigate the causes and alleviate the discoloration problem of freeze-dried carrots, this paper discusses various properties in terms of color, moisture content, enzyme activities of polyphenol oxidase, peroxidase and lipoxygenase, the content of color-related substances such as total phenols and total carotenoids, functional groups and microstructure. According to the correlation analysis, the discoloration of freeze-dried carrots was mainly due to enzymes. Polyphenol oxidase, peroxidase and lipoxygenase were significantly correlated with (Formula presented.) and (Formula presented.) Additionally, total phenols, carotenoids and moisture content also affected color. Freeze-dried carrot slices pretreated by the combination of microwave blanching at 700 W for 60 s and coated with 0.4% (w/w) pectin solution had the largest value of (Formula presented.) (16.44) and the smallest value of (Formula presented.) (77.69), which indicated the best color-protective effect. © 2022 Taylor & Francis Group, LLC.

93. Shen, J., et al., Effects of High Voltage Electrostatic Field and Gelatin-Gum Arabic Composite Film on Color Protection of Freeze-dried Grapefruit Slices. Food and Bioprocess Technology, 2022. 15(8): p. 1881-1895.

The original vivid red color of fresh grapefruit slices had faded considerably after freeze-drying, affecting visual enjoyment. The purpose of the study was to inquire the effect of high voltage electrostatic field for enzyme inactivation and gelatin-gum Arabic composite film for pigment retention on the color protection of freeze-dried grapefruit slices; the key cause of color fading was also analyzed. After being treated with high voltage electrostatic field at 5 kV/cm for 24 h, grapefruit slices were dipped in 0.4% (w/v) gelatin-gum Arabic solution containing 0.3% (w/v) tea polyphenols; the excess solution was then wiped. A series of physicochemical indicators and microstructure characteristics of freeze-dried grapefruit slices were investigated. Correlation analysis, principal component analysis, and cluster hierarchy analysis were established to derive the intrinsic causes affecting fading; both polyphenol oxidase (PPO) enzyme activity and water activity (aw) were highly significant positive correlated with △E (p < 0.01), and PPO enzyme activity was highly significant positive correlated with aw (p < 0.01), so lowering the value of PPO enzyme activity or aw could contribute significantly to the color preservation effect. The freeze-dried grapefruit slices pretreated by high voltage electrostatic field and gelatin-gum Arabic composite film containing 0.3% (w/v) tea polyphenols had the best color (△E = 29.61 ± 1.90). © 2022, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

94. Sehrawat, R., et al., Role of drying technology in probiotic encapsulation and impact on food safety. Drying Technology, 2022. 40(8): p. 1562-1581.

The world's urban population is expected to double by 2050. Urbanization is changing food consumption patterns, and the global market is flooded with functional foods, specifically probiotics, for their gut health advantages. Awareness about the healthy human microbiome among the consumer has prompted them to demand probiotic foods. Due to their potential health benefits, probiotics have been incorporated into several dairy and nondairy products. To overcome the hurdles associated with the low viability of the beneficial microorganism, microencapsulation of probiotic bacteria and yeast is of immense importance. Microencapsulation enhances the viability of

probiotics during different processing techniques and under gastrointestinal conditions. So, it is critical to control and design the drying process technology for probiotics encapsulation to achieve higher viability. The purpose of the review is to compile the commonly utilized drying technique for probiotics with their principle, advantages, and disadvantages, mechanism of inactivation, recent research, and cost involved in the processing. © 2022 Taylor & Francis Group, LLC.

95. Ren, M., et al., Comparison of ultrasound and ethanol pretreatments before catalytic infrared drying on physicochemical properties, drying, and contamination of Chinese ginger (Zingiber officinale Roscoe). Food Chemistry, 2022. 386.

This study aimed to investigate the effects of different pretreatment methods on the drying process and quality of catalytic infrared dried ginger slices, particularly the safety quality. Four different pretreatments strategies were used: sample submerged in distilled water, water + US pretreatment, ethanol pretreatment, and ethanol + US pretreatment. The results showed that all pretreatments reduced drying time, and sample pretreatment by ethanol + US had the highest drying efficiency, hardness, highest total phenolic content, and total flavonoid content retention. However, these pretreatments slightly decreased the rehydration ratio and gingerol content. The possible explanation for these results has been put forward by microstructure analysis. CIR-dried ginger samples were pretreated by four methods required by the agricultural standards of China. This study provides a new perspective on the commercial application of ethanol + US pretreatment for CIR-dried ginger slices. © 2022 Elsevier Ltd

96. Qu, P., et al., Efficient drying of laser-treated raspberry in a pulse-spouted microwave freeze dryer. Drying Technology, 2022. 40(12): p. 2433-2444.

Pulse-spouted microwave freeze drying (PSMFD) has been shown to be more energy efficient than the conventional vacuum freeze dryer. PSMFD yields higher drying rate and better energy efficiency due to volumetric heating. Because of the mass transfer resistance due to the berry's epidermal barrier during drying, the raspberry skin was subjected to laser pretreatment so as to perforate the surface with pre-selected number of fine holes generated by a CO2 laser. The perforations allow vapor generated within the bulk of the berry to escape with no resistance of the waxy skin. In addition to studying the effect of perforation parameters on drying time; therefore, quality indicators of the dried product (shrinkage ratio, hardness, rehydration capacity, color,

flavor, and anthocyanin content) were also explored. The micropore parameters in experiments were set as follows: P-0 (no perforations), P-3 (12 perforations), P-6 (24 perforations), and P-9 (36 perforations). As expected, greater the number of perforations per berry shorter is the drying time, by up to 23.08%. Moreover, the shortened drying time has a positive effect on product quality as well. The shrinkage rate could be reduced by about 3.95% and the retention rate of anthocyanin could be increased by 20.02%. © 2022 Taylor & Francis Group, LLC.

97. Qiu, S., et al., A multi-scale model for impingement drying of porous slab. Journal of Food Engineering, 2022. 335.

Air impingement drying of a planar sheets of porous materials offers advantages of high and controllable heat and mass transfer rates. The governing heat and mass transfer phenomena involve multi-scale physical mechanisms ranging from mesoscopic pore scale to macroscopic jet scale. This work presents a pore-scale heat and mass transfer model of an unsaturated porous material based on statistically self-similar fractal scaling laws of pore structures. Furthermore, the effective transport coefficients are derived and applied to develop a cross-scale mathematical model for hot air impingement drying of a slab made of an unsaturated porous material. The flow and thermal fields of jet impingement and drying characteristics of unsaturated porous material are modeled numerically. The quantitative correlations between the mesoscopic pore structure and macroscopic heat and mass transfer properties are explored. The proposed fractal pore-scale model of porous material and cross-scale mathematical model of jet impingement show good agreement with experimental data. The effects of jet velocity, porosity as well as pore and tortuosity fractal dimensions on drying rate are discussed in detail. The computational results show that the mesoscopic pore structures indicate significant effect on the drying rate during later stage of drying. Results of this study provide useful guidance for efficient design of impingement drying of porous materials. © 2022 Elsevier Ltd

98. Qiu, L., et al., Recent developments in key processing techniques for oriental spices/herbs and condiments: a review. Food Reviews International, 2022. 38(8): p. 1791-1811.

Oriental spices/herbs and condiments are important components of daily food consumption in the oriental countries as well as around the world. They have gained more atterention as preservatives, flavor, and therapeutic agents recently. However, the quality of spices/herbs and condiments is closely related to the processing techniques. Therefore, to obtain oriental spices/herbs and condiments with high-quality, processing techniques should be thoughly seleted. This article reviews the recent progresses in key processing techniques for oriental spices/herbs and condiments including, new drying methods, cryogenic grinding, novel fermentation and sterilization techniques. Moreover, the outlook of using oriental spices/herbs and condiments and their application in food products is also disscussed. © 2020 Taylor & Francis.

99. Qiu, L., et al., Convenient use of near-infrared spectroscopy to indirectly predict the antioxidant activitiy of edible rose (Rose chinensis Jacq "Crimsin Glory" H.T.) petals during infrared drying. Food Chemistry, 2022. 369.

Infrared drying (IRD) was used for the dehydration process of rose petals for the purpose of improving drying efficiency as well as retaining product quality. A methodology to predict the antioxidant capacities of rose petals which include DPPH, ABTS radical scavenging capacities and ferric-ion reducing antioxidant power (FRAP) values during infrared drying (IRD) was established in this study. Partial least squares regression (PLSR) and back propagation-artificial neural network (BP-ANN) modelling were used to establish the relationships between the near infrared (NIR) spectrum and the antioxidant capacities. Results of model fitting showed that BP-ANN model displayed higher prediction accuracy than PLSR model for determining the DPPH, ABTS radical scavenging capacities and FRAP of rose petals during IRD based on NIR spectral data. The results obtained indicate that NIR spectroscopic parameters combined with multivariate calibration could be used reliably to predict the antioxidant capacities of IR-dried rose petals via appropriate mathematical models. © 2021 Elsevier Ltd

100. Phuhongsung, P., et al., Defects in 3D/4D food printing and their possible solutions: A comprehensive review. Comprehensive Reviews in Food Science and Food Safety, 2022. 21(4): p. 3455-3479.

3D food printing has recently attracted significant attention, both from academic and industrial researchers, due to its ability to manufacture customized products in such terms as size, shape, texture, color, and nutrition to meet demands of individual consumers. 4D printing, which is a technique that allows evolution of various characteristics/properties of 3D printed objects over time through external stimulation, has also been gaining more attention. In order to produce defect-free printed objects via both 3D and 4D printing, it is necessary to first identify the causes of defects and then their mitigation strategies. Comprehensive review on these important issues is nevertheless missing. The purpose of this review is to investigate causes and characteristics of defects occurring during and/or after 3D food printing, with a focus on how different factors affect the printing accuracy. Various techniques that can potentially minimize or eliminate printing defects and produce high-quality 3D/4D printed food products without the need for time-consuming trial and error printing experiments are critically discussed. Guidelines to avoid defects to improve the efficiency of future 3D/4D printed food production are given. © 2022 Institute of Food Technologists®.

101. Pattarapon, P., M. Zhang, and A.S. Mujumdar, Application potential of 3D food printing to improve the oral intake for immunocompromised patients: A review. Food Research International, 2022. 160.

Unappetizing food is referred to food that has poor characteristic such as texture, nutrition and appearance, causing poor oral intake in hospitalized patients. Poor oral intake is a cause and/or consequence of malnutrition. This symptom can result in worse clinical outcomes when happens in immunocompromised patients which refers to those who have a weakened immune system and currently being at a higher risk of severe COVID-19 outcomes, consequently increasing susceptibility to infectious pathogens, leading to a higher risk of mortality. According to these concerns, the purpose of this review is to highlight the potential of 3D food printing (3DFP) technology to improve oral intake and nutritional needs in patients, as its ability to create personalized food that matches the need of consumers. Three aspects of 3DP potential were introduced as a key potential to enhance oral intake in the patients, including the potential to create foods with a variety of textures, the potential to produce a variety of food materials, and

the potential to design food appearance. In addition, challenges and specific concerns about using 3DFP in patients were also introduced. © 2022 Elsevier Ltd

102. Parniakov, O., et al., Insect processing for food and feed: A review of drying methods. Drying Technology, 2022. 40(8): p. 1500-1513.

Production of insects for food and feed purposes is rapidly emerging in Europe, filling an important niche of locally supplied protein and fat sources with improved environmental sustainability. Processing of insect biomass is becoming of utmost importance to fulfill the requirements for safe edible biomass and find efficient ways to reduce potential biological and chemical hazards. Current methods of insect biomass processing, well-developed, and established in food and feed industry, rely on thermal treatment (blanching, boiling, drying, cooling, freezing, freeze drying), mechanical (grinding, pressing, milling), and fractionation processes (extraction, purification, separation, centrifugation). This article summarizes and reviews recent activities performed by different interdisciplinary research groups dealing with insect drying. The diverse techniques for insect drying are discussed with the objective of identifying the ones with the highest economic, environmental, and social potential. Moreover, the quality attributes of insects dried with different methods (starting from simple sun drying and finishing with Pulsed Electric Fields enhanced lyophilization) are analyzed. Finally, selected legal aspects concerning usage of dried insects as food are presented. © 2021 Taylor & Francis Group, LLC.

103. Pardeshi, S.R., et al., Statistical optimization of voriconazole nanoparticles loaded carboxymethyl chitosan-poloxamer based in situ gel for ocular delivery: In vitro, ex vivo, and toxicity assessment. Drug Delivery and Translational Research, 2022. 12(12): p. 3063-3082.

The research study reflects the development of novel voriconazole (VCZ) loaded nanoparticles (NPs) for prolonged delivery for the management of ocular diseases. The in situ ophthalmic gel was prepared by incorporating NPs into carboxymethyl chitosan (CMCh) and poloxamer. The central composite design was used to optimize the process for the preparation of nanoparticles by the o/w solvent evaporation method. The developed nanoparticles were evaluated for the encapsulation efficiency (89.6 ± 1.2%), particle size (219.3 ± 1.8 nm), polydispersity index (PDI, 0.1), zeta potential (− 21.1 ±

1.12 mV), saturation solubility, DSC study, and drug release. The etherification process grafts carboxyl surface functional groups, on chitosan, and was confirmed by FTIR and NMR studies. The developed CMCh-poloxamer based gelling system was found to be clear and transparent with gelation temperature varying from 33 to 40 °C. The nanoparticle-loaded gel containing CMCh demonstrated enhanced antifungal activity against Candida albicans. The optimized batch containing CMCh showed improved mucoadhesion by 2.86-fold compared to VCZ nanosuspension. The drug release was prolonged up to 8 h with an ex vivo study suggesting the enhanced permeation across goat cornea estimated via fluorescent microscope. The hen's egg chorioallantoic membrane study revealed that the formulation was non-irritant and tolerated by the chorioallantoic membrane. The present study concludes that the VCZ loaded nanoparticulate in situ ophthalmic gel using CMCh may act as a potential alternative for traditional eye drops. Graphical abstract: [Figure not available: see fulltext.]. © 2022, Controlled Release Society.

104. Pani, A., S.S. Shirkole, and A.S. Mujumdar, Importance of renewable energy in the fight against global climate change. Drying Technology, 2022. 40(13): p. 2581-2582.

105. Niu, D., et al., Recent progress on quality improvement and detection technologies of special foods used for activities in space and aviation: a review. Critical Reviews in Food Science and Nutrition, 2022.

This paper focuses on the development and evolution, quality improvement and research progress in the rapidly emerging area of new detection technologies of special foods for use in space and to some extent aviation. The quality improvement aspects covered in this review ranged from the special food processing technology, sterilization treatment and product packaging to new detection technologies for quality assurance based on DNA microarray technology, sensor, imaging technology, carbon nanotubes and novel probe technology. © 2022 Taylor & Francis Group, LLC.

106. Long, Y., et al., Valorization of turmeric (Curcuma longa L.) rhizome: Effect of different drying methods on antioxidant capacity and physical properties. Drying Technology, 2022. 40(8): p. 1609-1619.

Turmeric has high commercial demand internationally, owing to its high nutrient and medical value. In this research, turmeric samples were subjected to several drying methods viz. infrared freeze drying (IRFD), freeze drying (FD), and pulse-spouted microwave-assisted freeze-drying (PSMFD). Over the range of operating conditions employed in this study, IRFD of infrared radiation was showed to shorten the drying time by 21.27% relative to FD, while the retention valves of ascorbic acid, curcumin, total phenols, and total flavonoids remains at 75.61%, 94.06%, 69.00%, and 80.09%, respectively over the range of experimental parameters. IRFD significantly ($P < 0.05$) reduced 25.19% of the energy consumption in comparison with FD. Furthermore, the interior of IRFD samples exhibited a honeycomb porous structure, and increased hardness, lower shrinkage, apparent density compared to PSMFD. Additionally, IRFD also performed better than PSMFD and FD under vacuum freezing conditions. © 2022 Taylor & Francis Group, LLC.

107. Liu, W., et al., Novel hybrid strategy for improving product quality of freeze-dried dumplings: different cooking methods combined with chitosan coating. Drying Technology, 2022. 40(14): p. 2930-2940.

To improve the quality of freeze-dried dumplings, a novel hybrid strategy that different cooking methods combined with chitosan coating were applied in the preparation of dumplings. The dumplings, obtained according to the formula, first treated by three different cooking methods (microwave, boiling, and steaming), respectively, and then coated with chitosan with a mass fraction of 1.5%. The dumplings without coating treatment was used as control group. Results showed that, the drying time of steamed dumplings was the shortest (720 min), but its whiteness and rehydration performance were unacceptable to consumers. The whiteness of boiled dumplings was the highest, but its drying time was 90 min longer than that of steamed dumplings. The freeze-dried dumplings pretreated by microwave cooking had the best rehydration performance (rehydration rate, cracking rate of rehydrated dumplings, and rehydration loss rate) and hardness. Chitosan coating treatment of cooked dumplings was been found to have a satisfactory positive effect on inhibiting the cracking rate of freeze-dried dumplings, the cracking rate of rehydrated dumplings and the rehydration loss rate of freeze-dried dumplings. Microwave cooking combined with chitosan coating was considered to be

the most suitable hybrid strategy for the production of high-quality freeze-dried dumplings. © 2021 Taylor & Francis Group, LLC.

108. Khairnar, G., et al., Production of antihyerglycemic and antihypertensive drug loaded sustained release nanoparticles using spray drying technique: Optimization by Placket Burman Design. Drying Technology, 2022. 40(3): p. 626-637.

Repaglinide (RPG, antidiabetic) and Diltiazem HCL (DIL, antihypertensive) loaded ethyl cellulose (EC) nanoparticles were prepared by the spray drying process using Placket Burman Design (PBD). The amount of EC (A, mg), Methanol (B, ml), Inlet temperature (C, OC), Feed rate (D, rpm), Nozzle diameter (E, mm) and Aspiration (F, rpm) were considered independent variables while EE of RPG (Y1) and EE of DIL (Y2) were selected as dependent variables. The optimized DIL and RPG loaded EC nanoparticles were further used for the development of oral fast disintegrating sustained release tablets by direct compression method. The tablets were evaluated for weight variation, thickness, hardness, disintegration time, friability and dissolution test. FTIR study showed no chemical interaction between drug and polymer. Scanning electron microscope showed spherical as well as oval shape and discrete nature of both nanoparticles. The physical parameters of oral fast disintegrating tablets developed with optimized formulation of drug loaded nanoparticles were found within the range. Drug loaded nanoparticles as well as oral fast disintegrating tablets showed very good sustained release behavior. © 2020 Taylor & Francis Group, LLC.

109. Jiang, Q., et al., Pressurized carbon dioxide combined with ultrasound-assisted immersion freezing: Effects on microstructure and nucleation of honeydew melon. International Journal of Refrigeration, 2022. 137: p. 212-219.

To reduce freezing-induced damage, a novel freezing method based on pressurized CO2 pre-injection combined with ultrasound-assistance was developed for quick freezing of pieces of honeydew melon. The samples were first exposed to CO2 at different pressures (0.2 MPa, 0.5 MPa and 0.8 MPa) and then placed in an ultrasound-assisted freezing device. The ultrasonic intensity was 0.15 W/cm2 at 20 kHz. The results indicate that pre-injection of CO2 enhanced ultrasonic cavitation and significantly (p < 0.05) increased the nucleation temperature, thus shortening the freezing time. CO2 combined with ultrasonic assisted freezing can reduce the variation in the state of water

in the sample after freezing and thawing. The results of SEM, cryo-microscopy and inverted fluorescence microscopic observations show that the cellular structure of the sample was better protected and the tissue was less damaged by ice crystals. This suggests that CO2 pre-injection combined with ultrasound assist during freezing can effectively control ice nucleation, ice crystal growth and reduce freezing-induced damage. © 2022 Elsevier Ltd and IIR

110. Jiang, Q., et al., Combination strategy of CO2 pressurization and ultrasound: To improve the freezing quality of fresh-cut honeydew melon. Food Chemistry, 2022. 383.

The effects of CO2 pressurization combined with ultrasound-assisted immersion freezing (CO2USIF) on improving the freezing quality of honeydew melon were studied. The cut melon samples were first subjected to 0.2, 0.5 and 0.8 MPa CO2 pressure for 2 h respectively, and then frozen by an ultrasound-assisted freezing device. The results indicated that the CO2 pressurization affected the water state and reduced the freezable water content. Cryo-observed results showed the ice crystal area of the 0.5CO2USIF sample was 66.6% smaller than that of the SF, and 60.8% smaller than that of the IF. The drip loss of 0.5CO2USIF sample was 58.2% lower than that of SF. The indexes of vitamin C, flavor, texture and color of CO2USIF samples were kept better. The SEM results showed that the cell structures of CO2USIF samples were better maintained. These demonstrated that CO2USIF technology has application potential in improving the quality of frozen food. © 2022 Elsevier Ltd

111. Jiang, Q., et al., Comparative freezing study of broccoli and cauliflower: Effects of electrostatic field and static magnetic field. Food Chemistry, 2022. 397.

The effects of 1, 3, 5 kV/cm electrostatic field (EF) and 2, 5, 8 mT static magnetic field (MF) on the quality of frozen broccoli and cauliflower (B and C) were studied. The freezing parameters were significantly improved by 3, 5 kV/cm EF or 8 mT MF treatment ($P < 0.05$), a maximum reduction of nucleation time and phase transition time by 20.14 % and 32.09 % was found in 5 kV/cm EF treated cauliflower. EF or MF treatment improved sample quality to some extent, the overall effect of 3 kV/cm EF was the best, which led to a maximum drip loss reduction of 64.3 % in cauliflower, accompanied by lower relative conductivity, higher ascorbic acid and less cell rupture.

EF or MF did not significantly reduce the damage of the flavor. MF was less effective than EF in improving the quality of frozen B and C. © 2022 Elsevier Ltd

112. Jiang, Q., M. Zhang, and A.S. Mujumdar, Novel evaluation technology for the demand characteristics of 3D food printing materials: a review. Critical Reviews in Food Science and Nutrition, 2022. 62(17): p. 4669-4683.

As a recently developed way of food manufacturing–3D printing–is bringing about a revolution in the food industry. Rheological and mechanical properties of food material being printed are the determinants of their printability. Therefore, it is important to analyze the requirements of different 3D printing technologies on material properties and to evaluate the performance of the printed materials. In this review, the printing characteristics and classification of food materials are discussed. The four commonly used 3D printing techniques e.g. extrusion-based printing, selective sintering printing (SLS), binder jetting, and inkjet printing, are outlined along with suitable material characteristics required for each printing technique. Finally, recent technologies for evaluation of 3D printed products including low field nuclear magnetic resonance (LF-NMR), computer numerical simulation, applied reference material, morphological identification, and some novel instrumental analysis techniques are highlighted. © 2021 Taylor & Francis Group, LLC.

113. Huang, Y., et al., 4D printing of mixed vegetable gel based on deformation and discoloration induced by acidification and dehydration. Journal of Food Process Engineering, 2022. 45(12).

This research was aimed at exploring the feasibility of 4D printing of Chinese cabbage puree–carrot powder–xanthan gum mixed gel system using white vinegar and hot air dehydration (HAD) as stimuli to realize double change of shape and color. Firstly, 4D printability of five mixed vegetable gels (MVG) were characterized by water distribution and rheological properties. The results showed that apparent viscosity, G′, G″, G* and yield stress were positively related to carrot powder content, while transverse relaxation time (T2) were negatively related to it. Next, the formula with 15% carrot powder content was chosen as printing ink due to its better 4D printing behavior. The results showed that bending angle reached the maximum (371.01°) at 210 min, and initial green color completely turned brown at 120 min. Finally, complex

models such as butterfly and four-petal flowers were further applied to verify the feasibility of this 4D food printing. Practical Applications: This study provides a simple but innovative method for simultaneous deformation and discoloration of 3D printed objects. These procedures would allow chlorophyll-rich vegetarian dishes show deformation and discoloration before consumption for added interest. © 2022 Wiley Periodicals LLC.

114. Huang, L., et al., Simulation of temperature during vacuum microwave drying of mixed potato and apple slices. Drying Technology, 2022. 40(15): p. 3177-3185.

The increased use of vacuum microwave drying in food industry is attributed to shorter drying time and lower temperature. The temperature change of materials is difficult to model due to the vacuum condition. A simplified mathematical model is presented subject to some assumptions to predict the temperature distribution in slices made using a mixture of potato and apple purées. Dielectric loss factors of mixed slices were found to increase with temperature and water content. The model accounts for temperature and moisture-dependent dielectric loss factor which yields a useful predictive tool. © 2021 Taylor & Francis Group, LLC.

115. Hu, R., M. Zhang, and A.S. Mujumdar, Application of infrared and microwave heating prior to freezing of pork: Effect on frozen meat quality. Meat Science, 2022. 189.

The effect of thermal treatment using infrared and microwave fields on freezing of pork loin was investigated. Several infrared and microwave treatment protocols were designed and tested to determine the thawing losses is each case to identify the most suitable one which yielded the best quality. In addition, the state of moisture in the meat, cooking loss, texture, color, pH, Thiobarbituric acid-reactive substances (TBARS), and other indicators were also evaluated. The results show that both microwave and infrared pre-dehydration can reduce the thawing loss of pork loin; the minimum loss is only about 1.7% using microwave 50 W intensity of 1.92 W/g of wet pork. Pre-dehydration also reduced the hardness of all samples and increased springiness, cohesiveness, and resilience. It is noteworthy that pretreatment did not damage the color. Based on the results of this study it is concluded that thermal pretreatment using microwave or

infrared fields of appropriate strength prior to freezing can yield good quality frozen pork meat. © 2022 Elsevier Ltd

116. Hu, R., M. Zhang, and A.S. Mujumdar, Novel assistive technologies for efficient freezing of pork based on high voltage electric field and static magnetic field: A comparative study. Innovative Food Science and Emerging Technologies, 2022. 80.

To enhance the freezing rate and thawed product quality of pork tenderloin, an experimental study was conducted using the high voltage electric field and static magnetic field separately during freezing. Pork tenderloin pieces were frozen at −20 °C under several high voltage electric fields (10 kV/m (HVEF1), 30 kV/m (HVEF3), 50 kV/m (HVEF5)) and magnetic fields of 2 mT (MF2), 4 mT (MF4), 6 mT (MF6) and 8 mT (MF8). The effects of different methods on freezing rate, ice crystal size as well as the distribution, and product quality after thawing were investigated. The freezing time of pork tenderloin was reduced by 40.04% and 37.81% respectively, under the optimal electric and magnetic field conditions tested. The thawing loss decreased from 5.7% of conventional freezing to 1.7% of HVEF1 and 2.4% of MF2, respectively. In addition, both high-voltage electric field freezing and magnetic field freezing can better maintain the moisture state in the sample. The results for color and pH confirmed that the thawed product quality using HVEF1 and MF2 was superior to that obtained under other conditions. The myofibrillar protein in the thawed products obtained from HVEF1 and MF2 treatments was also found to be thermally more stable. It is noteworthy that the HVEF1 treated sample has the highest umami signal and the lowest salty signal. Considering the enhanced freezing efficiency and improved quality, application of HVEF1 is recommended as a viable strategy to produce high-quality frozen pork tenderloin. Industrial relevance: The slow freezing rate of frozen meat products and serious deterioration of product quality are the key problems. Therefore, improving the efficiency of freezing is desirable. This study provides ideas for pork preservation. It caters to the need of industrial production of meat product where better efficiency freezing process is highly desirable, and the findings of this study is beneficial to the meat processing industry. © 2022 Elsevier Ltd

117. Hu, R., et al., Novel synergistic freezing methods and technologies for enhanced food product quality: A critical review. Comprehensive Reviews in Food Science and Food Safety, 2022. 21(2): p. 1979-2001.

Abstract: Freezing has a long history as an effective food preservation method, but traditional freezing technologies have quality limitations, such as the potential for water loss and/or shrinkage and/or nutrient loss, etc. in the frozen products. Due to enhanced quality preservation and simpler thawing operation, synergistic technologies for freezing are emerging as the optimal methods for frozen food processing. This article comprehensively reviewed the recently developed synergistic technologies for freezing and pretreatment, for example, ultrasonication, cell alive system freezing, glass transition temperature regulation, high pressure freezing, pulsed electric field pretreatment, osmotic pretreatment, and antifreeze protein pretreatment, etc. The mechanisms and applications of these techniques are outlined briefly here. Though the application of new treatments in freezing is relatively mature, reducing the energy consumption in the application of these new technologies is a key issue for future research. It is also necessary to consider scale-up issues involved in large-scale applications as much of the research effort so far is limited to laboratory or pilot scale. For future development, intelligent freezing should be given more attention. Freezing should automatically identify and respond to different freezing conditions according to the nature of different materials to achieve more efficient freezing. Practical Application: This paper provides a reference for subsequent production and research, and analyzes the advantages and disadvantages of different novel synergistic technologies, which points out the direction for subsequent industry development and research. At the same time, it provides new ideas for the freezing industry. © 2022 Institute of Food Technologists®

118. Gao, Y., et al., Numerical investigation of aqueous graphene nanofluid ice slurry passing through a horizontal circular pipe: Heat transfer and fluid flow characteristics. International Communications in Heat and Mass Transfer, 2022. 134.

Ice slurry is an attractive phase-change cold storage medium that offers excellent thermal performance, thus rendering it a good prospect for applications in renewable energy storage, power peak-cutting, and valley filling. In this study, a computational

fluid dynamic (CFD) numerical framework is employed based on the particle dynamics approach of an Euler-Euler two-fluid model coupling interphase transfer mechanisms. Thermal transport of a water-based graphene nanofluid ice slurry moving in the turbulent regime in a horizontal circular straight pipe is simulated and described. During the flow, the ice crystals tend to cluster on the top of the horizontal pipe, according to the findings, while uniformity of the crystal size distribution improves with an increase of velocity and the ice packing factor (IPF). Under the conditions of inlet IPF of 10% and heat flux q = 8000 (W m−2), the heat transfer coefficient on the heated section wall is increased by around 9% and 15%, respectively, as compared to pure water ice slurry and water. However, since the nanofluids have a higher viscosity than water, the pressure drop of nanofluid ice slurry is about 5% higher than that of pure water ice slurry in the same working environment. © 2022

119. Gan, S., et al., Effects of different thawing methods on quality of unfrozen meats. International Journal of Refrigeration, 2022. 134: p. 168-175.

The effects of thawing frozen meats using physical field-based methods and traditional thawing methods on frozen meat were examined is a critical analysis of relevant literature. Based on published data it can be concluded that physical field thawing methods reduce thawing cooking losses and retain color and texture of the thawed meat. Compared with meat samples thawed at room temperature, the loss due to ultrasonic thawing of pork, beef and mutton was lower by about 43%, 45% and 43%, respectively. The corresponding cooking loss decreased by 8.1%, 7.5% and 10.10%, respectively, under the test conditions. The results of MMb content and TBARS indicates that physical field thawing reduces protein and lipid oxidation of meat. Compared with the room temperature thawing group, the MMB content of the ultrasonic thawing group decreased by 10.13%, 15.70% and 12.69%, while the TBARS value of the ultrasonic thawing group was also the lowest, which decreased by 14.58%, 15.20% and 15.87% compared with the room temperature thawing group. LF-NMR results show that the ultrasonic thawing has the highest content of bound water and immobilized water. These results indicate that the physical field thawing methods can better maintain the quality of meat samples. Among different thawing methods tested ultrasonic thawing showed the best effects. © 2021 Elsevier Ltd and IIR

120. Duan, X., S.S. Shirkole, and A.S. Mujumdar, Special issue to honour professor Min Zhang for his contribution to food drying R&D. Drying Technology, 2022. 40(12): p. 2431-2432.

121. Du, Y., et al., Effect of addition of rice flour and yeast on improving 3D printing of fermented dough. Journal of Food Processing and Preservation, 2022. 46(11).

The application of 3D printing in the food field has received a lot of attention, and 3D printing can be used to make food that is easy to chew. Steamed buns are a traditional Chinese food, and no one has yet used 3D printing to make easy-to-swallow buns. In this study, rice flour and yeast were added to flour to improve its printing properties and textural properties, the effects of water addition on these properties were also studied. According to the results of preliminary exploration, a response surface with chewiness and cohesiveness as the response values was designed. When the water content was 64%, the addition of rice flour was 25%, and the addition of yeast was 0.36%, the chewiness of the optimal solution was 4.941 N and cohesiveness was 0.66, which were considered acceptable. It provides a new idea for developing steamed buns that meet the needs of various groups of people. Novelty impact statement: As a traditional Chinese food, the commercial value of steamed buns is gradually increasing. The steamed buns made by 3D printing were similar in shape to traditional steamed buns but smaller and easier to chew and swallow. It can be considered easy-to-swallow food. This study also provides new ideas for the development of easy-to-swallow foods. © 2022 Wiley Periodicals LLC.

122. Du, Y., et al., Innovative applications of freeze-drying to produce compound formula instant foods: A review. Drying Technology, 2022. 40(13): p. 2583-2597.

Due to the fast pace of life around the globe and the increasing demand for high-quality convenience foods by consumers, instant foods have attracted widespread attention. By adjusting the process and formula, the quality of compound formula foods can be optimized. Drying is a common way. However, conventional drying methods have some shortcomings. Freeze drying can overcome most of them. Foam mat freeze-drying can increase the drying area of materials, and the drying efficiency of it is also higher. For thermal-sensitive materials, it is a suitable drying method. Microwave freeze

drying, infrared drying, and others are relatively new processing technologies that are suitable for the production of instant foods. This paper provides an overview of recent developments in processing technologies for the production of compound formula instant foods. © 2021 Taylor & Francis Group, LLC.

123. Deng, L.Z., et al., An emerging pretreatment technology for reducing postharvest loss of vegetables-a case study of red pepper (Capsicum annuum L.) drying. Drying Technology, 2022. 40(8): p. 1620-1628.

Drying and pretreatment play key roles in reducing postharvest losses and improving food security. High humidity hot air impingement blanching (HHAIB) was employed in the present work to pretreat red peppers and its effects on natural micro flora, quality and drying characteristics of red pepper were evaluated. Results showed that the aerobic bacteria were decreased to1.72 log CFU/g; meanwhile, the mold and yeast populations were under the detection limit (<1.0 log CFU/g) after blanching for 30 s. Moreover, HHAIB treatment enhanced the drying rate, and the drying time was reduced by 14%-29% compared to the untreated samples. Weibull model precisely described the drying behavior of red pepper. HHAIB treatment (within 30 s) caused the decreases in ascorbic acid contents. At the same time, there was no significant ($p > 0.05$) effect on the surface color and natural pigment contents. The findings indicate that HHAIB pretreatment is a promising technique for increasing red pepper microbial safety and drying rate. © 2022 Taylor & Francis Group, LLC.

124. Demei, K., et al., 3D food printing: Controlling characteristics and improving technological effect during food processing. Food Research International, 2022. 156.

3D printing technology has a wide range of application in the food industry. Current research has focused on the improving printing accuracy and expanding the range of printing materials, while the feasibility of 3D printing technology in controlling processing characteristics and improving technological aspects have not yet been critically reviewed. This paper provides a concise critical evaluation of techniques to enhance the characteristics of 3D printed foods including their post-processing e.g. drying, frying, baking, cooling, sterilization etc. This paper provides guidance for future research and development in the field of post-treatment of 3D food printed products

which is critically important for wider industrial application of this rapidly evolving technology. © 2022 Elsevier Ltd

125. Chen, Y., et al., Combination of epigallocatechin gallate with L-cysteine in inhibiting Maillard browning of concentrated orange juice during storage. LWT, 2022. 154.

Orange juice is popular with consumers because of its unique taste, flavor as well as nutritional value which accounts for a large proportion of the global juice market. Concentrated orange juice (COJ), undergoes browning during storage seriously affecting its quality and commercial. This study was the first to evaluate the effects of epigallocatechin gallate (EGCG) and L-cysteine (L-cys) on Maillard browning of COJ during storage. The results show that EGCG and L-cys reduce significantly the production of 5-hydroxymethylfurfural (5-HMF), the characteristic product of Maillard reaction (MR), and the combined use of EGCG and L-cys was even more effective. Furthermore, the color of the treated COJ displayed negligible change after storage, with higher L* and b* values and marginally lower a* values. The flavor, taste, main volatile substances as well as rheological properties of the treated COJ were also determined; none of these properties were affected adversely during storage. This treatment method ensures that the key sensory quality and material properties of COJ are preserved by the proposed treatment while inhibiting Maillard browning during storage. © 2021

126. Chen, X.H., et al., Internal structure design for improved shape fidelity and crispness of 3D printed pumpkin-based snacks after freeze-drying. Food Research International, 2022. 157.

This study aimed to use the internal design of 3D food printing (3DFP) technology to obtain freeze-dried pumpkin with controllable crispness and higher shape fidelity. Two internal structural variables, namely filling pattern (honeycomb, rectilinear, grid, and triangular) and filling rate (25, 50, 75, and 100%), were studied to assess the impact on the shape fidelity and crispness characteristic of the product. As the filling rate decreased, the printing accuracy of the samples increased. Regardless of the filling patterns, the 75% filled samples exhibited the greatest deformation. The crispness of the samples was closely related to the filling pattern and filling rate. In the case of the high filling rate, the internal structure of the samples was dense. It was less likely to be

broken under the action of force and the crispness was reduced. In addition, the internal structure of the sample influenced its physical properties, and the crispness customization of the product can be achieved by designing the porosity. Morphological differences between printed and cast samples suggested that 3DFP was beneficial for the processing and preparation of highly viscoelastic materials. The crispness of cast sample was obviously less than that of the 100% filled printed samples. The results opened an interesting perspective to create crisp foods with high shape fidelity that meet specific texture requirements and provide new sensory perceptions. © 2022 Elsevier Ltd

127. Chen, X., et al., Recent Progress in Modeling 3D/4D Printing of Foods. Food Engineering Reviews, 2022. 14(1): p. 120-133.

Based on the design of printing models, three-dimensional (3D) and four-dimensional (4D) printing technologies have shown extensive and promising application potential in the food industry. The majority of previous researches on printing models focus on single or multiple models to test the performance of printers and inks, assess the influence of printing parameters on product performance, and print new products. This review compares the differences between the recently proposed 3D/4D printing models and summarizes the key factors needing to be considered in model design. The solid models are mainly used to explore printing parameters, while the filling models are used to study the texture characteristics of food. Models with changing shapes or colors reflect the importance of model structural design. The reasons for distortion in the process of transition from digital models to food models are analyzed, and the corresponding solutions are proposed. In the future, it is necessary to expand model database and develop cloud platform services so as to facilitate the sharing of related resources and strengthen the personalized nutrition of different consumer groups. © 2021, The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature.

128. Chen, J., et al., 4D printing induced by microwave and ultrasound for mushroom mixtures: Efficient conversion of ergosterol into vitamin D2. Food Chemistry, 2022. 387.

This study hoped to use microwave and ultrasound combined with 4D printing technology to promote the conversion of ergosterol into vitamin D2 in printing model with mushroom scraps. Under the UV irradiation, the conversion was different in the printed model with different irradiation areas and different physical field pretreatment. Compared with raw materials, vitamin D2 concentrations in the printed models was 4.6 time higher. Vitamin D2 in the product after physical field pretreatment was 2.2–3.8 times higher than that without pretreatment. From partial least square regression (PLS) analysis, irradiation area had the greatest impact while ultrasound treatment had the least. Pretreatment enhanced vitamin D2 content, possibly because pretreatment meant ergosterol was more susceptible to UV radiation, and expansion of the irradiated area increased the beneficial effect. This study established an artificial neural network model to predict ergosterol and vitamin D2 content. © 2022 Elsevier Ltd

129. Chen, F., et al., Non-thermal Technology and Heating Technology for Fresh Food Cooking in the Central Kitchen Processing: A Review. Food Reviews International, 2022. 38(4): p. 608-627.

The central kitchen model has promoted the industrialization of the catering industry. The quality of central kitchen products is related to processing technology. The new non-thermal technology and heating technology not only have advantages over traditional technologies in improving product quality and safety, but also have more precise control over the processing process and a higher degree of automation. Using non-thermal technology conditioning before cooking can change the properties of food ingredients, and improve the quality and safety of cooked food. The new heating technology replaces the traditional heating method to provide thermal energy for food cooking, and has the advantages of shortening cooking time, improving quality attributes, improving processing efficiency and product safety. This article reviews the application and research progress of non-heating and heating technologies in fresh food processing in the central kitchen. © 2020 Taylor & Francis.

130. Chen, C., et al., Improvement of microwave reheating uniformity for baked pancake from dielectric properties and heating mechanisms. Journal of Food Processing and Preservation, 2022. 46(10).

Baked pancake (BP) was unevenly heated during 2450 MHz microwave reheating (MR) and the water migrated by the temperature difference resulted in poor eating quality. The strategies to improve the edible quality of MR-BP were explored in terms of dielectric properties and reheating mechanisms. The only outer distribution of salt and sugar reduced the temperature difference during MR by increasing the dielectric loss factor (ε′) and loss tangent (tan δ). MR-BP exhibited promising moisture distribution and texture consistency when the ratio of the outer layer with salt and sugar to the inner layer without was 1:1. Furthermore, by reversing the temperature difference during MR without changing the salt and sugar distribution, infrared combined with 915 MHz microwave reheating (IMR) increased heating and texture uniformity, improving eating quality. Practical applications: The eating quality of Chinese pancakes decreased during MR. In this study, adding salt and sugar only to the outer layer improved the quality of MR-BP. Furthermore, IMR increased the quality of reheating BP without changing salt and sugar distribution. Current work aims to improve consumer satisfaction with Chinese pancakes and promote its commercialization. © 2022 Wiley Periodicals LLC.

131. ***Barani, Y.H., et al., Study of anthocyanins as related to stability of infrared freeze-dried rose flower using novel ultrasound pretreatment. Drying Technology, 2022. 40(16): p. 3455-3465.***

The present study was undertaken to determine the mechanism of anthocyanin content (ACNs) and related stability of infrared freeze-dried rose flowers using novel ultrasound pretreatments (20 kHz and 45 kHz for 5, 10 and 15 min). Additionally, the impact of such processing on peroxidase, polyphenol oxidase, color, moisture, total phenolic, total flavonoid, anthocyanins degradation during storage and chemical structure of infrared freeze-dried flowers was evaluated quantitatively. Peroxidase in rose flowers was effectively inactivated while polyphenol oxidase was activated very slowly (85, 95.67, 87.33, 77.67, 93, 98, 90.67%) by ultrasound pretreatment at 45 kHz and 20 kHz for 5, 10 and 15 min, respectively. The TPC and TFC of dried rose flowers pretreated by 45 kHz ultrasound (US) was also higher than that of dried roses pretreated by 20 kHz US. Moreover, US at 45 kHz was beneficial for the retention of color and anthocyanins of roses after infrared freeze-drying. In addition, US treatment at 45 kHz for 10 min resulted the lowest ACNs degradation rate during storage. These results demonstrate that US treatment at 45 kHz is a potential technique for improving the

stability of anthocyanins during its processing and storage. © 2022 Taylor & Francis Group, LLC.

132. Barani, Y.H., et al., Preservation of color and nutrients in anthocyanin-rich edible flowers: Progress of new extraction and processing techniques. Journal of Food Processing and Preservation, 2022. 46(9).

133. Acar, C., I. Dincer, and A. Mujumdar, A comprehensive review of recent advances in renewable-based drying technologies for a sustainable future. Drying Technology, 2022. 40(6): p. 1029-1050.

Conventional drying technologies generally rely on drying processes driven by using hot air, where these processes have significantly high energy consumption and greenhouse gas emissions. With our knowledge based on the limited nature of fossil fuels and the impact of climate change, it is clear that every technology has to be cleaner, cheaper, and more efficient to limit our carbon footprint while maintaining sustainable development. In this regard, the present study comprehensively reviews the recent advances in drying technologies and energy consumption and the efficiency and economic performances of several alternative drying technologies. The reviewed drying technologies include adsorption mediated, agitated thin film, electrotechnologies, hybrid systems, impingement, heat pumps, microwave, ohmic-heating, refractance window, rotating drum, superheated steam, and vacuum. The selected performance criteria are final heat use, final electricity use, primary energy use, thermal and energy efficiencies, and operating cost. With these criteria taken into account, the results show that the refractance window has the highest sustainability ranking (8.28/10), and superheated steam has the lowest sustainability ranking (2.90/10). Besides, the sustainability of the different drying fuels and technologies is conducted, and the results show that renewables have the highest sustainability ranking. Besides, it is seen that some novel approaches in drying, such as solar-based hybrid drying systems and refractance window drying, are amongst the most promising sustainable technologies. They could be the key to clean, affordable, reliable, and efficient drying of different kinds of products in industrial processes. © 2020 Taylor & Francis Group, LLC.

134. Zhang, M., et al., Special issue on recent drying R&D at Jiangnan University. Drying Technology, 2021. 39(9): p. 1135.

135. Zhang, L., M. Zhang, and A.S. Mujumdar, Development of flavor during drying and applications of edible mushrooms: A review. Drying Technology, 2021. 39(11): p. 1685-1703.

Edible mushrooms are rich in nutrition and have strong aroma as well as delicious umami taste. The flavor is not only the main indicator for evaluating the quality of edible mushrooms, but also an important factor influencing consumer preference. Thermal drying prolongs the shelf life of edible mushrooms, but it also causes modification of the flavor-containing components so that dried mushrooms show different flavor characteristics from those of fresh ones. As expected, different drying methods as operating conditions have important impact on product flavor. This paper discussed the formation pathways of the numerous flavor-containing compounds in foods; these include Maillard reaction, lipid oxidation and degradation, protein hydrolysis and Strecker degradation, as well as the main enzyme activity in aroma synthesis pathway. A comparison is presented of the effects of different drying conditions on flavor substances. The application prospects and possible development of more effective drying technology to ensure better retention of flavor in dried mushrooms so as to provide reference for the further research in production of high quality dried edible mushrooms. © 2021 Taylor & Francis Group, LLC.

136. Zhang, L., M. Zhang, and A.S. Mujumdar, New technology to overcome defects in production of fermented plant products- a review. Trends in Food Science and Technology, 2021. 116: p. 829-841.

Background: Fermented plant products (FPP) are functional liquids or solids produced by probiotics by fermentation of one or more fresh vegetables, fruits, mushrooms, herbs, etc. They have enriched nutritional value due to presence of polyphenols, flavonoids, organic acids, probiotics, prebiotics, vitamins, minerals and biological enzymes. This is an area of rapidly increasing interest around the world. Scope and approach: This review elucidates recent studies of fermented plant products from the viewpoints of fermentation technology, functional properties, defects and remedy

technologies to overcome potential defects. Several existing problems and development prospects for fermented plant products are discussed. Key findings and conclusions: Fermented plant products possess many functional properties, such as antioxidation, bacteriostasis, improving intestinal function and immunity, antialcohol, protecting liver etc. Particularly, there are many defects in production of FPP, including possible generation of biogenic amines, methanol, formaldehyde and nitrite during fermentation, safe control of microorganisms, deficiency of trace elements, as well as stability in storage. Moreover, many technologies have been proposed to remedy the defects of FPP. This review contributes to a deeper understanding of fermented plant products as well as processing and utilization of plants and modernization of their production. © 2021 Elsevier Ltd

137. Zhang, J., et al., Intensive pulsed light pretreatment combined with controlled temperature and humidity for convection drying to reduce browning and improve quality of dried shiitake mushrooms. Journal of the Science of Food and Agriculture, 2021. 101(13): p. 5608-5617.

BACKGROUND: The change of surface color caused by browning during the drying process of shiitake mushrooms seriously affects its market circulation. Intensive pulsed light (IPL) as a non-heat-treatment method can reduce enzyme activity by changing the enzyme structure. Therefore, in this study, the use of IPL pretreatment before drying was aimed to reduce the adverse reactions caused by the browning reaction during the drying processing of shiitake mushrooms. RESULTS: Shiitake mushrooms pretreated with 25 pulses of IPL energy of 400 J reduced the initial polyphenol oxidase enzyme activity, the browning index, and browning degree values by 42.83%, 43.02%, and 47.54% respectively. The IPL pretreatment enhanced the polysaccharides and reducing sugars contents and it reduced 5-hydroxymethylfurfural generation in the dried shiitake mushrooms. The pretreatment also improved the surface color, the antioxidant activity, and retained the umami taste characteristics in the dried shiitake mushroom. CONCLUSION: The IPL pretreatment combined with controlled temperature and humidity for convection drying could be a suitable method to improve the quality of dried shiitake mushrooms. Therefore, this study provides a new pretreatment method for materials that are prone to browning during drying. © 2021 Society of Chemical Industry. © 2021 Society of Chemical Industry.

138. Xu, K., et al., A novel two-step process to produce high-quality basil flavoured chicken powder: Effect of ultrasonication followed by microwave vacuum and hot air drying. Flavour and Fragrance Journal, 2021. 36(3): p. 323-331.

The objective of this experimental investigation was to develop a novel two-step process for production of high-quality chicken powder infused with basil. The first step consists of ultrasonication of an aqueous chicken pieces mixed with chopped basil leaves to enhance extraction of basil flavour and also pretreat the chicken microstructure to intensify the drying kinetics in the second step. The drying was carried out using microwave vacuum followed by hot air. The results showed that the drying time of chicken was the shortest (110 minutes) after US 40 minutes. In terms of product quality, the best rehydration (136.18%), the lowest hygroscopicity (3.84%) and the best colour of basil chicken powder were obtained after US 40 minutes. In the aspect of flavour addition, the content of linalool, estragole and eucalyptol in the chicken powder treated by US 40 minutes was the highest, and these three compounds were the main flavour substances of basil. At the same time, the content of some substances with bad smell, such as benzaldehyde, was greatly reduced after adding basil flavour. The overall quality of chicken powder produced by this novel process was found to be superior to that of commercially available spray-dried chicken powder. © 2020 John Wiley & Sons Ltd.

139. Xu, K., et al., Effect of different drying methods on the characteristics of chicken powder added with basil during storage. Drying Technology, 2021. 39(9): p. 1251-1260.

Basil was used as a source of flavor components and antioxidants to prepare new chicken powder products to improve flavor and shelf life. Microwave vacuum drying (MVD), radio frequency drying (RFD), and hot air drying (HAD) were used to compare the product characteristics and storage. GCMS, electronic nose, and electronic tongue were used to assess effect of three different drying methods on powder flavor and taste. The results showed that MVD basil chicken powder had the most abundant flavor. At the same time, MVD basil chicken powder also had good stability, the lowest hygroscopicity during storage period, followed by RFD and HAD. This was due to the change of the physical properties of samples and the secondary structure of protein. In

addition, MVD had a convinced protective result on antioxidant components in basil chicken powder during storage period. The results showed that MVD had positive effects on maintaining the rich flavor, good physicochemical properties, and antioxidant activity of basil chicken powder during shelf life. © 2021 Taylor & Francis Group, LLC.

140. Wang, J., et al., Effect of drying method and cultivar on sensory attributes, textural profiles, and volatile characteristics of grape raisins. Drying Technology, 2021. 39(4): p. 495-506.

The sensory characteristics, texture profiles, and volatile compounds were investigated for grape raisins dehydrated by pulsed vacuum drying (PVD) and shade drying (SD) from three varieties (Thompson Seedless, Flame Seedless, and Munage). Results indicated that raisins dried from PVD were less brown, possessed stronger fruity aroma and flavor. Texture profile analysis revealed that samples dried by PVD displayed lower hardness and higher springiness, cohesiveness and resilience than the SD ones. In terms of the volatiles analysis, 34 compounds were identified including 7 alcohols, 7 aldehydes, 5 acids, 3 esters, 2 ketones, 5 terpenoids, 1 pyrazine, 2 furfurals, and 2 aromatic compounds. Raisins dried by PVD displayed higher relative content of esters and terpenoids, which contributes to the floral and fruity aroma. The drying methods were well differentiated according to the principal component analysis. The current findings indicate that PVD is an alternative promising technology for production of high-quality raisins. © 2020 Taylor & Francis Group, LLC.

141. Wang, H., et al., Effects of postharvest ripening on physicochemical properties, microstructure, cell wall polysaccharides contents (pectin, hemicellulose, cellulose) and nanostructure of kiwifruit (Actinidia deliciosa). Food Hydrocolloids, 2021. 118.

Kiwifruit undergoes rapid softening and quality changes after harvest, which has an important impact on consumer appeal, shelf life and market value. Effects of postharvest ripeness on physicochemical properties, microstructure, cell wall fraction (pectin, hemicellulose and cellulose) contents and nanostructure, and pectin molecular weight were investigated. As the postharvest time increased from 0 to 6 days, the contents of total soluble solid and water-soluble pectin increased by 77.4% and 113.0%, respectively; while the content of starch, water insoluble pectin, and hemicellulose

decreased by 89.9%, 46.5%, and 33.5%, respectively. Disappearance of starch granules and the increase of intercellular space were observed using SEM. AFM analysis showed that both hemicellulose and pectin depolymerized gradually during storage. Measurements of the molecular weight confirmed the occurrence of depolymerization and degradation of pectin, while the cellulose content, nanostructure, and diameter of individual microfibrils did not change significantly. The findings in current work revealed the quality evolution and related mechanism of kiwifruit during storage. © 2021 Elsevier Ltd

142. Teng, X., M. Zhang, and A.S. Mujumdar, 4D printing: Recent advances and proposals in the food sector. Trends in Food Science and Technology, 2021. 110: p. 349-363.

Background: 4D printing technology has attracted extensive attention in academic and industrial circles since 2013 although commercialization still requires additional research and development. 4D food printing is an extension of 3D printing, which permits customization of new food products. Compared with aerospace, automobile, robotics, biomedicine and materials etc, there are few reviews on 4D food printing. Scope and approach: This review shows recent advances in 4D printing technology applied to foods. To adapt current 4D printing technology to foods it is necessary to improve the extrusion printer and develop the necessary software. Aspects of recombination of different food materials and reasons of alterations in color, shape, flavor and nutrition via 4D food printing are discussed critically. The key to the success of 4D food printing and diverse solutions to the corresponding problems are outlined and analyzed. Future prospects for 4D food printing technology are discussed along with research and development needs. Key findings and conclusions: At present, 4D food printing experiment is mainly based on soy protein isolate, starch and hydrogels and is realized through material properties, internal structural design and spatial arrangement of recombined food materials. The stimulation factors responsible for causing alteration of 3D printed products include pH, water absorption, microwave and temperature, resulting in deformation, modification of color, flavor and nutritional value. It is noteworthy that 4D food printing is still at research stage. There are opportunities for enhancement in the link between internal structure and stimulation,

design of the printer, printing software, printing materials as well as evaluation of the properties of the printed foods. © 2021 Elsevier Ltd

143. Teng, X., M. Zhang, and A.S. Mujumdar, Potential application of laser technology in food processing. Trends in Food Science and Technology, 2021. 118: p. 711-722.

Background: The considerable demand for high-quality foods derives us to adapt and adopt novel automated technologies in order to reduce waste and increase nutrition and sensory quality of processed foods. The emerging area of laser-based technology has shown significant potential to enhance the quality and safety of foods due to the better monochromaticity and directivity of laser beams. Base on the applications of lasers in food packaging and food detection, laser-assisted food processing is a growing area arousing considerable interest among scientists in the past decade. Scope and approach: This review critically evaluates relevant literatures to address the potential for laser technology applied to food processing. The key to the success of laser-assisted food processing is outlined and analyzed from the perspective of properties of both lasers and food materials. Aspects of processing mechanism via laser technology and application are discussed. The corresponding problems and future prospects for laser-assisted food processing are discussed along with research and development needs. Key findings and conclusions: Base on thermal and photochemical process, lasers display great potential in the field of food processing including material pretreatment, drying, cooking, microbial inhibition, laser marking, extraction, fermentation and aging of liquid foods etc. The operational parameters of lasers and optical and thermal properties of the targeted material affect the quality of the products. To adapt current laser technology to industrial food processing it is necessary to offset some limitations, especially the control of thermal damage, establishment of mathematical models/databases, and automatic and safety processing equipment. © 2021 Elsevier Ltd

144. Sun, Y., et al., Pulse-spouted microwave freeze drying of raspberry: Control of moisture using ANN model aided by LF-NMR. Journal of Food Engineering, 2021. 292.

To achieve intelligent control of the drying terminal point in pulse-spouting microwave freeze drying (PSMFD) of raspberries, low-field nuclear magnetic resonance (LF-NMR) was used to monitor the moisture status and moisture content changes during

drying. As expected, three states of water were observed: bound water, immobile water and free water (around 18, 187, and 1304). From the T2 spectrum, the bound water content was observed not to change significantly (p > 0.05), while its proportion gradually increased, and the contents of non-flowing water and free water decreased significantly (p < 0.05). Statistical analysis of moisture content at drying end points showed that PSMFD (RSD value 16.21%) could improve the drying uniformity compared with microwave freeze drying (RSD value 32.87%), magnetic resonance imaging and infrared thermal imaging tests showed that PSMFD raspberries lose water both inside and outside. The intelligent control models (PLS and BP-ANN) for the drying end-point were established based on LF-NMR measurements and the prediction performance was compared. The correlation coefficient R2 of the BP-ANN model after training was 0.9955 with RMSE 0.0211, which had well fitted and had a strong approximation ability. © 2020 Elsevier Ltd

145. Sun, Y., et al., Novel nondestructive NMR method aided by artificial neural network for monitoring the flavor changes of garlic by drying. Drying Technology, 2021. 39(9): p. 1184-1195.

Flavor changes of garlic during drying process were monitored using LF-NMR combined with partial least squares (PLS) and back-propagation artificial neural network (BP-ANN). Results show that with elapsed drying time, the free water (A23) and total moisture content (A) of garlic decrease with different drying conditions. Correspondingly, the sulfide of main flavor components in garlic was significantly reduced, but alcohol and acid components increased slightly and the overall aromatic flavor showed a downward trend, which was consistent with the GC-MS volatile component detection results. Electronic nose sensors S2, S5, S8, S10 were determined as feature sensors by principal component analysis (PCA) and linear discriminant analysis (LDA). The univariate linear model of NMR parameters and electronic nose characteristic sensors show high correlation. Furthermore, ANN and PLS garlic flavor prediction model were established, although the PLS model was not as good as the BP-ANN model (RP2 of 0.9713 and 0.9975) to monitor flavor changes, it also yields relatively accurate prediction performance with RP2 of 0.9418 and 0.9633 for mid-shortwave infrared drying and microwave vacuum drying, respectively. © 2020 Taylor & Francis Group, LLC.

146. Sun, Q., M. Zhang, and A.S. Mujumdar, Evaluation of potential application of artificial intelligent control aided by LF-NMR in drying of carrot as model material. Drying Technology, 2021. 39(9): p. 1149-1157.

As a new sensing technology for rapid nondestructive detection, low field nuclear magnetic resonance technology (LF-NMR) is being widely applied in many fields of food science and technology. The purpose of this study was to evaluate the potential of the LF-NMR technique to detect in the endpoint in drying off carrots as a model food material. Taking relative standard deviation (RSD) as the evaluation index, the research examined the effect of sample quantity and moisture content (MC) on the precision of detection. The results showed that adjusting the number of scans (NS) during drying and sample quantity can help improve the detection performance of LF-NMR. The MC level of 20% was observed to be the key point for adjustment of the detection parameter while the sample quantity at the drying endpoint is recommended to be 1.0-1.5g to achieve good precision. © 2020 Taylor & Francis Group, LLC.

147. Shirkole, S.S., B.N. Thorat, and A.S. Mujumdar, Critical reviews for facilitating innovations and advances in drying science and technology. Drying Technology, 2021. 39(5): p. 577-579.

148. Shirkole, S.S., A.S. Mujumdar, and P.P. Sutar, Studies on thermal stability of high-power short time microwave dried paprika (Capsicum annuum L.) considering the interaction of water molecules with sorption sites. Drying Technology, 2021. 39(1): p. 52-65.

The moisture adsorption isotherms of high-power short time microwave dried paprika (Capsicum annuum L., a pulverized product of dried red pepper) were determined for thermodynamic analysis and assessment of its stability at elevated temperatures. The thermal stability of paprika was evaluated based on alterations in quality characteristics due to the interaction of water molecules with sorption sites during the adsorption process. The GAB model constants revealed the physical significance and the exothermic interaction of the water molecules with the sorption sites on the surfaces of the paprika. The differential enthalpy was found to decrease with increasing water activity due to the existence of highly active polar sites on the surface of paprika at low

water activity. The differential entropy decreases due to a rise in water activity as molecular water movement was highly restricted at an elevated water activity. The safe water activity levels corresponding to monolayer moisture content (M o) of paprika at 30°, 40°, 50°, and 60 °C were found to be 0.58, 0.49, 0.43, and 0.30, respectively. Moreover, the acceleration in quality degradation of paprika was found to increase beyond M o at the respective adsorption temperature. © 2019 Taylor & Francis Group, LLC.

149. Shi, H., et al., Influence of drying methods on the drying kinetics, bioactive compounds and flavor of solid-state fermented okara. Drying Technology, 2021. 39(5): p. 644-654.

Solid-state fermented Omar's was dried using microwave vacuum drying (MVD) and infrared freeze-drying (IFD). Hot air drying (AD) and traditional vacuum freeze-drying (FD) were used as controls. The effects of different drying methods on the drying kinetics, physicochemical properties (such as water retention capacity, oil retention capacity, swelling capacity, solubility, color), bioactive compounds (total phenols, soybean isoflavones, antioxidant activity) and flavor of solid-state fermented okara were studied. The results show that compared with AD, MVD required 86.2% less drying time and 62.2% lower energy while the fermented okara powder produced by MVD had better physicochemical properties and higher content of bioactive compounds. In terms of physicochemical and functional properties, IFD was close to FD, but it reduced drying time by 13.9% and energy consumption by 29.4%. As for flavor, MVD and IFD products were closer to fresh solid-state fermented okara. © 2019 Taylor & Francis Group, LLC.

150. Sharma, A.K., et al., Scale analysis of electrochemical and thermal behaviour of a cylindrical spiral-wound lithium-ion battery. Electrochimica Acta, 2021. 400.

Design and sizing of lithium-ion battery is a challenging task because of inherent multiphysical and multiscale nature of this battery type. Detailed mechanistic models have been developed to resolve the design effects on physico-chemical processes taking place inside the battery and in turn, on battery performance. However, such models are hold back by their mathematically complexity and associated computational cost. In this paper, we come up with efficient design guidelines for Li-ion battery while

addressing these model complexities. In essence, we carry out scale analysis of electrochemical and thermal behaviour of a cylindrical spiral wound Li-ion battery. We secure non-dimensional numbers and scales for the leading-order phenomena of charge, energy and species transport as well as associated heat generation and electrochemical reactions. The scales, in particular, provide quick quantification of variables such as temperature increase, potential losses and state of charge during charge/discharge. We verify reliability of the derived scales by comparing their predictions with the results from numerical simulations of an electrochemical-thermal model of battery. Overall, good agreement between the predictions from scales and simulations is obtained. The non-dimensional numbers and scales – which characterize the cell both thermally and electrochemically – are also discussed from the viewpoint of battery design. © 2021 Elsevier Ltd

151. Shankarrao Shirkole, S., et al., Dry pasteurization of paprika (Capsicum annuum L.) by short time intensive microwave-infrared radiation: Inactivation of Salmonella Typhimurium and Aspergillus flavus considering quality degradation kinetics. Food Chemistry, 2021. 338.

The inactivation of S. Typhimurium and A. flavus along with quality degradation kinetics was studied during combined microwave-infrared (MW-IR) heating of paprika. The spatial changes in the distribution of temperature and variation in water activity (aw) of the paprika samples resulted in a 7.389 log reduction in S. Typhimurium, and 6.182 log reduction in A. flavus. During heating, the deterioration of red pigments was more pronounced compared to that of the yellow pigments. The alteration of color was observed to be due to the increase in a large number of brown pigments. The inhibition of DPPH radicals accelerated with an increase in the power level of MW-IR radiation; the inhibition rate increased from 0.0859 to 0.1485 s−1. Also, the pungency of dried paprika was found to increase due to moisture reduction, inactivation of peroxidase, and the short-duration of heating. © 2020 Elsevier Ltd

152. Ren, M., et al., Visualizing the knowledge domain of pulsed light technology in the food field: A scientometrics review. Innovative Food Science and Emerging Technologies, 2021. 74.

Pulsed Light (PL) is now recognized as a promising non-thermal food processing technology with a wide range of applications in disinfection, extending shelf life, and inhibiting allergic reactions from the consumption of certain foods. In recent years, the research in PL has developed rapidly, and the knowledge domain associated with this area has made significant progress. Interested scholars in this and allied areas need to keep up with the new tendency and critical developments. In this study, a progressively integrated network is derived from 475 archived articles on PL technology obtained from the Web of Science Core Collection (WoSCC) database in "Food Science Technology" between 2011 and 2020. These scientific documents were analyzed through HistCite and CiteSpace. The hot-spots and landmark references of PL technology were obtained by scientometric analysis. This review will guide scholars to track new trends and identify critical new applications of PL technology in the food industry. © 2021 Elsevier Ltd

153. Rekik, C., et al., Study of interval infrared Airflow Drying: A case study of butternut (Cucurbita moschata). LWT, 2021. 147.

Interval process is defined as a means of operating short-time intervals configured to allow the material to attain characteristics to match higher drying rate. The innovative Interval Infra-Red Airflow Drying (IIRAD) involves successive heating intervals (tON) of several seconds followed by tempering periods (tOFF) of a few minutes. IIRAD provides heat only when the product surface is fully rewetted. Drying of winter squash slices was performed in three cases; continuous IR-drying, IIRAD-I: tON = 5 s and tOFF = 2 min, and IIRAD-II: tON varies throughout the process with tOFF = 2 min. A higher drying rate was observed during IIRAD-I. Measured evaporating-bulb temperatures were below 21 °C with energy consumption of 0.98 and 0.77 kWh/kg of evaporated water for I-IIRAD and II-IIRAD, respectively, wherein they exceeded 66 °C and 2.19 kWh/kg of evaporated water for continuous drying. IIRAD resulted in better preservation of flavonoids and better retention of color. However, continuous IR-dried samples displayed better rehydration and higher total polyphenol content. Overall, IIRAD is shown to be a promising drying technique for heat sensitive materials in terms of efficiency, energy consumption, and preservation of key quality attributes linked to lower operating temperature, but with increased drying time. © 2021

154. Qiu, L., et al., Effect of edible rose (Rosa rugosa cv. Plena) flower extract addition on the physicochemical, rheological, functional and sensory properties of set-type yogurt. Food Bioscience, 2021. 43.

Edible rose (Rosa rugosa cv. Plena) flower is known to have health-promoting benefits due to its content of bioactive substances. In this study, a functional yogurt fortified with Rosa rugosa cv. Plena extract (RPE) was prepared and its physicochemical, rheological, and functional properties during storage were determined. In addition, E-nose, E-tongue, sensory analysis, and microstructure observation of the fortified yogurt samples were carried out on the first day of storage. Results showed that incorporation of RPE in yogurt increases the pH, water holding capacity (WHC), a* and b* values, total phenolic content (TPC), antioxidant capacity, α-Amylase and α-Glucosidase inhibitions, and proteolytic activity of yogurts, whereas a decrease occurs in lightness, titratable acidity (TA), and syneresis of yogurts. RPE also affected the viscoelasticy, flavor, taste, microstructure and sensory properties of the samples. Furthermore, yogurt containing 0.1% RPE exhibited the highest sensory scores as well as the best viscoelastic properties and flavor attributes. During storage, reduction occurs in pH, syneresis, lightness, TPC and DPPH radical scavenging ability. The values of other attributes of the fortified yogurt improve with extended storage period. Finally, 0.1% RPE has the potential to develop a functional yogurt with improved physicochemical, rheological, functional and sensory properties compared to plain yogurt. © 2021 Elsevier Ltd

155. Piacentini, R.D., M. Vega, and A.S. Mujumdar, Beyond industrial revolution 4.0: How industrial revolution 5.0 is related to drying technology. Drying Technology, 2021. 39(4): p. 437-438.

156. Pardeshi, S., et al., A meticulous overview on drying-based (spray-, freeze-, and spray-freeze) particle engineering approaches for pharmaceutical technologies. Drying Technology, 2021. 39(11): p. 1447-1491.

Drying is an indispensable operation in the preparation of pharmaceutical powders and always remained one of the energetic tasks in the pharmaceutical industry. Improving the stability, solubility, and dissolution of pharmaceutical products are being prime

objectives of the drying process, intending to produce the products loving the dry state. Although there are voluminous literatures available concerning drying operations, there is scant information available regarding the applicability of drying in drug delivery and process scale-up. The current communication embodies the different particle engineering technologies of drying viz. spray-, freeze-, and spray-freeze drying. In addition, potential uses of drying in the taste masking, and the development of inhalable powders presented briefly. Recent advancements in the drying of novel drug delivery systems is the major focus of the present review. In our opinion, the commercial aspects, regulatory guidelines, and scale-up strategies presented herein provide an opportunity to readers, researchers, and industrialists to ruin the critical issues during drying operations and aid in developing quality pharmaceutical technologies. © 2021 Taylor & Francis Group, LLC.

157. Naik, J.B., et al., Synthesis and evaluation of UV cross-linked Poly (acrylamide) loaded thymol nanogel for antifungal application in oral candidiasis. Journal of Polymer Research, 2021. 28(1).

Oral candidiasis is an infection that occurs inside of the cheek and oral cavity which is very painful. Treatment of oral candidiasis is very important for its commonness and the inadequate medication options are available for the treatment. Synthesis and evaluation of Poly (acrylamide) loaded thymol nanogelalternative for conventional creams was the main aim of this study. Polyacrylamide nanogel was synthesized from acrylamide monomer using N, N'-methylene bisacrylamide (cross-linker) and Irgacure (initiator) by UV induced cross-linking. Variation of reaction parameters such as cross-linker, initiator, light intensity, and exposure time has been used for the optimization. Nanogel characteristics were evaluated through the In vitro drug release, Ex vivo permeation study, FTIR Spectroscopy, FESEM, and antifungal activity. From the results, the drug release was found 75.47% to 99.62%, while viscosity was observed in therange of 76.68 to 34.44 cps. The contour plots shows that when cross-linker concentration varied from 0.12 w/v to 0.68 w/v, viscosity was increased from 34.44 cps to 76.68 cps with respect to UV curing time. The particle size distribution of nanogel was observed from 18.17 to 142.2 nm with average particle size of 132 nm and polydispersity index 0.4. Nanogel incorporated with thymol could be a new approach

for topical delivery of thymol for antifungal activity compared to conventional cream. © 2021, The Polymer Society, Taipei.

158. Mujumdar, A.S. and S.S. Shirkole, Archival publications on drying. Drying Technology, 2021. 39(16): p. 2177-2178.

159. Mujumdar, A.S., Perspectives on role of IDS series on global R&D in drying. Drying Technology, 2021. 39(2): p. 133.

160. Mounir, S., et al., Phytochemicals, chlorophyll pigments, antioxidant activity, relative expansion ratio, and microstructure of dried okra pods: swell-drying by instant controlled pressure drop versus conventional shade drying. Drying Technology, 2021. 39(15): p. 2145-2159.

This study is aimed at comparing swell drying versus conventional shade drying and optimizing the texturing by instant controlled pressure drop (DIC) of green okra pods. Differences in quality attributes such as content of flavonoids, carotenoids, and chlorophyll pigments, functional characteristics such as the antioxidant activity (AOA), microstructure and relative expansion ratio of dried okra pods were considered. The DIC processing parameters were the saturated steam pressure (0.2-0.6 MPa) and duration (40-60 s). A 2-parameter, 5-level central composite rotatable design was selected for establishing the experimental trials. They represent 8 factorial and star trials, and five repetitions of central/middle point of the square edges. Significant variations in total phenolic and flavonoid contents, carotenoids, antioxidant activity, and chlorophyll pigments were observed between swell-dried and conventional shadow dried okra pods. An increase of 25% and 99% was respectively observed for the relative expansion ratio and flavonoid content in swell dried okra pods compared with conventional shadow dried ones. The microstructure observations showed a significantly more porous open solid matrix of swell-dried okra pods compared to the compact/dense solid matrix of the conventional shadow dried okra pods. The optimum conditions of DIC-texturing were found to be 0.4 MPa for 50 s exhibiting the highest values of total phenolic content, flavonoids, antioxidant activity, and chlorophyll

pigments with good preservation of the carotenoid content. © 2020 Taylor & Francis Group, LLC.

161. Mohammadpour, J., et al., Evaluation of Al2O3-Water nanofluid in a microchannel equipped with a synthetic jet using single-phase and Eulerian–Lagrangian models. International Journal of Thermal Sciences, 2021. 161.

The present work is focused on a novel cooling device consisting of a microchannel and nanofluid synthetic jet generated through the activation of membrane oscillation at frequencies (f) of 280, 420 and 560 Hz and five different amplitudes (A) ranging from 20 to 40 μm Al2O3 nanoparticles in the fluid domain are set at particle volume fractions (φ) of 2, 3 and 5% with diameter sizes of 50, 75 and 100 nm. The single-phase model (SPM) and Eulerian-Lagrangian (DPM) model are applied and compared to examine the fluid flow and heat transfer enhancement followed by validation against experimental data. Parametric studies reveal that the best heat transfer enhancement is found at a setting of φ = 2% and an oscillating frequency of 560 Hz with an amplitude of 30 μm for nanoparticles 100 nm in size. Comparison between SPM and DPM shows that there is an over-prediction of heat transfer enhancement in the SPM while DPM cooling is more realistic through the consideration of different forces acting on the particles and base fluid. The thermophoresis force is identified as the most significant force contributing to the heat transfer coefficient. It is further concluded that better heat transfer enhancement is achieved through the adoption of smaller particle diameters and higher oscillation membrane frequencies. © 2020 Elsevier Masson SAS

162. Luan, C., et al., Influence of pulse-spouted infrared freeze drying on nutrition, flavor, and application of horseradish. Drying Technology, 2021. 39(9): p. 1165-1175.

Horseradish is a herb with a special pungent flavor. The objective of this research is to examine the effect of pulse-spouted infrared freeze drying (PSIRFD) on the nutritional value, flavor and application of horseradish. Several key product quality parameters were compared with those of samples dried by hot air drying (HAD), infrared-assisted hot-air drying (IRHAD), and freeze drying (FD). PSIRFD samples displayed similar color to that of the freeze dried samples. FD sample had higher total phenolics content (TPC; 22.71 mg GAE/g) as well as ascorbic acid content (4.32 mg/100 g). The content of isothiocyanates (ITCs) was the highest in PSIRFD samples, accounting for 97.44%

of the total volatile compounds. PSIRFD can not only retain good flavor and taste, but also reduce the drying time and energy consumption. Horseradish paste made from PSIRFD samples was observed to possess the best DPPH scavenging ability, mellow taste, and higher viscosity. © 2020 Taylor & Francis Group, LLC.

163. Liu, W., et al., Innovative hybrid strategy for efficient production of high-quality freeze-dried instant noodles: Combination of laser with leavening agent. Innovative Food Science and Emerging Technologies, 2021. 73.

The present study was carried out to improve the drying efficiency and quality of freeze-dried instant noodles by a novel hybrid pretreatment method that combines laser puncturing along with use of a leavening agent mixture. The influence of several variants of this combined treatment on drying time, energy consumption, rehydration behavior and pasting properties of dried noodles as well as the quality parameters of soaked noodles were examined. Results demonstrate that the intervention of laser puncturing treatment and the addition of leavening agent mixture are all positive on reducing drying time and energy consumption of noodles, but the drying enhancement effect of puncturing treatment is better. Combining laser puncturing treatment with leavening agent mixture can further reduce drying time of noodles by up to 34.15% and energy consumption by up to 33.17%. Although all single treatment methods can improve the quality of products including soaking time, rehydration rate and hardness, the effect is unsatisfactory. Hybrid strategies are found to have a synergistic effect on the production of high-quality freeze-dried instant noodles and according to the sensory evaluation results, the optimum conditions are as follows: 0.1 mm perforation diameter, 10 mm spacing between perforations, 2 mm depth and 3% leavening agent mixture (on flour basis). Industrial relevance: Difficult rehydration of products and high energy consumption of the production process are the key issues that limit the industrial production of freeze-dried instant noodles. Laser puncturing treatment and adding a leavening agent mixture can increase the contact area between freeze-dried noodles and water and enrich the internal porous structure of freeze-dried noodles, respectively, which promotes the mass production of high-quality freeze-dried instant noodles. © 2021 Elsevier Ltd

164. Liu, W., et al., Effects of chitosan coating on freeze-drying of blueberry enhanced by ultrasound pre-treatment in sodium bicarbonate medium. International Journal of Biological Macromolecules, 2021. 181: p. 631-643.

Sodium bicarbonate medium ultrasound pre-treatment can enhance the freeze-drying process of blueberries, but the quality of dried products cannot meet the actual production needs. To yield higher quality products, chitosan coating was applied in blueberry sodium bicarbonate medium ultrasound pre-treatment enhanced freeze-drying process. The improvement effect of different chitosan coating methodologies on the procedure of blueberry freeze-drying, enhanced by ultrasound pre-treatment in sodium bicarbonate medium, was investigated. These include: chitosan solution soaking alone (CH-A), chitosan medium ultrasound treatment (US-CH), first sodium bicarbonate medium ultrasound treatment then chitosan solution soaking (US-NaHCO3 + CH) and first sodium bicarbonate soaking followed by chitosan medium ultrasound treatment (NaHCO3 + US-CH). While the treatments that presoaking in sodium bicarbonate solution (NaHCO3-A), water medium ultrasound treatment (US-W) and sodium bicarbonate medium ultrasound treatment (US-NaHCO3) were used as the control groups. Results demonstrated that ultrasound treatment and sodium bicarbonate soaking have positive effect on improving the freeze-drying characteristics of blueberries, while chitosan coating has a negative effect. Chitosan coating has a significant effect on strengthening limit effect of blueberry skin on juice overflow and weakening moisture absorption capacity of dried blueberry. US-NaHCO3 + CH pretreatment yielded the best results for blueberry freeze-drying. © 2021 Elsevier B.V.

165. Kaimal, A.M., A.S. Mujumdar, and B.N. Thorat, Resistant starch from millets: Recent developments and applications in food industries: Resistant starch from millets. Trends in Food Science and Technology, 2021. 111: p. 563-580.

Background: Resistant starch (RS) has been unanimously identified as a replacement for dietary fiber due to its balanced nutritional functionality and sensory implications. Main source of resistant starch is presently from tubers and cereals. However, on the basis of dependence on resource intensiveness, these crops were questioned recently and a necessity of shifting starch source to a sustainable source was highlighted. This resulted an increase in interest for millet sourced RS, lately. Recently, this fact attracted research community's attention and numerous studies have been reported. However, a

literature compiling the recent developments and highlighting the importance, opportunities of RS sourced millets as a cereal replacement is limited. Scope and approach: This review is focused on comprehending the recent developments and food application of millet RS. Starch profile of different millets and influence of different millet and various unit operations in millets RS formation has been also conferred. Research prospects and importance of millet RS in meeting future RS demand sustainably is highlighted. Commercial viability of high RS millet flour and conventional corn RS has been evaluated. Key Findings and Conclusion: Millets is a sustainable raw-material for RS manufacturing and a potential replacement to cereals. The inherent nutraceutical functionality and climatic tolerance gives millets an edge over cereals. Thermal and chemical treatments are efficient manufacturing processes for millet RS. Influence of millet protein and fat could increment the RS content. The versatility of millet RS permit multiple food applications. © 2021

166. Islam, M., M. Zhang, and A.S. Mujumdar, Low temperature vacuum frying of edamame assisted by ultrasound and microwave: Effects on the kinetics of oil and product storage properties. Drying Technology, 2021. 39(5): p. 608-619.

Ultrasonic microwave-assisted vacuum frying (USMVF) process was investigated to achieve better process efficiency and shorten the frying time and improve the quality of fried edamame at lower frying temperature. Kinetics of oil uptake in vacuum frying (VF), microwave-assisted vacuum frying (MVF) and USMVF samples was investigated. It was studied applying an empirical kinetic model in order to fit the oil content during frying. The first order model fitted properly the values of oil uptake during VF, MVF, and USMVF. For all the studied conditions of the model, the specific rate increased with the application of microwave and ultrasound and frying temperature, however the equilibrium oil content decreased with the application of microwave and ultrasound and frying temperature. The USMVF samples are the least temperature sensitive with an activation energy of 15.92 kJ/mol, while for MVF and VF it was 18.80 kJ/mol and 20.76 kJ/mol. The changes in moisture content, oil content, water activity, and vitamin C and chlorophyll retention of USMVF edamame at selected storage temperatures (0, 10, and 25 °C) were studied during a storage period of 6-months. Vitamin C and chlorophyll content retention was 72% and 80%, at the storage

temperature of 10 °C and, 54% and 73% at 25 °C respectively. © 2019 Taylor & Francis Group, LLC.

167. Gao, Y., Et Al., Experimental Investigation Of Specific Heat Of Aqueous Graphene Oxide Al2o3 Hybrid Nanofluid. Thermal Science, 2021. 25(1 Part B): P. 515-525.

The specific heat of aqueous graphene+Al2O3 (1:1) hybrid nanofluid was measured using the cooling method. The influence of nanoparticle mass fraction and temperature on the specific heat capacity of the hybrid nanofluids was investigated, the specific heat of the hybrid nanofluid was compared with that of aqueous graphene oxide nanofluid and Al2O3 nanofluid. A fitted formula of the specific heat of the hybrid nanofluid was proposed based on the experimental data. It indicates that the specific heat reduction ratio increases with increase of nanoparticle fraction and the maximum reduction ratio is 7% at 0.15 wt.% at 20 °C. The mass fraction of nanoparticle affects the specific heat of hybrid nanofluid more significantly at lower temperature. Temperature impacts the specific heat more distinctly than the nanoparticle fraction. The specific heat increases with temperature and the maximum specific heat reduction ratio of the hybrid nanofluid diminishes from 7% at 20 °C to 2% at 70 °C at the mass fraction of 0.05%. © 2021. Society of Thermal Engineers of Serbia.

168. Feng, C., et al., Effect of drying method on post-processing stability and quality of 3D printed rose-yam paste. Drying Technology, 2021. 39(9): p. 1196-1204.

The addition of rose pollen to the yam paste for 3D printing could not only meet consumers' needs for nutrition and health, but also provide a new way to achieve personalized customization of healthy food. In this work, the rose-yam paste was selected as material, by comparing the post-treatment shape and color stability, bioactive substance content and hardness to explore the effect of hot air drying (HD), microwave vacuum drying (MVD) and freeze drying (FD) on the stability and quality of printed products. FD products illustrated the best post-processing stability, while HD products were the worst. FD products had a higher anthocyanin retention rate of 72.45% and a higher total phenol content of 31.33 mg/100g. However, FD products showed the lowest hardness. Although MVD products showed lower sensory score in appearance and color than FD products, their flavor score was higher than FD products, and the total sensory score of MVD products was equivalent to FD products. Moreover, MVD

illustrated the highest drying efficiency, and a reduction of 84% drying time was obtained when compared with FD. Therefore, the combination of MVD and 3D printing could obtain the best quality products. This study would provide useful information on the development of post-processed high value-added 3D printed products, especially for the bio-active substances. © 2020 Taylor & Francis Group, LLC.

169. Fan, H., et al., Effect of different drying methods combined with fermentation and enzymolysis on nutritional composition and flavor of chicken bone powder. Drying Technology, 2021. 39(9): p. 1240-1250.

Chicken bone powder was dried by using spray drying (SD), hot air drying (AD), freeze drying (FD), and infrared freeze drying (IFD) in this study. Nutritional composition, antioxidant property, physical property, energy consumption, and flavor were compared, respectively. The results demonstrated that IFD powder had the highest content of amino acid nitrogen (49 mg/100 g). And in terms of polypeptide content, IFD and FD powder showed no significant difference, were obviously higher than AD and SD powder. As for antioxidant property, IFD and FD powder had higher DPPH and ·OH scavenging capacity than AD and SD powder. In addition, IFD powder had the highest L* value (74.59) and SD powder had the lowest L* value (65.35), which was consistence with the result of appearance score. Concerning flavor and sensory evaluation, IFD powder showed the highest umami value (11.85) and acceptability score (52.52) among four drying methods. Besides, the typical E-nose sensors response values of the IFD powder were closest to those of the enzymatic hydrolysate before drying and SD powder had the highest response value in all sensors. Finally on the basis of energy consumption, SD showed the minimum drying time and energy consumption. © 2021 Taylor & Francis Group, LLC.

170. Devi, S., M. Zhang, and A.S. Mujumdar, Influence of ultrasound and microwave-assisted vacuum frying on quality parameters of fried product and the stability of frying oil. Drying Technology, 2021. 39(5): p. 655-668.

Vacuum frying (VF), which combines sonication, with microwave heating was used to evaluate the quality attributes of fried mushroom chips as well as the stability of the frying oil. Frying was performed at 90 °C, 0.015 MPa, 1000 W microwave power input at two ultrasound power levels. Mushroom (Agaricus bisporus) chips were fried using

four frying conditions, namely: VF, microwave vacuum frying (MVF), 300 W ultrasound-assisted MVF (300UMVF), and 600 W ultrasound-assisted MVF (600UMVF). The fried samples were evaluated in terms of their moisture content, oil content, protein content, bioactive compounds (total phenolic compound, total flavonoid compound), and color characteristics. The 600UMVF sample required less processing time to reach at the same final moisture content. The oil content was also found to be lower in the high-power sonicated sample. The contents of protein, total phenolic compound, and total flavonoid compound in the fried mushroom chips (FMC) were preserved to a greater extent by the ultrasound treatment. All fried samples displayed natural color; the best result found for the 600UMVF sample. UMVF was found to delay oil deterioration by enhancing its oxidative stability. Microstructure observations revealed that the cell structure of the fried sample is preserved better by the ultrasound treatment. The findings of this work show that sonication-enhanced frying minimizes the loss of nutrients, bioactive compounds, and preserves the color of the original sample. © 2019 Taylor & Francis Group, LLC.

171. Deng, L.Z., et al., Thermal Decontamination Technologies for Microorganisms and Mycotoxins in Low-Moisture Foods. Annual Review of Food Science and Technology, 2021. 12: p. 287-305.

The contamination risks of microorganisms and mycotoxins in low-moisture foods have heightened public concern. Developing novel decontamination technologies to improve the safety of low-moisture foods is of great interest in both economics and public health. This review summarizes the working principles and applications of novel thermal decontamination technologies such as superheated steam, infrared, microwave, and radio-frequency heating as well as extrusion cooking. These methods of decontamination can effectively reduce the microbial load on products andmoderately destruct the mycotoxins. Meanwhile, several integrated technologies have been developed that take advantage of synergistic effects to achieve the maximum destruction of contaminants and minimize the deterioration of products. © 2021 Annual Reviews Inc.. All rights reserved.

172. Chen, K., et al., Quinoa protein-gum Arabic complex coacervates as a novel carrier for eugenol: Preparation, characterization and application for minced pork preservation. Food Hydrocolloids, 2021. 120.

Minced pork is prone to quality deterioration during storage. To maintain the quality of minced pork for longer time, eugenol encapsulated multi-core microcapsules were developed using quinoa protein (QP) and gum Arabic (GA) as wall materials via complex coacervation. The optimum conditions for the formation of QP-GA coacervates were determined as pH 4 and a QP-GA mixing ratio of 4:1. The optimally produced eugenol microcapsules were found to possess multi-core structure with an average particle size of 29.53 μm. Fourier transform infrared (FTIR) analysis further proved existence of electrostatic interaction between QP and GA, and formation of hydrogen bonds between eugenol (core material) and coacervates (shell material). After freeze drying, the eugenol microcapsules were studied on encapsulation yield (EY), encapsulation efficiency (EE), payload (PL), thermal stability, and release behavior. The results revealed the high EY (94.27%), EE (88.60%), and PL (60.33%) of eugenol microcapsules, while eugenol showed good thermal stability and release property after microencapsulation using QP and GA. Moreover, the eugenol microcapsules were found to be more effective in inhibiting the increases in pH, total volatile basic nitrogen (TVB-N), and total bacterial counts (TBC) than free eugenol and prolonged the shelf life of minced pork to 9 days at 4 °C, which suggested its good application prospect in meat preservation. © 2021 Elsevier Ltd

173. Chen, K., et al., Edible flower essential oils: A review of chemical compositions, bioactivities, safety and applications in food preservation. Food Research International, 2021. 139.

In the context of consumers' growing concerns and boycotts of artificial and harmful chemicals, satisfying the demands for good-quality food products possessing clean and safe images is a challenge for food industry. Due to natural and avirulent images, various bioactivities as well as potentials to be used as safer substitutes for chemical preservatives, flower essential oils (EOs) have aroused increasing interests in the recent past. Many literatures have verified the biological activities of flower EOs, and have given high value to the preservative potentials of flower EOs in food systems. In this work, a review is done on the most recent publications associating the chemical constituents, bioactivities (antibacterial, antifungal, antioxidant and anti-pest abilities)

and safety of flower EOs. The effects of flower EOs on food flavor are also discussed. Finally, the current combined preservation applications of flower EOs and other technologies are summarized. © 2020 Elsevier Ltd

174. Chen, F., et al., Comparative analysis of composition and hygroscopic properties of infrared freeze-dried blueberries, cranberries and raspberries. Drying Technology, 2021. 39(9): p. 1261-1270.

The nutrient and antioxidant content in blueberries were significantly higher than cranberries and raspberries, except crude fiber. Fourier infrared spectroscopy was used to characterize quantitatively the differences in the composition of the tissues of three berries viz., blueberries, cranberries, and raspberries. The three berries have 10 characteristic common peaks in the 400–4000 cm−1 range. The specific differences in three berries were characterized by comparing the relative absorption intensities and the second derivative spectra. The results of the comparison of the relative absorption intensity showed that there were significant differences between the values of three berries at the two peak positions of A 3406/A 2927 and A 1057/A 2927. Furthermore, thermogravimetric (TG) analysis was employed to establish for the three berries' TG% and DTG thermal analysis map. While the dynamic vapor sorption was used to measure for infrared freeze-dried samples of the berries the moisture content, the results showed that the adsorption isotherm of berries was III, and there was a moisture sorption hysteresis. © 2021 Taylor & Francis Group, LLC.

175. Chen, C., et al., Investigation of 4D printing of lotus root-compound pigment gel: Effect of pH on rapid colour change. Food Research International, 2021. 148.

The feasibility was investigated of 4D printing of lotus root gel compounded with a pigment that responds to pH change and alters colour. The pigment comprised of a combination of anthocyanins and lemon yellow; it was used in gel preparation for printing. The flowability and self-support properties of the lotus root-pigment gel were studied to evaluate its 3D printing performance. The gel viscosity decreased with the increase of printing temperature over the range 40, 50, and 60 °C. The gel with a ratio (lotus root powder/compound pigment) of 0.35 extruded smoothly and maintained high formability at temperatures below 60 °C. The pH response of compound pigment enabled the printed sample to change colour from reddish/yellowish to green after spraying with NaHCO3. The a* and b* values decreased significantly (p < 0.05) after

spraying for 1 min. The gel with ratios of 0.30 and 0.35 achieved rapid colour change both superficially and internally. Through several different model designs (apple, Christmas tree, letters, and Chinese characters), high-quality 4D printing could be realized without problem. Thus, lotus root gel can be mixed with suitable pigments in correct proportion for 4D printing at appropriate temperature to ensure good flowability. © 2021 Elsevier Ltd

176. Chavan, A., et al., Natural convection and direct type (NCDT) solar dryers: a review. Drying Technology, 2021. 39(13): p. 1969-1990.

Solar drying is one of the most beneficial and sustainable technologies benevolent to our society. In this paper, comprehensive review of various designs of natural convective and direct type (NCDT) of solar dryers has been brought forward for the simple reason of collating the desired and the most intriguing state of the art of practicing of solar drying technology for the benefit of one and all. Further, the comparison of performance of existing dryers was attempted based on parameters such as design simplicity, capital cost, compactness, portability, thermal performance, and other equally important parameters contributing to the dried product quality attributes. The dryers utilize convection and radiation as a major heat transfer mechanism. Solar dryer based on the conduction mechanism appears to be more efficient and cost-effective. In our opinion, inclusion of the conduction mechanism amongst the prevalent solar dryers will only lead to further consolidation of solar drying technology. The work done by the authors on their innovative solar conduction dryer is also highlighted and its performance compared with the rest of the reported designs of NCDT dryers. © 2020 Taylor & Francis Group, LLC.

177. Chaedir, B.A., et al., Advances in dewatering and drying in mineral processing. Drying Technology, 2021. 39(11): p. 1667-1684.

In mineral processing, dewatering and drying are critical aspects from the technical and economical viewpoints. These operations should be considered carefully to achieve optimal water/moisture removal with minimal energy consumption. Various mineral dewatering and drying technologies have been proposed and numerous studies on their operations/performances have been reported. The existing dewatering and drying units were generally designed empirically based on conventional technologies. Meanwhile,

information on recent developments and guidelines for efficient and sustainable design of dewatering and drying units are widely dispersed creating difficulties to harness important new knowledge. This article is prepared with the main objective of providing a concise yet comprehensive overview of the progress in mineral dewatering and drying with special focus on technologies in mineral dewatering and drying developed over the last decade. Furthermore, a brief discussion of future research needs and opportunities is included from the industrial perspective. © 2021 Taylor & Francis Group, LLC.

178. Bhatkar, N.S., et al., Drying of tomatoes and tomato processing waste: a critical review of the quality aspects. Drying Technology, 2021. 39(11): p. 1720-1744.

Tomatoes are a valuable highly perishable agricultural product that are dried on a large scale for extending shelf life. The drying of both tomatoes and tomato processing waste can yield valuable products. The dried forms serve as raw material for different commercial products, as an ingredient for functional foods. It is also used all over the world for direct consumption. However, the production of dried forms with quality attributes equivalent to those of fresh tomatoes such as the nutrient content, appearance, flavor, texture, reconstitution properties etc. are major challenges. This paper provides an overview of the diverse drying techniques employed along with the effects of pretreatment to produce dried tomatoes, powders, and various by-products of tomato processing industries. A comparison is provided with regard to the quality of dried tomato products obtained by different drying techniques for lycopene content, ascorbic acid, β-carotene, total phenolic content, flavonoids, antioxidant activity, rehydration ratio, color change, texture, and flavor. © 2021 Taylor & Francis Group, LLC.

179. Azam, S.M.R., et al., Multi-frequency multi-mode ultrasound treatment for removing pesticides from lettuce (Lactuca sativa L.) and effects on product quality. LWT, 2021. 143.

This article presents the efficacy of multi-frequency (20, 40, and 60 kHz) multi-mode ultrasound treatment (MFMU) in sequential and simultaneous combination for the removal of abamectin b1 (AB), alphamethrin (AL), and emamectin benzoate (EB) from fresh lettuce surface. UHPLC-MS/MS was used to determine the effectiveness of the water wash and ultrasonic cleaning methods based on the pesticide reduction level. The

most effective treatment for removing the pesticides was found to be the triple-frequency sequential mode (TSQ), which removed 92.31, 89.36, and 95.25% of AB, AL, and EB, respectively, after 8 min of ultrasonication. The effects of ultrasound on the physiological and nutritional properties suggest that the TSQ treated lettuce quality is comparable to that of the water washed produce based on the total chlorophyll and total carotenoid contents. Scanning electron microscope observations reveal that TSQ results in the least lettuce surface damage. Furthermore, the studied optimal condition retained better overall color (ΔE) and greenish appearance than other treatments. The application of MFMU in a sequential mode to remove pesticide residues from lettuce is found to be a promising vegetable-cleaning method without compromising product integrity and quality. © 2021 Elsevier Ltd

180. Zielinska, M., et al., Review of recent applications and research progress in hybrid and combined microwave-assisted drying of food products: Quality properties. Critical Reviews in Food Science and Nutrition, 2020. 60(13): p. 2212-2264.

The growing concerns over product quality have increased demand for high quality dried food products and encouraged researchers to explore and producers of such products to implement novel microwave (MW)-assisted drying methods. This paper presents a critical review of the key principles and drawbacks of MW-assisted drying as well as needs for future research. In this article, recent research into application of microwaves as an alternative heat source, applications and progress in hybrid MW-assisted drying that rely on various drying media and combined two or three stages of MW-assisted drying for the preservation of food products is reviewed critically. The effect of different MW-assisted drying methods, conditions and initial pretreatments on the thermophysical properties, color, nutritional value and rehydration potential of dried food products is discussed in detail along with the discussion on how the material properties evolve and change in structure, color, and composition during MW-assisted drying and recent attempts at mathematical modeling of these changes made for different fruits and vegetables. It should be noted that most of the published results were obtained in laboratory-scale dryers. Pilot-scale testing is needed to bridge the gap between laboratory research and industrial applications to fulfill the potential for novel hybrid and combined MW-assisted drying methods and to expand their role in food processing. © 2019, © 2019 Taylor & Francis Group, LLC.

181. Yu, X.L., et al., Multistage relative humidity control strategy enhances energy and exergy efficiency of convective drying of carrot cubes. International Journal of Heat and Mass Transfer, 2020. 149.

Industrial drying is one of the most energy intensive unit operations encountered in most industrial sectors. Therefore, much effort has been devoted to energy savings in drying. Most methods applied to convective drying are based on heat recovery from dryer exhaust. However, there are major limitations on how much of the energy can be recovered cost-effectively. Here a new concept based on the relative humidity (RH) control of convective drying of carrot cubes was evaluated with the purpose of enhancing the energy and exergy efficiency of drying. Numerical simulations of heat and mass transfer were performed to investigate hot air drying behavior of carrot cubes. The model fitted well the moisture ratio and the material temperature data with average relative errors of 6.5% and 0.8%, respectively. Results show that both the energy loss caused by exhaust air and the irreversibility loss of thermodynamic process decreased with increase in RH of the drying medium from 4% to 40%. Multistage relative humidity control strategy improved both the drying rate and exergy efficiency. Among the tested schemes, the three-stage RH control strategy, i.e. (1) RH of 40% for 2 h, (2) RH of 20% for 2 h and (3) RH of 4% for 3.5 h was found to be the strategy with the highest exergy efficiency (53.3%). It was almost three times higher than that for constant 4% RH values. © 2019

182. Xiao, H.W. and A.S. Mujumdar, Importance of drying in support of human welfare. Drying Technology, 2020. 38(12): p. 1542-1543.

183. Wu, X.F., et al., Effect of ultrasound-assisted osmotic dehydration pretreatment on the infrared drying of Pakchoi Stems. Drying Technology, 2020. 38(15): p. 2015-2026.

The effect of ultrasound-assisted osmotic dehydration (UOD) prior to infrared drying (IR) on the drying time and quality properties of dried Pakchoi stems was studied. Results suggested that the ultrasound application could significantly increase the mass transfer during the osmotic process. The UOD pretreated samples showed higher relaxation times of T23 and lower relative signal intensities of A23 using low-field

nuclear magnetic resonance (LF-NMR) analysis. Moreover, the cell structural damage and mircrochannel formation caused by the UOD pretreatment resulted in a 25 ~ 42% reduction in drying time. Although, the chlorophyl and ascorbic acid contents of IR dried Pakchoi stems with UOD pretreatment were relatively lower in comparison with those of untreated samples, the color was better retained and the rehydration ratio was significantly improved by UOD pretreatments. © 2019 Taylor & Francis Group, LLC.

184. Wang, H., et al., High-humidity hot air impingement blanching (HHAIB) efficiently inactivates enzymes, enhances extraction of phytochemicals and mitigates brown actions of chili pepper. Food Control, 2020. 111.

In current work, high-humidity hot air impingement blanching (HHAIB) was employed to inactivate peroxidase enzymes (POD) of chili pepper under three independent variables, namely blanching temperature (105, 110, and 115 °C), relative humidity (20%, 30%, and 40%), and blanching time (30, 60, and 90 s). Response surface methodology (RSM) was used to optimize the blanching conditions based on product POD residual activity and browning index. Results indicated that blanching temperature of 110 °C, relative humidity of 40% and blanching time of 38 s were the optimum blanching conditions, which resulted in the minimum POD residual activity (0.52%) and browning index difference (7.09). Validation test showed that the predicted data had good agreement with the experimental data. Results also indicated that compared with the non-blanched samples, the extraction content of ascorbic acid and red pigment from blanched pepper under optimal blanching conditions increased by 42.85% and 8.20%, respectively. Ultrastructural observations explained why moderate blanching can promote the extraction of phytochemicals. The findings in current work indicate that HHAIB can efficiently inactivate enzymes, enhance extraction of phytochemicals and at the meantime mitigate brown actions under optimal conditions. © 2019 Elsevier Ltd

185. Verma, U., A. Mujumdar, and J. Naik, Preparation of Efavirenz resinate by spray drying using response surface methodology and its physicochemical characterization for taste masking. Drying Technology, 2020. 38(5-6): p. 793-805.

In the present study, taste masked drug–resin complex (DRC) of efavirenz (EFV) was prepared by spray drying technique. The DRC was then incorporated in to a fast

dissolving tablet dosage form. EFV is antiretroviral agent of very bitter taste and low oral bioavailability. To investigate the influence of the independent variables on encapsulation efficiency (EE) as well as on the bitter taste of EFV, response surface methodology was employed. Ion-exchange resin (tulsion-335) and amount of solvent were selected as the independent variables while the EE was selected as the dependent variable. DRC was characterized for EE, X-ray diffraction, particle size distribution, Fourier transform infrared spectroscopy, surface morphology, and in vitro dissolution study. The spectrophotometric method was used for the evaluation of bitter taste of EFV. The EE was found to be 37–84%. The compressed tablets were evaluated for the hardness, Friability, wetting time, disintegration time and in vitro drug release studies. This study confirmed that complexation of the drug with an ion-exchange resin can effectively mask the bitter taste of the drug in combination with production of fast dissolving tablets. © 2019, © 2019 Taylor & Francis Group, LLC.

186. Song, X.D., et al., Effect of drying air temperature on drying kinetics, color, carotenoid content, antioxidant capacity and oxidation of fat for lotus pollen. Drying Technology, 2020. 38(9): p. 1151-1164.

Hot air drying of lotus pollen at temperatures ranging from 40 to 70 °C was investigated experimentally. Results indicated that the whole drying process occurred in the falling rate period. Color analysis showed that lotus pollen suffered color deterioration. The antioxidant capacity decreased and the fat oxidation activity increased following drying. The carotenoid content exhibited significant loss when dried at 70 °C ($p < .05$). Zero-order, first-order, and fractional conversion models were employed to fit the experimental data for color profile, antioxidant capacity, and fat oxidation. The first-order fraction model can precisely describe the color change and the antioxidant capacity deterioration, while the kinetics of thiobarbituric acid reactive substances followed the linear model. There is a correlation between color, antioxidant activity, and fat oxidation. © 2019, © 2019 Taylor & Francis Group, LLC.

187. Shirkole, S.S. and A.S. Mujumdar, Facilitating drying R&D via critical review papers. Drying Technology, 2020. 38(14): p. 1817-1818.

188. Rajput, R.L., et al., Synthesis and evaluation of luliconazole loaded biodegradable nanogels prepared by pH-responsive Poly (acrylic acid) grafted Sodium Carboxymethyl Cellulose using amine based cross linker for topical targeting: In vitro and Ex vivo assessment. Polymer-Plastics Technology and Materials, 2020. 59(15): p. 1654-1666.

Fungal infection in immuno compromised patients causes skin syndromes and problems. At Present, innovative alternatives are required to cure skin disorders and infections. Luliconazole is a novel, broad spectrum, imidazole antifungal agent. The purpose of this study was to develop biodegradable, pH responsive, chemically cross-linked and Poly (acrylic acid) grafted sodium carboxymethyl cellulose nanogels. Nanogels had been synthesized to evaluate its applicability as an effective carrier of luliconazole for topical (skin) targeting. Chemically cross-linked sodium carboxymethyl cellulose-grafted-Poly acrylic acid (NaCMC-g-PAA) was synthesized from acrylic acid and sodium carboxymethyl cellulose using N, N'-methylene bisacrylamide (cross-linker) and potassium persulfate (initiator) using free radical polymerization. Variation of reaction parameters such as pH, cross linker, initiator and temperature has been used to optimize the best one. The developed nanogels reveal significant pH sensitive drug releasing behavior. NaCMC-g-PAA nanogels has been characterized using various physicochemical characterization techniques. Nanogels characteristics were evaluated through the In vitro drug release, Ex vivo permeation study, Nuclear magnetic resonance spectroscopy, Fourier Transform Infrared Spectroscopy, Field Emission Scanning Electron Microscope, Stability Study and antifungal activity. All batches were characterized for particle size analysis and ranged from 78.82 nm to 190 nm. The viscosity of developed nanogels was found to be 5941 cps. It was observed that the developed drug-loaded NaCMC-g-PAA nanogels were more effective in killing the fungus. Consequently, Nanogels incorporated with luliconazole could be a new approach with improved antifungal activity and increased topical delivery for a drug with poor aqueous solubility rather than coarse drug-containing cream. © 2020 Taylor & Francis.

189. Piacentini, R.D., I. Novara, and A.S. Mujumdar, Climate change and pandemics: New challenges for science and technology. Drying Technology, 2020. 38(11): p. 1391-1392.

190. Patil, J., et al., Generation of sustained release chitosan nanoparticles for delivery of ketorolac tromethamine: a tubular microreactor approach. International Journal of Polymeric Materials and Polymeric Biomaterials, 2020. 69(8): p. 516-524.

Sustained release ketorolac tromethamine (KT) loaded chitosan nanoparticles were generated using tubular microreactor with syringe pump. 32 full-factorial design was employed for the optimization of formulation parameters. The chitosan concentration (X1) and cross-linking agent concentration (X2) was designated as the independent variables while drug release (Y1) and encapsulation efficiency (Y2) was selected as dependent variables to achieve desired entrapment efficiency and sustained drug release. The obtained nanoparticles were evaluated for particle size, field emission scanning electron microscopy (FE-SEM), Fourier transform infrared spectroscopy (FT-IR), X-ray powder diffractometry (XRD), encapsulation efficiency and in vitro drug release study. Scanning electron microscopy of optimized run showed that the nanoparticles are spherical, and the particle size distribution of nanoparticles were found in the range of 164.2–255 nm. An encapsulation efficiency was obtained between 76% - 96%. Based on in-vitro drug release study, KT loaded chitosan nanoparticles exhibited sustained release action over a period of 12 h. An application of in-vitro drug release statistics to numerous kinetic equations designated that the diffusion (Higuchi model) of drug was responsible for drug release. © 2019, © 2019 Taylor & Francis Group, LLC.

191. Patil, G.K., et al., Effect of process parameters on the recovery of lactose in an antisolvent acetone/acetone-ethanol mixture: A comparative study based on sonication medium. Ultrasonics Sonochemistry, 2020. 67.

Recovery of lactose from the whey using sonocrystallization was studied experimentally. The effect of sonication medium and irradiation power levels was evaluated using three different ultrasonic equipments. Effects of various parameters such as sonication time, pH of the medium, antisolvent (acetone and acetone-ethanol mixture) and concentration of lactose were determined. The optimal parametric conditions were analyzed using differential scanning calorimetry, thermogravimetric analysis, particle size distribution, and zeta potential measurements. Overall, the highest lactose recovery was obtained using a mixture of acetone and ethanol as antisolvent in bath sonication as well as atomization process. © 2020

192. Pardeshi, S., et al., Preparation and characterization of sustained release pirfenidone loaded microparticles for pulmonary drug delivery: Spray drying approach. Drying Technology, 2020. 39(3): p. 337-347.

Pirfenidone (PFD) is a drug of choice for the treatment of idiopathic pulmonary fibrosis. For the preparation of sustained release microparticles of PFD, Ethyl cellulose (EC 300) with Eudragit RS 100 in combination was used as encapsulating agents. The 3-level 2-factorial design was employed for the design of experiments (DoE). The spray dried microparticles were studied for their particle size distribution, surface topography, drug entrapment, in-vitro drug release, and aerodynamic performance. Compatibility between drug and excipients were evaluated by Fourier Transform Infrared (FTIR) Spectroscopy and Differential Scanning Calorimetry (DSC). Particle morphology and size distribution were performed using Field Emission Scanning Electron Microscopy (FESEM) and Dynamic light scattering (DLS). The average particle size of the optimized PFD loaded formulation was found to be 3.99 μm. The surface topography study of the optimized formulation showed that the microparticles are nearly spherical with a smooth surface. In addition, the in-vitro aerosol performance was studied by Anderson cascade impactor and developed microparticles showed favorable aerodynamic performance (MMAD 4.25 μm) with narrow particle diameter distribution (GSD 1.52), therefore developed microparticles can be used as a dry powder for inhalation (DPI) for the targeted delivery to the lungs. In conclusion, sustained release microparticles of PFD were successfully prepared by the spray drying technique. © 2020 Taylor & Francis Group, LLC.

193. Naik, J.B., et al., Mucoadhesive Micro-/Nano Carriers in Ophthalmic Drug Delivery: an Overview. BioNanoScience, 2020. 10(3): p. 564-582.

The eye is a challenging organ for ophthalmic drug delivery due to the barriers associated with the anterior and posterior segments like nasolacrimal drainage, blinking, induced lacrimation, impermeability of corneal epithelial membrane, and blood-ocular barrier. Although there are conventional approaches, such as eye drop, ointment, suspension, implants, and injection, they suffer from limitations of low bioavailability, poor patient compliance (due to invasive approach and repeated dosing), and potential for several side effects. This review explored the various

mucoadhesive polymers, derivatized polymers, and different modification methods for such polymer derivatization (via carboxymethylation, thiolation, and quaternization) for their effective drug delivery toward ophthalmic application. Various types of micro and nanoparticulate systems of such derivatized mucoadhesive polymer-based carriers have been also exemplified and discussed here for their improved medicinal efficacy. To address the issues associated with conventional ophthalmic formulations, mucoadhesive drug delivery has been proposed. The emerging technologies play an important role in the development of more efficient mucoadhesive carriers obtained by derivatization or modification of core polymers with various functional groups such as carboxymethyl, amine, and new generation thiols. Mucoadhesive polymers form bonding with mucin (hydrogen, covalent, electrostatic bonding, etc.) and enhance corneal residence time and cellular uptake of the drug. Mucoadhesive carriers are designed to associate with the micro and nanoparticulate systems to overcome the ocular barriers with improved therapeutic efficacy. © 2020, Springer Science+Business Media, LLC, part of Springer Nature.

194. Mujumdar, A.S. and M.W. Woo, Effects of electric and magnetic field on freezing, in Drying Technologies for Biotechnology and Pharmaceutical Applications. 2020, wiley. p. 283-301.

The freeze-drying process is commonly used in the preservation of food, biologicals, and pharmaceutical materials. The premise of the effect of magnetic and electric field on the freezing process is that water consists of dipole molecules. When an electric or magnetic field is applied to water, the dipole behavior will cause the molecules to rotate with the negative end of the molecule toward the positive end of the magnetic or electric field. Depending on how the field is applied, this can then be used to manipulate the structure of the water in the liquid state as well as during the formation or solidification of water. The freezing-drying process also consists of the lyophilization process in which the ice crystals are sublimed under vacuum. This chapter also focuses on how the electric and magnetic field can affect the sublimation stage in the freeze-drying process. © 2020Wiley-VCH Verlag GmbH & Co.

195. Mujumdar, A.S., Tribute to late professor Czesław Strumiłło: Dedicated educator, outstanding researcher, conscientious mentor, and exceptional human being. Drying Technology, 2020. 38(1-2): p. 2.

196. Mujumdar, A.S., Editorial. Drying Technology, 2020. 38(15): p. 1957.

197. Mounir, S., et al., Instant controlled pressure drop (DIC) coupled to intermittent microwave/airflow drying to produce shrimp snacks: Process performance and quality attributes. Drying Technology, 2020. 38(5-6): p. 695-711.

Effects of operating parameters of the instant controlled pressure drop (DIC) texturing process followed by intermittent microwave (MW) and airflow drying were studied for the manufacture of novel swell-dried shrimp snacks. The DIC processing parameters were the absolute pressure of saturated steam (P = 0.4, 0.55, and 0.7 MPa) and the treatment time (t = 70, 100, and 130 s). Intermittent MW drying with active time tON of 30 s and tempering time tOFF of 60 s followed DIC-texturing of blanched shrimp samples (30 g cubes of 1 cm3). The MW density power (Formula presented.) levels tested were 6, 12, and 24 W/g wb (wet basis). The airflow condition was fixed at 3.2 m/s, 20 °C, and 276 Pa water vapor pressure. Drying performance along with the organoleptic, structural, and functional quality parameters was measured for the dried product. The results showed that the highest DIC processing parameters of P = 0.7 MPa for 170 s were the best texturing conditions, while the MW power level of 24 W/g wb yielded the most effective drying performance when 90% of moisture was removed in 10 min, with organoleptic quality attributes and structural properties better than those of conventionally dried shrimp. Furthermore, the aroma was better preserved, and the exceptionally high absolute expansion ratio (Ɛabs = 13.84) and porosity (φ = 92.83%) allowed enhancement of the desired crispness of the snacks as well. The highly porous microstructure also results in improved rehydration performance. © 2019, © 2019 Taylor & Francis Group, LLC.

198. Li, J., et al., Performance evaluation of mass transport enhancement in novel dual-channel design of micro-reactors. Heat and Mass Transfer/Waerme- und Stoffuebertragung, 2020. 56(2): p. 559-574.

Various design configurations of semi-T-shaped dual-channel micro-reactors were numerically examined for their laminar mass transport performance in heterogeneous catalytic combustion of methane and air. One single-channel and five dual-channel configurations (i.e., parallel, divergent, convergent, zig-zag, and curved configurations) were investigated with a two-dimensional computational fluid dynamics model. These innovative design configuration were compared in terms of CH4 utilization, pressure drop, CO/CO2 ratio, catalyst utilization, and a performance index at various Reynolds numbers. Dual-channel micro-reactors were found to enhance mass transport due to the well mixed flow and the increased reaction contact area. By suitably modifying the dual-channel layout angle and shape, recirculation zones can be formed within the reactor which increase CH4 utilization. However, the improved conversion rate is achieved at the cost of high pressure drop. The parallel dual-channel design provides the highest conversion per unit pressure drop over the range of the Reynolds numbers studied. For Reynolds numbers of 20 and 40, compared to the single-channel micro-reactor, divergent, convergent and curved channel designs yield higher conversion per unit pumping power. However, further increase of Reynolds number (i.e., 60, 80, and 100) deteriorates their performance due to the significantly increased pressure drop and shorter residence time. © 2019, Springer-Verlag GmbH Germany, part of Springer Nature.

199. Ju, H.Y., et al., Step-down relative humidity convective air drying strategy to enhance drying kinetics, efficiency, and quality of American ginseng root (Panax quinquefolium). Drying Technology, 2020. 38(7): p. 903-916.

As a measure to enhance drying kinetics, efficiency, and quality of the whole American ginseng root, step-down relative humidity (RH) convective hot air drying strategy was experimentally investigated. The effects of drying temperature (45, 50, 55, and 60 °C), RH (20, 30, and 40%), step-down RH, and continuous dehumidification, on hot air drying characteristics and quality attributes were examined. Results showed that the effective moisture diffusion coefficient varied from 1.155 × 10−10 to 2.885 × 10−10 m2/s while the activation energy was found to be 51.14 kJ/mol. Quality evaluation revealed that drying temperature, RH, and step-down RH had significant effect on color change. Additionally, the energy consumption was related to the drying time. The total ginsenosides content decreased with increasing drying temperature and decreasing RH.

Microstructure comparison showed that a gel layer was formed on the sample surface when dried at temperature of 60 °C, which impeded internal moisture diffusion. Based on evaluation of the drying time and quality, air temperature of 55 °C and RH of 40% holding 5 h and then dropping it to 20% were proposed as the best drying conditions for whole root. © 2019, © 2019 Taylor & Francis Group, LLC.

200. Jiang, Q., M. Zhang, and A.S. Mujumdar, UV induced conversion during drying of ergosterol to vitamin D in various mushrooms: Effect of different drying conditions. Trends in Food Science and Technology, 2020. 105: p. 200-210.

Background: Mushrooms are increasingly popular around the world as a nutritional food which is an excellent source of vitamin D2. Although natural mushrooms often contain very little vitamin D2 as many are grown in the dark, they are rich in ergosterol, a precursor to vitamin D2. Ergosterol can be converted to vitamin D2 under ultraviolet radiation. Due to the high water content of fresh mushroom, its quality deteriorates rapidly after harvest, and drying is the most commonly used technology to extend the shelf life. The vitamin D2 content of dried mushrooms depends on the drying conditions used. Scope and approach: In this review, the chemistry of the photo-conversion process of ergosterol to vitamin D2 under ultraviolet radiation is introduced. The ergosterol and vitamin D contents in different mushroom varieties are discussed. The effects of several drying methods and the influence of different drying conditions are reviewed. Key findings and conclusions: Thermal drying in the presence of UV has been proven to convert ergosterol into vitamin D and enhance the nutritional content of all types of edible mushrooms. Solar drying, hot air drying, freeze drying, microwave drying and infrared drying can be used for mushrooms drying under selected operating conditions. A critical evaluation of published literature demonstrates the importance of applying appropriate drying methodology to maximize the nutritional value of various types of edible mushrooms. © 2020 Elsevier Ltd

201. Jahangiri, S., et al., Numerical study of the oscillation amplitude effect on the heat transfer of oscillatory impinging round jets. Numerical Heat Transfer, Part B: Fundamentals, 2020. 79(2): p. 70-82.

In this study, the effect of oscillation amplitude on the pulsed impinging jets in different nozzle to surface distances and Reynolds numbers investigated. Generally, the heat

transfer increases by increasing frequency and amplitude. For distances smaller and longer than the length of the jet potential core the threshold frequency is highly dependent on the amplitude. As the amplitude increases, the threshold Strouhal number decreases, while for nozzle to surface distance near the end of the jet core the threshold Strouhal number is approximately independent from the oscillation amplitude and the Reynolds number and is about (Formula presented.) Also, although increasing the Reynolds number causes an enhancement in the threshold frequency, but in smaller amplitudes the heat transfer, increased relative to the corresponding steady jet. © 2020 Taylor & Francis Group, LLC.

202. Gao, Y., et al., Thermal conductivity and stability of novel aqueous graphene oxide-Al2O3 hybrid nanofluids for cold energy storage. Applied Sciences (Switzerland), 2020. 10(17).

Thermal ice storage has gained a lot of interest due to its ability as cold energy storage. However, low thermal conductivity and high supercooling degree have become major issues during thermal cycling. For reducing the cost and making full use of the advantages of the graphene oxide-Al2O3, this study proposes heat transfer enhancement of thermal ice storage using novel hybrid nanofluids of aqueous graphene oxide-Al2O3. Thermal conductivity of aqueous graphene oxide-Al2O3 nanofluid was measured experimentally over a range of temperatures (0-70 °C) and concentrations. Thermal conductivity of ice mixing with the hybrid nanoparticles was tested. The influences of pH, dispersant, ultrasonic power and ultrasonic time on the stability of the hybrid nanofluids were examined. A new model for the effective thermal conductivity of the hybrid nanofluids considering the structure and Brownian motion was proposed. The results showed that pH, dispersant, ultrasonic power level and ultrasonication duration are important factors affecting the stability of the hybrid nanofluids tested. The optimum conditions for stability are pH = 11, 1% SDS, 375 W ultrasonic power level and 120 min ultrasonic application time. The thermal conductivity of hybrid nanofluids increases with the increase of temperature and mass fraction of nanoparticles. A newly proposed thermal conductivity model considering the nanofluid structure and Brownian motion can predict the thermal conductivity of hybrid nanofluids reasonably well. © 2020 by the authors.

203. Devi, S., et al., Co-influence of ultrasound and microwave in vacuum frying on the frying kinetics and nutrient retention properties of mushroom chips. Drying Technology, 2020. 38(15): p. 2102-2113.

The frying kinetics (moisture loss rate and oil uptake rate) of an innovatively designed ultrasound and microwave-assisted vacuum frying (UMVF) system was investigated and the possibility of UMVF for reducing the nutrient losses during frying were evaluated in this work. The white button mushroom was the tested sample in this study. The chips were fried into two frying temperatures (80 and 90 °C), three different frying processes, vacuum frying (VF), microwave vacuum frying (MVF), and UMVF at a fixed vacuum pressure (12 ± 1 kPa). The first-order kinetic model was used for the mass transfer (moisture loss and oil uptake). Concerning the fitting performances, the logarithmic model and Pedrischi model showed the best-fitted model for moisture loss rate and for oil uptake respectively. Combining ultrasound and microwave in VF, the calculated moisture diffusivity rate was increased from 1.599 × 10−10 to 2.769 × 10−10 m2/s and oil uptake rate was decreased from 0.0121 to 0.0059 s−1. Total oil content (TOC) of fried mushroom chips (FMC) was quantified into two segments, surface oil (SO), and structure oil (STO) at a different time interval during frying. STO had the highest fraction of TOC and results revealed that UMVF had significantly low level of STO, which means UMVF helped to reduce the oil absorption during frying. In order to consider the nutrient retention values, UMVF exhibited the highest nutrition retention values. The exponential spectra of LF-NMR clearly revealed the water–oil distribution of FMC. © 2019 Taylor & Francis Group, LLC.

204. Deng, L.Z., et al., Recent advances in non-thermal decontamination technologies for microorganisms and mycotoxins in low-moisture foods. Trends in Food Science and Technology, 2020. 106: p. 104-112.

Background: Low-moisture foods (LMFs) are generally considered “lower risk” in terms of food safety, however, the frequent foodborne illnesses involved in the consumption of LMFs has heightened the public concern. The low aw environments also offer considerable protection against microorganisms. Meanwhile, the relatively high contamination risk of mycotoxins in low-moisture foods is a challenge for the food industry. Thermal decontamination techniques usually destroy heat-sensitive nutrients and lower product quality, and they are not adequate for mycotoxins detoxification. Therefore, developing non-thermal decontamination technologies to improve the safety

of LMFs is of great interest in both of economics and public health. Scope and approach: This review discusses the effects of non-thermal decontamination technologies, including ultraviolet and pulsed light, ionizing irradiation, cold plasma, and ozone, on microbial population and mycotoxin contents on LMFs. Furthermore, the working principles, applications, factors affecting processing efficacy and limitations of these decontamination technologies are summarized. The further research opportunities in commercialization are identified and discussed. Key findings and conclusions: Non-thermal decontamination technologies like UV and pulsed light, ionizing irradiation, cold plasma, and ozone have high potential as promising technologies for microbial inactivation and mycotoxin degradation for improving the safety and quality of LMFs. The operating conditions of the treatment, food property, species of microorganisms and mycotoxins are the major determinants affecting the processing efficacy. Further studies are recommended to evaluate the degradant toxicology and its interaction with food components, and particularly scaling-up the technology for commercial applications should be given more attention. © 2020 Elsevier Ltd

205. Deng, L.Z., et al., Hot air impingement drying kinetics and quality attributes of orange peel. Journal of Food Processing and Preservation, 2020. 44(1).

In the recent work, hot air impingement drying was employed to orange peel processing under different temperatures and its effects on drying kinetics and quality attributes of the orange peel were investigated. Results showed that the drying time of peels decreased from 150 to 75 min as the temperature increased from 50 to 70°C, and the Weibull model precisely described the drying kinetics. The total polyphenols, flavonoids, ascorbic acid (AA), and antioxidant capacity markedly decreased after drying. The total polyphenols, flavonoids, ascorbic acid (AA), and antioxidant capacity of the orange peel markedly decreased after drying. In the case of total flavonoids and color, no significant effect ($p > .05$) was observed for different drying temperatures. While, the water retention capacity decreased with increasing of drying temperature. The findings contribute to a better understanding of air impingement drying characteristics of orange peel and help to optimize drying conditions for the maximum preservation of its phytochemicals and antioxidant capacity. Practical applications: As the primary by-product of orange juice processing, orange peel is an excellent source

of physiochemical compounds, which take an important role in health promoting. However, it is often discarded as garbage as it rots easily and hard to preserve due to its high moisture content. Drying is an essential step for the preservation and utilization of peel waste. Several drying techniques have been applied for the dehydration of citrus by-products, such as sun drying, hot air drying, freezing drying, etc. But they are difficult to achieve the rapid and reliable industrial processing of peel waste. The findings of this work indicate that hot air impingement drying is a promising drying technique for orange peel and drying temperature of 65°C allowed the best preservation of polyphenols and ascorbic acid as well as the antioxidant capacity. © 2019 Wiley Periodicals, Inc.

206. Deng, L.Z., et al., Emerging chemical and physical disinfection technologies of fruits and vegetables: a comprehensive review. Critical Reviews in Food Science and Nutrition, 2020. 60(15): p. 2481-2508.

With a growing demand for safe, nutritious, and fresh-like produce, a number of disinfection technologies have been developed. This review comprehensively examines the working principles and applications of several emerging disinfection technologies. The chemical treatments, including chlorine dioxide, ozone, electrolyzed water, essential oils, high-pressure carbon dioxide, and organic acids, have been improved as alternatives to traditional disinfection methods to meet current safety standards. Non-thermal physical treatments, such as UV-light, pulsed light, ionizing radiation, high hydrostatic pressure, cold plasma, and high-intensity ultrasound, have shown significant advantages in improving microbial safety and maintaining the desirable quality of produce. However, using these disinfection technologies alone may not meet the requirement of food safety and high product quality. Several hurdle technologies have been developed, which achieved synergistic effects to maximize lethality against microorganisms and minimize deterioration of produce quality. The review also identifies further research opportunities for the cost-effective commercialization of these technologies. © 2019 Taylor & Francis Group, LLC.

207. da Silva Veloso, Y.M., et al., Hybrid phenomenological/ANN-PSO modelling of a deformable material in spouted bed drying process. Powder Technology, 2020. 366: p. 185-196.

In this work, a hybrid (phenomenological/ANN-PSO) model has been developed to simulate the spouted bed drying of deformable solid materials, considering material shrinkage and the physical property variation during drying. Accordingly, an artificial neural network (ANN) model has been coupled to a phenomenological one to describe the heat and mass transfer during the drying of these materials, specifically of guava pieces, in a spouted bed dryer. The optimum architecture of ANN (4–7-3) has been obtained using a Particle Swarm Optimisation (PSO) algorithm. This model demonstrated higher accuracy in its ability to estimate the material physical properties (R2 = 0.99, MSE = 0.00048 and RMSE = 0.069). Furthermore, a comparison between the model results and experimental data provided high correlation. This differs from the usual approach, which neglects variation of the physical properties; the hybrid model is able to simulate the drying deformable particle process behaviour considering the transient variation of the properties obtained from the ANN-PSO model. The results differ significantly from those predicted with the assumption of constant properties. © 2020

208. Chen, J., et al., Artificial intelligence assisted technologies for controlling the drying of fruits and vegetables using physical fields: A review. Trends in Food Science and Technology, 2020. 105: p. 251-260.

Background: Artificial intelligence (AI), which is characterized by ability to learn and adapt continuously, can enhance the fault tolerance and robustness in process control. Application of high-efficiency physical fields such as microwave, radio frequency, infrared radiation and ultrasonic fields can result in efficient production of dried fruit and vegetable products with high quality. Whether the combination of AI technology and efficient physical field can obtain better dried products of fruits and vegetables, and how AI can be applied in the drying process of fruit and vegetable, has attracted extensive attention. Scope and approach: The application of artificial intelligence technology to assist the efficient physical field in the drying of fruits and vegetables is the development trend of fruit and vegetable drying industry in the future. This paper aims to provide a concise overview of recent research in the rapidly emerging area of AI-assisted drying of fruits and vegetables using physical fields to provide energy for drying process. A selection of AI technologies is introduced such as sensor technology, computer vision systems as well as a few relevant AI technologies used in the drying

process of fruits or vegetables. Afterwards, it summarizes the application of artificial intelligence in the physical drying of fruits and vegetables, and how to improve the shortcomings of highly efficient physical field drying of fruits and vegetables with AI. Key findings and conclusions: The application of high efficiency physical field in the drying process of fruits and vegetables can solve the problems of large energy consumption, uneven drying, poor sensory evaluation, and large nutrient loss. The drying process and the corresponding drying model of fruits and vegetables can be detected and controlled online, and the optimum drying scheme can be determined using artificial intelligence technology. The most important thing is to make up for the shortcomings of highly efficient physical field drying of fruits and vegetables. The artificial intelligence technology has a promising application prospect to assist the efficient physical field drying of fruits and vegetables. © 2020 Elsevier Ltd

209. Amanor-Atiemoh, R., et al., Effect of simultaneous dual-frequency ultrasound aided ethanolic pretreatment on drying kinetics, bioactive compounds, antioxidant activity, and physicochemical properties of apple slices using pulsed vacuum dryer. Journal of Food Process Engineering, 2020. 43(11).

This work aims at investigating effect of different pretreatments and varied temperature on the drying kinetics, bioactive compounds, antioxidant activity, microstructure and functional group of apple slices using pulsed vacuum dryer. Pretreated apple slices (Ethanol, US + W, and US + E) dried at varied temperature (60, 70, and 80°C) were analyzed to determine total phenolic content (TPC), total flavonoid content (TFC), 1,1-diphenyl-2-picrylhydrazyl (DPPH+), 2,2-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid (ABTS+), color, microstructure and FT-IR spectroscopy. The findings revealed that US + E pretreatment significantly (p <.05) decreased drying time (20–33.33%). Activation energy and moisture effective diffusivity were 17.60–29.86 kJ/mol and 1.52–3.60 × 10−8 m2/s, respectively. Microstructure evaluation showed disruption of cells structure and microchannels formation but was more prominent in US + E pretreatment with noticeable larger pores and several microchannels. US + E pretreatment retained TPC (64.89–75.75 mg/100 g GAE dw), TFC (45.96–56.25 mg/100 g ER dw), DPPH+ (66.85–73.34%) and ABTS+ (62.58–71.17%) than Ethanol, US + W, and control and was further corroborated by the observed peaks as revealed by the FT-IR spectroscopy. Color (L*, a*, b*, whiteness) was better retained by Ethanol

and US + E pretreatments. US + E pretreatment decreased drying time and also preserved bioactive compounds, antioxidant activity and color of apple slices. Practical application: Apples are popularly consumed fruits and confer various nutritional and health benefits to humans. Drying is the most common approach for apple processing and shelf life extension. However, drying often leads to a reduction in quality parameters as well as degradation of nutritional components of the apple. Novel pretreatment techniques like ultrasonic aided ethanolic pretreatment preceding to apple drying provides an added advantage over conventional drying methods in that it reduces dehydration time as a result of faster moisture removal, lowers energy consumption, improves process efficiency leading to industrial competiveness and it also preserves the nutritional and sensorial parameters of dried apple slices. © 2020 Wiley Periodicals LLC.

210. Zhang, X.L., et al., Cold plasma pretreatment enhances drying kinetics and quality attributes of chili pepper (Capsicum annuum L.). Journal of Food Engineering, 2019. 241: p. 51-57.

Chili pepper is difficult to dry as the outermost surface is covered with an epicuticular wax layer, which hinders moisture transfer. Chemical dipping pretreatments and thermal blanching methods are often employed to enhance its drying process. However, chemical pretreatments hold the issues of chemical additives residue and thermal blanching methods tend to result in a high loss of bioactive compounds. Cold plasma is an ionized gas that contains different electrons, ions, and reactive neutral species. In current work, the feasibility of cold plasma as a non-thermal pretreatment technology for chili pepper drying is explored. The effects of different cold plasma pretreatment time (15, 30, 45, 60 s) on hot air drying kinetics and quality attributes of chili pepper, such as colour, red pigment retention, antioxidant activity, and microstructure were investigated. Results indicate that cold plasma can enhance the drying rate and the exposure time of 30 s achieves the optimum result. Microstructure observations show the existence of micro-holes, which explain how plasma treatment can enhance the drying kinetics. Quality attributes showed that the colour parameters had no significant changes under various treatment times. The retention of red pigment content was improved by plasma treatment of 30 s, whereas longer exposure times had a negative effect. The antioxidant activity of samples increased with the increase of cold plasma

exposure time. Results indicate that cold plasma is a promising pretreatment technology for chili peppers as it enhances drying kinetics and quality attributes of chili pepper. © 2018 Elsevier Ltd

211. Yu, X.L., H.W. Xiao, and A.S. Mujumdar, Heat and mass transfer simulation of intensification drying technologies: Current status and future trends, in Heat and Mass Transfer in Drying of Porous Media. 2019, CRC Press. p. 83-103.

212. Yu, X.L., et al., Experimental and simulation studies of heat transfer in high-humidity hot air impingement blanching (HHAIB) of carrot. Food and Bioproducts Processing, 2019. 114: p. 196-204.

A mathematical model was presented to characterise heat transfer in high-humidity hot air impingement blanching (HHAIB) of cuboid carrots. The model accounts for condensation heat transfer and predicts the sample's core temperature evolution with time. The simulation was performed at different relative humidity of 20%, 40%, 60%, 80% with constant temperature of 383 K. Results showed that the heat transfer process of HHAIB is divided into two stages based on vapor–liquid phase transition, namely a condensing heat transfer segment and a non-condensing heat transfer segment. In the initial stage of HHAIB, a comprehensive and intense condensation occurred on the sample surface leading to high heat transfer coefficient and greatly enhancing heat transfer, but at the same time creating a huge temperature gradient in the sample. The relative humidity of 40%–60% at 383 K could not only enhance the heat transfer rate but also improve the homogeneity of temperature distribution in the sample. Simulated core temperatures were compared with experimental measurements, showing good agreement with a coefficient of determination R 2 of 0.991. The findings of current work provide theoretical basis to better design and control of the process conditions of HHAIB as it elucidates the heat transfer characteristic taking account condensation phenomenon and illustrates the temperature distribution and evolution profiles. © 2019 Institution of Chemical Engineers

213. Xue, L., et al., Heating Control Technology of Vacuum Pulse Drying Based on Drying Uniformity. Nongye Jixie Xuebao/Transactions of the Chinese Society for Agricultural Machinery, 2019. 50(4): p. 317-325.

In order to solve the problem of non-uniformity of material drying caused by difference of heating plate and disturbance of air flow in vacuum pulse drying, a hardware circuit for controlling radiation intensity of heating plate based on zero-crossing trigger control was designed. The control circuit was designed as daisy-chaining connection mode to facilitate installation and expansion. Combining the theory of PID control with outlier detection method in data mining technology, an integral separation PID control strategy for temperature outlier optimization of heating plate was proposed. The control effect of the control system was validated by using the uniform moisture content of the patches as the test material and the uniformity of drying as the evaluation index. The experimental results show that the control system can effectively reduce the difference of radiation intensity between different heating plates. The average temperature control accuracy was ±0.8℃ and the initial transient time was 120 s. The surface temperature of heating plate can recover quickly after disturbed by air flow disturbance. In terms of drying uniformity, the outlier optimization integral separation PID control was superior to the heating plate independent PID control and the heating plates whole PID control. It can reduce the influence of air disturbance on drying uniformity and improve the drying uniformity of the patches from 90% to more than 95%. © 2019, Chinese Society of Agricultural Machinery. All right reserved.

214. Xu, P., A.P. Sasmito, and A.S. Mujumdar, Heat and mass transfer in drying of porous media. Heat and Mass Transfer in Drying of Porous Media. 2019: CRC Press. 1-210.

Heat and Mass Transfer in Drying of Porous Media offers a comprehensive review of heat and mass transfer phenomena and mechanisms in drying of porous materials. It covers pore-scale and macro-scale models, includes various drying technologies, and discusses the drying dynamics of fibrous porous material, colloidal porous media and size-distributed particle system. Providing guidelines for mathematical modeling and design as well as optimization of drying of porous material, this reference offers useful information for researchers and students as well as engineers in drying technology, food processes, applied energy, mechanical, and chemical engineering. © 2020 by Taylor & Francis Group, LLC. All rights reserved.

215. Xu, P., A.P. Sasmito, and A.S. Mujumdar, Preface. Heat and Mass Transfer in Drying of Porous Media, 2019: p. ix-x.

216. Xu, P., et al., Multiscale modeling of porous media, in Heat and Mass Transfer in Drying of Porous Media. 2019, CRC Press. p. 55-81.

217. Waghulde, M., et al., Production and evaluation of vildagliptin-loaded poly(dl-lactide) and poly(dl-lactide-glycolide) micro-/nanoparticles: Response surface methodology approach. Drying Technology, 2019. 37(10): p. 1265-1276.

A laboratory scale spray dryer was used to encapsulate vildagliptin (VLG), an antihyperglycemic drug, into different polymers such as poly(dl-lactide) (PDLA), poly(dl-lactide-glycolide)-50:50 (PLGA 50:50), and poly(dl-lactide-glycolide)-75:25 (PLGA 75:25). Response surface methodology (RSM) was employed to evaluate the effects of process and formulation factors on the encapsulation efficiency (EE). The physicochemical properties of the drug-loaded micro-/nanoparticles, mainly the drug loading (DL), particle size distribution, surface morphology, drug–polymer compatibility, and release rate were investigated. % EE of drug-loaded micro-/nanoparticles were in the range of 57.10% to 76.44%. PLGA50:50 micro-/nanoparticles showed highest EE as compared to PDLA and PLGA75:25 micro-/nanoparticles. The mean particle size of the micro-/nanoparticles containing PLGA 50:50, PLGA 75:25, and PDLA polymers were 428 nm, 640 nm, and 1.22 μm, respectively. Surface morphology study revealed smooth, spherical and nonporous surface structures of the micro-/nanoparticles. Fourier transform infrared spectroscopy studies confirmed the drug–polymer compatibility. Powder X-ray diffraction analysis of micro-/nanoparticles revealed that VLG was present in the amorphous form within the micro-/nanoparticles formulations. In vitro release study demonstrated that VLG is slowly released from micro-/nanoparticles for 12 h and the drug release rate was influenced by type and viscosity of polymers used. This work suggests that PDLA, PLGA 50:50, and PLGA75:25 polymers are able to sustain the VLG release rates from micro-/nanoparticles. © 2018, © 2018 Taylor & Francis.

218. Waghulde, M., A. Mujumdar, and J. Naik, Preparation and characterization of miglitol-loaded Poly (d, l-lactide-co-glycolide) microparticles using high pressure homogenization-solvent evaporation method. International Journal of Polymeric Materials and Polymeric Biomaterials, 2019. 68(4): p. 198-207.

Sustained release Miglitol-loaded poly (d, l-lactide-co-glycolide) (PLGA) microparticles were prepared using high pressure homogenization-solvent evaporation method. 2 3 full factorial design was employed to study effect of independent variables (X 1 -Polymer amount; X 2 -Surfactant concentration and X 3 -Homogenization Pressure) on percent encapsulation efficiency (%EE) as response. The microparticles produced were characterized for particle size, morphology, % EE, drug polymer compatibility and in vitro drug release. An average particle size of Miglitol-loaded PLGA microparticles was 230.1 nm and found almost spherical with smooth surface. % EE ranged from 58.7% ± 2.11 to 86.5% ± 0.24 depending on the polymer amount, surfactant concentration and homogenization pressure. An absence of chemical interaction between drug-polymer and reduction in % crystallinity of drug was confirmed by FTIR and X-ray diffraction analysis respectively. In vitro release studies showed a sustained release of Miglitol from microparticles up to 12 hrs. © 2018, © 2018 Taylor & Francis.

219. Wagh, P., A. Mujumdar, and J.B. Naik, Preparation and characterization of ketorolac tromethamine-loaded ethyl cellulose micro-/nanospheres using different techniques. Particulate Science and Technology, 2019. 37(3): p. 347-357.

Sustained-release micro-/nanospheres of the ketorolac tromethamine (KTC) were prepared using four different techniques viz., single emulsion solvent evaporation, high pressure homogenization, spray drying, and using a microreactor. Ethyl cellulose (EC) was used as an encapsulating agent for the preparation of sustained-release micro-/nanospheres of KTC. The Plackett–Burman design was employed for design of the experiments. The resulting micro-/nanospheres were characterized for their size, morphology, encapsulation efficiency, and in vitro drug release performance. Interactions between the KTC and EC were quantified by Fourier transform infrared (FTIR) spectroscopy and X-ray powder diffractometry (XRPD). Particle morphology characterization was performed using field emission scanning electron microscopy. The micro-/nanospheres showed encapsulation efficiency of 42.34–89.33% by the solvent evaporation technique, 76.36–91.13% by the high-pressure homogenization technique, 70.74–79.68% by spray drying, and 79.00–89.49% by the microreactor technique. The micro-/nanospheres were found to be spherical and oval with smooth surface. The FTIR analysis confirmed no interaction of KTC with EC polymer. The XRPD analysis

revealed good dispersion of the drug within the micro-/nanospheres formulation. Sustained KTC release profile over 12 h was achieved successfully by EC polymer. In conclusion, EC sustained-release micro-/nanospheres containing KTC can be prepared successfully using different techniques. © 2018, © 2018 Taylor & Francis.

220. Sun, Y., M. Zhang, and A. Mujumdar, Berry Drying: Mechanism, Pretreatment, Drying Technology, Nutrient Preservation, and Mathematical Models. Food Engineering Reviews, 2019. 11(2): p. 61-77.

Fresh berries containing in bioactive compounds are perishable under natural conditions. Drying is one of the most effective processing techniques to extending the shelf life of berry products, and the nutrients and active components of berries can be retained to a great extent. However, the flavor and texture of the final product considerably correlate with drying techniques. Therefore, the present reviewed work summarizes the research progress of berry drying technology by the perspectives of traditional drying technology and innovative drying concepts and explores the research situation of convective drying, freeze drying, vacuum drying, microwave drying and innovative drying technology for berry drying. The dehydration mechanism, pretreatment methods, and drying technology of various berries were summarized. And the effects of different drying treatments on nutritional components of berry drying were presented; application status of mathematical modeling employed in berry drying was also discussed. Moreover, the research direction and development trend of berry drying techniques in the future were pointed out, which are aimed at improving the drying efficiency of berries, preserving the active components of berries to the greatest extent, and promoting the processing utilization of berries and economic benefits in the future to provide a reference for further research and utilization of drying technology. © 2019, Springer Science+Business Media, LLC, part of Springer Nature.

221. Sun, Q., et al., Combined LF-NMR and Artificial Intelligence for Continuous Real-Time Monitoring of Carrot in Microwave Vacuum Drying. Food and Bioprocess Technology, 2019. 12(4): p. 551-562.

In this paper, intelligent technology of combined low field NMR (LF-NMR) and back propagation artificial neural network (BP-ANN) was used to monitor moisture content in carrot during microwave vacuum drying. The relationship between different drying

powers (200, 300, and 400 W) and NMR signals (A 21 , A 22 , A 23 , and A total) was investigated. Results show that as the drying time elapsed, the NMR signals of A total and A 23 decrease all drying conditions, A 21 and A 22 tend to increase at high moisture content and then decrease, which is consistent with the state of water while changes during drying. NMR signals can be used as indicators for online monitoring of moisture and control of the drying process. With NMR signals as input variables, a BP-ANN model was built optimized by transfer function, training function, and the number of neurons to model the moisture content (output). Compared with a linear regression model and multiple linear regression model, the BP-ANN model with the topology of 4-25-1, transfer function of tansig and purelin, and training function of trainlm outperformed the fitting performance and accuracy. This shows that the combined approach of utilizing LF-NMR and BP-ANN has great potential in intelligent online monitoring and control applications for carrot drying. © 2019, Springer Science+Business Media, LLC, part of Springer Nature.

222. Sun, Q., M. Zhang, and A.S. Mujumdar, Recent developments of artificial intelligence in drying of fresh food: A review. Critical Reviews in Food Science and Nutrition, 2019. 59(14): p. 2258-2275.

Intellectualization is an important direction of drying development and artificial intelligence (AI) technologies have been widely used to solve problems of nonlinear function approximation, pattern detection, data interpretation, optimization, simulation, diagnosis, control, data sorting, clustering, and noise reduction in different food drying technologies due to the advantages of self-learning ability, adaptive ability, strong fault tolerance and high degree robustness to map the nonlinear structures of arbitrarily complex and dynamic phenomena. This article presents a comprehensive review on intelligent drying technologies and their applications. The paper starts with the introduction of basic theoretical knowledge of ANN, fuzzy logic and expert system. Then, we summarize the AI application of modeling, predicting, and optimization of heat and mass transfer, thermodynamic performance parameters, and quality indicators as well as physiochemical properties of dried products in artificial biomimetic technology (electronic nose, computer vision) and different conventional drying technologies. Furthermore, opportunities and limitations of AI technique in drying are

also outlined to provide more ideas for researchers in this area. © 2018, © 2018 Taylor & Francis Group, LLC.

223. Roknul Azam, S.M., et al., Effects of drying methods on quality attributes of peach (Prunus persica) leather. Drying Technology, 2019. 37(3): p. 341-351.

In this article, the effect of four drying techniques namely hot air drying (AD), infrared drying (IRD), hot air-assisted radio frequency drying (RFD), and microwave-assisted hot air drying (MWD) on quality attributes of dried peach (Prunus persica) leather (PL) was investigated. Drying tests were conducted at 70°C, air velocity of 1.0 m/s and at fixed power level of 4 W/g for RFD, IRD, and MWD. Moisture distribution, texture, rehydration ratio, color, and microstructure of PL were investigated. The results showed that the samples dried by MWD had the shortest drying time (180 min) followed by IRD (210 min), RFD (210 min) and AD (300 min). Study on microstructure and flavor analysis reveals that IRD gave the best results. Sensory tests using electronic tongue and electronic nose that evaluate the odor and taste profiles of dried PL indicates that IRD produced the best quality among the four drying techniques. © 2018, © 2018 Taylor & Francis.

224. Mujumdar, A.S. and H.W. Xiao, Advanced drying technologies for foods. Advanced Drying Technologies for Foods. 2019: CRC Press. 1-246.

The goal of all drying research and development is to develop cost-effective innovative processes that yield high-quality dried products with less energy consumption and reduced environmental impact. With the literature on drying widely scattered, Advanced Drying Technologies for Foods compiles under one cover concise, authoritative, up-to-date assessments of modern drying technologies applied to foods. This book assembles a number of internationally recognized experts to provide critical reviews of advanced drying technologies, their merits and limitations, application areas and research opportunities for further development. Features: Provides critical reviews of advanced drying technologies. Discusses the merits and limitations of a variety of food drying technologies. Explains drying kinetics, energy consumption and quality of food products. Reviews the principles and recent applications of superheated steam drying. The first four chapters deal with recent developments in field-assisted drying technologies. These include drying techniques with the utilization of electromagnetic

fields to deliver energy required for drying, for example, microwave drying, radio frequency drying, electrohydrodynamic drying, and infrared radiation drying. The remainder of this book covers a wide assortment of recently developed technologies, which include pulse drying, swell drying, impinging stream drying, and selected advances in spray drying. The final chapter includes some innovative technologies which are gaining ground and are covered in depth in a number of review articles and handbooks, and hence covered briefly in the interest completeness. This book is a valuable reference work for researchers in academia as well as industry and will encourage further research and development and innovations in food drying technologies. © 2020 by Taylor & Francis Group, LLC. All right reserved.

225. Mujumdar, A.S. and H.W. Xiao, Preface. Advanced Drying Technologies for Foods, 2019: p. vii.

226. Mujumdar, A.S., Editorial. Drying Technology, 2019. 37(3): p. 269.

227. Mujumdar, A.S., Role of academia in industrial developments. Drying Technology, 2019. 37(6): p. 679.

228. Mujumdar, A.S., IDS in 1992 and 2020. Drying Technology, 2019. 37(14): p. 1743-1744.

229. Li, K., et al., Recent developments in physical field-based drying techniques for fruits and vegetables. Drying Technology, 2019. 37(15): p. 1954-1973.

Modern physical field technologies mainly include microwave, radio frequency, infrared radiation, ultrasound, pulsed electric field, and so on. Nowadays, the application of physical field technology on conventional drying is one of the recent strategies to solve some problems in traditional drying. In this article, physical field-based drying techniques refer to hybrid drying methods consisting of the conventional heating combined with different physical field technologies, in which physical field technologies provide various heat sources differ from conventional ones. A review is presented of recent five-year literature in the development of selected physical field-

based drying technologies (microwave, radio frequency, infrared radiation, and ultrasound) for fruits and vegetables. As shown by examples from the literature, these physical field-based drying techniques provide faster drying kinetics and better thermal efficiency and obtain dried products of improved quality (e.g. color, aroma, texture, and nutrition retention) relative to conventional hot air drying. The combination of these techniques and conventional hot air drying showed enhanced cost-effectiveness as well. Furthermore, recommendations are made for further research and development needs and opportunities in this area. © 2019, © 2019 Taylor & Francis Group, LLC.

230. Kurnia, J.C., et al., Thermal drying utilizing intermittent and pulsating impinging jet, in Heat and Mass Transfer in Drying of Porous Media. 2019, CRC Press. p. 105-129.

231. Khairnar, G., et al., Development of nanoparticulate sustained release oral drug delivery system for the antihyperglycemic with antihypertensive drug. Materials Technology, 2019. 34(14): p. 880-888.

The oral-sustained release dosage form containing Repaglinide (RPG, antidiabetic) and Diltiazem HCL (DIL, antihypertensive) loaded chitosan nanoparticles were prepared by the ionotropic gelation method. The chitosan concentration (A) and TPP concentration (B) were selected as independent variables while percentage drug loading of Repaglinide (Y1) and Diltiazem HCL (Y2) were chosen as the dependent variables. The RPG and DIL-loaded chitosan nanoparticles produced in this study were evaluated for drug-polymer interaction, surface morphology, encapsulation efficiency, drug loading, particle size and invitro drug release. The release of Repaglinide from the drug-loaded nanoparticles in a phosphate buffer (pH 7.4) solution was observed to be sustained over a period of 19 h (batch1) while Diltiazem showed sustained release behaviour over a period of 20 h in distilled water. FTIR analysis confirmed compatibility of the drug with excipients. Apparent particle size data showed that the particles were nano size with a low polydispersity index. © 2019, © 2019 Informa UK Limited, trading as Taylor & Francis Group.

232. Khaing Hnin, K., et al., Emerging food drying technologies with energy-saving characteristics: A review. Drying Technology, 2019. 37(12): p. 1465-1480.

Drying is one of the most vital preservation techniques used in the food industry. It demands different levels of energy to produce commercially high-quality-dried food products. Novel drying technologies minimize deterioration of the food ingredients and produce novel products for consumers. In recent years, there have been many developments in the technology connected with the industrial drying of foods. Recent research has shown that novel food drying technologies could be utilized to improve the efficiency of drying by lowering the energy consumption and also to enhance the product quality. This article reviews selected energy- saving techniques in drying and discusses some novel combined drying technologies. These include solar-assisted, infrared-assisted, microwave-assisted and similar hybrid drying methods for food drying. Recommendations are also made for future research and development. © 2018, © 2018 Taylor & Francis Group, LLC.

233. Karim, A., et al., Drying and instant controlled pressure drop swell drying: Towards high-quality dried foods and starch-free snacks, in Advanced Drying Technologies for Foods. 2019, CRC Press. p. 31-51.

234. Kar, S., A.S. Mujumdar, and P.P. Sutar, Aspergillus niger inactivation in microwave rotary drum drying of whole garlic bulbs and effect on quality of dried garlic powder. Drying Technology, 2019. 37(12): p. 1528-1540.

Microwave rotary drum drying of whole garlic bulbs was investigated for the Aspergillus niger inactivation and moisture removal. The Weibull and Bigelow models were applied to microbial inactivation data. Garlic bulbs with initial moisture content in the range 1.95–2.14 g water g−1dry matter were dried up to 0.06 g water g−1dry matter. The microwave power density (PD) was varied from 1.03 to 2.67 Wg−1 at 1.5 and 2.0 pulsation ratios (PRs). Effect of PD and PR on A. niger inactivation, product temperature, moisture diffusivity, moisture ratio, drying rate, color, and sensory parameters was studied. Page model was found to be a better fit for microwave rotary drying characteristics of whole garlic bulbs. Microwave rotary drum drying resulted in the average log reduction of A. niger between 1.12 and 1.60. Weibull model predicted A. niger inactivation better than the Bigelow model as it considered the nonlinearity associated with a microbial population in the sterilization process. Garlic powder prepared at 2.0 PR and 1.85 Wg−1 PD was chosen as the best process based on sensory

score. The cracking and peeling of garlic cloves were observed during microwave rotary drum drying. The SEM images confirmed the increase in the pore size of the microwave treated garlic sample than the untreated garlic which might be the reason for cracking and loosening of peel in garlic. © 2018, © 2018 Taylor & Francis Group, LLC.

235. Jangam, S.V. and A.S. Mujumdar, Miscellaneous drying technologies, in Advanced Drying Technologies for Foods. 2019, CRC Press. p. 205-222.

236. H. Bagheri, M., et al., Numerical study and POD snapshot analysis of flow characteristics for pulsating turbulent opposing jets. International Journal of Numerical Methods for Heat and Fluid Flow, 2019. 29(6): p. 2009-2031.

Purpose: The purpose of this study is to investigate the coherent structures of pulsed opposing jets by large eddy simulation (LES) model and proper orthogonal decomposition (POD) snapshot method. Flow pulsation as an active flow control method is considered for the enhancement of transport phenomena in impinging jets. The effect of flow pulsation parameters such as pulsation signal shape and frequency on the vortical coherent structures, the energy content of primary modes and their variation are studied numerically. Design/methodology/approach: In this study, flow field of turbulent pulsating opposing jets has been simulated using LES. The result of the simulation in different time steps (snapshots) are stored and POD is applied on the snapshots. In this study, the POD method and calculation of spatial modes has been done using OpenFOAM, and time coefficients have been calculated using a MATLAB code. Findings: The results of this study show that the flow excitation has a great effect on the coherent structure formation and the energy containment of fundamental modes of the flow. When the flow was excited by a harmonic sinusoidal or step function, the turbulent kinetic energy accumulated in the set of primary modes. On the other hand, the pulsed opposing jets had more regularity compared to the steady jets. The shapes, patterns and energy values of dominant modes depended on the inlet pulsation signal. An increase in pulsation frequency leads to an augmentation in energy content of the primary modes. Research limitations/implications: The predictions may be extended to include various pulsation conditions such as: various amplitudes, Reynolds number and aspect ratio. Practical implications: The results of this study are a valuable source of

information for active control of transport phenomena in opposing jet configurations which is used in different industrial applications such as cooling, combustion, reactors, heating and drying processes. Originality/value: In this study, the coherent structures and energy content of primary modes was studied for the first time by LES model and POD snapshot method and a comprehensive discussion on numerical results is provided. © 2019, Emerald Publishing Limited.

237. Guo, C., A.S. Mujumdar, and M. Zhang, New Development in Radio Frequency Heating for Fresh Food Processing: a Review. Food Engineering Reviews, 2019. 11(1): p. 29-43.

Fresh foods, such as vegetables, fruits, and aquatic products, have high water activity and are highly heat-sensitive. Thermal processing of fresh foods is often employed to extend shelf-life without chemical treatment in order to avoid any chemical residues in the preserved food. Radio frequency (RF) heating is one of the most promising heating methods applicable to fresh foods due to rapid heating, low cost, deep thermal penetration, and possibility of better quality control. This paper reviews the recent literature on applications of RF heating in fresh food processing, including cooking, microorganism reduction, disinfestation, thawing, and blanching. The heating efficiency and product quality of aforementioned applications were further discussed. Moreover, recommendations were made for future research on RF to effectively achieve enhanced thermal processing and reliable scale-up. The present study provides some useful information for the use of RF heating in industry and the future study of RF application in fresh food processing. © 2019, Springer Science+Business Media, LLC, part of Springer Nature.

238. Fan, K., M. Zhang, and A.S. Mujumdar, Recent developments in high efficient freeze-drying of fruits and vegetables assisted by microwave: A review. Critical Reviews in Food Science and Nutrition, 2019. 59(8): p. 1357-1366.

Microwave heating has been applied in the drying of high-value solids as it affords a number of advantages, including shorter drying time and better product quality. Freeze-drying at cryogenic temperature and extremely low pressure provides the advantage of high product quality, but at very high capital and operating costs due partly to very long drying time. Freeze-drying coupled with a microwave heat source speeds up the drying

rate and yields good quality products provided the operating unit is designed and operated to achieve the potential for an absence of hot spot developments. This review is a survey of recent developments in the modeling and experimental results on microwave-assisted freeze-drying (MFD) over the past decade. Owing to the high costs involved, so far all applications are limited to small-scale operations for the drying of high-value foods such as fruits and vegetables. In order to promote industrial-scale applications for a broader range of products further research and development efforts are needed to offset the current limitations of the process. The needs and opportunities for future research and developments are outlined. © 2017, © 2017 Taylor & Francis Group, LLC.

239. Deng, L.Z., et al., High-humidity hot air impingement blanching (HHAIB) enhances drying quality of apricots by inactivating the enzymes, reducing drying time and altering cellular structure. Food Control, 2019. 96: p. 104-111.

Effects of high-humidity hot air impingement blanching (HHAIB) on peroxidase (POD) and polyphenol oxidase (PPO) activities, ultrastructure, water distribution, drying time, and key quality attributes of apricots were investigated under air temperature of 110 °C and relative humidity of 35%–40% for various exposure times ranging from 30 to 150 s. HHAIB inactivated POD and PPO fully within 120 s, induced alteration of cellular structure and resulted in redistribution of water among the cell compartments. Compared to the untreated sample, HHAIB reduced the drying time by 19.36%–36.40%. Optimal pretreatment (120 s) resulted in dried apricots with higher total phenolics (TP) and total carotenoids (TC) along with enhanced antioxidant capacity, as well as better color. The TP, TC and antioxidant capacity were observed to be significantly correlated to POD and PPO activities, water distribution and drying time. Over-blanching (150 s) prolonged drying time, induced higher degradation of TP, TC, antioxidant capacity and color compared to dried products pre-blanched for 120 s. Hence, proper HHAIB pretreatment enhances drying process and improves the quality attributes of dried apricots. © 2018 Elsevier Ltd

240. Deng, L.Z., et al., Chemical and physical pretreatments of fruits and vegetables: Effects on drying characteristics and quality attributes–a comprehensive review. Critical Reviews in Food Science and Nutrition, 2019. 59(9): p. 1408-1432.

Pretreatment is widely used before drying of agro-products to inactivate enzymes, enhance drying process and improve quality of dried products. In current work, the influence of various pretreatments on drying characteristics and quality attributes of fruits and vegetables is summarized. They include chemical solution (hyperosmotic, alkali, sulfite and acid, etc.) and gas (sulfur dioxide, carbon dioxide and ozone) treatments, thermal blanching (hot water, steam, super heated steam impingement, ohmic and microwave heating, etc), and non-thermal process (ultrasound, freezing, pulsed electric field, and high hydrostatic pressure, etc). Chemical pretreatments effectively enhance drying kinetics, meanwhile, it causes soluble nutrients losing, trigger food safety issues by chemical residual. Conventional hot water blanching has significant effect on inactivating various undesirable enzymatic reactions, destroying microorganisms, and softening the texture, as well as facilitating drying rate. However, it induces undesirable quality of products, e.g., loss of texture, soluble nutrients, pigment and aroma. Novel blanching treatments, such as high-humidity hot air impingement blanching, microwave and ohmic heat blanching can reduce the nutrition loss and are more efficient. Non-thermal technologies can be a better alternative to thermal blanching to overcome these drawbacks, and more fundamental researches are needed for better design and scale up. © 2017, © 2017 Taylor & Francis Group, LLC.

241. Chaedir, B.A., et al., Heat and mass transfer phenomena in porous media - application to drying, in Heat and Mass Transfer in Drying of Porous Media. 2019, CRC Press. p. 1-36.

242. Cao, X., et al., Evaluation of quality properties and water mobility in vacuum microwave-dried carrot slices using pulse-spouted bed with hot air. Drying Technology, 2019. 37(9): p. 1087-1096.

Fried carrot slices feature high fat content to impair people healthy. To resolve this issue, microwave hot air-assisted pulse-spouted vacuum drying (MHAPSVD) has been designed using microwave vacuum dry on pulse-spouted bed with hot-air steam. Dying characteristics, moisture mobility and qualities of carrot slices had been confirmed after dying using 915 MHz microwave generator. Experiment was carried out at 3 W/g, 90 °C air stream, 0.08 MPa vacuum pressure and 2 s pulse interval for drying time of 10–80 min. The quality properties of color, odor, rehydration ratios, shrinkage ratios as well as tastes in 70 min drying are found to be suitable for a snack food. High moisture

stability of carrot slices was achieved after 50 min. Free water decreased dramatically from start to 20 min and bound water declined sharply from 20 to 50 min. MHAPSVD could be a high efficient and quality drying technology for crisp product. © 2018, © 2018 Taylor & Francis Group, LLC.

243. Cao, X., et al., Effect of microwave freeze-drying on microbial inactivation, antioxidant substance and flavor quality of Ashitaba leaves (Angelica keiskei Koidzumi). Drying Technology, 2019. 37(6): p. 793-800.

To decrease microbial quantity and conserve antioxidant substances of Ashitaba leaves, microwave freeze-drying was conducted at 1, 1.5, and 2 W/g in pilot scale. After drying, microbial inactivation and quality parameters of color, chlorophylls, flavonoids, moisture content, and flavor of dried Ashitaba leaves were evaluated. After drying, the highest contents of chlorophylls and flavonoids maintained 14.62 g/kg and 15.75 mg/g, respectively; microbial colonies decreased by about 2-log; various tastes of dried sample were improved. It could be a suitable dehydration in processing of Ashitaba leaves. © 2018, © 2018 Taylor & Francis.

244. Cao, X., et al., Radiofrequency heating for powder pasteurization of barley grass: antioxidant substances, sensory quality, microbial load and energy consumption. Journal of the Science of Food and Agriculture, 2019. 99(9): p. 4460-4467.

BACKGROUND: Young barley grass powder contains abundant nutrition and its antioxidant substances are severely impaired by radiation (60Co) sterilization. To overcome product quality degradation, radiofrequency pasteurization was conducted using pilot-scale radiofrequency equipment (27 MHz, 6 kW) with electrode gaps of 12, 14 and 16 cm, while hot-air (80 °C) pasteurization was used for comparison. RESULTS: Assessment suggested that uneven radiofrequency heating was improved for the 14 cm electrode gap. With an increase of electrode gap, microbial inactivation needs more energy consumption. A minimum energy consumption of 970 J g−1 was required for 1 log-reduction of colonies. Radiofrequency pasteurization retained better antioxidant substances, lightness (L*), green color (a*) and odors in barley grass powder, compared with hot-air sterilization. Contents of flavonoid and chlorophyll were 5.82 and 4.87 g kg−1 respectively, using the 14 cm electrode gap. Additionally, radiofrequency pasteurization led to an improvement in sourness, bitterness and umami tastes. CONCLUSIONS: Radiofrequency pasteurization would be a superior alternative for

the pasteurization of barley grass powder. © 2019 Society of Chemical Industry. © 2019 Society of Chemical Industry