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Application of High-Pressure Fluid on Green Food Processing

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Abstract

The fundamentals of the technologies of high pressure are from the perspective of the phenomenon of mass transfer and the thermodynamic considerations. The application of food processing is totally exposed and the relation to the extraction, chemical analysis, and particle formation and reaction process is fully outlined. Moreover, the aim of the processing of green food is to promote new and innovative ideas that eliminate or reduce the use of hazardous materials such reagents and solvents in the operation and design of the process related to food processing. The processing of green food considers the aspects of prospective, market opportunities and industrial scaling in the processes related to high-pressure food.

Keywords

Extraction, Solvents, Lubrication, Reagents, Supercritical Fluids.

INTRODUCTION

The fundamentals of the technologies of high pressure are from the perspective of the phenomenon of mass transfer and the thermodynamic considerations. The applications of the novel food are totally exposed and their relationship to the reaction, extraction, particle formation and chemical analysis are outlined. The mission for the processing of green food is to promote the new and innovative technologies that eliminate or reduce the generation or use of hazardous materials like reagents, solvents in the operation and designing of the related food processes for improving quality and food safety. Moreover, there are several technologies that are efficient, affectionate and environment friendly that is based on the utilization of green solvents and high pressure.

Moreover, these technologies are demonstrated for being sustainable alternatives to the traditional process within the food industry. Moreover, there are several ideas that stimulate the engineering tools and then design the processes that are still under the process of development. The technology of high-pressure fluid in the processing of green food is present in the depth analysis and outlines the method towards maturity. The technology of the high-pressure fluid for the processing of green food includes mass transfer, fundamental reaction and thermodynamics that are related to the processing of high pressure in the food materials.

Usage of Different Techniques in Green Food Processing

Green food processing has several techniques like transformation. Extraction and reservation advances the practical objectives and ethics of this process. Moreover, it offers the technological tools and methodological tools in the innovative techniques of food processing with their role in the promotion of the industry of sustainable food [5]. However, the techniques that include ultrasound, instant pressure drop, processing of supercritical fluid, electric field pulse, extrusion and microwave lie within the boundary of food microbiology, food chemistry and food processing. Moreover, these are presented with the technological tools that make transformation, extraction and preservation greener.

The industry of food processing constantly requires innovation and reshaping itself for achieving the financial, environmental and social demands. The processing of green food responds to the challenges in enhancing the nutritional quality and shelf life of the food products [9]. Moreover, it reduces the unit operations and the energy used in eliminating the byproducts and wastes, processing, reducing the use of water in harvesting, using the ingredients that are naturally derived and processing and washing.

Principles of High-Pressure Fluid Technology in Processing of Green Food

The pressure processing process in which the food is placed in the vessel that is filled with the fluid, fully mixed in water with either mineral or vegetable oil for the equipment of corrosion and lubrication purpose of prevention. Moreover, the surrounding fluid that exerts the “hydrostatic pressure” within the food is transferred inside the food that is uniformly and instantaneously. Moreover, it also transmits into the food with pressure vessels and the shape and size of the food [11]. However, for the compression of adiabatic food, the total temperature that increases about at least 3 degrees Celsius per 100 MPa depends on the value of compressibility of the food.

Moreover, it also depends on the medium used for pressure transmitting, initial food and also on the medium temperature. However, when the desired pressure reaches, there is no extra consumed energy. Moreover, the application is uniform and instantaneous of the pressure that is across the facilities of the food scaling process from the laboratory to the industrial scale. Hence, it is the significant advantage of commercialization in this technology of novel processing [6]. Therefore, the temperature changes and the heat transfer that is caused by the decomposition and compression of the food and also the pressurized liquid that have the thermo physical properties changes with temperature and pressure.

Application of Fluid on the Processing of Green Food

The applications that are used in the processing of food are the supercritical fluid and the liquefied analogues that are traditionally used in the operations of a single unit that is fractionation, extraction, using the supercritical net carbon dioxide with the appropriate modifiers. Several processes of extraction of supercritical fluid are devoted to the extraction of natural and food products. Moreover, the technique of chromatographic and columnar is followed by the reactions of supercritical fluid that are developed for facilitating the derived products or extracts of supercritical fluid [12]. Therefore, it thereby extends the application of the processing platform of critical fluids beyond the Supercritical Fluid Extraction (SFE). Moreover, these new developments are investigated in part for the complexity of several matrices of natural products and concentrate on the target components for food and several other uses of the industry.

The advantages of the option in the coupling process use the processing of critical fluid. Hence it combines the different processes of several units and by sequencing them with the multiple uses that are utilized in different pressure and temperature (Uzbek *et al.* 2018). Moreover, one of the users can obtain the multiple products and then optimize the reaction or extraction process. There are different specific options that are illustrated in the cases of processing the materials that are lipid-based like concentrates of sterols, phospholipids and tocopherols. Moreover, the sequential isolation of the polar and nonpolar ingredients is documented by using the combination of the fluids or the unit processes. Therefore, the difficulties and merits for integrating the new technology of critical fluids are the concepts of bio refinery [10]. Hence the supercritical fluid also advocates the total use in the theory of solubility parameter for rationalizing the supercritical media to the nutrient and food-bearing materials and also optimizing the processing conditions.

MATERIALS AND METHODS

For understanding the principles of the fluid that have high-pressure is in the processing of green fluid, it is significant to give importance to the several techniques that are used in processing green food. The data collection is an integral; part of the development process in this research. Moreover, in this research secondary data is collected that are chosen from reliable and authentic journals and the research articles from Google scholar. As per the views of Alexandre *et al.* (2019), the experiment was conducted on the high-pressure fluids in the processing of green foods[1].

Table 1: Applications and Experimental conditions[1].

Application	Matrix	Treatment conditions	Benefits
Preservation			
Inactivation	Ringer solution contaminated with *B. subtilis* spores	(PEF + heat) 6 < E < 11 kV/cm; Q < 350 kJ/kg	Inactivation of spores with reduced heat load
	Carrot puree	(Chilling + PEF) 0.1 < E < 1.1 kV/cm; 0.15 < Q < 15.58 kJ/kg	Improvement of the stability of vitamin C and reduction of the residual activity of AAO and POD
Freezing/thawing	Apple; spinach	(PEF + impregnation + freezing + thawing) 0.58 < E < 0.8 kV/cm; Q: n.d.	Acceleration of freezing/thawing process and comparable texture after defrosting to fresh samples
Osmotic dehydration	Apple, carrot	(PEF + impregnation) 0.22 < E < 10 kV/cm; 0.15 < Q < 106.7 kJ/kg	Increase of water loss Solute uptake by the matrix depends on the matrix and operational conditions
Convective drying	Carrot, red pepper	(PEF + hot air drying) 0.5 < E < 2.5 kV/cm; 1.8 < Q < 56.5 kJ/kg[a]	Increase of drying rates and color quality (red pepper)
Extraction			
Diffusion	Grape pomace, sugar beet	(PEF + extraction by diffusion) 0.6 < E < 3 kV/cm; Q < 19.4 kJ/kg	Increase of polyphenols and sucrose concentration; selective extraction towards anthocyanins, lower coloration and better filtrability of juices (sugar beet)
Expression	Apple, grape	(PEF + extraction by pressing) 0.4 < E < 0.65 kV/cm; 15 < Q < 32 kJ/kg	Increase of juice and polyphenol yield, decrease of juice turbidity and better odor intensity
Filtration	BSA suspension	(PEF + cross flow UF) E = 4.5 kV/cm, Q: n.d.	Improvement of concentrating rate of protein in retentate and reducing the solute-related resistance to the permeate flux
Distillation	Roses (*R. alba* L.)	E = 25 kV/cm, 10 < Q < 20 kJ/kg	Increase of oil essential oil yield and possible reduce of distillation time
Transformation			
Cutting	Carrot	E = 0.8 kV/cm, Q < 166 kJ/kg	Decrease of the cutting force
Softening	Meat	0.32 < E < 0.48 kV/cm; Q/n.d.	Improving meat tenderness
Frying	Potato	0.75 < E < 2.5 kV/cm; Q: 18.9 kJ/kg	Improving potato color and reducing oil uptake after frying
Fermentation	*S. cerevisiae*	100 < E < 6 kV/cm; Q: n.d.	Increase of sugars consumption, decrease of fermentation time

Food preservation is achieved in inhabiting or by controlling the outer contaminants or the internal conditions of the reactions that are biological that can alter the nutritional and organoleptic quality of food [1]. Moreover, there are two strategies that are used in this experiment that is applying the thermal treatment and decreasing the total activity of water in the matrix of food for inhibiting the biological reactions. The application of preservation activation works on the matrix of ringer solution that is contaminated with the pores of B. subtilis in carrot puree. The application of extraction and diffusion works on the matrix of grape pomace and sugar beet. Moreover, there are several similar applications that work on the matrixes. However, these applications are dealt with several results with their benefits.

RESULT AND DISCUSSION

As a peer, the results present in table 1 states that the application with their treatment conditions. The application of preservation and inactivation has the matrix of ringer solution that is contaminated within the B. subtilis spores of carrot puree results in (PEF + heat) $6 < E < 11$ kV/cm;$Q < 350$ kJ/kg (Chilling + PEF) $0.1 < E < 1.1$ kV/cm; $0.15 < Q < 15.58$ kJ/kg. Moreover, their benefits are inactivation of the spores with a load of reduced heat and improvement in the stability of the Vitamin C. The application of freezing or thawing in the matrix Apple and spinach results in (PEF + impregnation + freezing + thawing) $0.58 < E < 0.8$ kV/cm; Q: n.d. Therefore the benefit of this application is the acceleration of the process of freezing or thawing and the texture is comparable after defrosting the fresh samples [3]. Moreover, the application of osmotic dehydration in the matrix apple and carrot results in (PEF + impregnation) $0.22 < E < 10$ kV/cm; $0.15 < Q < 106.7$ kJ/kg. Hence the benefit of this application is an increase in water loss and the solute that is updated by the matrix is dependent on the operational and matrix conditions. Moreover, in the application of extraction and diffusion in the matrix grape pomace and sugar beat the result is (PEF + extraction by diffusion) $0.6 < E < 3$ kV/cm; $Q < 19.4$ kJ/kg. Therefore, the benefit of this application is an increase in the concentration of sucrose and polyphenols and the extraction is towards better filterability, anthocyanin and lower colorations [2]. The application of expression in the matrix apple and grapes, the result is (PEF + extraction by pressing) $0.4 < E < 0.65$ kV/cm; $15 < Q < 32$ kJ/kg. Therefore its benefits are to increase the polyphenol and juice yield and decrease the turbidity of juice with nice odor intensity.

The worldwide and continuing growth of the high-pressure fluid in the processing technologies is to sterilize and pasteurize the food that justifies the effects on the abiotic contaminants and functional compounds. Moreover, these are affected by the processing of high-pressure fluid. Moreover, there are complex effects of the matrices of food on the chemical reactions that are leading to the losses of the functional components and nutrients. Moreover, the other effects of producing the toxic compounds and the modifications of the toxic residues present in the chemical. However, these are used in the production of food or from the materials of food contact [7]. The processing of the high-pressure technology is developed as an alternative to the thermal process and it aims in obtaining the microbiology in the products of safe food. Moreover, it is done by avoiding the total changes in the process of nutrition, physicochemical and the total sensory properties of the food products. Moreover, in the processing of high pressure, foods are primarily placed in the vessels filled with fluid that is generally mixed in the mineral oil for the prevention of corrosion and lubrication purposes.

The main application of the high-pressure fluid in processing of food is the green extraction of supercritical fluids that is a significant method for the large scale purification of solid matrices or complex fluids. Moreover, the main advantage regarding supercritical fluids is the higher selectivity as the solvation power of the high-pressure fluid is adjusted in changing the pressure and temperature. Moreover, the other advantage is the higher diffusivity and lower viscosity of the supercritical fluid that allows the quick mass transfer of the solutes from the materials.

CONCLUSION

From this above research, it is concluded that the by-products of the food industry especially vegetable and fruit processing industries. Moreover, the milling industry, oil industry and processing industry of seafood are much richer in the effect of bioactive compounds. However, these compounds are polyunsaturated fatty acids (PUFAs), carotenoids, polyphenols and many more. The extraction of carbon dioxide that is supercritical of the oils that are richer inside the bioactive compounds, the fractionation of the oils or the by-products for enriching the bioactive compounds. Moreover, the processing of green food might respond to the challenges in enhancing the quality of nutrition and shelf life of the different food products. Hence, it reduces the unit operations and energy used for eliminating the waste materials and reducing the use of the water for harvesting.

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