

Ultrasound applications in food industry

Food process	Principle	Food matrix	Advantages /Disadvantages	TRL	Reference
Emulsion formation	Cavitation Phenomenon	Mayonnaise Milk Pork Food isolated proteins Gelatin Polysaccharides emulsions	Advantages: Droplet size reduction Less polydisperse emulsions Improvement of the rheological and emulsifying properties of emulsions Increased emulsion stability Reduction of processing time Limitations: Few studies on animal fat, which limits its application in the meat industry.	9	[1]
Microbial / enzyme inactivation	Cavitation Phenomenon	Liquid products	Advantages: Non-thermal inactivation treatment Limitations: Extended processing time	4/5	[2]
	Combined Process (US with heat, high pressure, pulsed electric field, high hydrostatic pressures, UV light)		Advantages: Increased lethal efficacy Inactivation of vegetative cells and spores at 40°C Low temperatures than traditional treatment Limitations: Industrial application technically limited	4/5	[3]
Microbial decontamination	Cavitation Phenomenon	Solid Products	Advantages: Reduces washing times	5/6	[3]
Component Extraction	Mass transfer enhancement	Extraction of interest compounds: aromatic compounds, antioxidants, pigments from vegetable matrix Elimination of health risk compounds	Advantages: Increased extraction yields Minimal use of contaminant solvents Lower water and energy consumption Reduced processing time Elimination of health risk compounds (Cd from edible crabs and acrylamide from fried potatoes)	9	[3,4]
Drying and dehydration	Mass transfer enhancement	Vegetables Fruits	Advantages: Reduction of drying time Lower temperature Increase in diffusion coefficient Reduction of energy consumption Quality improvement Limitations: Technical difficulty of scaling to industrial level Low generator efficiency	5	[5,6]

Food process	Principle	Food matrix	Advantages /Disadvantages	TRL	Reference
Marinating and pickling	Mass transfer enhancement	Vegetables Meat Fish Cheese	Advantages: Reduction of processing time Quality improvement Low water activity and longer shelf life Uniform distribution of salt in less time Required less sodium chloride	5	[3,7]
Heating/cooking	Energy transfer enhancement	Liquid and viscous products (soups, puree, creams) Immersed solid product (beef, packaged sausages, meatballs, mortadella, etc)	Advantages: Improved heating uniformity Reduced processing time and energy consumption Quality improvement	4	[3]
Freezing	Energy transfer enhancement	Meat Fish Vegetables/fruits Bakery products	Advantages: Controlled crystal growth Nucleation enhancement Reduction of freezing time Quality improvement	4/5	[3,8]
Thawing	Energy transfer enhancement	Meat Fish Vegetables/fruits	Advantages: Reduction of thawing time Quality improvement Limitations: High power requirement resulting in overheating of the surface Considerable loss of ultrasonic energy in the form of heat	7	[3,8]
Foaming	Dispersion of gas bubbles	Milk Egg white Protein	Advantages: Lower viscosity and surface tension Higher protein solubility Protein structural changes Better functional properties Limitations: Reduces the foam stability and water retention capacity	9	[9–11]
Degassing capacity	Agitation	Carbonic beverages	Advantages: Less bottle breakage and overflow of beverages Reduction of fermentation times Limitations: Excellent for liquid products but more challenging for viscous products	9	[7]
Filtration	Microstreaming	Liquids products	Advantages: Prevents filter saturation Time reduction	9	[12]
Cutting	Cavitation Phenomenon	Sticky products (cream cakes, bread, pastries, biscuits, cheese, etc)	Advantages: Cutting accuracy Reduced product loss	9	[3]

For questions about this table, please contact:

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