Global Science Research Journals

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Perspective | Open Access

Global Journal of food Science and Technology

ISSN:2408-5456 Vol. 10 (2), pp. 376-377
April, 2022

Ultrasound technology application in dairy processing

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Received: 25-May-2022, Manuscript No. GJFST-22-62699; **Editor assigned:** 30-May-2022, PreQC No. GJFST-22-62699(PQ); **Reviewed:** 13-Jun-2022, QC No GJFST-22-62699; **Revised:** 20-Jun-2022, Manuscript No. GJFST-22-62699(R); **Published:** 27-Jun-2022, DOI:10.15651/2408-5456.22.10.050.

DESCRIPTION

Alternative methods to improve traditional food processing have increased in recent decades. In addition, the development of new dairy products is becoming more important as consumers are in increasing demand for delicious, healthy and minimally processed products. Sonication or sonication is a promising alternative technology in the food industry as it has the potential to improve the technical and functional properties of milk and dairy products.

The advancing food processing technology focuses on producing delicious, healthy, safe, nutritious and minimally processed foods. The search for such alternative processes is drawing attention to new food technologies such as non-thermal technologies to avoid altering the flavor or nutritional value of foods during production. High Intensity Ultrasound (HIU) is a promising new technology specifically designed for economy, simplicity and energy efficiency. HIU has a great deal of interest in food science and technology due to its wide range of applications, either in product processing or evaluation. HIU offers great potential to control, improve and accelerate processes without impacting the quality of foods and other products. Therefore, HIU applications in the food industry, including the dairy industry, continue to be the subject of research.

Ultrasound (US) is defined as sound waves of high frequency, above the threshold of human hearing (~20 kHz), ultrasound application can be divided in high intensity-low frequency (I=10-1000 W/cm^2 and F=20-100 kHz) and low intensity-high frequency (I<1 W/cm^2 and F>1 MHz). Ultrasound generates alternating high- and low-pressures, causing compression and expansion (rarefaction) cycles in the medium.

In Rarefaction, cavitation bubbles are formed. Cavitation bubbles are tiny vacuum bubbles that form when negative pressure is applied. Vacuum bubbles can no longer hold energy and grow over several compression/ thinning cycles until the cavitation bubbles explode and release energy. This process of bubble generation, growth, and implosion is called acoustic cavitation or implosion. Cavitation bubbles generate extreme temperatures (5000 K) and pressures (500 atm.) that can produce very high shear forces. The violent collapse of cavitation bubbles has physical and chemical effects on liquids such as microstreaming, agitation, turbulence, micro-jetting, shock waves, radical generation and sonoluminescence etc. The chemical reactions that occur in these environments are the formation of highly reactive radical species. When argon-saturated water is sonicated, H radicals are naturally reduced and OH radicals are naturally oxidized, resulting in the formation of H radicals and OH radicals. It is now known that radical yields increase with increasing frequency, it reaches maximum values, and decrease with further frequency increases. The highest sonochemical yield is achieved at 200-800 kHz. In general, the release energy to a medium causes structural damage on a nano, micro, or macro scale.

Ultrasound-induced chemical and physical effects lead to changes in milk constituents that have a significant effect on the properties of milk and dairy products. Ultrasound is used to process foods and dairy products for applications such as enhance whey ultrafiltration, extracting functional foods, reducing product viscosity, homogenizing milk fat globules, crystallization of ice and lactose, and cutting cheese blocks. In recent years, research on HIU dairy products or dairy by-products has aimed to reduce processing time or improve the physicochemical quality of various foods. Since 2018, many studies have been published. Most of them give very consistent results about HIU's benefits over quality parameters for fresh milk, cheese, butter, ice cream, fermented milk products, whey protein preparations and other beverages.

However, the application of ultrasound to food processing has shown a negative impact of heat on thermo-labile compounds such as vitamins and pigments. But the application of ultrasound in beverages has also shown

health benefits such as increased levels of antioxidants and bioactive compounds. The effectiveness of HIU applications in dairy farming systems has become prominent in food science and technology. Its effects on microorganisms have been extensively studied as a preservation method due to its role in improving the safety and delaying spoilage of foods. As well as in the inactivation of enzymes in milk. One of the most relevant uses of ultrasound is in fermentation processes and the production of functional fermented beverages, with a significant improvement in sensory properties.