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DESIGN OF ULTRASONIC DISINFECTION SYSTEM IN DAIRY PRODUCTION PLANTS

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Abstract
In this article, we will consider the methods of using ultrasonic disinfection methods in industrial production. General information about ultrasonic disinfection technology, the technological basis of disinfection operation processes, the improvement of the operation process of ultrasonic disinfection, the structural scheme of management, the modern trends of the development and improvement of the control of ultrasonic disinfection technologies for control processes, the calculation of the costs of the operation of the ultrasonic disinfection control system and the economic efficiency calculation of indicators, main parts of the technology and their principles of operation, fields of application, advantages and types of ultrasonic disinfection technology were studied.

Keywords: Types of ultrasonic disinfection, field of application in industrial production, classification of principle and structural schemes of ultrasonic disinfection and working processes.

Introduction

The formation and bursting of bubbles in an aqueous environment allows the elimination of waste on all surfaces of submerged parts, keeping the base material intact. In addition, ultrasonic equipment achieves excellent washing results with low energy consumption and is characterized by high performance[1]. This optimizes the industrial process and improves the quality of the end result of the parts. The ultrasonic cleaning system with the advanced technologies offered by UltraTecno allows for perfect cleaning of the ship's engine, as well as other parts such as marine fuel injectors. Our experts have extensive experience in marine care and will provide you with the best advice on boat maintenance. We specialize in custom project development for all types of industries[2]. Please contact us and ask for specifics. We will be

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happy to help you. Discover the power of the cavitation process created by ultrasound equipment.

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An ultrasonic digital cleaning system allows you to remove dirt, oil or grease from any type of part or tool, even the most complex or difficult to clean. Also, unlike traditional industrial cleaning methods, a digital ultrasonic cleaner tunes your components and guarantees their optimal performance. Due to the cavitation cleaning system and the possibility to choose from different applications, ultrasonic digital cleaning systems are ideal for all types of tools and materials in the shipping, aeronautics, railway and food industries[5].

Methods

The history of using high hydrostatic pressure (HHP) goes back to the 19th century when Soxhlet applied pressure to convert starch into glucose. HHP involves the use of pressure in the range of 100–800 MPa, with or without the application of heat. In practical applications, the combined intensity of both thermal and pressure effects can cause various physical, chemical, and biological changes in foods[6]. HHP can be conducted in either batch or semicontinuous process depending on the type of food. The use of HHP alters the characteristics of milks, particularly proteins, and leads to desired texture, sensory attributes, and nutritional value[7].

The effect of HHP can also contribute to reducing the allergenic character of some plant-based beverages. For instance, the impact of HHP on allergenic almond proteins was evaluated by Dhakal et al. In this study, the stability of the main almond allergenic protein amandin in the raw almond milk was evaluated under HHP treatment (450 and 600 MPa for 0, 30, 60, 180, 300, and 600 s at 30 °C) and traditional thermal processing (0, 30, 180, and 300 s at 72, 85, and 99 °C)[8]. The results showed that amandin levels were affected by all HHP treatments. The reactivity with antilinear epitopes of monoclonal antibodies was reduced by half while the signal from specific anticonformational monoclonal antibodies was no longer detected in HHP-treated samples. One of the explanations indicated by authors for these results was the aggregation of amandin, which can potentially reduce the immunological response in amandin-sensitive people[9]. It is worth noting that similar results for conventional thermal processing were reported for treatments at increased temperature and time of 300 s at 85 and 99 °C. Additionally, the authors highlighted the necessity for further studies regarding the inactivation of allergenic proteins in almond milk, since HHP alone may not inactivate all allergenic factors. Combining HHP with other strategies such as changing pH, adding chemical additives, and increasing temperature could improve the inactivation of allergenic almond proteins, as stated by the authors[10].

The use of HHP also displayed an important role in the development of soymilk enriched with calcium. In this experiment, a Doehlert design was used to optimize the HHP processing conditions (500–700 MPa at 73–95 °C) and level of calcium (5, 10, and 15 mmol/L) in order to enhance protein solubility and inactivation of trypsin inhibitors and lipoxygenase. The authors indicated that, in the optimum conditions (614 MPa, 85.5 °C, and 8.53 mmol Ca/L), both enzymes were completely inhibited and more than 70% of proteins were solubilized in the bulk of soymilk[11].

The gas dissolved in the liquid medium expands under the action of ultrasonic waves, completing a series of reactions—such as the formation and rupture of cavitation bubbles. At the same time, cavitation caused by changes in temperature and pressure will also cause chemical changes that accelerate the cleaning efficiency. When turbulent microcirculation is generated near a solid surface, a microjet with a velocity of approximately 110 m/s and a high impact force is produced, resulting in a collision density of up to 1.5 kg/cm^2 . Figure 1 shows the ultrasonic cleaning process for cavitation bubbles[12].

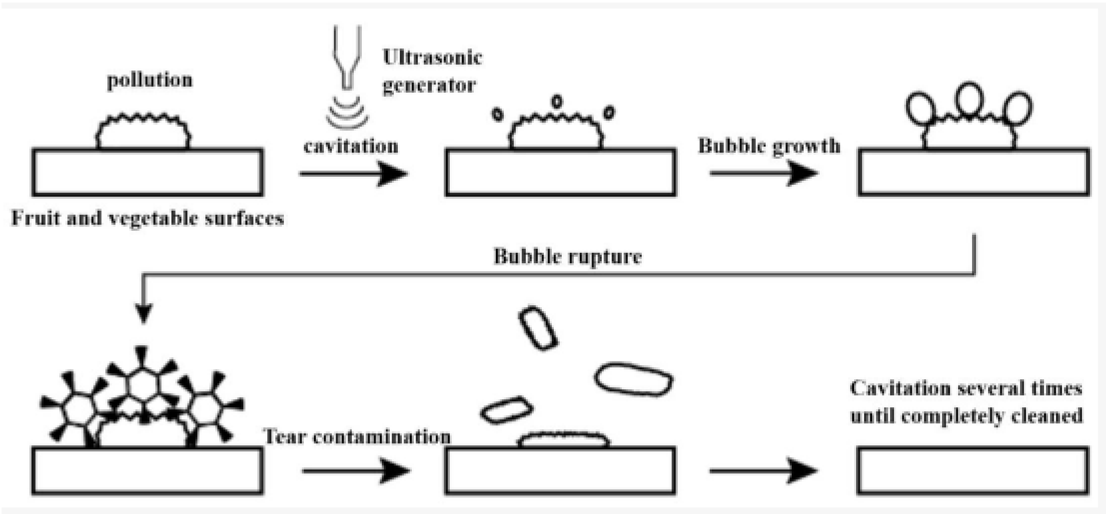

Figure-1. Ultrasonic cleaning process

High-Pressure Homogenization

The high-pressure homogenization (HPH) or ultra-high-pressure homogenization (UHPH) is an alternative food processing method which can be used to improve the stability of plant-based milk emulsions and their physicochemical properties with minimum effect on the nutritional properties. This technique uses high pressures ranging from 200 to 600 MPa and temperatures between 30 and 85 °C and can improve the stability of plant-based beverages by reducing the particle size of emulsions and producing more uniform size particles[13]. Apart from reducing colloidal particles, simultaneous destruction of microorganisms can be achieved using UHPH. In a study performed by Briviba et al, a threefold increase in mean particle size was reported, while no significant reduction in vitamin B_1 and B_2 contents after UHPH treatment (350 MPa at 85 °C) was observed. Moreover, the application of UHPH treatment resulted in reducing the almond protein antigens response by 99.8%.

The impact of UHPH (200–300 MPa) on the physicochemical properties (particle size and color) of soybean-based milks was compared with the results obtained from UHT-treated samples. A significant reduction of particle size after UHPH was observed, but the aggregate formation was found only at 300 MPa. Although a partial protein denaturation after 200 MPa was observed, UHPH at 300 MPa led to similar protein denaturation to that found after UHT treatments. Moreover, UHPH soybean-based milks were more stable than UHT processed samples (particle aggregation during storage)[14]. Processing (UHPH and UHT), as well as storage time, had a significant influence on color parameters (CIE-Lab) wherein the lowest values were found in the samples treated by UHPH at 300 MPa (79.68, −2.66, and 16.01 for L, a*, and b*, respectively) in relation to UHPH at 200 MPa (82.24, −2.00, and 16.57 for L, a*, and b*, respectively) and UHT (84.31, −0.28, and 18.37 for L, a*, and b*, respectively)[15].

In another study, the impact of UHPH (200–300 MPa/40–50 °C) on the properties of soybean-based milks was evaluated and compared with conventional thermal treatments (UHT and autoclaved). The authors evaluated the characteristics of soy-yogurts obtained from heat-treated soybean-based milks. The study showed an increased onset of gelation as well as decreased aggregation rate and gel network density on soybean-based milks treated by UHPH compared to heat treatments, which resulted in improved physiochemical properties (i.e., firmness) [16].

The results of this study indicated non-significant differences in the chemical composition of almond milks subjected to both UHPH treatments and conventional thermal processing (pasteurization and ultra-high-temperature). It is worth mentioning that UHPH treatments did not affect the essential amino acid content, particularly lysine (a limiting amino acid in almond milks). However, the impact in a potential bioactive component can be greater than in chemical composition of plant-based beverages. In this sense, Toro-Funes et al evaluated the effect of UHPH on the stability of phytosterols, tocopherols, and polyamines in almond milk. UHPH (200 and 300 MPa at 55, 65, and 75 °C) treatment affected the content of phytosterols, tocopherols, and polyamines. Increasing pressure and temperature reduced the total tocopherol content (sum of α-, β-, and γ-tocopherol) from 50.63 to 3.15 and 4.14 mg/L, in raw almond milk treated at 200 MPa, 75 °C and 300 MPa, 75 °C, respectively. However, an inverse effect was reported for total phytosterols content, which increased from 22.08 mg/L in raw almond milk to 27.24 and 29.54 mg/L after UHPH treatment at 200 MPa, 75 °C and 300 MPa, 75 °C, respectively. According to the authors, this outcome could be derived from the mechanical forces (such as shear force, turbulence, and cavitation) reducing the fat globule size and facilitating the release of phytosterols in the bulk of the beverage [17].

Conclusion

In the production of milk products, I got information about the disinfection and processing of equipment with ultrasonics. I got a lot of information about the ultrasonic disinfection device, the device is started and programmed using Arduino microcontrollers. As ultrasonics is a relatively new field of endeavor in dairy research and development, the availability of industrial-scale – or even pilot-scale – ultrasonic processing equipment is still quite limited.

This may hinder adoption of the technology in the short term, but experience with the development of ultrasonics technology in other industries (for example, homogenizers and spray-drying systems) suggests that this issue could readily be overcome once the economic advantages of ultrasound use are clearly demonstrated. In the dairy industry at present, the best opportunities for adoption of this technology would seem to be either as an adjunct process in an existing processing line or as a way of developing a new or improved functionality in a relatively low volume/high value dairy ingredient stream.

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