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Enhancing Date Seed Protein Concentrate Functionality through High-intensity Ultrasonic Treatment

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Abstract

Date Seed Protein Concentrate (DSPC) is an emerging functional food ingredient rich in proteins, fibers and antioxidants, derived from date seeds, a by-product of date fruit processing. This study investigates the potential of high-intensity ultrasonic treatment to enhance the functionality of DSPC. The research focuses on optimizing ultrasonic treatment parameters to improve DSPC solubility, emulsifying properties and foaming capacity. Results demonstrate that ultrasonic treatment significantly enhances DSPC functionality by disrupting protein aggregates and promoting protein unfolding. The optimized parameters offer valuable insights for the food industry to harness the full potential of DSPC as a sustainable and nutritious ingredient in various food formulations. This research contributes to advancing processing techniques for plant-based protein concentrates, addressing the demand for functional food ingredients with enhanced nutritional and functional attributes.

Keywords: Date seed • Protein concentrate • Ultrasonic treatment

Introduction

Date Seed Protein Concentrate (DSPC) has gained attention as a promising source of plant-based protein with diverse nutritional and functional properties. Date seeds, a by-product of date fruit processing, contain valuable bioactive compounds, including proteins, fibers and antioxidants. Among these, DSPC stands out for its high protein content and balanced amino acid composition, making it an attractive alternative to conventional protein sources in food formulations. However, the functional properties of DSPC, such as solubility, emulsifying activity and foaming capacity, often present challenges for its application in food products. These limitations stem from the native structure and composition of date seed proteins, which may form aggregates and exhibit poor dispersibility in aqueous solutions. To address these challenges and unlock the full potential of DSPC, various processing techniques have been explored [1]. One promising approach is high-intensity ultrasonic treatment, which has shown efficacy in improving the functionality of protein concentrates from different sources. Ultrasonic treatment involves the application of high-frequency sound waves (>20 kHz) to a liquid medium, leading to the generation of acoustic cavitation. This phenomenon entails the formation, growth and collapse of microbubbles within the liquid, resulting in intense shear forces and localized heating. These physical effects can disrupt protein aggregates, promote protein unfolding and facilitate interactions between proteins and other food components. The effect of high-intensity ultrasonic treatment on enhancing the functionality of DSPC. Specifically, we seek to optimize ultrasonic treatment parameters to maximize improvements in DSPC solubility, emulsifying properties and foaming capacity. By elucidating the underlying mechanisms of ultrasonic treatment on DSPC functionality, this research aims to provide valuable insights for the food industry to develop innovative formulations with improved nutritional and functional attributes [2].

Literature Review

Date Seed Protein Concentrate (DSPC) has emerged as a promising ingredient in the food industry due to its nutritional composition and functional properties. Extracted from date seeds, DSPC contains a high proportion of proteins with essential amino acids, making it suitable for various food applications. Despite its nutritional value, DSPC exhibits certain limitations, particularly in terms of solubility, emulsifying properties and foaming capacity. These functional deficiencies hinder its widespread utilization in food formulations. To overcome these challenges and enhance the functionality of DSPC, researchers have explored different processing techniques, including enzymatic hydrolysis, chemical modification and physical treatments. Among these techniques, high-intensity ultrasonic treatment has garnered significant interest for its ability to induce structural modifications in proteins, thereby improving their functional properties. Ultrasonic treatment involves the application of high-frequency sound waves to a liquid medium, leading to the formation and collapse of cavitation bubbles. These bubbles generate intense shear forces and localized heating, which can disrupt protein aggregates and promote protein unfolding. Several studies have investigated the effects of ultrasonic treatment on protein concentrates from various sources, including soy, whey and pea proteins. These studies have demonstrated that ultrasonic treatment can enhance protein solubility, emulsifying activity and foaming capacity, thereby improving the overall functionality of protein concentrates [3].

Limited research has been conducted to explore the potential of ultrasonic treatment for enhancing functionality. However, preliminary studies suggest that ultrasonic treatment holds promise for improving DSPC solubility and emulsifying properties. The effects of ultrasonic treatment on DSPC extracted from different varieties of dates. The researchers observed a significant increase in DSPC solubility following ultrasonic treatment, attributed to the disruption of protein aggregates and the promotion of protein unfolding induced by ultrasonic waves. The impact of ultrasonic treatment on the emulsifying properties of DSPC. The researchers found that ultrasonic treatment improved the stability and creaming properties of DSPC-stabilized emulsions, indicating enhanced emulsifying activity. These improvements were associated with the reduction in particle size and the increase in interfacial area facilitated by ultrasonic treatment. Despite these promising findings, several gaps remain in our understanding of the effects of ultrasonic treatment on DSPC functionality. First, the optimal ultrasonic treatment parameters for maximizing improvements in DSPC functionality have not been systematically investigated. Second, the underlying mechanisms governing the effects of ultrasonic treatment on DSPC structure and functionality require further elucidation [4].

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Discussion

The results of our study demonstrate that high-intensity ultrasonic treatment can effectively enhance the functionality of Date Seed Protein Concentrate (DSPC). By optimizing ultrasonic treatment parameters, including frequency, amplitude and processing time, we observed significant improvements in DSPC solubility, emulsifying properties and foaming capacity. The enhancement in DSPC solubility following ultrasonic treatment can be attributed to the disruption of protein aggregates and the promotion of protein unfolding. Ultrasonic waves generate acoustic cavitation within the liquid medium, leading to the formation and collapse of microbubbles. These cavitation-induced shear forces exert mechanical stress on protein structures, causing the disruption of non-covalent interactions and the unfolding of protein molecules. As a result, previously insoluble protein aggregates become dispersed in the aqueous phase, leading to increased solubility. Furthermore, ultrasonic treatment promotes the formation of smaller protein particles with increased surface area, facilitating interactions with water molecules and other food components [5]. This phenomenon contributes to the improved emulsifying properties of DSPC, as evidenced by the stability and creaming properties of DSPC-stabilized emulsions. In addition to solubility and emulsifying properties, ultrasonic treatment enhances the foaming capacity of DSPC by promoting the formation of stable protein foam networks. The mechanical agitation induced by ultrasonic waves facilitates the entrapment of air bubbles within the protein matrix, resulting in the formation of stable foams with desirable texture and stability. Overall, the findings of this study highlight the potential of high-intensity ultrasonic treatment as a promising technique for enhancing the functionality of DSPC. By optimizing ultrasonic treatment parameters, food manufacturers can develop innovative formulations with improved nutritional and functional attributes. However, further research is needed to fully elucidate the underlying mechanisms of ultrasonic treatment on DSPC structure and functionality, as well as its potential applications in various food systems [6].

Conclusion

In conclusion, this study demonstrates the effectiveness of high-intensity ultrasonic treatment in enhancing the functionality of Date Seed Protein Concentrate (DSPC). Through systematic optimization of ultrasonic treatment parameters, including frequency, amplitude and processing time, we achieved significant improvements in DSPC solubility, emulsifying properties and foaming capacity. The enhanced functionality of DSPC following ultrasonic treatment can be attributed to the disruption of protein aggregates, promotion of protein unfolding and formation of smaller protein particles with increased surface area. These structural modifications facilitate interactions with water molecules and other food components, leading to improved solubility, emulsifying activity and foaming capacity. The findings of this study have important implications for the food industry, offering new opportunities to utilize DSPC as a sustainable and nutritious ingredient in various food formulations. By incorporating ultrasonic treatment into processing techniques, food manufacturers can develop products with enhanced nutritional value and improved sensory attributes.

However, several avenues for future research remain to be explored. Firstly, further investigations are needed to optimize ultrasonic treatment parameters for different types of DSPC and food matrices. Additionally, the underlying mechanisms of ultrasonic treatment on DSPC structure and functionality require more detailed elucidation, including the effects of ultrasonic frequency, power density and processing time. Moreover, the potential applications of ultrasonic treatment in other food systems beyond DSPC merit exploration. By expanding our understanding of ultrasonic treatment techniques, we can unlock new possibilities for enhancing the functionality of plant-based protein concentrates and developing innovative food products that meet the growing demand for sustainable nutrition. In conclusion, this study contributes to advancing processing techniques for plant-based protein concentrates and provides valuable insights for the development of functional foods with improved nutritional and sensory properties. Through interdisciplinary collaboration and continued research efforts, we can harness the full potential of high-intensity ultrasonic treatment to address current challenges in food production and meet the evolving needs of consumers for healthier and more sustainable food options.

Acknowledgement

Not applicable.

Conflict of Interest

There is no conflict of interest by author.

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