Advances in Food Process Engineering

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PREFACE

Food Process Engineering has witnessed remarkable transformations in recent decades, driven by the urgent need for sustainable technologies, effective waste valorization, and the growing consumer demand for natural, safe, and functional food products. The book “Advances in Food Process Engineering” is a compilation of recent innovations, emerging techniques, and interdisciplinary research in the domain, particularly focusing on bio-based materials, novel extraction techniques, and food preservation strategies.

This volume brings together eight carefully selected chapters that reflect the dynamic evolution of food process engineering. Each chapter is grounded in experimental work and offers insights into practical applications that contribute to enhanced food quality, safety, sustainability, and nutritional functionality. From the application of sodium alginate and kadam leaf extract coatings to extend the shelf life of cape gooseberry, to microwave-assisted protein extraction from mustard meal, the book explores cutting-edge research and development across diverse food matrices.

In particular, this book emphasizes the utilization of agro-industrial by-products, such as lemon waste, pineapple peel, coconut shell, and mustard meal, highlighting their potential to be transformed into valuable food additives, packaging materials, and bioactive compounds. It also introduces readers to eco-leather as a secondary packaging material, biodegradable films, and microencapsulation techniques, reflecting the growing trend toward green technologies and circular economy principles in food systems.

The intended audience includes food scientists, process engineers, researchers, graduate students, and industry professionals who are interested in sustainable innovation and novel applications in food processing. We hope this compilation will serve as both a reference and inspiration for ongoing research and industrial applications.

We extend our heartfelt gratitude to the contributing authors for their valuable research and to all those who supported the creation of this volume. It is our sincere belief that this book will contribute meaningfully to the growing body of knowledge in food process engineering and foster new ideas for future innovations.

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Chapter – 5

Optimization of ultrasound-assisted extraction of bioactive compounds from green coconut shell

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ABSTRACT

Coconut is a tropical fruit widely consumed across many countries. In numerous households, green coconut shells account for more than 60% of total waste by volume. These shells are primarily composed of lignin and cellulose—components similar to those found in wood—making them suitable for phytochemical extraction. To analyse these phytochemicals, ultrasound-assisted extraction was performed under varying conditions, including extraction times (10, 20, and 30 minutes), temperatures (30°C, 35°C, and 40°C), and solid-to-solvent ratios (1:10, 1:20, and 1:30). Optimization of the extraction process was achieved using Response Surface Methodology (RSM). Quantitative analysis of the extracts confirmed the presence of bioactive compounds such as phenols, flavonoids, and tannins, all of which contribute to notable antimicrobial and antioxidant activities. The results showed total phenolic content (TPC) ranging from 7.08 to 33.46 mg GAE/g, total flavonoid content (TFC) from 2.09 to 28.46 mg QAE/g, and total tannin content (TTC) from 70.5 to 141.09 mg TAE/g. The antioxidant activity ranged from 49.98% to 66.1%. The antimicrobial activity was also significant, with inhibition zones against *E. coli* ranging from 3.7 to 9.6 mm and against *S. aureus* from 5.8 to 11 mm.Fourier-transform infrared (FT-IR) spectroscopy

analysis revealed the presence of functional groups such as O-H, C=O, and C-H. Additionally, the optimized conditions for ultrasound-assisted extraction were compared to those of microwave-assisted extraction (300 watts for 2 minutes), and the ultrasound method yielded superior results.

Keywords: Green coconut shell, Phytochemicals, Ultrasound-assisted extraction, Response Surface Methodology

1. Introduction

The production of coconut waste has increased both in dry and green forms due to the higher consumption of coconut water. This consumption has led to a massive generation of waste. This waste is harmful to our environment and society. In India, the coconut is among the five Devavarikshas (God's trees) and is considered one of the most useful trees in the world. The uses of coconut can be judged by the Indonesian saying "There are many uses of coconut as there are days in the year". The coconut has been a great source of versatility. It is a tropical tree belonging to the Arecaceae family and has been described as the "tree of life". Coconut probably originated from Indo-Malaya and spread in tropical regions of the world (Prades, A. 2019). In India, the largest producers of coconut are the states of Kerala, Karnataka, and Tamil Nadu. The annual production of coconut fruit is 61.4 million metric tons with worldwide cultivation of 12.3 million hectares (Statista, 2020). India utilizes 50% of the yearly crop for culinary and religious purposes, 35% for copra, 2% for value-added product manufacture, 11% for tender applications, and 2% for seed purposes. Coconut trees may grow up to 30m in length, with pinnate leaves 4-6m long and pinnae 60 90 cm long (A.S. et al., 2013). Coconut fruit is surrounded by a hard shell and comes under the subcategory of Drupes. The fruit has three layers: the exocarp, mesocarp, and endocarp. Both exocarp and mesocarp make up coconut husk while green coconut shell is made by endocarp. The endocarp is filled with liquid endosperm and has an edible portion- coconut flesh (Bolivar-Telleria, M. et al., 2018).