

Chapter 6

Conclusions and future scope:

6.1 Conclusion:

The valorization of Queen Pineapple (*Ananas comosus*) waste in Northeast India holds substantial promise both economically and environmentally. Queen Pineapple, renowned for its superior taste and high nutritional value, is a significant crop in this region. However, the generation of waste, including peels, core, and crown, poses a considerable challenge. Effective utilization of this waste can transform it from an environmental burden into valuable resources, promoting sustainable development. The primary aspect of valorizing Queen Pineapple waste involves exploring various avenues for its utilization. This includes the extraction of bioactive compounds like bromelain, dietary fibers, and antioxidants.

The current investigation has evidenced that the Queen pineapple waste is remarkably high in dietary fiber (DF) and can be utilized as a dietary supplement. The optimized parameters of DF extraction by ultrasound-assisted extraction method revealed a solid: liquid ratio of 27.5 g/mL, an amplitude of 46.90%, extraction period of 22.35 min at constant hydrolysis temperature (60°C). Ultrasonic extraction evinced a better yield (86.67%) of DF compared to conventional (alkaline) extraction (64.43%) and the former also revealed better functional properties than the latter. FT-IR, XRD, SEM, and TGA of the ultrasound-assisted extracted (UAE) DF results evinced a typical polysaccharide structure with all the functional groups, semi-crystalline pattern, honeycomb structure with a rough surface, and good thermal stability as compared to the conventional and dried powder, respectively. UAE increased the surface porosity and semi-crystallinity of the DF which resulted in improved GAC and GDRI. Thus, ultrasound-assisted extraction can be used as a useful source of natural dietary fiber and as a supplement to improve the functional properties of foods.

Enzymatic modification of dietary fiber derived from pineapple waste resulted in increased soluble fiber content and improved structural characteristics, rendering it a promising functional ingredient for food applications. The comprehensive findings revealed that enzyme-modified dietary fiber (EMDF) obtained from pineapple waste exhibited enhanced water-holding capacity (WHC), swelling capacity (SC), oil holding capacity (OHC), cation exchange capacity (CEC), cholesterol adsorption capacity (CAC), and demonstrated hypolipidemic effects. The elevated WHC, SC, and OHC of EMDF can be attributed to the exposure of hydrophilic groups. Moreover, the higher CEC of EMDF is indicative of its favorable physicochemical properties. The increased CAC of EMDF is attributed to its structural alterations, expanded surface area, and higher porosity as demonstrated by scanning electron microscopy (SEM).

Enzyme-modified dietary fiber (EMDF) from queen pineapple waste was also effective for α -glycosidase, and α -amylase inhibition. The EMDF also showed strong inhibitory activity against DPP IV enzymes. After the *in vitro* toxicity study, it was also revealed that EMDF is nontoxic to human cell lines (Caco2 and Hepg2). The *in vitro* antidiabetic study revealed the health-beneficial potential of EMDF at different concentrations. An effective and popular molecular biology technique called RNA sequencing, or RNA-seq, offers previously unheard of information about an organism's transcriptional landscape. 2389 differentially expressed genes (DEGs) were identified by RNA-seq analysis between the treatment and control groups. The up- and down-regulated genes were 1298 and 1091, respectively. To examine the impact of the treated material on immunological function after it enters the human intestine and liver cell lines, as well as any potential molecular mechanisms, GO enrichment analysis was carried out following the DEGs found.

Incorporating various levels of enzyme-modified dietary fiber (EMDF) - 1%, 2%, 5%, and 10% of the flour mixture exerts notable impacts on both the chemical and physical characteristics of bread. It significantly influences attributes such as starch digestibility and glycemic index (pGI). Increased EMDF incorporation correlates with heightened bread hardness, with the highest total dietary fiber content observed at the 10% EMDF level. Furthermore, escalating EMDF levels result in decreased specific volume (5.28 cm³/g) and yield firmer bread characterized by elevated chewiness and reduced springiness, as evidenced by texture analysis data. Choosing an EMDF incorporation level of 5% of the flour mixture yields nutritionally balanced bread comparable to the control variant in terms of specific volume, hardness, and springiness. Moreover, functional bread maintains acceptable sensory characteristics concerning color, taste, tenderness, appearance, and overall acceptability. EMDF supplementation alters starch digestibility, notably reducing rapidly digestible starch (RDS) and increasing slowly digestible starch (SDS) content compared to the control. Additionally, functional bread fortified with EMDF exhibits higher resistant starch (RS) content compared to the control, indicative of its potential health benefits. The glycemic index (pGI) diminishes with increasing EMDF incorporation, with the lowest value observed in bread fortified with 10% EMDF, underscoring its potential as a low-glycemic option.

In conclusion, the valorization of Queen Pineapple (*Ananas comosus*) waste in Northeast India presents a multifaceted opportunity to address environmental challenges, promote sustainable development, and enhance economic growth. By transforming waste into valuable bioactive

compounds, the region can unlock the potential of this agricultural waste, contributing to a circular economy.

6.2 Future Prospects

The research work presents the waste utilization of queen pineapple and its valorization to develop a functional food. The extraction and modification of dietary fiber from queen pineapple waste were found to be non-toxic and with health-beneficial properties like anti-diabetic. Future research should focus on expanding the scientific knowledge and practical applications of dietary fiber extracted from queen pineapple waste, with emphasis on innovative extraction techniques and food product development. Techniques like supercritical fluid extraction could be explored to increase both yield and bioactivity of dietary fiber. Comprehensive nutritional and functional studies are needed to better understand the health benefits linked to its consumption. Prioritizing the creation of fiber-enriched food products, such as baked goods, snacks, and dairy alternatives, is essential, ensuring sensory attributes and consumer acceptance are optimized through pilot studies and market analysis. *In vivo* and clinical trials are also critical to validate health claims related to glycemic control and metabolic health, providing scientific backing for incorporating pineapple waste-derived fiber into functional foods. Additionally, life cycle assessments and cost-benefit analyses are vital to ensure large-scale production meets sustainability and economic goals. Promoting consumer awareness and education on the health benefits and sustainability of such products is crucial for market success. By addressing these research directions, future studies will enhance the valorization of pineapple waste, contributing to health promotion, sustainability, and innovation in the food sector.