Abstract

The present research focuses on investigating ethnomedicinal plants, specifically exploring their traditional uses and conducting a survey to document these practices comprehensively. The study aims to go beyond traditional knowledge by delving into the biochemical properties of these plants. This involves the characterization of their bioactive compounds and functional properties that could potentially enhance food product development, aiming for improved nutritional profiles or functional benefits. Moreover, the research extends into the field of encapsulation technology, exploring how plant extracts can be effectively encapsulated into beads. This encapsulation process is crucial as it not only preserves the bioactive compounds but also facilitates their controlled release and integration into food products, enhancing their functionality and potential health benefits. Ultimately, the study seeks to bridge traditional ethnomedicinal knowledge with modern scientific approaches to innovate in the realm of food science and technology.

The Thesis is divided into eight chapters that are discussed below:

Chapter 1 includes the general introduction of the overall work of our research examining the critical importance of ethnomedicinal practices in modern healthcare systems. It also investigates the possibility for treating numerous ailments in the North-east region, which is rich in biodiversity. Furthermore, we highlight the use of green extraction technologies and environmentally friendly solvents in current research activities, as well as the optimization of phytochemical extracts in plants. By eliminating toxic chemicals, we help to ensure environmental sustainability. In addition, we address the emerging practice of adding phytocompounds into food products for their health benefits. Encapsulation techniques improve compound stability, making them a good choice for functional meals.

Chapter 2 comprises of the review of literature cited related to the research objectives. Our research embarks on a journey through ethnomedicinal plants, emphasizing its significance within modern healthcare systems. The North-east region, rich in biodiversity, emerges as a hotspot for exploring novel treatments. We delve into green extraction technologies, advocating for eco-friendly solvents to mitigate environmental hazards. Furthermore, we discuss the integration of phytocompounds into food products, a trend driven by their health benefits, and explore encapsulation techniques for compound stability. In this chapter, we unravel the pivotal role of medicinal plants in disease

prevention. Their natural antioxidants combat oxidative stress, promoting health and longevity. Hypertension, a major cardiovascular concern, takes center stage. We delve into angiotensin-converting enzyme (ACE) inhibitors, essential for blood pressure management. Simultaneously, we champion green extraction techniques, emphasizing cleaner, more efficient processes. Lastly, we explore how encapsulation enhances the oral bioavailability of natural antioxidants, revolutionizing their application.

Chapter 3 describes ethnopharmacological field investigations into key indigenous plant species, primarily in the search for new treatments and products. The current study provides thorough information on the Thadou-Kuki tribe's traditional use of ethnomedicinal herbs in Churachandpur district, Manipur. An open-ended, semi-structured questionnaire was administered to 80 informants. The Informant consensus factor (ICF) and Fidelity level (FL) were used to assess the collected data. The survey identified 55 therapeutic plants across 55 genera and 34 families. The Asteraceae family was the most prominent of the other families. Herbs accounted for the largest proportion of indigenous people in the community (38.18%). The leaves were the most used plant part. Decoction and oral intake were found to be the most common ways of preparation and application, respectively. The consensus analysis found that liver ailments, cardiovascular problems, and respiratory diseases had the highest ICFs (0.96, 0.92, and 0.91, respectively). While at least three plant species used to treat hypertension and one plant species used to treat gastrointestinal disorders demonstrated 100% FL value. Our findings revealed that the inhabitants of the researched area continue to use medicinal plants to cure a variety of ailments. Our findings will provide baseline data for establishing the relationship between traditional knowledge professionals and scientific researchers. Given the higher Fidelity value in the cardiovascular section and the Consensus information discovered, it was agreed that further physicochemical analysis and potential antihypertensive activity would be carried out in the plants namely *Passiflora edulis* Sims, *Plantago major* L, *Clerodendrum glandulosum* Lindl., *Solanum indicum* L, *Centella asiatica* (L) Urb, and *Phlogocanthus thyrsiformis* (Roxb. Ex. Hardw.) Mabb. All 80 responders strongly supported the usage of these plants to treat cardiovascular diseases.

Chapter 4 discusses two subheadings consisting of (a) Qualitative phytochemical (b) Quantitative phytochemical analysis of the six selected plant samples.

4(a). This subsection summarizes the proximate, elemental, phytochemical, and antimicrobial analyses of six medicinal plants used in Manipur: *Passiflora edulis* Sims, *Plantago major* L, *Clerodendrum glandulosum* Lindl., *Solanum indicum* L, *Centella asiatica* (L) Urb., and *Phlogocanthus thyrsiformis* (Roxb. Ex. Hardw.) Mabb. The proximate analysis includes ash, moisture, protein, fiber, lipids, and carbohydrates. The elemental analysis was carried out utilizing energy dispersive X-rays and a variable scanning electron microscope (SEM-EDX). The medicinal plants had thirteen elements, with relative weight percentages assigned to C, O, Mg, Al, Si, P, S, Cl, K, Ca, Fe, Br, and Mo. Plants' proximate and elemental compositions reveal important information about their medicinal and nutritional value. The plants' mineral composition suggested that they could help maintain low blood pressure and other cardiovascular problems. Plant extracts were phytochemically analysed and found to contain saponins, tannins, alkaloids, flavonoids, phenolics, and glycosides. Ethanolic extracts from all six plant samples shown high antibacterial activity against all tested bacterial strains. Finally, plant extracts are effective natural antimicrobials that can be safely utilized as food preservatives. With the current expansion in the usage and consumption of raw plant materials, it is more necessary than ever to monitor these plants since they may serve as a source of new medication and food development.

4(b). described the plant extracts utilizing three methods: solvent extraction, ultrasound-assisted extraction, and supercritical fluid extraction. Extracts from six selected plants were studied., *Clerodendrum glandulosum* Lindl. had the highest TPC and TFC values respectively when tested using ultrasound. *Phlogocanthus thyrsiformis* (Roxb. Ex. Hardw.) Mabb. finished second. HPLC analysis, along with antioxidant assays (DPPH, FRAP, and ABTS), led to the discovery of antioxidant compounds. While all species extracts include antioxidants, *Clerodendrum glandulosum* Lindl., and *Phlogocanthus thyrsiformis* (Roxb. Ex. Hardw.) Mabb were the most effective radical scavengers and reducing agents. This could be attributed to its increased phenolic content compared to other species. The RP-HPLC analysis revealed that all of the plant samples contained phenolics, with gallic acid being the most common. The UAE-extracted *Clerodendrum glandulosum* Lindl. extracts were found to be the most effective inhibitors of the ACE enzyme. Overall, the extracts of all the species, particularly *Clerodendrum glandulosum* Lindl. and *Phlogocanthus thyrsiformis* (Roxb. Ex. Hardw.) Mabb, should be considered promising sources of phyto-ingredients with pharmacological properties.

Chapter 5 describes the successful use of RSM to optimize the phytochemical components and antihypertensive activity of *Clerodendrum glandulosum* Lindl. with CCD proving to be an efficient tool for optimizing these parameters. Second-order polynomial models for predicting responses were created, and the best extraction duration, power, and solvent concentration in the UAE were determined to be 19.27 minutes, 152.52 watts, and 70% ethanol, respectively. The best extraction parameters for SFE were 40 minutes, 64.84°C, and 250 bar. FT-IR examination of the secondary metabolites found in both the UAE and SFE extracts revealed the presence of an O-H stretch in hydrogen-bonded hydroxyl groups, which is crucial in the study of plant extracts since it can suggest the presence of phytochemicals like phenol. As a result, *Clerodendrum glandulosum* Lindl. could be a natural source of polyphenol compounds that can be used as functional food ingredients or in pharmaceuticals to treat cardiovascular disease. This study demonstrates that leaf extracts of *Clerodendrum glandulosum* Lindl. (using UAE and SFE) are an effective treatment for a variety of inflammatory diseases. The extracts were non-toxic to THP-1 cells and effectively inhibited the generation of inflammatory mediators such IL-1β, TNF-α, and COX-2 in macrophages. As a result, it could be a promising avenue for future study into developing anti-inflammatory medications or formulations as nutraceuticals or functional components.

Chapter 6 summarizes the development of pasta using selected plant leaf extracts and leaf powder. Health-conscious individuals are looking for pasta products that are high in minerals, phenolic compounds, and have a low glycemic index. This study investigated the impact of *Clerodendrum glandulosum* Lindl. leaf powder and leaf extract powder on pasta quality. Functional pasta was made by combining durum wheat semolina, leaf powder, and extracted leaf powder. Plant and extract powder were added to the formulation in four different amounts (2.5%, 5.0%, 7.5%, and 10%, respectively). The cooking attributes, textural properties, color, phytochemical properties, and sensory characteristics of the final products were also studied. The addition of leaf powder and extracts significantly increased antioxidant activity and total phenolic content. The moisture content drops (55.79 ± 1.53 to 48.58 ± 1.51%) when the leaf or leaf extract powder concentration increases. Functional pasta had lower swelling and water absorption indices than control pasta. The addition of additional leaf and extract powder lowered the product's lightness (L*) and yellowness (b*), while increasing its redness (a*). The hardness, springiness, and chewiness were determined to be much lower than the Control. The

current study's findings revealed that among fortified pastas, the pasta with *Clerodendrum glandulosum* Lindl. additions up to E-2.5% had the highest sensory acceptability. Good marketing expectations are set because it provides sensory acceptability comparable to the standard product.

Chapter 7 highlighted the use of plant extract beads and their inclusion into pasta. *Clerodendrum glandulosum* Lindl. is a potential source of phytochemicals for use as a functional component in foods; however, its low resistance to oxidation and thermal degradation limits its practical application. The purpose of this research was to encapsulate ultrasonicated aqueous leaf extracts of *Clerodendrum glandulosum* Lindl. hydrogel beads with sodium alginate in a calcium chloride solution to produce heat-resistant components for culinary applications. The beads were then incorporated into four distinct pasta formulations: 2.5%, 5%, 7.5%, and 10%. Furthermore, the developed pasta was evaluated for total phenolic content (TPC), antioxidant stability, texture, and cooking properties. Increased formulations led to significant increases in TPC content and antioxidant content respectively. The FTIR measurements were also positive when we increased the formulations. SEM micrographs revealed that the surface morphology of the pasta sample with beads is more varied. In conclusion, our study's findings suggest that *Clerodendrum glandulosum* Lindl. could be used as a component in fresh pasta as a healthy dietary option.

Chapter 8 deals with the concluding remark of each objective with its future scope. Objective 1 concludes that ethnopharmacological field studies are essential for learning about key indigenous plant species, especially in the hunt for new treatments and products. The current study provides thorough information on the Thadou-Kuki tribe's traditional use of ethnomedicinal herbs in Churachandpur district, Manipur. Our findings revealed that the inhabitants of the researched area continue to use medicinal plants to cure a variety of ailments. Our findings will provide baseline data for establishing the relationship between traditional knowledge professionals and scientific researchers. Objective 2 revealed the qualitative and quantitative phytochemical analysis of plant extracts the presence of saponins, tannins, alkaloids, flavonoids, phenolics, and glycosides. Ethanolic extracts from six plant samples exhibited strong antibacterial activity against various bacterial strains. These natural antimicrobials could be safely used as food preservatives. Monitoring these plants is crucial due to their potential as sources for new medications and food development. RP-HPLC analysis confirmed the presence of phenolics, with gallic

acid being the most abundant. Objective 3 focuses on the study on the leaf's extracts of *Clerodendrum glandulosum* Lindl. (optimized samples of UAE and SFE) is an effective choice for treating a variety of inflammatory illnesses. When fed to THP-1 cells, the extracts were found to be non-toxic, and they showed potent anti-inflammaotory activity by inhibiting the production of inflammatory mediators such as IL-1β, TNF-α, and COX-2 in macrophages. Objective 4 examined the effect of adding leaf powder and leaf extract powder of *Clerodendrum glandulosum* Lindl. on pasta quality. These tests demonstrated that the fortified pastas were highly palatable. Good marketing expectations are established since the sensory acceptance is comparable to the standard product. Objective 5 concluded that encapsulates of ultrasonicated aqueous leaf extracts of *Clerodendrum glandulosum* Lindl. beads with sodium alginate in a calcium chloride solution were made and incorporated into pasta. In conclusion, the findings provided in this study reveal potential prospects for *Clerodendrum glandulosum* Lindl. utilization as a component in fresh pasta as a healthy dietary option.