Chapter-1

Introduction

1. Introduction

Terminalia chebula Retzius (Haritaki) is widely cultivated in South East Asia including India. It is referred to as "Haritaki" in Sanskrit and "Harad" in Hindi and one of the most frequently used herbs in Ayurveda. It is believed as the 'King of Medicine' in Tibet and Ayurvedic Materia Medica places substances with extraordinary therapeutic characteristics at the top of the list [28]. It is referred to as a hub of medicinal activities and an important ethnomedicinal plant of human society. It has been used as medication to treat illnesses from ancient times. The fruit is drupe-like and is between 1.2 and 2.5 cm in width and 2 to 4.5 cm in length. It has five longitudinal ridges and a black or yellowish-brown mark on it. Astringent, acidic, and sweet flavours are present in the starchy, fibrous fruit [29]. Haritaki is thought to contain a variety of biochemicals, including hydrolyzable tannins, phenolic compounds, and flavonoids; as a result, it might be a useful therapeutic option. Its high tannin content (32%) contributes to its bitter and astringent flavour and is the key factor in the consumer's uncommon acceptance of the product.

A sizable section of the world's population, mostly in underdeveloped nations, only uses the traditional medical system. The balanced nutrition is being impacted by modern eating practises. Life is no longer normal since there is an ever-widening nutrient intake gap. In this setting, consumers frequently use herbal medicines and dietary supplements as complementary or alternative goods. Theraupetic activities of *T. chebula* have included hypocholesterolaemia, anti-inflammatory, anti-allergic, antibacterial, and antioxidant effects, among others [16, 32]. These characteristics result from the fruit's content of phytochemicals, particularly phenolics and flavonoids [32]. Plants have long been used as a source of medicine, and India's healthcare system heavily relies on this tradition. Today, it is becoming more and more evident that many diseases are brought an imbalance results in "oxidative stress," between pro-oxidant generation and detoxification. Therefore, using haritaki with antioxidant activity to guard against oxidative stress has garnered more interest from phytotherapy researchers [24].

The process of drying, which occurs between the interior of the material and the drying air under temporary conditions that cause changes in the material during drying and prevent potential deterioration, contamination, and other factors during lengthy storage periods, is a crucial preservation technique [22]. Thin layer drying models of agricultural goods are used to represent the drying phenomenon, which is both theoretical and empirical [25]. Simple techniques like sun drying or mechanical dryers like tray dryers can be used to dry agricultural produce [3]. Different biological materials have different physiochemical properties, which necessitates adjusting the drying processes and parameters to match the requirements for the final product's quality [23]. Sun drying has some drawbacks, including a greater labour cost, a need for a broad area, contamination with foreign materials and bug infestations that can cause damage or sickness, and a lengthier drying time, especially during wet seasons [18]. There are numerous drying techniques available, including hot air drying (convective), vacuum drying, and freeze-drying [26]. Due to its numerous benefits, including faster and more uniform drying than solar drying, tray drying is a prominent drying method in many industrial applications. It has a straightforward design and can dry goods in large quantities [21]. Alternative dehydration techniques, such as vacuum drying, are thought to be suitable for heat-sensitive materials like fruits [6]. The benefit of this method is that it results in shorter drying times, uses lower temperatures and less energy, and prevents food molecules from oxidising by removing oxygen from the drying process [1, 5]. Lyophilization, also known as freeze-drying, is favoured for drying temperature-sensitive products because it is recognised to preserve a product's qualities the best compared to when it was fresh [2].

In comparison to traditional procedures supercritical carbon dioxide ($scCO_2$) extraction has been demonstrated to be a more effective method than processes like hydrodistillation, steam distillation, and solvent extraction way for extracting aromatic lipophilic chemicals from natural resources. The use of safe solvents, moderate temperatures to minimise thermolabile chemical degradation, the ability to alter selectivity, improved resource utilisation, and increased extraction efficiency are all features of this extraction technique [33].

Numerous papers have emphasised the benefits of employing supercritical fluid extraction to reduce labour costs, increase shelf life, and save energy during the extraction process. A recent, eco-friendly method for selectively extracting lipophilic, non-polar, or moderately polar compounds that has been utilised with success for related molecules is called supercritical CO_2 extraction [17, 30].

In order to prevent component deterioration, thermal pre-treatments and treatments that elevate the temperature continuously must be optimised. Mechanical pre-treatments are sufficient for plant materials with a compact cellular wall. In addition, some materials, such the Usnea barbata lichen and the Nannochloropsis oculate algae [7, 14], require a significant alteration in the structure of the material as well as a reduction in particle size. However, these processes may cause an excessive loss of vital materials, especially volatile compounds. Although it takes time, soaking the substance in ethanol and water might weaken the cellular structure of the material and make solvent penetration easier [34]. By applying microwave radiation to plant material, energy is directly transferred, resulting in electromagnetic field interactions with molecules. In this manner, consistent heating can be achieved rather quickly. This increases the material's porosity, allowing the solvent to penetrate more easily and the chemicals to be more readily available [27]. Given that microwave radiation involves the release of energy that is largely moisture content absorbed by the plant, combining moistening and microwave exposure can result in a considerable increase in material permeability in a short period of time [10]. Enzymatic pre-treatment is a biodegradation process that breaks the cellular wall in moderate circumstances. This preparation can increase the amount of oil released by the plant [20]. The enzymatic pre-treatment also has the benefit of not requiring complicated equipment [19].

Bioactive substances found in haritaki have a very delicate nature and require protection from the outside environment. A biopolymer can protect a bioactive chemical from oxygen, water, light, or other environmental factors, increasing its stability and converting liquid solutions into powders for easier management [8]. The capacity to form films, viscosity, solids content, hygroscopicity, gastrointestinal tract resistance, biodegradability and price should all be taken into consideration when using different encapsulating agents, both individually and in combination [31]. Bioactive substances have been encapsulated using a variety of techniques using food-grade polymers and proteins [4]. Zein, a protein found in corn that is alcohol-soluble and high in prolamine, is one of them. Three parts of the amino acids are lipophilic, while one portion is hydrophilic [9]. It is useful for encapsulating delicate lipophilic bioactive chemicals due to its excellent mechanical properties, high temperature resistance, film-forming prowess, biocompatibility, oxygen barrier, moisture barrier, and biodegradability [12]. Zein protein, according to research, is steady in a simulated stomach environment lasting up to 120 minutes but becomes unstable in just 30 sec in a simulated intestinal environment. It demonstrated that zein will improve the bioaccessibility of the sensitive bioactive molecule by boosting its defence against gastric circumstances and encouraging release of the compound only in intestinal fluid [11]. By using a phase separation approach and creating powder by drying in a rotary evaporator [15], encapsulated β-carotene in zein nanoparticles, achieving regulated administration and improved pharmacokinetic properties. Oil and surfactants have also been employed as carriers for lipophilic compounds in addition to zein [13].

Our best understanding tells us that there is limited research focusing on drying characteristics of haritaki pulp and extraction of phytocompounds using novel green technologies. Hence, the present research has been formulated to assess the impact of drying techniques on the phytocompounds and determined by the chemical's retention in dried matter, selected for further research work. Thereafter, to enhance the extraction of phytocompounds, different novel green pre-treatment methods are combined and extracted the phytocompounds using SFE. The extracted compounds are encapsulated via conventional and advanced methods to confer the stability of bioactive compounds and the encapsulates are used for the development of functional yoghurt.

The whole work is divided into the following objectives to achieve the aim of the present research/thesis:

1. To study the drying behavior of fresh haritaki (*Terminalia chebula*) fruit
2. To extract the bioactive compounds from fresh and dried fruit using various green and novel technologies and their combination
3. To encapsulate the bioactive compounds extracted from haritaki using a combination of biopolymeric materials
4. To develop a functional yoghurt by incorporating extract and microencapsulated extract containing bioactive compounds from haritaki

2. References

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