Chapter 1

Chapter I

Introduction

1.1 Preamble

Turmeric (*Curcuma longa* L.) is one of the major crops in India, and India has the largest share in the world in terms of its production, consumption and export. In the year 2022-23, India produced 11.61 lakh tons (over 75% of global turmeric production) of turmeric grown across more than 20 states. More than 30 varieties of turmeric are grown in these states. In the year 2022-23, India exported 1.534 lakh tons of turmeric worth 207.45 million USD, which constitutes over 62 % of the world's turmeric exports (Prasath et al., 2024). Depending on the consumer requirement, turmeric is commercialized as a whole, as a ground powder, or in extracted forms such as curcumin. While consumers in poor nations prefer whole turmeric and those in urban areas prefer powdered forms, Western consumers prefer finely ground turmeric. Additionally, oleoresins and ground turmeric are used in the Western institutional sector. No extra attention is required when producing ground turmeric because it is quite stable at mild temperatures. Bulk turmeric powder is kept out of the elements and in containers that don't absorb moisture. For up to six months, these products remain stable (Amalraj et al., 2017).

Turmeric has various uses. In India it is mostly used as a culinary ingredient of daily diet for imparting color and utilize its medicinal properties. In addition, turmeric constitutes an important ingredient of various medicinal products in Asian countries such as Ayurveda, Siddha medicine, Unani, and traditional Chinese medicines (Bhowmik et al., 2009). Considering the medicinal benefits from turmeric powder, its utility as an ingredient in infusion drink is explored in this work.

Table 1.1 Chemical Composition of Turmeric Rhizome

6–13% moisture
60–70% carbohydrates
6–8% protein
2–7% fiber
3–7% mineral matter
5–10% fat
3–7% volatile oil
2–6% curcuminoids

Turmeric rhizomes contain color-enhancing pigments, as well as essential and fixed oils, flavonoids, bitter principles, carbohydrates, protein, minerals, and vitamins. Typical

composition of turmeric rhizome is shown in Table 1.1. Near the turmeric rhizome, the major components of the spice is carbohydrate (Ariyarathna & Karunaratne, 2016).

From the perspective of the final product's look and color, processing raw rhizomes becomes crucial. Curing, drying, polishing, and grinding are the steps involved in processing turmeric immediately after harvest (Bora et al., 2015)

Before drying, turmeric rhizomes are treated. In essence, curing entails softening fresh rhizomes by boiling them in water, followed by drying (Bezbaruah & Hazarika, 2014). Boiling eliminates the raw odor, speeds up drying, produces an evenly colored product, and kills the vitality of fresh rhizomes (Hailemariam, 2023). Rhizomes can be boiled in copper, galvanized iron, or earthen pots with just enough water to soak them, according to some ancient techniques of curing turmeric. When froth forms and white vapors with the characteristic turmeric scent are released, the boiling process is stopped. The rhizomes are tender after 45 to 60 minutes of simmering. Compared to fingers, bulbs take longer to cook.

Cooking rhizomes before drying speeds up the dehydration process, aids uniform drying, and encourages the starch to gelatinize. Additional advantages include a more appealing result that is less wrinkled and makes polishing easier, as well as a consistent distribution of hues throughout the rhizome (Prasad et al., 2006).

Because it is simpler to attain a lower final moisture content in small pieces of rhizome without compromising the product's quality, the rhizomes are sliced before drying in order to shorten the drying time and enhance the quality of the finished product. After cooking, the fingers or bulbs are dried until their final moisture content is between 10 and 12 percent. The pieces of rhizome are typically spread out on spotless concrete floors and allowed to dry in the sun. Depending on the environment and the size of the rhizome pieces, this process may take anywhere from 10 to 15 days. Turmeric can be dried using several kinds of mechanical dryers. These consist of cabinet driers, solar driers, cross flow air tunnels, and tray driers.

Traditionally produced turmeric powder fulfils the requirements of its culinary use i.e., the release of the color when cooked in curry. For this the traditional processing of turmeric involves curing the cleaned rhizomes by Cook the rhizomes by boiling them in water. After being cured, the rhizomes are dried until they are brittle and rigid. After being dried, rhizomes are "polished" by hand rubbing and then ground into a powder.

However, the quality enhancement by processing of turmeric depends on the presence of the strong bioactive compound i.e., curcumin. Curcumin is an orange-yellow crystalline powder obtained by solvent extraction of turmeric and purification of the extract by crystallization. Curcumin, or 1,7-bis-(4-hydroxy-3-methoxy-phenyl)-hepta-1,6-diene-3,5-dione, and its desmethoxy- and bis-desmethoxy-derivatives in different ratios make up most of the product.

Curcumin has several biological effects, exhibiting anti-inflammatory, antioxidant, and hypolipidemic activities. Curcumin is being studied extensively as a chemo preventive agent in several cancers (Galano et al., 2009). It has been suggested that curcumin may contribute in part to the lowered rate of colorectal cancer in Asian countries. However, when turmeric powder is used as a culinary ingredient, the full benefit is not available due to lower curcumin content. Turmeric powder having an improved rate of water infusion of curcumin is likely to facilitate better availability of curcumin when consumed as a drink. A better release of curcumin is proposed to be achieved by the microstructural modification of the rhizomes during the curing process, by subjecting it to the instant controlled pressure drop (ICPD) treatment.

1.2 Opportunity for ICPD based Interventions in Turmeric processing

An inventive method for improving solute migration rates is ICPD treatment, which modifies the food material's structure before drying. As a high-temperature short-time (HTST) steam treatment, the ICPD involves exposing food items to high steam pressure (P<1.0 MPa) for a brief amount of time. Following the HTST process, there is a quick drop in pressure to a vacuum state (to 3.0 to 5.0 kPa in around 10 to 60 ms), which causes a mechanical impact and the subsequent auto-vaporization of some of the product's water. The product's rapid cooling prevents thermal deterioration and allows for controlled product expansion (Mounir et al., 2012).

In this work, the name instant decompression assisted steam curing (IDASC) process is used to refer to the process of curing of turmeric slices by the ICPD treatment. The combination of the process of IDASC and appropriate follow-up drying is taken up for this investigation to assess the effects IDASC on the drying time and quality characteristics viz. curcumin content and yellowness value (YV), thereby to optimize the IDASC process conditions for the production of high-quality turmeric powder.

Refractance window drying (RW drying) is recognized for providing high-quality powders and flakes at comparatively lower operating costs and time requirements as compared to traditional

drying methods (Talukdar et al., 2025). RW dried items have a longer shelf life and are less susceptible to oxidation and the production of free radicals. RW drying is a new non-thermal technique for drying items, such as fruit and vegetable slices and heat-sensitive purees. This direct drying process has several uses in the pigment handling, pharmaceutical, nutraceutical sectors due to its many benefits (Marsiglia et al., 2021). The benefit of utilizing RW drying as a follow up drying for the IDASC process is taken up for comparison with that for hot air drying.

A drink as an infusion is created by adding a flavoring component to a liquid, like hot water. One of the main sources of phenolic compounds in our diet is herbal infusions. Research on the phenolic profiles and antioxidant activity of herbal infusions is still ongoing. The main focus of this study will be on applying the IDASC procedure to guarantee a drink with excellent curcumin quality.

1.3 Objectives:

Following objectives are taken up in this study.

1. **To enumerate the effects of instant decompression assisted steam curing (IDASC) in inducing swell drying of turmeric slices**
2. **To standardize the processing condition of IDASC parameters for improved quality of turmeric powder**
3. **To evaluate a curcumin enriched infusion drink based on turmeric powder obtained by incorporation of IDASC treatment**

1.4 Justification

Justification for Objective 1

The tasks for this objective will be implemented with the hypothesis that the IDASC treatment in combination with hot air-drying process (named as IDASC+HAD) improve the quality of dried turmeric slices in terms of drying behaviour and curcumin content. A comparison of the turmeric powder quality obtained from IDASC+HAD against the powder obtained from the conventional hot air drying (HAD) would be utilized to validation. A standardized condition of IDASC treatment will be identified and will be utilized in the next objective.

Justification for Objective 2

Turmeric powder mix will be produced based on the standardized conditions of IDASC (standardized conditions obtained in objective-1) and Refractance window drying based hybrid approach (named as IDASC+RWD). Properties of the turmeric powder obtained from IDASC-HAD, IDASC-RWD and conventional drying methods will be compared. Response surface methodology (RSM) based approach will be utilized to identify the best processing conditions in terms of treatment pressure, duration, and drying temperature by comparing the responses in the forms of curcumin content and phenolic compounds.

Justification for Objective 3

This objective will determine the optimum formulation for the IDASC+RWD based curcumin rich drink. The infusion quality along with sensory properties will be evaluated for the formulations. To prepare the IDASC turmeric powder-based infusion drink, vanilla, lemon flavour, honey, and rock sugar will be used. The loss in quality of the drink with time will also be investigated.

1.5 Arrangement of thesis

The thesis is arranged in five chapters for sequential presentation of the work done and respective findings.

Chapter 1: This chapter gives a summary of the work and introduces the proposed idea. Brief literature is presented in support of the work. The chapter extends to a discussion of the research gap and including scientific justification, followed by objectives of the research work.

Chapter 2: This chapter consists of a literature review of the work that helped to foster rational research and better understanding of concept of the topic.

Chapter 3: This chapter gives an account of the material and methods, and the methodology implemented for completing the objective.

Chapter 4: This chapter gives an account of the findings of the investigations carried out against each of the objectives. Based on the findings, the rationale of the benefits of the IDASC intervention is presented

Chapter 5: This chapter gives summary of all research work and findings.

1.6 Chapter Summary

A technique called instant decompression assisted steam curing (IDASC) is utilized to raise the effectiveness of turmeric curing. Here is a rundown of its advantages that is aimed to be established. Traditionally, turmeric is cured by steam, which helps to activate the enzymes and

improve the flavor and color. The immediate decompression introduced by the IDASC technique would improve this procedure. The turmeric quickly decompresses when it meets steam. The extractability of useful chemicals from turmeric would be improved by this abrupt drop in pressure. Turmeric would yield a superior color, and additionally, it would raise the concentration of curcumin in a water extract.