DEVELOPMENT OF NUTRITIONALLY IMPROVED DATES-NUTMEG TART FORTIFIED WITH TAMARIND SEED POWDER

Dissertation submitted to Mahatma Gandhi University in partial

Fulfilment of the requirements for the award of degree of

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B. Voc Food Processing Technology

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DECLARATION

We, **Nandana Jayan (VB21FPT011), Nusha Sultan (VB21FPT015) and Sneha P Ullas (VB21FPT020)** hereby declare that the project entitled "**Development of Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder**" is a bonafide record of the project work done by us during the course of study and that the report has not previously formed on the basis for the award to us for any degree, diploma, fellowship or other title of any other University or society.

Date: Nandana Jayan

Place: Nusha Sultan

Sneha P Ullas

CERTIFICATE

This is to certify that the project entitled "**Development of Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder**" submitted in partial fulfilment of the requirements for the Award of the degree of B.Voc.Food Processing Technology to St.Teresa's College, Ernakulam is a record of bonafide research work carried by Nandana Jayan, Nusha Sultan and Sneha P Ullas under my guidance and supervision and that no part of the project has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prize and that the work has not been published in part in any scientific or popular journal or magazine.

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ABSTRACT

The integral role of seeds in pre-agricultural diets is understandable given their high energy and nutrient density. Seeds are also particularly important in human nutrition because of their unique composition in bioactive compounds. Tamarind (*Tamarindus indica* L.) is a member of the dicotyledonous family Fabaceae (Leguminosae). It grows in more than 50 countries of the world. While *Tamarindus indica* is believed to be native to tropical Africa, it has been cultivated for an extensive period of time on the Indian subcontinent. The tamarind seed, often overlooked in the tamarind pulp industry, is an undervalued resource with potential for various applications. While only a fraction of the seed is currently utilised in industries such as textiles and paper through tamarind kernel powder (TKP), there is a vast untapped potential for its use in other sectors. Despite the numerous possibilities for incorporating tamarind seed into food formulations and other products, it remains largely unexplored. The present study aimed at the "**Development of Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder**" using descriptive-quantitative research methods. In this experimental study, a tart shell prepared using roasted wheat flour and tamarind seed powder combined with equal parts of sugar and butter was made. A date-nutmeg filling was prepared in (75%+25%) ratio by first grinding the dates into a paste consistency and straining it to get rid of any unwanted skin. The nutmegs were first blanched at 100 degree celsius for 7-8 minutes and shredded into fine flakes which was combined with the dates paste and simmering it on high heat until a thick filling consistency was attained. Standardization of Tamarind seed powder to Wheat flour were prepared in six varying ratios like S1(0%+100%), S2(10%+90%), S3(20%+80%), S4(30%+70%), S5(40%+60%) and S6(50%+50%). The study determined the most preferred concentration of tamarind seed powder added to the tart shell recipe based on sensory evaluation using descriptive testing of the product's colour, taste, aroma, texture and acceptability rating of the six formulations. Out of the six varying concentrations of tamarind seed powder to wheat flour, the optimal ratio of sample S5(40:60) obtained the highest sensory acceptability of the sensory panel. Proximate analysis resulted in high carbs, potassium, magnesium and calcium levels in the final product. The Shelf life of the refrigerated tarts was longer (6 weeks) compared to those stored at room temperature, which showed signs of spoilage after 4 weeks. The result suggested that the tamarind seed powder based date-nutmeg tart is a good source of potassium and magnesium and is capable of providing opportunities in developing nutritious products from waste utilization of tamarind seed in the food industry.

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CHAPTER 1 INTRODUCTION

The current food industry places a strong emphasis on the creation of convenient health foods that offer not only nutritional value but also functional benefits. This shift in focus is in response to the growing demand from consumers who are becoming more health conscious. To cater to these consumer needs, an experimental study was conducted, specifically targeting the nutritional information required for developing baked products such as pastry dough and fillings. The aim of this study was to not only ensure superior taste and sensory qualities but also to provide consumers with the nutritional and functional benefits they are seeking. This development in modern food technology offers an alternative avenue for individuals who may struggle to prepare their own healthy meals, allowing them to conveniently obtain the desired supplements or special nutrients from prepared baked products of their choosing.**(Aller et al., 2015)**

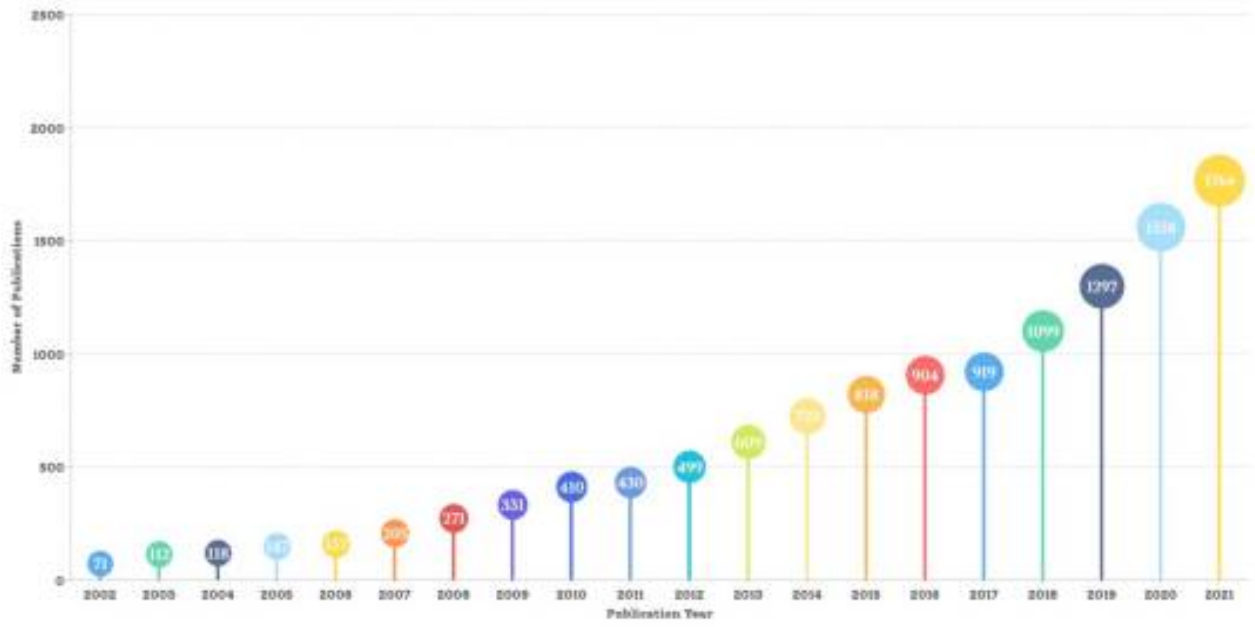


Fig 1:1 Annual global publications on healthy eating research between 2002 and 2021.

Source: (Fang T et al ., 2023)

A pastry is a type of dough made with a mixture of flour, water, and shortening that can be either savoury or sweet. Sweet pastries are often considered a form of confectionery created by bakers. The term "pastries" encompasses a wide variety of baked goods made with ingredients like flour, sugar, milk, butter, shortening, baking powder, and eggs. In French cuisine, the word "tarte" can be translated as either pie or tart, as they are similar in nature but with slight differences - pies typically have a pastry covering the filling, while tarts and flans

have an open top. Tarts are a type of baked dish consisting of a filling placed over a pastry base with an exposed top. According to the Oxford Companion to Cooking by Davison Allan, tarts are usually made with a short crust pastry and can have sweet or savoury fillings. Modern tarts are often fruit-based and can be enjoyed as a dessert or a savoury dish. Tarts are commonly consumed as small treats in upscale dining establishments and are not as widely enjoyed by the general public. The creation of tamarind seed powder tarts can offer tangible benefits not only to potential investors but also to those involved in tamarind cultivation. (Curammeng et al., 2021)

Tamarind seed powder, also known as TSP, is derived from the seeds of the tamarind plant and is a naturally occurring hydrocolloid. (Mohite et al ., 2020). It has been recognized for its potential to be extensively utilised in the food industry due to its various properties and characteristics.Tamarind is readily available and accessible at all times, as it can be found in abundance even in the backyard of numerous households. Additionally, it can be conveniently purchased from the market at a significantly affordable cost. In the Tamarind industry the tamarind seed is a residual product of the pulp industry and is commonly disposed of as waste following pulp extraction. Tamarind seeds are a necessary raw component in the food industry because of their ability to substitute traditional food additives and their nutrient- and phytochemical-rich qualities. (Hiwale,2015).

Tamarindus indica is renowned worldwide for its exceptional nutritional value and its ability to promote good health. In recent times, there has been significant research conducted on natural antioxidants and their role in preventing and treating various ailments. Tamarindus indica is particularly notable for its abundant presence of polyphenol and flavonoid compounds, which are believed to be responsible for its high antioxidant activity. These phenolic compounds found in tamarind have proven benefits for cardiovascular and immunological health, as well as specific functions in combating microbes and fighting cancer. Moreover, the flavonoids found in different parts of the tamarind tree have been identified as effective anti-inflammatory, antidiabetic, and antihyperlipidemic agents, offering potential treatments for a range of human health risks. (Devi et al, 2020).

Table 1.1 Average antioxidant composition of 100g Tamarind seed

Source : Richa et al ., 2018

Antioxidants	Chemical Value
Radical Scavenging (u/ug dpph)	2.36±0.20
Total Phenol (mgGAE/g)	94.48±0.98
Flavonoid (mg/100g)	12.39±0.16

Myristica fragrans is a spice that is grown annually and is part of the Myristicaceae family. It is widely grown globally and is commonly used for adding flavour to food, as well as for essential oil purposes and in traditional medicine practices. Nutmeg is primarily composed of terpenes and phenylpropenes, with the specific chemical makeup of these compounds varying depending on the growing conditions. This spice is a crucial component in a wide range of industrial products, including food and cosmetics, and is also valued for its pharmaceutical uses due to its antioxidant and antimicrobial qualities.Nutmeg contains compounds such as β-caryophyllene and eugenol, which have hydrogen atoms located in the allylic or benzylic positions. These compounds contribute to the antioxidant activity of nutmeg as they are easily able to donate hydrogen atoms from these specific positions. As a result, nutmeg exhibits a high level of antioxidant activity.(Naeem et al ., 2016).

The nutmeg pericarp makes up a significant portion, approximately 80-85%, of the overall weight of the nutmeg fruit. Despite its substantial presence, this part of the fruit is often overlooked and under-utilised, leading to a significant amount of agricultural waste that can have detrimental effects on the environment. The lower economic value attributed to the pericarp compared to the seeds and mace of the nutmeg is a major factor contributing to its neglect.(Suwarda et al ., 2021).

Nutmeg holds significant importance in the food industry, as well as in clinical applications. It carries great value in Ayurveda and offers numerous benefits, such as aiding in insomnia treatment, hormonal balance, skin care, pain relief, cognitive enhancement, mood stabilisation, depression alleviation, reducing inflammation and skin irritation, promoting digestion, and regulating blood pressure. Nutmeg is widely utilised as a fragrant ingredient in various culinary creations, such as custards, pastries, and desserts.(Pandit et al ., 2022)

The presence of bioactive compounds like β-caryophyllene and eugenol in nutmeg contributes to its antioxidant properties. Eugenol, specifically, enhances antioxidant activity

by boosting the performance of enzymes such as superoxide dismutase, catalase, glucose-6-phosphate dehydrogenase, and glutathione peroxidase and glutamine transferase. These enzymes work in tandem to neutralise free radicals, which are byproducts of energy production from carbohydrates, proteins, and fats. Antioxidants play a crucial role in cancer prevention by inhibiting the growth of carcinogens within the body. Additionally, nutmeg contains the compound carvacrol, which exhibits antimicrobial and antifungal properties by eliminating bacterial cells. These diverse properties of nutmeg make it a valuable ingredient in various applications, both in the food sector and for maintaining overall health and well-being. (Gupta et al ., 2020)

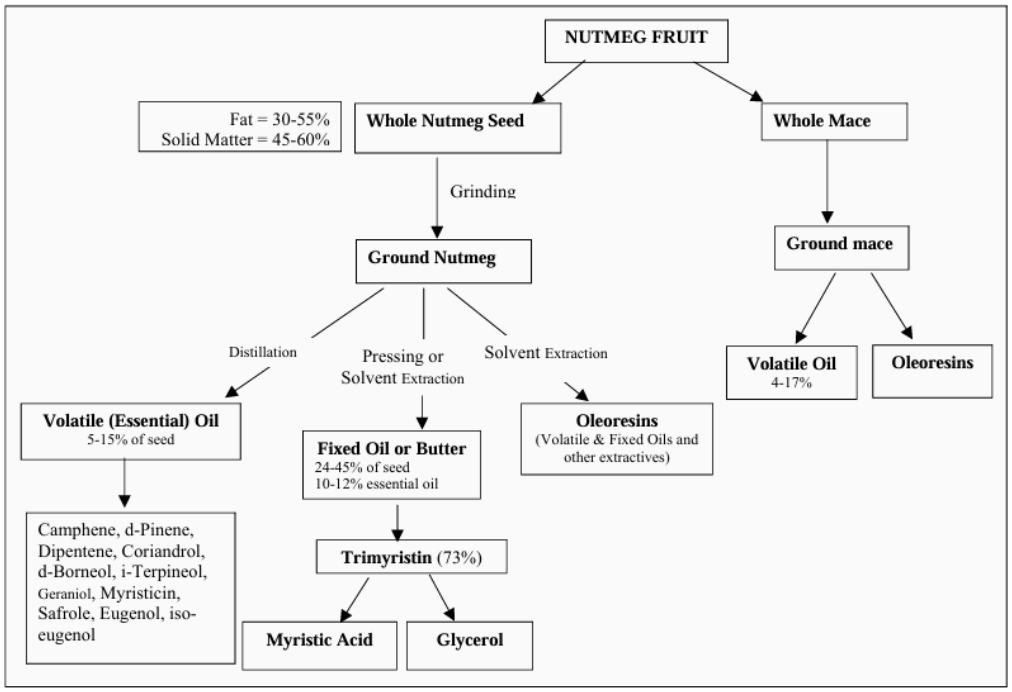


Fig 1.2 : Figure depicting principle commercial products obtained from nutmeg

Source : Singh et al., 2003

Date fruit has been a crucial part of the Arab diet for generations, offering a wide range of essential nutrients and potential health advantages to those who consume it. The chemical makeup of date fruit includes carbohydrates, dietary fibre, enzymes, protein, fats, minerals, vitamins, phenolic acids, and carotenoids, all of which play a role in its nutritional and medicinal properties. The composition of date fruit can differ based on factors such as ripeness, variety, growing conditions, and post-harvest handling.(Tang et al .,2013). The β-glucan from date fruits have strong anti-tumor, immune-modulating, anti-diabetic,

anti-inflammatory and cholesterol lowering potential, and encourage the growth of beneficial gut microflora.(Hussain et al ., 2020).

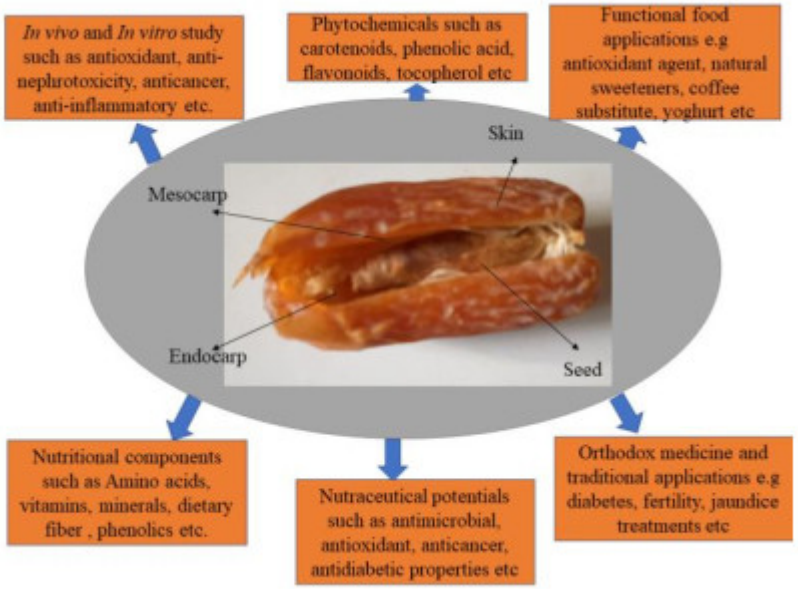


Fig 1.3 : Health benefits and applications of a typical date fruit containing seed

Source : Idowu et al ., 2020

Date palm holds significant nutritional and medicinal value in its fruit and seeds. Despite this, these components have not been fully explored as potential functional food ingredients to create health-promoting foods. According to existing literature, date fruit and seeds are rich in phytochemicals such as phenolics, anthocyanins, carotenoids, tocopherols, tocotrienols, phytosterols, and dietary fiber. These components have been reported to possess various health benefits, both in vitro and in vivo studies. Expanding research in this area would provide crucial insights for utilising date fruit and seeds as functional food ingredients. (Maqsood et al ., 2020).

Wheat (Triticum aestivum L.) is the primary cereal crop and a staple diet for around two billion people worldwide. Triticum aestivum L., or wheat, is one of the major grains grown globally. The two main varieties of wheat grown for commercial purposes are durum wheat (Triticum turgidum) and bread wheat (Triticum aestivum), which vary in their genetic composition, adaptation, and use.

The endosperm of common wheat, known as Triticum aestivum L., is rich in nonenzymatic storage proteins that make up gluten. Gluten is a complex protein compound that is found naturally and is composed of gliadin and glutenin. Gliadin is a soluble fraction that is primarily monomeric and can be dissolved in solutions containing alcohol. On the other hand, glutenin consists of multiple polypeptides that are linked together covalently and non-covalently to form high-molecular-weight complexes. These complexes are insoluble in alcohol but can be dissolved in solutions containing dilute acids or alkali, denaturants, detergents, or disulfide-reducing agents. Additionally, some albumin and globulin proteins, which are typically soluble in water or weak salt solutions, can also become part of gluten during the process of extraction or mixing. Numerous comprehensive reviews have been conducted to examine the composition, properties, relationships between the constituent proteins, and the use of gluten in genetic analysis. (Heyne et al ., 1987).

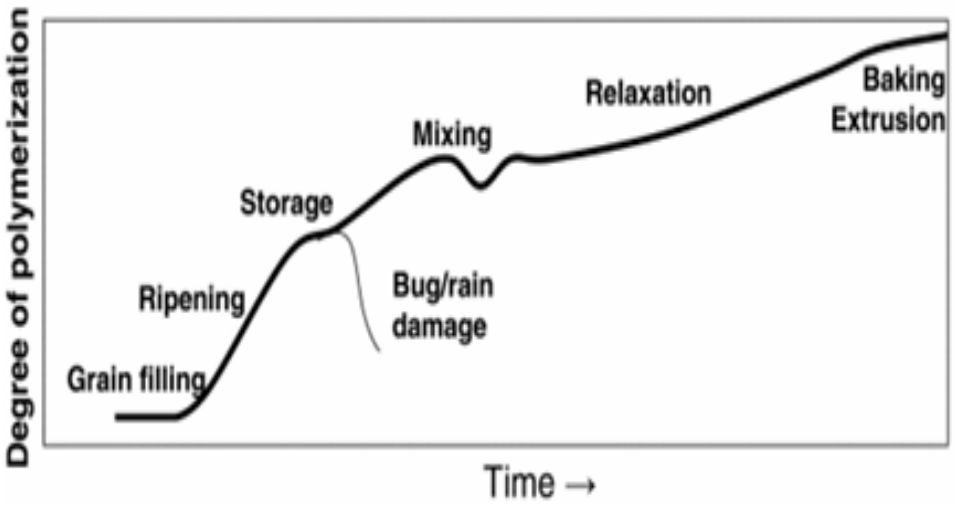


Fig 1.4 : Degree of polymerization of glutenin protein (vertical axis), due to disulfide-bond formation, a process that continues throughout grain filling, and into storage and processing.

Source : Wrigley et al ., 2006

Naturally grown wheat possesses numerous medicinal benefits. Each component of the whole-wheat grain contributes essential nutrients for human health. Starch and gluten in wheat supply warmth and energy, while the inner bran layer provides phosphates, mineral salts, and other vital elements. The outer bran layer offers necessary fiber for smooth bowel movement. The wheat germ delivers vitamins B and E, and proteins in wheat aid in muscle

building and repair. Crucially, the wheat germ, removed during refining, is rich in vitamin E, deficiency of which can cause heart issues. The refining process, however, leads to the loss of vitamins and minerals, resulting in widespread constipation, digestive issues, and nutritional disorders. (Kumar et al ., 2011)

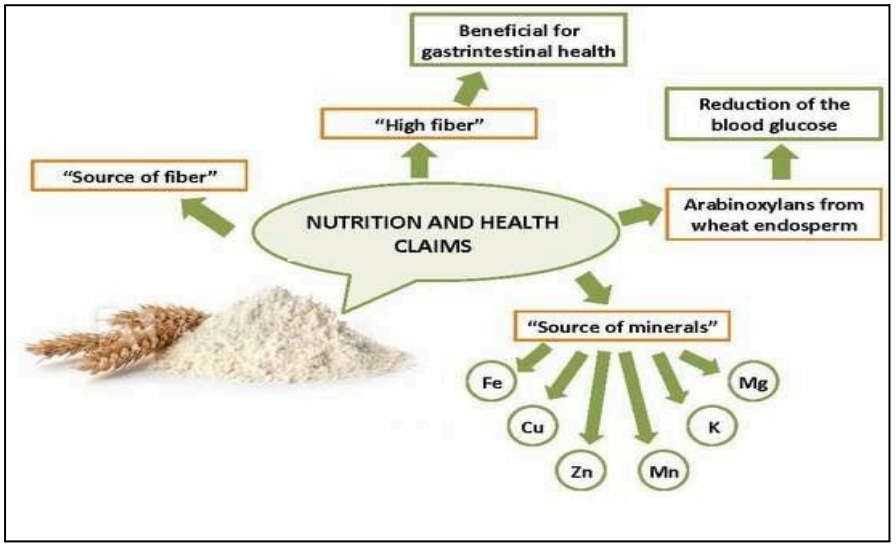


Fig 1.5 Health claims and nutrition sources of wheat flour

Source:Ciudad-Mulero et al.,2020

CHAPTER 2 TERMINOLOGY

ABBREVIATION	TERM
%	Percent
et al.	And others
G	Gram
i.e.,	That is
Mg	Milligram
Mg/100g	Milligram per 100 grams
TIU/g	Trypsin inhibitor activity
µg	microgram
Kcal/Kg	Kilocalorie (IT) Per Kilogram
TKP	Tamarind kernel powder
TSP	Tamarind seed powder
β	Beta
cm	centimetre
°C	Degree Celsius

CHAPTER: 3 REVIEW OF LITERATURE

3.1 TAMARIND SEED, AN ANTIOXIDANT POWERHOUSE

Tamarindus indica L is an abundantly grown chief leguminous plant of Asian countries hailing from the Fabaceae family. Its seed is an abundant and cheaply available by-product of the tamarind pulp industry. Tamarind seed is rich in protein, containing high amounts of several essential amino acids, such as isoleucine, leucine, lysine, methionine, phenylalanine and valine. In addition to this, seeds are also a good source of essential fatty acids and minerals, particularly calcium, phosphorus and potassium which is relatively high compared to other legumes. (Bagul, Sonawane, & Arya, 2015)

Tamarind seeds have a flattened, glossy appearance and are round to diamond-shaped. They typically measure around 3-10 cm in length and 1.3 cm in width. These seeds are classified as dicotyledonous, meaning they have two seed leaves. In terms of colour, they are hard and range from red to purple-brown. When you open the seed, you will find chambers lined with a membrane similar to parchment, along with thick cotyledons. The tamarind seed makes up approximately 20-30% of the seed coat or Testa and 70-75% of the kernel or endosperm. Interestingly, the seed portion accounts for about 40% of the entire tamarind fruit. It is worth noting that tamarind seeds are a by-product of the tamarind fruit's commercial or non-commercial usage. This waste product, primarily generated through commercial utilisation, can be utilised as a valuable source for tamarind seeds. (Chawananorasest et al ., 2016)

NUTRITIONAL COMPOSITION

The entire tamarind seed and its parts are rich sources of protein, with fat or oil making up 4.5-16.2% of the total composition. The unrefined fibre content is low in the entire seed, while the seed coat is high in fibre (20%) and tannins (20%). Carbohydrates make up the remaining 50 to 57% of the seed. Tamarind seeds contain high levels of essential amino acids such as Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, and Valine. Tamarind oil is classified as a non-drying oil due to its iodine value being below 100 mg/100 g. The fatty acid composition of tamarind seeds is predominantly unsaturated (55.6%) rather than saturated (44.4%), with linoleic acid being a key polyunsaturated acid that may help reduce or prevent cardiovascular diseases. (Bagul et al ., 2015). Tamarind seeds are also a good source of minerals like calcium, phosphorus, magnesium, and potassium, with the high potassium content playing a vital role in neuro-muscular function. (Ajay et al ., 2006)

NUTRIENTS	CHEMICAL VALUE
Moisture (%)	9.38±0.16
Energy (kcal)	353.52±1.44
Total carbohydrate (%)	53.66±1.72
Protein (%)	23.06±0.57
Fat (%)	4.30 ±0.13
Ash (%)	2.60±0.08
Crude fibre (%)	7.00±0.08
Calcium (mg)	285.66±2.21
Potassium (mg)	30.53±0.32
Sodium (mg)	12.63±0.25
Magnesium (mg)	86.43±0.43

Table 3.1 Average nutrient composition of 100g of tamarind seeds.

Source : Richa et al ., 2018

ANTI NUTRITIONAL FACTORS

Another aspect of tamarind seeds that has been evaluated is their trypsin inhibitor activity, which is found to be low. This activity refers to the ability of tamarind seeds to inhibit the enzyme trypsin, which plays a crucial role in protein digestion. Fortunately, there are effective processing methods that can eliminate phytic acid from tamarind seeds. Soaking and autoclaving have been found to be particularly successful in reducing phytate levels. Additionally, tamarind seeds contain a relatively low amount of cyanogen, specifically 2.8 mg per 100 g. This level is generally considered to be too low to cause any significant concerns. Tamarind seeds are known to have relatively low levels of phytic acid, similar to lima beans. Phytic acid is a compound that can significantly decrease the bioavailability of certain minerals and potentially interfere with the utilisation of proteins. This interference occurs because phytic acid forms complexes with proteins and minerals, known as phytate-protein complexes and phytate-mineral-protein complexes. Furthermore, phytic acid can inhibit digestive enzymes, as supported by studies conducted by Reddy et al. (1982) and Siddhuraju et al. (1995).

Anti Nutrients	Chemical value
Tannin (mg/100g)	20.10±0,01
Trypsin Inhibitor (TIU/g)	10.72±0.04

Phytate (mg/100g)	1.73±0.06
Saponin (%)	1.01±0.01
Oxalate (mg/100g)	0.66±0.05
Alkaloid (%)	0.23±0.04

Table 3.2 Average Antinutrient composition of 100g of tamarind seeds.

Source: Richa et al ., 2018

Tannins, phytic acid, and various other substances that hinder nutrient absorption are present in the seed, rendering it unfit for direct consumption. As a result, it is typically disposed of as waste material. Nevertheless, through the process of soaking and boiling in water or through fermentation, the levels of these antinutrients can be significantly reduced. Therefore, soaking and cooking legumes are proven to be efficient methods for diminishing or eliminating these antinutrients. (Olagunju et al ., 2018)

Fig 3.1 Flow Diagram for the production of soaked Tamarind seed nut flour.

Source : Akajiaku set al .,2014.

Effect of fermentation on antinutrient contents of tamarind seed.

Fermentation period (days)	Phytate (mg/100 g)	Trypsin inhibitor activity (TIU/g)	Tannin (mg/ 100 g)
0	$4.17^{a} \pm 0.04$	$3.50^{a} \pm 0.01$	$4.02^{a} \pm 1.41$
1	$3.93^{b} \pm 0.03$	$2.10^{b} \pm 0.10$	$3.01^{b} \pm 1.41$
2	$3.64^{c} \pm 0.13$	$1.20^{c} \pm 0.01$	$2.00^{c} \pm 0.02$
3	$2.12^{d} \pm 0.10$	$0.50^{d} \pm 0.01$	$1.02^{d} \pm 0.01$

Table 3.2 Effect of fermentation on antinutrient composition of tamarind seeds

Source : (Olagunju et al ., 2018)

3.2 DATES AND IT'S COMPONENTS

The fruit-bearing date palm (Phoenix dactylifera L.) tree has many opportunities. Its fruits, seeds, and metabolites, also referred to as pits, have nutritional and therapeutic value.

When it comes to date fruit's commercial potential, it hasn't been completely utilised as a useful component of many diets that promote health. A variety of elements, including dietary fibre, phenolics, vitamins, minerals, and amino acids, are abundant in date fruits and seeds. Dates have a wide range of biological activity potential, including antibacterial, antioxidant, anticancer, and antidiabetic properties. Phytochemicals such as tocopherol, flavonoids, phenolic acid, carotenoids, phytosterols, etc., are present and promote these bioactivities. Date fruits were widely used for conventional and traditional medicinal purposes in the past. Date flesh is high in carbohydrates, primarily fructose and glucose, but lacking in fat and protein. With an average of 314 kcal per 100 g of flesh, it is a high source of energy. There were ten identified minerals, with magnesium, copper, potassium, and selenium being the most common. The main vitamins in dates include C and the B-complex. Dates included a high percentage of insoluble dietary fibre (8.0 g/100 g), which made up the majority of the dietary fibre content. Carotenoids and phenolics make up the majority of the antioxidants found in dates. Compared to the flesh, date seeds have higher levels of fat (9.0 g/100 g) and protein (5.1 g/100 g). Moreover, it has significant levels of antioxidants (80400 micromole/100 g), phenolics (3942 mg/100 g), and dietary fibre (73.1 g/100 g). [Al-Farsi et al., 2008)

The three main carotenoids found in dates are lutein, neoxanthin, and β-carotene. Total carotenoids in fresh and dried dates are, on average, 913 and 973 µg/100g of dates, respectively. Although dates are low in vitamin A, C, and B1, 100 g of dates can provide roughly 7% of the daily required intake of these nutrients. Vitamin A (23.85 µg), B1 (78.61 µg), B2 (116.5 µg), B3 (1442 µg), B6 (207 µg), B9 (53.75 µg), and vitamin C (3900 µg) are all present in date fruit. Water soluble vitamins (B-complex and C) are mostly found in dates as opposed to fat soluble vitamins. Dates are a significant and abundant source of vital minerals, including copper, magnesium, potassium, and selenium. Dates with a high potassium content and low salt content are good for those with hypertension. The two primary phenolic acids found in dates are ferulic and caffeic acids. [Nasir et al ., 2015]

Dates' nutritional and phytochemical characteristics differ based on the type, harvest stage, and preparation method. The following is a description of the dates' fruit growth stages:

- Hababouk stage: During the first 4-5 weeks following fertilisation, this stage has 80–90% moisture content.

- Kimri stage: The fruit grows longer, heavier, sugarier, and more acidic during this stage. Depending on the cultivar, the fruit will turn red or yellow as this stage comes to a close.

Fig 3.2 : Dates processing - Kimri stage

Source : Sidhu et al ., 2006

- Khalal stage: Depending on the variety, this stage marks the beginning of the fruit's transformation from green to yellow purplish-pink, red, or yellow, scarlet. While the moisture level drops by up to 50%, the glucose content rises. As the tannins begin to precipitate and become less astringent and make dates for palatable.

Fig 3.3 : Dates processing - Khalal stage

Source : Sidhu et al ., 2006

- Rutab stage: Sucrose turns into invert sugars, which have a lower tannin concentration than in the preceding stage and a moisture level of 35–40%. The dates soften, become halfway ripe, and take on a light brown hue.

Fig 3.4 : Dates processing - Rutab stage

Source : Sidhu et al ., 2006

- Tamar stage: At this point, the date fruit's primary sugar is inverted. Date fruit softens when its moisture level reaches 20–25%. [Hussain et al ., 2020]

Fig 3.5 : Dates processing - Tamar stage

Source : Sidhu et al ., 2006

3.3 NUTMEG AND ITS COMPONENTS

Myristica fragrans is a tropical evergreen tree in the Myristicaceae family. It yields two spices: mace and nutmeg. The dried nutmeg seed is the most significant portion of the plant in terms of its pharmacological effect and its commercial value. Nutmeg is a spice with a unique aroma and a mildly sweet flavour. It's a condiment that's used all around the world to flavour baked goods, confections, sausages, sauces, meats, and a variety of other meals. Traditional medicine has made considerable use of this spice to cure a variety of illnesses. The nutmeg samples were found to be rich in Ca2+, K+, Po3+, Mg2+, Fe2+, and ascorbic acid, and poor in Zn2+, thiamine, niacin, and riboflavin. They also had high quantities of fat (26.7%), protein (18.7%), carbohydrates (28.9%), energy (3938.3 Kcal/Kg), and fibre (9.4%). High concentrations of alkaloids, phytates, tannins, oxalates, flavonoids, terpenoids, and antioxidants were found in the phytochemical analysis. There were also no cyanogenic glycosides that could be found.[Okiki et al ., (2023)].

Nutritional composition of Nutmeg:

Analyte	Concentration
Moisture content (%)	9.37±0.06
Protein (%)	18.67±0.21
Ether Extract/Fat (%)	26.73±0.25

Ash(%)	3.87±0.21
Crude Fibre (%)	12.43±0.12
Carbohydrates (%)	28.93±0.61
Energy (kcal/kg)	3938.33±2.08
Iron(mg/100g)	7.63±0.15
Zinc (mg/100g)	0.53±0.06
Calcium(mg/100g)	166.67±7.64
Potassium (mg/100g)	68.33±2.89
Ascorbic acid(mg/100g)	14.77±0.25
Thiamine(mg/100g)	0.10±0.01
Niacin(mg/100g)	1.2867±0.02
Riboflavin(mg/100g)	0.10±0.01

Table 3.3 Average nutrient composition of 100g of nutmeg fruit
Source : [Okiki et al ., (2023)].

Nutmeg has garnered global recognition for its diverse applications in food flavouring, essential oil extraction, and traditional medicine. It has found its way into numerous industrial sectors, extending from the culinary world to cosmetics. Its pharmaceutical applications are particularly noteworthy, owing to its inherent antioxidant and antimicrobial properties. The continuous exploration and discovery of novel uses for nutmeg byproducts further underscore its immense potential. In the realm of traditional medicine, nutmeg has been employed as an essential ingredient in the preparation of remedies for a wide array of ailments. These include treatments for dysentery, flatulence, stomachache, nausea, vomiting, rheumatism, sciatica, malaria, and even early stages of leprosy. This versatile spice continues to be a valuable resource in addressing various health concerns and maintaining overall well-being. (Gupta et al ., 2022)

3.4.BUTTER AND IT'S COMPONENTS

Butter is a product with a high calorie and nutritional value since it is a mechanical agglomeration of fat that comprises at least 80% fat, at most 16% water, 0.5% protein, 0.5% carbs, and fat-soluble vitamins and minerals.(Méndez-Cid et al., 2017).

As an emulsion of water in oil, butter is a milk fat product in which the water droplets are distributed throughout the partially crystallised and continuous fat phase (Méndez-Cid et al., 2017).

It is typically produced with cow milk, contains over 80% milk fat, tastes and smells nice, is easily digested, and contains important fatty acids (Kahyaoğlu & Çakmakçi, 2018; Staniewski et al., 2021).Cow milk butter melts at about 35 °C, stays solid when refrigerated, and softens to a spreadable form when left out of the refrigerator (Adewumi et al., 2017).

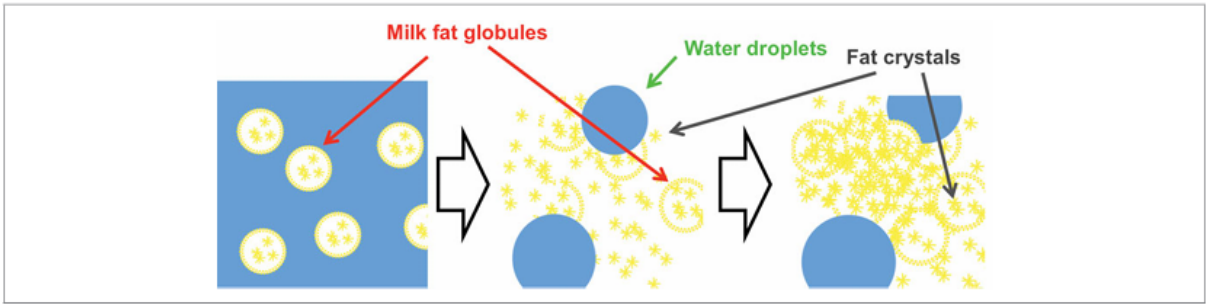


Fig 3.6 Illustration of microstructure of cream and milk

Source : Ronholt et al ., 2013

Butter, a multiphase emulsion, is comprised of fat globules, crystalline fat, and an aqueous phase dispersed in a continuous oil phase. The textural properties of butter and milkfat are intrinsically linked to their underlying structures. During churning, cream undergoes phase inversion as fat globule membranes are disrupted, leading to coalescence and oil leakage, forming the continuous phase. This continuous phase contains crystal aggregates and remnants of fat globules. Butter's yield values and viscoelastic behaviors result from a 3D network of fat crystals associated with a continuous oil phase. Fat crystal networks are held together by van der Waals forces. The extent of solidification, determining the ratio of solid to liquid fat, primarily dictates butter's consistency. (Wright et al ., 2001)

Butter's physical characteristics, including its hardness, solid-phase content, melting and crystallisation temperatures, can be altered by the kind and quantity of fatty acids it contains (Staniewski et al., 2021). In addition to having a high fat content, butter also contains significant amounts of cholesterol (between 183 and 248 mg/100 g), calcium, phosphorus, vitamin K (60 µg/100 g), vitamin D (1.2 µg/100 g), and vitamin A (retinol equivalent) 653.0 µg/100 g. It also has a low protein content.It is commonly recognised that the presence of

carotene (lycopene), vitamin A, and other fat-soluble pigments gives butter its colour. (Pădureţ, S. (2021).

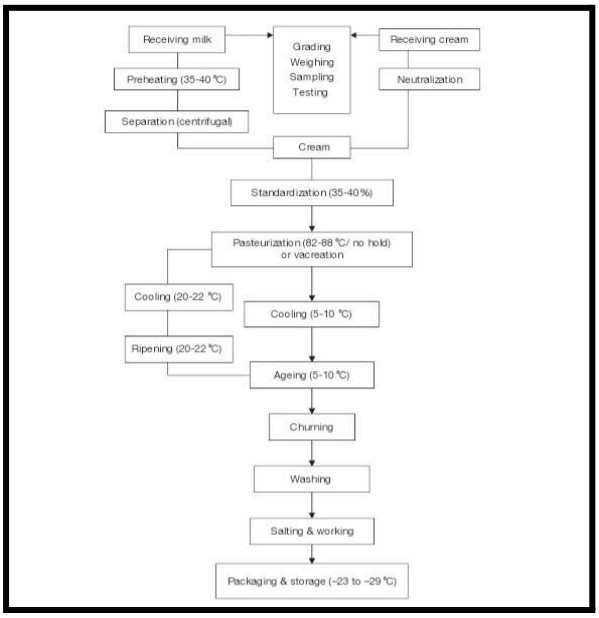


Fig 3.7 Flow diagram for the production of butter from milk
Source : (Deosarkar et al ., 2016)

3.5 WHEAT FLOUR AND ITS COMPONENTS

The cereal crop known as wheat (Triticum spp.) is a member of the Poaceae family (order Poales). The complex architecture of a wheat kernel can be broadly categorised into three vital components: bran, endosperm, and germ. Among these, the endosperm stands as the predominant constituent, comprising approximately 81-84% of the grain. It primarily consists of starch granules, embedded within a proteinaceous matrix. The germ, accounting for 2-3% of the grain, houses the embryo and the scutellum.In contrast, bran constitutes a more modest 14-16% of the grain. This intricate structure is composed of all the outer layers, including the aleurone layer. Although botanically classified as the outer layer of the endosperm, the aleurone layer is typically removed alongside the other bran layers during the milling process. This step is essential as it helps in achieving a higher refinement level in the final flour product. (Mousia et al ., 2004).

For around 40% of the world's population, wheat provides a staple source of nutrition With a protein level of roughly 13%, which is comparatively high when compared to other major cereals, it is the main source of vegetal protein in human meals. Proteins, carbs, iron, and B vitamins like niacin and riboflavin are all found in wheat endosperm. In addition, it has trace

minerals and soluble fibre.A tiny portion of the food is made up of vitamins like thiamine and vitamin B, minerals like zinc and iron, selenium, and magnesium, and 78% of the diet is made up of carbohydrates, 14% of protein, 2% of fat, and 2.5% of minerals.[Iqbal, M. J., Shams, N., & Fatima, K.] The second most significant ingredient in wheat flour, protein is mostly found in the endosperm of wheat grains. Wheat flour will lose more protein the more accurately it is processed[.Int. J. Metrol. Qual. Eng. 11, 6 (2020)]

Nutritional composition of Wheat Flour

S#	Nutritional value of wheat	Units	White wheat flour	Whole grain flour
1	Energy	kcal	364	340
2	Protein	gm	10.3	13.2
3	Total fat	gm	1.0	2.5
4	Carbohydrates	gm	73.6	61.3
5	Fiber	gm	2.7	10.7
6	Calcium	mg	15	34
7	Iron	mg	1.2	3.6
8	Magnesium	mg	22	137
9	Phosphorus	mg	108	357
10	Potassium	mg	107	363
11	Sodium	mg	2.0	2.0
12	Zinc	mg	0.7	2.6
13	Thiamin (B1)	mg	0.1	0.5
14	Riboflavin (B2)	mg	0.04	0.2
15	Niacin (B3)	mg	1.3	5
16	Vit. B6	mg	0.04	0.4
17	Folate	DFE	26	44

Table 3.4 Average nutrient composition of Wheat Flour and wheat grain

Source : Nutritional facts of wheat (*USDA datasheet).

Milling, a meticulously designed process to manufacture flour from wheat, encompasses a series of intricate stages such as grinding, reduction, shifting, and purification. The two principal objectives of this elaborate procedure are to minutely fragment the endosperm into smaller, finer particles and to meticulously separate the bran. Despite the optimization of milling conditions, it is crucial to acknowledge that the complete separation of the starchy endosperm from the bran remains elusive. Consequently, a minuscule quantity of bran particles inadvertently evades the separation process and permeates the flour streams, contaminating them. This contamination, as evidenced by ash content and color, adversely

impacts the refinement of the flour. The yield of milling, therefore, plays a pivotal role in determining the overall quality of the final product. (Mousia et al ., 2004)

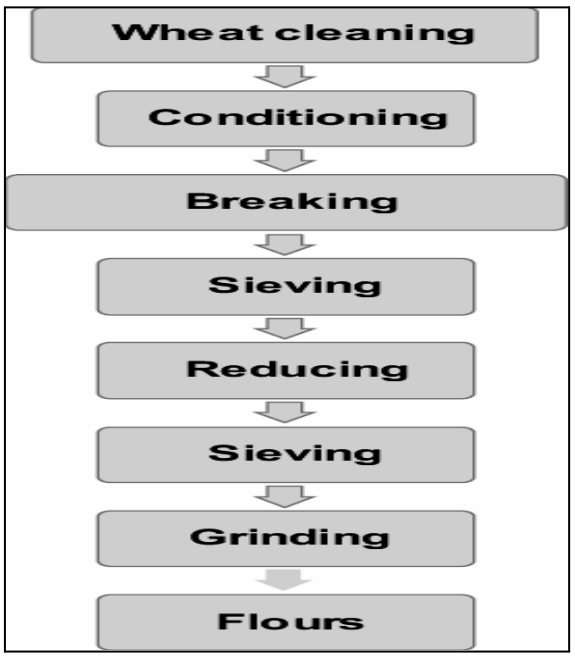


Fig 3.8 : Flow diagram for the production of wheat flour.

Source : Papageorgiou, Maria & Skendi, Adriana. (2018).

CHAPTER 4 RATIONALE AND SCOPE OF STUDY

The primary focus of this research lies in investigating the potential of tamarind seed powder as a key ingredient in the production of tarts. The objective of the study is to evaluate consumer satisfaction by assessing various factors, such as visual appeal, aroma, flavour, and consistency of the tarts. In recent years, there has been a growing consumer demand for food products rich in antioxidants, driven by the increasing awareness of their potential health benefits. Antioxidants play a crucial role in combating the detrimental effects of free radicals, which are known to contribute to various diseases and ageing processes. Consumers are increasingly seeking out food items that not only satisfy their taste buds but also provide essential nutrients, such as antioxidants, to maintain their overall health and well-being.

Against this backdrop, the research presented herein focuses on the potential of tamarind seed powder as a key ingredient in the production of tarts. The study aims to evaluate consumer satisfaction by assessing various factors, such as visual appeal, aroma, flavour, and consistency of the tarts. By incorporating tamarind seed powder and nutmeg in a unique tart formulation, the study seeks to explore the combined impact of these ingredients on the overall sensory experience while addressing the growing demand for antioxidant-rich food products in the market.

To increase the utilisation of tamarind seed powder and nutmeg, a novel tart formulation has been developed. The tart base is created using tamarind seed powder, while nutmeg is incorporated into the filling. This innovative approach not only promotes the utilisation of these ingredients but also seeks to explore their combined impact on the overall sensory experience of the tarts.

CHAPTER 5 OBJECTIVES OF THE STUDY

The primary mandate of this study is twofold: firstly, to explore the potential of utilising tamarind seed powder, a byproduct of tamarind pulp processing, as a key ingredient in food production. Secondly, the study intends to investigate the potential of incorporating nutmeg flesh, another underutilised byproduct, into various food products. By focusing on these two aspects, the study intends to contribute to a more sustainable and resourceful food industry, reducing waste and promoting the utilisation of these byproducts.

1. Development Of Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder
2. Sensory Evaluation And Analysis Of Nutritional Composition .
3. Study The Shelf Life Of Developed Tart.

CHAPTER 6 MATERIALS AND METHODS

6.1 INTRODUCTION

This chapter deals with the “Development of a Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder''

6.2 MATERIALS REQUIRED

1.Tamarind seed powder - Fig 6.1

2. Wheat flour- Fig 6.2

3.Dates - Fig 6.3

4.Butter - Fig 6.4

5. Nutmeg - Fig 6.5

Fig 6.1

Fig 6.3

Fig 6.2

Fig 6.4

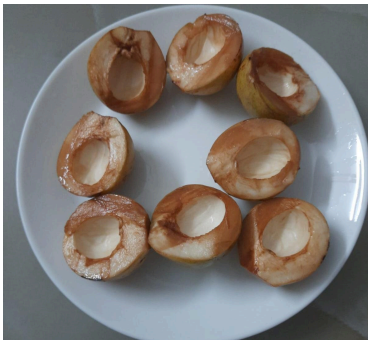


Fig 6.5

6.3 EQUIPMENT AND APPARATUS REQUIRED

1.Sieves - Fig 6.6

2.Convection oven- Fig 6.7

3.Tart pan/mould - Fig 6.8

4.Open pan evaporator - Fig 6.9

5.Weighing machine - fig 6.10

6. Mixer Grinder - Fig 6.11

Fig 6.6

Fig 6.7

Fig 6.8

Fig 6.9

Fig 6.10

Fig 6.11

6.3.1 SIEVE

Sieve plates are designed with mesh or perforated bottoms to selectively allow particles of a specific size to pass through. The mesh size of the plates can vary depending on the intended use, such as separating wheat husks and stones. For this purpose, larger mesh size sieve plates are utilised compared to those used for sifting flour**.**

6.3.2 CONVECTION OVEN

This is equipment used for the baking process. A convection oven is a specialised kitchen appliance that utilises the power of air circulation to evenly and effectively cook food. By incorporating a fan that circulates hot air throughout the oven, this innovative cooking method ensures that heat is evenly distributed, resulting in quicker cooking times and superior outcomes when compared to traditional ovens. The introduction of this circulating

air not only enhances the overall cooking process, but it also promotes a more efficient use of energy, making convection ovens an excellent choice for the cooking.

6.3.3 TART PAN /MOULD

A tart pan is a type of pan with a shallow design and smooth or fluted edges, typically round or oblong in shape. Some tart pans come with a removable bottom, making it simple to extract the contents and keep the pan clean while preserving the decorative fluted edges.

6.3.4 OPEN PAN EVAPORATOR

An open pan is a stainless-steel cooking tool with a thick copper bottom that conducts heat. It is used to remove water from a product so that a concentrated version can be obtained. When concentrating, agitation is provided manually at the household level or, in enterprises, mechanically.

6.3.5 WEIGHING MACHINE

It is a device for calculating an object's mass or weight. The digital weighing scale has a small LCD display that shows the weight and is simple to use. The digital weighing scale is an extremely fragile device because it runs on an external power source, primarily a battery. There are two ways to weigh anything. Analogue scales employ springs to indicate an object's weight, whereas digital scales use an electronic signal to represent an object's force.It is a device for calculating an object's mass or weight. The digital weighing scale has a small LCD display that shows the weight and is simple to use. The digital weighing scale is an extremely fragile device because it runs on an external power source, primarily a battery. There are two ways to weigh anything. Analogue scales employ springs to indicate an object's weight, whereas digital scales use an electronic signal to represent an object's force.

6.3.6 MIXER GRINDER

An apparatus for combining and grinding different culinary components is a mixer grinder. One of the main features of the mixer grinders is their capacity to quickly and precisely grind and mix different culinary components. Customers may adjust the speed and grind size of these machines to meet their specific needs thanks to their precision controls and settings. These gadgets are ideal for use in environments where food is made because they are usually quite easy to maintain and clean.

6.4 PREPARATION OF TART

6.4.1. SELECTION OF RAW MATERIALS

In this study, meticulous attention was given to the procurement of premium-quality raw materials to ensure the creation of a distinctive, nutritionally-rich tamarind seed powder-based tart with nutmeg and date filling. The sourcing process began with the acquisition of premium-grade dates from reputable market sources, ensuring their optimal freshness and nutritional value.

To further elevate the health benefits of the tart, nutmegs were procured from an organically grown garden, ensuring their purity and adherence to sustainable agricultural practices. The nutmegs underwent a rigorous blanching process to enhance their quality by inhibiting enzymatic activity, thus preserving their inherent nutritional properties.

In addition to the dates and nutmegs, essential ingredients such as wheat flour, tamarind powder, butter, and sugar were carefully selected from reputable market sources. These ingredients were chosen based on their superior quality, ensuring that they would contribute to the overall taste, texture, and nutritional profile of the tarts.

6.4.2 PREPARATION OF RAW MATERIALS

Preparation:-

In order to prepare the nutmeg filling for the tarts, the nutmeg was first washed thoroughly and subjected to a blanching process. By blanching the nutmeg at 100°C for 7 minutes, the process aimed to effectively improve its quality. This method helps in inhibiting the activity of enzymes like AAT (acid acylase transferase), which can negatively impact the nutmeg's properties. Additionally, blanching reduces the myristicin content, ensuring a better-quality nutmeg for the tart filling.Once blanched, the nutmeg was washed, grated into small pieces, and set aside. The dates were blended into a fine paste along with 8 tablespoons of water. This paste was then simmered to thicken it, after which it was strained to remove any undesirable particles. The nutmeg gratings were then added to this paste and combined. For the tart base, tamarind seed powder and wheat flour were first roasted to enhance the flavour properties. After cooling, softened butter, sugar and one tablespoon of ice cold water was added to form a soft dough. Sample formation was performed through various ratios. The ratio of wheat flour was taken as 45g, 40g, 35g, 30g and 25g to tamarind seed powder in weights of 5g, 10g, 15g, 20g, and 25g respectively.

TART SHELL PREPARATION

➔ DOUGH FORMATION

Begin by weighing different ratios of wheat flour and tamarind seed powder. Combine 25 grams of butter with the flour and tamarind seed powder mixture, then gradually add 25 grams of powdered sugar. Incorporate 1 tablespoon of ice-cold water to bind the dough, and refrigerate for 10 minutes. Knead the dough, form small balls, and place them in greased tart moulds, pressing the dough evenly across the base and sides. Trim excess dough, and bake the tarts at 160°C for 10-15 minutes. Allow the tarts to cool before filling with the nutmeg and date mixture.

PREPARATION OF TART SHELL

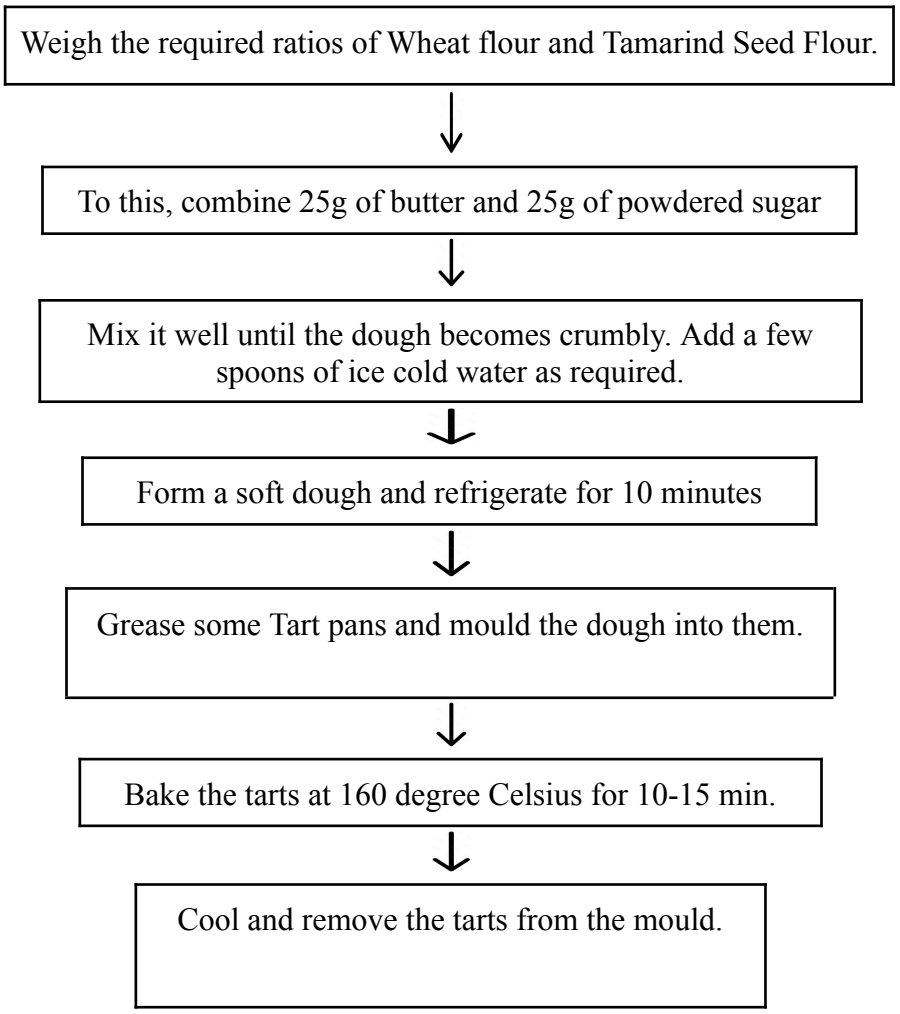


Fig 6.12 Preparation of Tart shell

PREPARATION OF TART FILLING

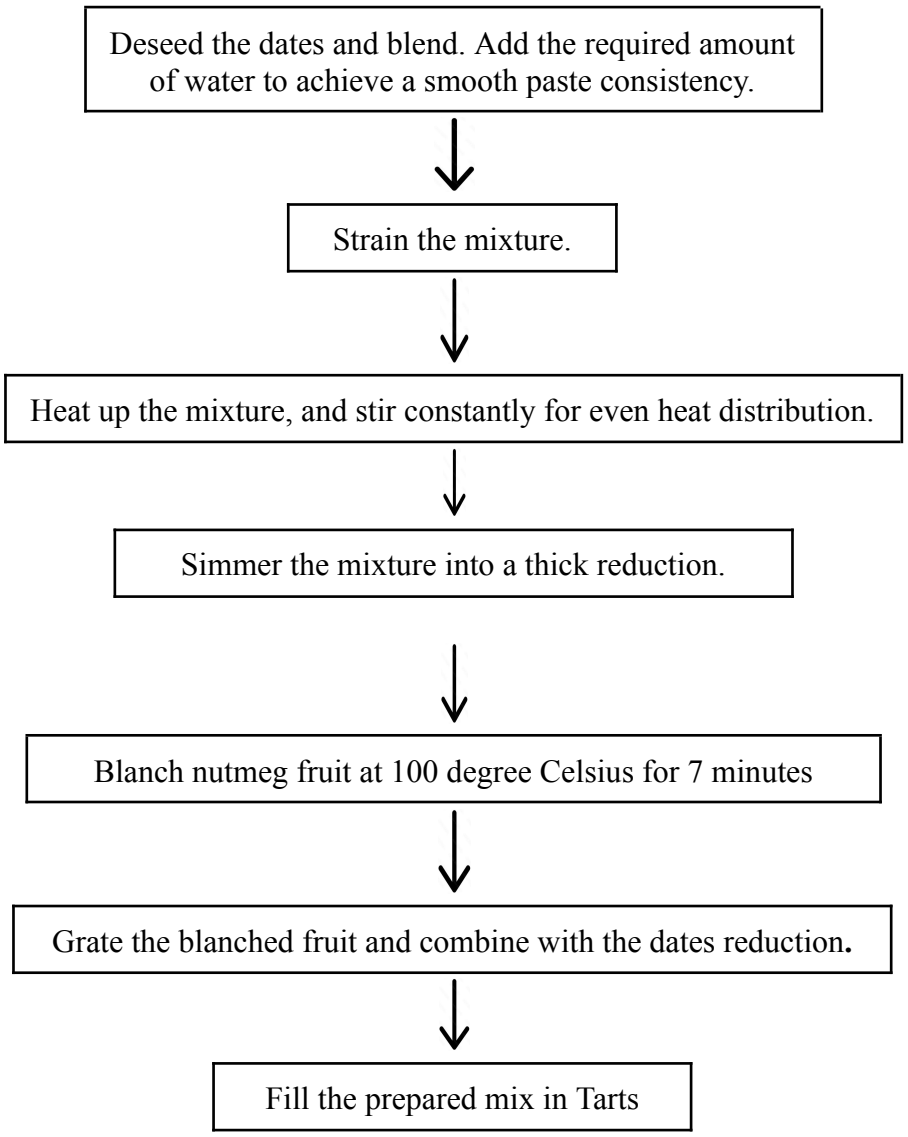


Fig 6.13 Preparation of Filling

6.4.3 DEVELOPMENT OF TARTS AND FILLING

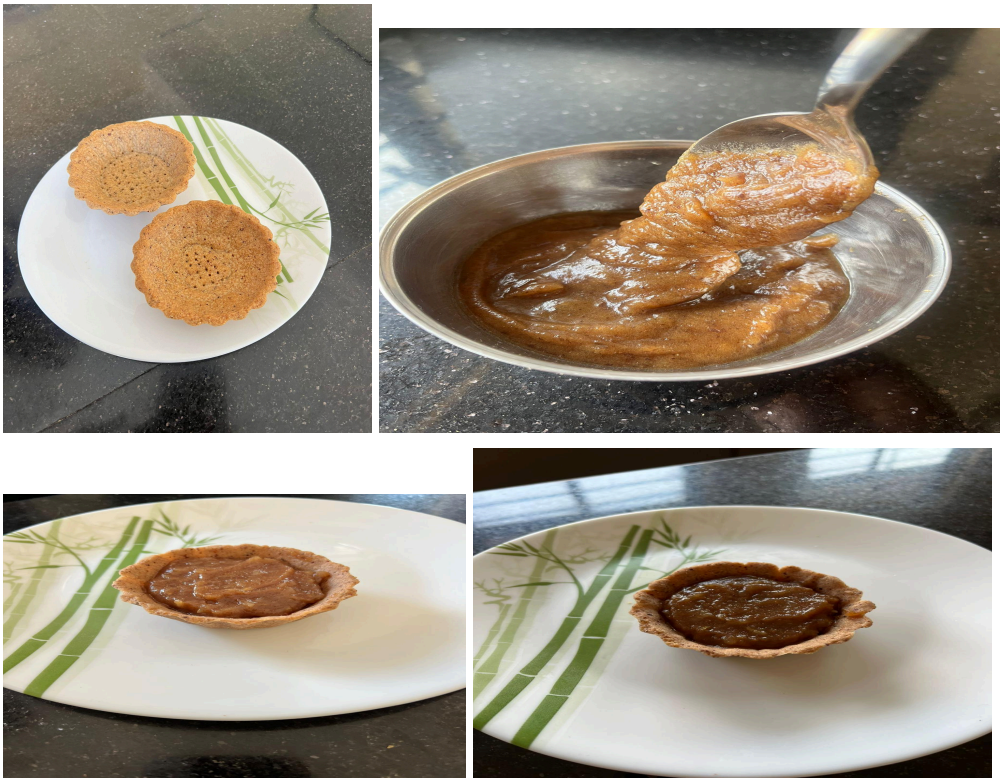


Fig 6.14 Tamarind Nutmeg Tart

The Tarts were prepared by combining the ingredients in 6 different ratios to find the appropriate combinations. The ingredients for all the six samples [S1,S2,S3,S4,S5,S6] were taken in different plates. They were prepared according to the procedure. The Filling for all the tart shells are of the same ratio. The best textural and Flavours properties were exhibited by the sample S5 and thus it was selected for further studies.

Table 6.1:Composition of Ingredients Taken For Different Trials

Sample	Tamarind Seed Powder (g)	Wheat flour (g)	Butter (g)	Sugar (g)
S1	0	50g	25g	25g
S2	5g	45g	25g	25g
S3	10g	40g	25g	25g
S4	15g	35g	25g	25g
S5	20g	30g	25g	25g
S6	25g	25g	25g	25g

6.5 SENSORY, NUTRITIONAL AND SHELF LIFE ANALYSIS

6.5.1 SENSORY ANALYSIS

HEDONIC RATING SCALE

On February 22, 2024, a sensory assessment was conducted involving four B.Voc. Food Processing Technology students and one assistant professor from the Department of Food Processing Technology. These evaluators were provided with a nine-point Hedonic Scale Score Card to assess six different food samples.

Tabel 6.2 :Hedonic Rating Scale

Nine - Point Hedonic Scale	
9	Like Extremely
8	Like Very Much
7	Like Moderately
6	Like Slightly
5	Neither Like or Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Table 6.3:Hedonic Rating Provided by Sensory Evaluation

Food Analysis	Sample	Appearance	Aroma	Taste	Texture	Overall Acceptability
Analyst 1	S1	8	8	8	7	7.75
	S2	9	7	7	8	7.75
	S3	7	7	8	7	7.25
	S4	8	7	6	7	7.0
	S5	8	7	6	6	6.75
	S6	7	7	5	6	6.25
Analyst 2	S1	8	7	9	7	7.75
	S2	8	8	8	8	8.0
	S3	8	9	7	8	8.0
	S4	9	8	8	9	8.5
	S5	8	8	8	8	8.0
	S6	9	9	6	8	7.5
Analyst 3	S1	9	8	8	8	8.25
	S2	8	7	8	7	7.5
	S3	9	8	9	8	8.5
	S4	8	9	8	7	8.0
	S5	7	9	8	9	8.25
	S6	8	7	7	8	7.5
Analyst 4	S1	9	8	9	8	8.5
	S2	9	8	7	9	8.25
	S3	9	7	7	7	7.5
	S4	8	8	7	7	7.5
	S5	7	9	9	8	8.25
	S6	7	7	5	6	6.25
Analyst 5	S1	9	7	8	9	8.25
	S2	9	7	9	9	8 5
	S3	8	7	7	9	7.75
	S4	9	7	7	8	7.75
	S5	9	7	9	8	8.25
	S6	7	7	5	7	6.5

6.5.2 NUTRITIONAL ANALYSIS

6.5.2.1 Methods for analysing various parameters of Tart

6.5.2.1.1 TOTAL ASH

APPARATUS

- Crucible made of porcelain
- Furnace
- Weighing balance
- Desiccator

PROCEDURE

- ➢ Weigh accurately about 5g of powdered sample in a crucible.
- ➢ Ignite the sample in the crucible with the flame of a suitable burner for about one hour. Transfer the crucible into a muffle furnace at 500 ±10˚C until grey ash results .
- ➢ Cool the crucible in a desiccator and weigh.
- ➢ Repeat the process of igniting, cooling and weighing at half-hour intervals until the difference in mass between two successive weighings is less than one milligram
- ➢ Record the lowest mass obtained.

CALCULATION

$$\text{Total ash(on dry basis), percent by mass} = \frac{100\,(M2-M) \times 100}{M1-M \times (100-W)}$$

Where M1 = mass, in g of dish with the material taken for test

M2 = mass in g of dish with ash

M = mass in g of the empty dish

W = moisture % of the sample

6.5.2.1.2 CRUDE FIBER

The determination of crude fibre in tart was done using the AOAC method.

PRINCIPLE

Crude fibre is the organic matter in the dried residue and is determined after digesting the sample with dilute sulphuric acid and sodium hydroxide. This method is applicable to all food products having crude fibre content**.**

REAGENTS

- Sulphuric acid solution 0.255 N, (12.5 g of sulphuric acid Sp.Gr. 1.84, dilute to 1 litre)
- Sodium hydroxide solution, 0.312 N (12.5 gm carbonate free NaOH per litre)
- Asbestos – Gooch grade,
- Ethyl alcohol, 95 %
- Methylene Chloride, anhydrous
- Sample preparation: Sample is prepared as per ASTA method No.I

PROCEDURE

Extract 2 gm of sample, taken in a thimble with methylene chloride to get the residue fat free. Transfer the residue to a digestion flask.

Add 200 ml of the sulphuric acid solution, connect the digestion flask to the condenser and place on a preheated hot plate adjusting so that the acid will boil in ca. 5 min, Continue boiling briskly for exactly 28 min. with frequent rotation of the flask to ensure thorough wetting and mixing of the sample. Material should not be allowed to remain on the sides of the flask out of the contact with the solution. Successive sample digestions should be started at ca. 3 min. intervals to facilitate accurate timing. After boiling for 28 minutes, remove the flask and filter immediately through a filter cloth in a funnel. Wash with boiling water until the washing is no longer acidic.

Transfer the sample quantitatively to the digestion flask, washing the filter cloth with 200 ml of the NaOH solution. Connect the flask to the reflux condenser, place on the preheated hot to boil in ca. 5 minutes, and boil for exactly 28 min. successive sample digestions should be started at ca. 3 min interval to facilitate accurate timing. After 28 min. remove the flask and immediately filter through a Gooch crucible. Wash the residue thoroughly with water and with ca. 15 ml of ethyl alcohol. Dry the crucible and the contents at 110 (+ / -) 2 C to a constant weight (ca. one hour). Cool in a desiccator and weigh. Ignite the crucible and contents in an electric muffle furnace at ca. 600 deg. C for 20 minutes. Cool in a desiccator and weighed. Determine the loss in weight on ignition.

CALCULATION

$$\text{Crude fibre \%} = \frac{\text{Loss in weight on ignition (gm)} \times 100}{\text{Wt. of original sample (gm)}}$$

6.5.2.1.3 CRUDE FAT

APPARATUS:

- Soxhlet Extraction Apparatus
- Electric oven
- Weighing balance

PROCEDURE:

Weigh accurately about 5g of the material in a suitable thimble and dry for 2 hours at 100±2˚C .Place the thimble in the Soxhlet extraction apparatus and extract with Petroleum Ether (40-60˚C) for 8 hours. Dry the extract contained in the Soxhlet flask, the empty mass of which has been previously determined by taring at 95˚C -100˚C for one hour.Cool in a desiccator and weigh. Repeat the process of drying, cooling and weighing at half-hour intervals until the difference in mass between two successive weighings is less than two milligram Record the lowest mass obtained.

CALCULATION:

$$\text{Fat, percent by mass} = \frac{100\,(M1-M2)}{M}$$

Where, M1 = mass, in g of Soxhlet flask with the extracted fat

M2 = mass in g of empty Soxhlet flask, and

M = mass in g of the material taken for the test.

6.5.2.1.4 IRON

REAGENTS

- o – Phenanthroline solution
- α,α-Dipyridyl solution
- Iron standard solution
- Hydroxylamine hydrochloride solution
- Magnesium nitrate solution
- Acetate buffer solution

PROCEDURE

By dry ashing:

Ash 5.00 g test portion in Pt, SiO2 or porcelain dishCool and weigh if percent ash is desired. Continue ashing until practically C- free, To diminish ashing time, or products that

do not burn practically C- free, use one of the following ash aids .Moisten ash with 0.5 – 1.0 ml Mg(NO3)2 solution or with redistilled HNO3Dry and carefully ignite in furnace, avoiding spattering. (do not add these ash aids to self rising flour (products containing NaCl) in Pt dish because of vigorous action on the dish.) Cool, add 5 ml HCl, letting acid rinse the upper portion of the dish, and evaporate to dryness in a steam bath. Dissolve residue by adding 2.0 ml HCl, accurately measured, and heat 5 min on steam bath with watch glass on dish. Rinse watch glass and dilute residue solution to 100 ml with H2O. If necessary, filter diluted residue solution through ashless paper and discard first 15 – 20 ml filtrate Pipet 10 ml aliquot into 25 ml volumetric flask and add 1 ml H2NOH.HCl solution; stand for 5 min. Add 5 ml Acetate buffer solution and 1 ml o – Phenanthroline, or 2 ml dipyridyl solution, and dilute to volume, Determine absorbance in spectrophotometer at ca 510 nm. From reading ,determine Fe concentration from equation of line representing standard points or by reference to standard curve for known Fe concentration If further dilution required to maintain test solution absorbance reading below highest standard point on curve, pipet smaller Aliquot into 25.0 ml flask, dilute to 10 ml with 2% HCl solution and continue as described in above procedure . Determine blank on reagents and make corrections.

Calculate Fe in flour as mg/Ib.

6.5.2.1.5 POTASSIUM

APPARATUS

Flame Photometer

REAGENTS

- Con. Hydrochloric Acid
- Con. Nitric Acid
- Standard Sodium solution : using 1000 ppm NIST

PROCEDURE

Preparation of Test solution: Weigh accurately about 5 gm of the sample dry in an air oven at 110ºC for an hour and cool. Then incinerate the sample at 400ºC to 450ºC till carbon is completely burnt. To that add 10 ml of hydrochloric acid, evaporate to syrupy consistency. Take up with 2 ml of concentrated hydrochloric acid and 10 ml of water, filter it. Then transfer solution and washings quantitatively to a 100 ml volumetric flask and make up to

the mark. Analyses the above prepared test solution in flame photometer by following the standard operating procedure.

CALCULATION

$$\text{Concentration of Alkali metal, percent by mass} = \frac{A \times D}{10000}$$

Where,

A = Concentration in µg/ml of alkali metal in the sample solution,

D = Dilution factor for the sample taken.

6.5.2.1.6 MAGNESIUM

PROCEDURE

Ash 5.00 g test portion in Pt, SiO2 or porcelain dish. Cool and weigh if percent ash is desired. Continue ashing until practically C- free, To diminish ashing time, or products that do not burn practically C- free, use one of the following ash aids. Moisten ash with redistilled HNO3.Dry and carefully ignite in the furnace, avoiding spattering. (do not add these ash aids to self-rising flour (products containing NaCl) in a Pt dish because of vigorous action on the dish.) Cool, add 5 ml HCl, letting acid rinse the upper portion of the dish, and evaporate to dryness in a steam bath. Dissolve residue by adding 2.0 ml HCl, accurately measured, and heat 5 min on steam bath with watch glass on dish. Rinse watch glass and dilute residue solution to 100 ml with H2O.

If necessary, filter diluted residue solution through ash less paper and discard first 15 – 20 ml filtrate. Pipette an aliquot of water sample, adjust the volume to 50 ml. Add 1 ml hydroxylamine hydrochloride solution. Add 1 to 2 ml buffer solution so that pH is between 10-10.1. Add 2 ml EBT solution. Titrate with std EDTA solution. Note the titer value as V.

Determination of Ca: Use 50 ml of sample or a smaller portion diluted to 50ml so that the Ca content is about 5 to 10mg.Add 2 ml NaOH solution or a volume sufficient to produce a pH 12 to 13. Stir. Add 1g of mix of Patton and Reeder reagent and NaCl or KCl may be used. Add EDTA titrant slowly. Let this volume be V1.

CALCULATION

$$\text{Magnesium(asMg)mg/l} = \frac{0.2435*100*(V2-V1)\times\text{dilution}\times\text{normality of EDTA}}{V \times \text{sample weight percent by mass}}$$

Where, V = Volume in ml of sample taken for the test.

V1= Volume of EDTA consumed in Ca determination and

V2= Volume of EDTA consumed in titration.

6.5.2.1.7 CALCIUM

APPARATUS:

- Porcelain dish
- Electric oven
- Weighing balance
- Volumetric flasks

PROCEDURE:

Weigh accurately about 2g of sample in a porcelain dish. Ignite in the furnace to carbon free ash, but avoid fusing. Boil the residue in 40 ml HCl(1+3) and a few drops of HNO3. Cool and transfer to a 250 ml standard flask, dilute to volume and mix. Pipette 25ml clear liquid into a beaker, dilute to 100ml and add 2 drops of methyl red. Add NH4OH(1+1) drop wise to pH5.6 (brownish orange colour). If overstepped add HCl(1+3) with dropper to orange .Add two more drops of HCl to pink and pH 2.5-3.0 Dilute to 150ml and boil .Add slowly with constant stirring 10 ml of hot saturated (4.2%) solution of ammonium oxalate .If red changes to orange or yellow, add HCl drop wise until pink .Let stand overnight for precipitate to settle. Filter the supernatant through Whatman no.40 and wash the precipitate .Thoroughly with NH4OH (1+50) .Place the paper in original beaker and add a mixture of 125ml water and 5 ml H2SO4.Heat to 70˚C and titrate against 0.02MKMnO4(0.1N) to slight pink colour Correct for blank.

6.5.2.1.8 CARBOHYDRATES

TEST METHOD: AOAC 20th Edn 2016 986.25

PROCEDURE

Total carbohydrates are calculated as follows after determining the percentage of moisture, total protein, fat and total ash.

CALCULATION

Total carbohydrates = 100 - (A+B+C+D)

Where A = percent by mass of moisture

B = percent by mass of total protein

C = percent by mass of fat and

D = percent by mass of total ash

Table 6.4 Test methods to analyse Nutritional value

SL NO	PARAMETERS	UNIT	TEST METHOD	RESULT
1	Total carbohydrates	%	AOAC 22nd Edn.2023;986.25,ch.50. 1.16	55.91
2	Total ash(on dry basis)	%	AOAC 22nd Edn.2023 923.03, Ch.32.1.05	1.47
3	Crude Fibre(on dry basis)	%	IS 12711: 1989; RA 2020, M.13	4.99
4	Crude Fat	%	SOP No. FQ LAB/SOP/C/F&C/7243	6.93
5	Iron	mg/100g	AOAC 22nd Edn.2023;944.02, Ch.32.1.09	1.85
6	Potassium	mg/100g	IS 9497: 1980; RA 2020	311.39
7	Magnesium	mg/100g	AOAC 22nd Edn.2023;931.10. Ch.37,1.25	157.34
8	Calcium	mg/100g	IS 9497: 1980; RA 2020	94.36

6.5.3 SHELF LIFE

Consumers are demanding high quality food and they expect this high quality is maintained during the period between purchase and consumption. Shelf life is the period during which the food remains safe for consumption. There are certain factors that affect the shelf life of the product. such as Water activity, Ph, Redox potential, Oxygen, Nutrients, Natural Microflora, Use of preservatives, Time, Temperature, Relative humidity etc. shelf life is a crucial part of the product that must be mentioned in the label of the product.

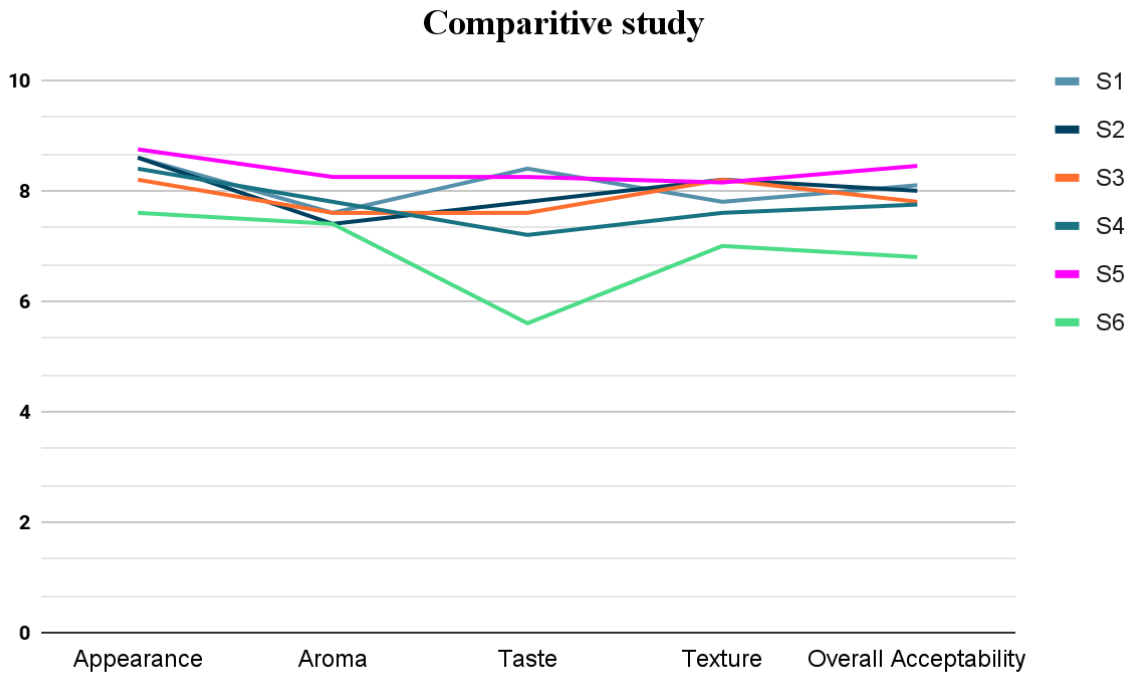
The Tarts base and filling is made by combining tamarind seed powder, wheat flour, dates and nutmeg as the ingredients. The product is packed in a stainless-steel bowl, tightly covered with a cling wrap. Two samples with the combination of 30% and 40% is the preferred product, in which one sample is kept in the Refrigeration Temperature (Tf) while the other one is kept in the Room Temperature (Tr).

Each sample is labelled with the date of production and it is inspected weekly. On daily assessment, it was visible that products kept in Tr have a lesser shelf life than products in the TT. After one week the sample in the Tr has initiated spoilage with white cottony mould growth, but the colour and aroma doesn't show any changes. The samples in the Tf have a shelf life extended to four weeks and the viscosity of the product has increased considerably. From this we can conclude that the product kept in the Tf has more shelf life than the product in the Tr.

CHAPTER 7 RESULT AND DISCUSSION

This chapter presents the findings and discussions derived from the observation conducted in the present study titled "Development of a Nutritionally Improved Dates-Nutmeg Tart Fortified With Tamarind Seed Powder." The primary aim of this study was to create a tart that is enriched with nutritional value. Specifically, the study aimed to enhance the utilisation of tamarind seed in future food production. To achieve this goal, a tart recipe containing Tamarind Seed Powder, Dates, and Nutmeg was developed. Subsequently, sensory evaluations and nutritional analyses were performed to assess the quality and nutritional content of the tart. The results of these assessments are provided below :

7.1 SENSORY ANALYSIS



GRAPH 7.1 : Comparative Study Of Six Samples Based On Sensory Analysis Using Hedonic Scale

The graph states that the accepted sample is S5(Pink) and the least accepted sample is S6(Light Green). Aromas of all these samples only have a slight variation. S6 seemed to have the least taste due to having the highest concentration of tamarind seed powder.

7.2 NUTRITIONAL ANALYSIS

In the given research product, the nutritional content can be analysed and compared to the Recommended Dietary Allowances (RDA) values for daily nutrient intake. The product contains 311.39 mg of potassium, which corresponds to approximately 9% of the AI(Adequate Intake) for adults aged 19-50 years and 10.3% for adults aged 51 years and older. The 157.34 mg of magnesium in the product equates to around 38% of the AI for adults aged 19-30 years, 34% for those aged 31-50 years, and 34% for adults aged 51 years and older. The product's 94.36 mg of calcium represents about 10% of the AI for adults aged 19-50 years and 8% for adults aged 51 years and older. Lastly, the 1.85 mg of iron in the product corresponds to approximately 10% of the RDA for both adult men and women. In terms of carbohydrates, the product contains 55.91%, which is in line with the RDA of 130 g/day for adults. Overall, this product offers a notable contribution to essential nutrients, particularly magnesium, while providing a good source of potassium, calcium, and iron, and aligning with the daily carbohydrate recommendations.

7.3 SHELF LIFE

Shelf life, a pivotal aspect in the food industry, pertains to the duration during which a food product remains safe and maintains its quality from the time of purchase to consumption. Numerous factors, such as water activity, pH, redox potential, oxygen, nutrients, natural microflora, preservatives, time, temperature, and relative humidity, significantly impact the shelf life of a product. It is crucial for manufacturers to disclose this information on the product's label to ensure consumer satisfaction and safety. The prepared six samples were packaged in stainless-steel containers, sealed with cling wrap, and each ratio of samples was divided into two groups. One group was stored at refrigeration temperature (Tf), while the other was kept at room temperature (Tr). Each sample was labelled with the production date and assessed weekly. Upon daily evaluations, it was observed that the products stored at room temperature exhibited a shorter shelf life compared to those stored at refrigeration temperature. After four weeks, the room-temperature samples began to spoil, evidenced by the emergence of green cottony mould growth. Despite this, the colour and aroma of the samples remained unaffected. Conversely, the refrigerated samples maintained their quality for an extended period, up to six weeks. This experiment highlights the significance of temperature in preserving the shelf life of the tarts, with refrigeration temperature providing a more prolonged shelf life compared to room temperature storage.

CHAPTER 8 SUMMARY AND CONCLUSION

The research thesis presented above focuses on the Development of nutritionally enhanced dates-nutmeg tart by incorporating tamarind seed powder. Tamarind seeds, often overlooked in the tamarind pulp industry, hold a significant potential for various applications in the food processing sector. The study aims to explore the untapped possibilities of utilising tamarind seed powder in food formulations and products.

To achieve this, the study employed a descriptive-quantitative research methodology, which involved preparing six varying ratios of tamarind seed powder and wheat flour in the ratios S1(0%+100%), S2(10%+90%), S3(20%+80%), S4(30%+70%), S5(40%+60%) and S6(50%+50%). The primary objective was to identify the optimal concentration of tamarind seed powder that would enhance the sensory attributes of the tart, including colour, taste, aroma, texture, and overall acceptability.

The sensory evaluation was conducted using descriptive testing, where a panel of experts assessed the characteristics of the six formulations. The results demonstrated that the sample S5, containing a 40:60 ratio of tamarind seed powder to wheat flour, achieved the highest sensory acceptability rating. This suggests that incorporating tamarind seed powder in this specific proportion can significantly improve the sensory qualities of the dates-nutmeg tart.

In addition to the sensory improvements, the proximate analysis of the final product revealed high levels of carbohydrates, potassium, magnesium, and calcium. These findings indicate that the incorporation of tamarind seed powder not only enhances the sensory attributes of the tart but also contributes to its nutritional value.

In conclusion, the research thesis provides valuable insights into the potential of using tamarind seed powder in the food processing sector, specifically in the development of a nutritionally improved dates-nutmeg tart. The optimal ratio of tamarind seed powder to wheat flour (40:60) has been identified, which can serve as a foundation for further research and development in this area. The findings of this study may encourage the food industry to explore alternative ingredients and formulations, ultimately contributing to more diverse and nutritious food products.

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SCORE CARD

HEDONIC RATING SCALE

Name:

Product:

Date:

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1					
Sample 2					
Sample 3					
Sample 4					
Sample 5					
Sample 6					

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: Signature:

F Q LAB
AND RESEARCH CENTRE
(P) LIMITED
Food Testing • Training • Food Safety Systems

♦ ISO 9001 QMS CERTIFIED ♦ APPROVED BY KERALA STATE POLLUTION CONTROL BOARD ("A" GRADE LAB) ♦
♦ MEMBER : AFI (USA), IFOAM (GERMANY), NIQR (INDIA) ♦ RECOGNISED BY BUYERS IN USA, EU, JAPAN & OTHER COUNTRIES ♦

Doc.No: FQLAB/F/7801A

TEST CERTIFICATE

B 7577

Date of Issue : 27.03.2024

Issued To:
Ms. Sneha P Ullas
Pulikottil House
Kumaranasan Road
Kadavanthra-682 020

Sample Code	: FQLAB/23-24/1415/C2621
Sample Receipt	: 19.03.2024
Date of Analysis	: 20.03.2024 - 26.03.2024
Reported Date	: 26.03.2024

Particulars of sample	: Tamarind seed powder based nutmeg tart
Condition of Sample	: Received in good condition
Customer Sample ID	: Nil
Sample Quantity	: 200g
Sample Drawn by	: Customer
Sample Description	: Dark brown colour cake

TEST RESULTS

SL NO.	PARAMETERS	UNIT	TEST METHOD	RESULT
1	Total Carbohydrate	%	AOAC 22nd Edn. 2023; 986.25, Ch.50.1.16	55.91
2	Total Ash (on dry basis)	%	AOAC 22nd Edn. 2023; 923.03, Ch.32.1.05	1.47
3	Crude Fibre (on dry basis)	%	IS 12711 : 1989; RA 2020, M.13	4.99
4	Crude fat	%	SOP No. FQLAB/SOP/C/F&C/7243	6.93
5	Iron	mg/100g	AOAC 22nd Edn. 2023; 944.02, Ch.32.1.09	1.85
6	Potassium	mg/100g	IS 9497 : 1980; RA 2020	311.39
7	Magnesium	mg/100g	AOAC 22nd Edn. 2023; 931.10, Ch.37.1.25	157.34
8	Calcium	mg/100g	IS 9497 : 1980; RA 2020	94.36

No.of parameters tested: 8

********** End of the Report **********

For FQLAB AND RESEARCH CENTRE (P) LIMITED

Authorised Signatory
MANOJ P
Sr.Technologist
(Chemistry)
FQL & RC

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Tel : + 91-484-402 6686/402 6691 E - Mail : synergee95@gmail.com / fqlabindia@gmail.com Website : www.fqlrc.com

SCORE CARD

HEDONIC RATING SCALE

Name: Sneha S

Product: Tamarind-Nutmeg Tart

Date: 22-2-2024

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1	09	7	8	9	8.25
Sample 2	9	7	9	9	8.5
Sample 3	8	7	7	9	7.75
Sample 4	9	7	7	8	7.75
Sample 5	9	7	9	8	8.25
Sample 6	7	7	5	7	6.5

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: Signature:

SCORE CARD

HEDONIC RATING SCALE

Name: Sherin Mary Simon.

Product: Tamarind-Nutmeg Tart

Date: 22-2-'24

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1	8	8	8	7	7.75
Sample 2	9	7	7	8	7.75
Sample 3	7	7	8	7	7.25
Sample 4	8	7	6	7	7.0
Sample 5	8	7	6	6	6.75
Sample 6	7	7	5	6	6.25

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: Sour taste persist as we proceed to 6th item.

Signature:

SCORE CARD

HEDONIC RATING SCALE

Name: Rosemol M.P.

Product: Tamarind-Nutmeg Tart

Date: 22-02-2024

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1	8	7	9	7	7.75
Sample 2	8	8	8	8	8.0
Sample 3	8	9	7	8	8.0
Sample 4	9	8	8	9	8.5
Sample 5	8	8	8	8	8.0
Sample 6	9	9	6	8	7.5

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: Nice presentation.

Signature: Rosemol

SCORE CARD

HEDONIC RATING SCALE

Name: Fouzia . M Yoosuf

Product: Tamarind-Nutmeg Tart

Date: 22/02/'24.

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1	9	8	8	8	8.25
Sample 2	8	7	8	7	7.5
Sample 3	9	8	9	8	8.5
Sample 4	8	9	8	9	8.0
Sample 5	7	9	8	9	8.25
Sample 6	8	7	7	8	7.5

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: Nil.

Signature:

SCORE CARD

HEDONIC RATING SCALE

Name: Ceyona Victor

Product: Tamarind-Nutmeg Tart

Date: 22/02/24

There are 6 samples. Taste the samples and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
Sample 1	9	8	9	8	8.5
Sample 2	9	8	7	9	8.25
Sample 3	9	7	7	7	7.5
Sample 4	8	8	7	7	7.5
Sample 5	7	9	9	8	8.25
Sample 6	7	7	5	6	6.25

9- Point Hedonic Scale	
9	Like Extremely
8	Like very much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

Comments: In sample 6 an after taste is formed.

Signature: Ceyona Victor