DEVELOPMENT AND POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER

DISSERTATION

Submitted in Partial Fulfilment of the Requirement for

The Award of the Degree of

MASTER'S PROGRAMME IN

CLINICAL NUTRITION AND DIETETICS

BY

SHREYA K P

(Register No: SM19MCN012)

DEPARTMENT OF CLINICAL NUTRITION AND DIETETICS

ST. TERESA'S COLLEGE (AUTONOMOUS)

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Signature of the External Examiner **Signature of the Internal Examiner**

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Signature of HOD **Signature of Guide**

DECLARATION

I hereby declare that the thesis entitled "**DEVELOPMENT AND POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER**" submitted in partial fulfilment of the requirement for the award of the Degree of Master's Programme in Clinical Nutrition and Dietetics is a record of original research work done by me under the supervision and guidance of Dr. Priya Pillai, Assistant Professor, Department of Clinical Nutrition and Dietetics, Women's Study Centre, St. Teresa's College (Autonomous), Ernakulam and that the thesis has not previously formed on the basis for the award of any degree work has not been submitted in part or full or any other degree/diploma/ fellowship or the similar titles to any candidate of any other University.

Place:

Date:

CERTIFICATE

I hereby certify that the dissertation entitled "**DEVELOPMENT AND POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER**" submitted in partial fulfilment of the requirement for the award of the Degree of Master's Programme in Clinical Nutrition and Dietetics is a record of original research work done by Ms. Shreya. K. P., during the period of her study under my guidance and supervision.

Signature of the Research Guide

Dr. Priya Pillai

Assistant Professor

Department of Clinical Nutrition and Dietetics,

Women's Study Centre

St. Teresa's College (Autonomous), Ernakulam

Signature of the HOD

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SHREYA. K. P

ABSTRACT

ABSTRACT

The present study entitled "Development and popularization of value added food products using pomegranate peel powder" by using Pomegranate peel powder for selected woman (20 – 60 years) working in office, Chennai, was done with an aim to prepare pomegranate peel powder incorporated food products, to study their shelf life qualities and to popularize these products among the working women staffs in offices. The study also measured awareness of the staff members about pomegranate peel powder. In order to meet the objectives, four products were prepared by incorporating Pomegranate peel powder namely Cookies, Nutritive bar, Rice laddoo and Tart base. These products were prepared in three variations namely variation 1, variation 2 and variation 3 which contained various proportions of pomegranate peel powder, incorporated from 5 – 40 percent which varies for each product along with other ingredients for achieving enhanced quality and adequate quantity of the nutrients in the products. A score card was prepared to select the judging panel of ten panel members. A 9 – hedonic scale score card was prepared to evaluate the sensory qualities of the prepared products. Organoleptic evaluations of the sensory qualities of the prepared products were done by employing the triangle test. Among the prepared variations, those variations with highest overall acceptability scores were considered as the best variation of the product. By testing the framed hypothesis using Friedman's ANOVA test, the alternate hypothesis for the test was identified. It revealed that the samples did not differ from each other according to their overall acceptability. So the null hypothesis was accepted.

The nutrient content of the best variation of each Pomegranate peel powder incorporated product per 100g was assessed with reference to their carbohydrate, protein, fat, calcium and phosphorous content. Pomegranate peel powder incorporated food products were found to be rich in nutrients especially calcium, phosphorous and protein and also carbohydrate and fat. The developed products were analyzed for their shelf life qualities for a period of 2 months at room temperature. The best variations of each Pomegranate peel powder incorporated product were also evaluated for the time taken in preparing them. Among the developed products, two of the best product variation with highest overall acceptability scores namely pomegranate peel powder incorporated nutritive bar (40.7) and rice laddoo (40) were popularized among the women with sedentary lifestyle working in offices. For the process of popularization, a questionnaire which collected information about the awareness of pomegranate peel powder and a score card was prepared for the sensory evaluation of

Pomegranate peel powder incorporated products and a questionnaire which collected the feedback from the women staff members. Each product were then organoleptically scored by the judging panel. The responses given by the staff members showed that they had the interest to cultivate pomegranate plant and incorporate its peel powder in their daily diet**.**

1. INTRODUCTION

INTRODUCTION

Adulthood, is the period in human lifespan in which full physical and intellectual maturity have been attained. Adulthood is commonly thought of as beginning at age 20 or 21 years. Middle age, commencing at about 40 years, is followed by old age at about 60 years (Kara Rogers, 2018).

Early and middle adulthood are marked by slow, gradual declines in body functioning, which accelerate as old age is reached. The muscle mass continues to increase through the mid – 20s, thereafter gradually decreasing. The skeletal mass increases until age 30 or so, and then begins to decrease, first in the central skeleton (pelvis and spine) and last in the peripheral skeleton (fingers and toes) (Kara Rogers, 2018).

Throughout adulthood there is a progressive deposition of cholesterol in the arteries, and the heart muscle that eventually grows weaker even in the absence of detectable disease. The production of both male and female hormones also diminishes with age (Kara Rogers, 2018).

Kara Rogers, states that, the typical age of attaining legal adulthood is 18, although definition may vary by legal rights, country, and psychological development. There is clear evidence that with increasing age adults display a slow, very gradual tendency toward decreasing speed of response in the execution of intellectual (and physical) tasks. Slowing rates of electrical activity in the older adult brain have been linked to the slowing of behaviour itself. This decline in the rate of central nervous system processing does not necessarily imply similar changes in learning, memory, or other intellectual functions.

The learning capacity of young adults is superior to that of older adults, as is their ability to organize new information in terms of its content or meaning. Older adults, on the other hand,

are equal or superior to young adults in their capacity to retain general information and in their accumulated cultural knowledge (Kara Rogers, 2018).

According to the United States Department of Agriculture's Dietary Guidelines for 2015 to 2020, early adulthood spans from ages 19 to 30. People in this age group should get plenty of calories for their daily activities. In fact, it's recommended that women within this age group eat around 2,000 calories per day and that men eat between 2,600 to 3,000 calories per day for optimum health. The more people are active, the more calories are used up to stay healthy. Young adults need plenty of calories because they are most active and burn up most of the calories every day. They also need to include plenty of fibre in their diet, that is, about 28 grams per day for women and 33.6 grams for men (Susan Paretts et al., 2018).

According to Susan Paretts, the middle age lasts from age 31 to 50. During this time, the body starts to slow down just a bit and they have to compensate for that through their diet. The USDA (United States Department of Agriculture) recommends that women in this age group should get around 1,800 calories per day and men around 2,200 to maintain their health. Eating fewer calories helps them to maintain their ideal body weight as their metabolism slows and also they burn about 100 to fewer calories per day for every decade as their age increases. Middle age also means a little less fibre in the diet. Women should get around 25.2 grams of fibre per day and men around 30.8 grams.

Middle – aged women need higher amounts of iron in their diet to stay healthy because their bodies have low iron stores. While all adults need 8 mg of iron per day, middle – aged women need 18 mg of iron in their diets. Lean red meats are good sources of iron, and foods rich in vitamin C aids in the absorption of the iron (Susan Paretts et al., 2018).

It's important for older women to get more calcium to prevent conditions like osteoporosis as they enter menopause and experience hormonal changes. Although all adults need around 1,000 mg of calcium per day, women over 51 require 1,200 mg per day (Susan Paretts et al., 2018).

Susan Paretts states that, many dietary requirements don't change throughout adulthood, including the protein and carbohydrate requirements. To stay healthy, all adults should aim to eat a low-sodium and low – fat diet & rich in fruits and vegetables. Fruits and vegetables are rich in healthy antioxidants and are wise choice at any age. During all stages of adulthood, we should look for foods rich in whole grains & stick to eating lean meats and should include fatty fish like salmon and sardines that are rich in omega-3 fatty acids.

Osteoporosis is a bone condition that causes bones to thin and weaken over time, making them easier to break. It affects both men and women in adulthood. One in two women over 50 and one in four men experience an osteoporosis related fracture in their lifetime. Also 2 million men have osteoporosis (Rodney J. Halvorsen et al., 2016).

According to Rodney J. Halvorsen, ninety – nine per cent of the calcium in the human body is found in the bones and teeth, where it makes tissue stronger and denser. Individuals receives an inadequate amount of calcium from their diet, especially during their childhood and teenage years, are much more likely to develop osteoporosis later on in life. Make a concentrated effort to eat at least 1,000 milligrams of calcium every day to protect and strengthen your bones.

Women tend to have smaller, lighter bones than men. This makes women more susceptible to osteoporosis as there is less mass, and menopause has a greater effect on their bones. Plus, after menopause the body produces less oestrogen and progesterone – two common female

hormones that help keep bones strong. A lack of oestrogen can cause bone loss in younger women too. Early menopause can cause early bone loss and disease well before the age of 65. Women lose more than 30% of their bone mass within five years after menopause (Rodney J. Halvorsen et al., 2016).

The most obvious sources of calcium are dairy products that mainly includes milk, yogurt and cheese. If you are a vegan or lactose intolerant, calcium can be obtained from vegetables and legumes including spinach, soybeans and broccoli. In millets, ragi is a rich source of calcium (Carolyn Robbins et al., 2018).

The Pomegranate (*Punica granatum*) is a fruit – bearing deciduous shrub in the family Lythraceae, subfamily Punicoideae that grows between 5 and 10 m (16 and 33 ft.) tall. It originated in Persia & its cultivation spread quickly throughout the Mediterranean and extended to Arabia, Afghanistan, India and China, where it was called the "Chinese apple," the alternate appellation (Basiri et al., 2014).

In ancient cultures (such as Indian and Egyptian), this fruit was commonly known as a "Paradise fruit" due to its extensive use in folk medicine (Basiri et al., 2014).

It has been reported that pomegranate peels have been used by ancient Egyptians and Indians as a therapeutic agent with medicinal properties against several ailments including cough, diarrhoea, dysentery, dental plaque, inflammation, ulcers, bleeding noses, infertility and intestinal worms (Ismail et al., 2012).

Pomegranate is one of the most favourite table fruits. The fresh fruits are used for table purpose and also can be used for the preparation of processed products like juice, syrup, squash, jelly, juice concentrates, carbonated cold – drinks, etc. (Seeram et al., 2016).

The pomegranate tree is native from Iran to the Himalayas in northern India & ranks first in pomegranate cultivation in the world. In India, Maharashtra is the leading producer of pomegranate followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. We can find the pomegranate plantations in India throughout the year. However, the best quality pomegranates hit markets during the monsoon season. The seeds for these fruits are planted in February and March (Seeram et al., 2016).

The fruit is typically in season in the Northern Hemisphere from October to February & in the Southern Hemisphere from March to May. There are some commercial orchards in Israel on the coastal plain and in the Jordan Valley (Seeram et al., 2016).

Maharashtra is leading with 90 thousand ha area with annual production of 9.45 lakh Mt tones and productivity of 10.5 Mt/ha. Maharashtra state accounts for 78 percent of the total area in India and 84 percent of the total production in the country. In Kerala, the pomegranates are brought from other states as it is less grown in the soils of Kerala (Seeram et al., 2016).

In Tamil Nadu, the major cultivation of pomegranates occurs in Dindigul, Erode, Coimbatore and Tirunelveli. The major markets are in Chennai & Coimbatore. Here, the preferred varieties of pomegranate are Bhagwa, Ruby & Ganesh (Dhinesh K Babu et al., 2014).

For the successful pomegranate cultivation, it is essentially dry and semi – arid weather, where cold winter and high dry summer quality enables fruit production. Pomegranate plant can tolerate frost to some extent and may be considered drought – tolerant. The optimum temperature for fruit development is 35 – 38° C. The region with 500 m above from sea level is best suited for pomegranate cultivation (Patricia Gullón et al., 2020).

The pomegranate, including the pomegranate peel, has been used worldwide for many years as a fruit with medicinal activity, mostly antioxidant properties. In the last few years, the

consumer's concern with the relationship between health and diet has led to the search of foods with functional properties beyond the nutritional. In this framework, the consumption of pomegranate has increased due to their sensorial attributes and remarkable amounts of bioactive compounds, which generate, at the same time, huge amounts of by – products (Patricia Gullón et al., 2020).

Pomegranate fruit is nutritious, rich in proteins. Minerals such as calcium, iron, and vitamins are also present in the fruit as well as in the peel. The juice is useful for leprosy suffering patients. Pomegranate peel contains high amount of polyphenols, condensed tannins, catechins, and prodelphinidins. The higher phenolic content of the peel yields extracts for use in dietary supplements and food preservatives. The by-products of pomegranates, especially pomegranate peel powder, have been increasing attention due to its scientifically confirmed therapeutic properties such as antioxidant, antimicrobial, anticancer, antiulcer, and anti – inflammatory activities (Jing Chen et al., 2020).

Jing Chen also states that, the scientific studies have suggested that pomegranate peel powder exhibits excellent antimicrobial activity against several foodborne pathogens and improves the postharvest storability of food products. Due to the antioxidant properties of the pomegranate peel, it prevents the risk of diseases like Cardio vascular diseases (CVD), Diabetes, Osteoporosis, Cancer, Inflammatory diseases and Intestinal diseases.

Additionally, pomegranate peel powder has the capability to treat some chronic diseases due to its anticancer properties such as colon and prostate cancer, melanogenesis (skin cancer), breast cancer and stomach ulcers (Sara Basiri et al., 2015).

The skin of the fruit is usually underutilized & discarded in India the reason is, lack of popularity of the pomegranate peel which is due to variety of reasons that includes ignorance

& lack of knowledge. Some of the products that have been produced using pomegranate peel powder are idly batter, tea powder, etc. (Sayeeda Fathima et al., 2013).

Other uses of pomegranate peel powder includes - fights acne, pimples and rashes, helps in detoxification of body, fights against wrinkles and ageing, cures sore throats and coughs, acts as a natural moisturiser, arrests hair loss and prevents dandruff, improves dental hygiene, etc. (Debjani Arora et al., 2016).

The development of the product has usually been called 'product development' and had connotations of laboratory formulation and sensory panel. Today, there may be real benefits in adopting food product design and in associating food product design with other areas of design (Pratiksha Supekar, 2018).

New Product development is a complex process. The product should fill the marketing requirement and should have more customers' preference compared to similar products. New products are categorized into – new to the world, new product line in the company, extension to existing product line etc. There are lots of inventions in food industries today (Pratiksha Supekar, 2018).

The reasons for which the new products are being developed are due to new innovation, demand from a customer (Change of lifestyle, healthy living), loss of current market and market pressure (Pratiksha Supekar, 2018).

There has been a little research work mentioning to find possibility of processing of jackfruit into durable and nutritious food products. So, it is now a burning issue to reduce the losses by developing the processing technique of jackfruit. Cottage industries and small scale industries establishment can be encouraged in our country, efforts of which are as yet quite inadequate. It can be hoped that a continuous increase of the agro based industries, unemployed people can be provided with work through auxiliary and useful services

which would lead the rural life more prosperous in near future. In consideration of the above circumstances, the present study was under taken to develop products by processing different parts of jackfruits and to know the nutritional quality of the processed products (Pratiksha Supekar, 2018).

OBJECTIVES OF THE STUDY

The objectives of the study titled '**DEVELOPMENT & POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER'** includes:

1. To process the pomegranate peel powder.
2. To develop pomegranate peel powder incorporated food products.
3. To evaluate the organoleptic parameters and assess the sensory qualities of the developed products.
4. To assess the nutrient values of the formulated recipes.
5. To evaluate the time taken for the preparation of pomegranate peel powder incorporated food products.
6. To add value to the developed products by packaging and labelling.
7. To estimate the shelf – life stability of the developed products for a period of 3 months.
8. To popularize the developed food products among the working women staffs in Chennai.
9. To promote awareness regarding the health benefits and effective utilization of pomegranate peel powder that are usually under – utilized or discarded.

2. REVIEW OF LITERATURE

REVIEW OF LITERATURE

The review of literature of the study titled '**DEVELOPMENT AND POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER'** are discussed under the following headings:

2.1. CULTIVATION AND UTILITY OF POMEGRANATE AND ITS PEEL

2.2. DESCRIPTION OF POMEGRANATE AND ITS PEEL

2.3. NUTRIENT COMPOSITION OF POMEGRANATE PEEL

2.4. CHEMICAL PROPERTIES OF POMEGRANATE PEEL

2.5. VALUE ADDED PRODUCT

2.6. HEALTH BENEFITS OF POMEGRANATE PEEL

2.7. PHYSICOCHEMICAL PROPERTIES OF POMEGRANATE PEEL

Figure 1

Figure 2

2.1. CULTIVATION AND UTILITY OF POMEGRANATE AND ITS PEEL

Punica granatum generally known as pomegranate is grown for its fruit crop, as ornamental trees and shrubs in parks and gardens. Mature specimens can develop sculptural twisted – bark, multiple trunks and a distinctive overall form. Pomegranates are drought – tolerant, and can be grown in dry areas with either a Mediterranean winter rainfall climate or in summer rainfall climates worldwide. In wetter areas, they can be prone to root decay from fungal diseases. They can be tolerant of moderate climate and frost down to about −12 °C (10 °F) (Amos Fawole et al., 2013).

Pomegranate grows easily from seed, but is commonly propagated from 25 to 50 cm (10 to 20 in) hardwood cuttings to avoid the genetic variation of seedlings. Air layering is also an option for propagation, but grafting fails (Olaniyi et al., 2013).

The pomegranate is native to a region from modern-day Iran to northern India. In India, Maharashtra is the leading producer of pomegranate followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. Important pomegranate varieties cultivated in India are Alandi or Vadki, Dholka, Kandhari, Kabul, Muskati Red, Paper Shelled, Spanish Ruby, Ganesh. In Tamil Nadu, the varieties cultivated are Bhagwa, Ruby & Ganesh (Linus Opara et al., 2013).

The study of many scholars showed that the antimicrobial activity of pomegranate peel powder was more potent than other parts, and the antimicrobial activity of pomegranate peel powder was related to the total flavonoids and tannins content. The peel is well known for its antimicrobial activity against bacterial and fungal pathogens and therefore are being used recently in many food products for better health results (Jing Chen, 2020).

Some of the products that have been produced using pomegranate peel powder are idly batter, tea powder, etc. Pomegranate skin powder incorporated in idli and other ready to cook products can also introduced from kids to adults to provide more nutritious meal. It improves

vitamin C and protein and to reduce cancer and cholesterol. The product has introduced to all community since it contains unique package of antioxidants especially vitamin C of special mention at an affordable price (Yamuna Devi et al., 2013).

2.2. DESCRIPTION OF POMEGRANATE & ITS PEEL

A shrub or small tree growing 5 to 10 m (16 to 33 ft.) high, the pomegranate has multiple spiny branches and is extremely long-lived, with some specimens in France surviving for 200 years. *P. granatum* leaves are opposite or sub – opposite, glossy, narrow oblong, entire, 3 – 7 cm (1 ¼–2 ¾ in) long and 2 cm (¾ in) broad. The flowers are bright red and 3 cm (1 ¼ in) in diameter, with three to seven petals. Some fruitless varieties are grown for the flowers alone (Umezuruike et al., 2013).

Red – purple in colour, the pomegranate fruit husk has two parts: an outer, hard pericarp, and an inner, spongy mesocarp (white "albedo"), which comprises the fruit inner wall where seeds attach. Membranes of the mesocarp are organized as non – symmetrical chambers that contain seeds inside sarcotestas, which are embedded without attachment to the mesocarp. Containing juice, the sarcotesta is formed as a thin membrane derived from the epidermal cells of the seeds. The number of seeds in a pomegranate can vary from 200 to about 1,400 (Umezuruike et al., 2013).

Jing et al. (2020) states that many scholars showed that the antimicrobial activity of pomegranate peel powder was more potent than other parts, and the antimicrobial activity of pomegranate peel powder was related to the total flavonoids and tannins content. Pomegranate peel powder is well known for its antimicrobial activity against bacterial and fungal pathogens.

The texture of the peel is glossy with soft seeds with total suspended solids (TSS). The colour of the fruit peel varies with the difference in species of the fruit which range from yellowish – orange to bright red (Andrew L. Myrthong et al., 2014).

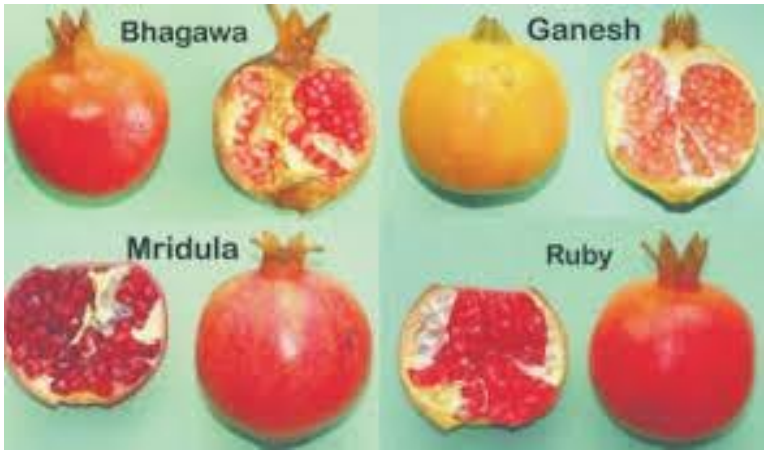


Figure 3

2.3. NUTRIENT COMPOSITION OF POMEGRANATE PEEL

The peel consists many macro and micro nutrients like carbohydrate, protein, fats, vitamins and minerals. It is also rich in complex carbohydrates especially fibre (Rowayshed et al., 2013).

The carbohydrate content in the peel is 80.5% and the fibre content is 11.22%. The crude fibers present in the peel provide numerous health benefits such as their ability to decrease serum LDL – Cholesterol level, improve glucose tolerance and the insulin response, reduce hyperlipidemia and hypertension, and contribute to gastrointestinal health and the prevention of certain cancers such as colon cancer (Emad et al., 2013).

Protein is an essential source for many body functions. The peel contains 3.1 %. Pomegranate peel powder protein contained a much higher content from lysine, leucine, aromatic fatty

acids (phenylalanine and tyrosine), threonine and valine. It has higher content of amino acids like lysine, isoleucine, Sulphur containing amino acids like methionine and cysteine (Mostafa Aboulfadl et al., 2013).

The fat content in the peel is 1.73%. The essential fatty acids resent in the fruit peel, contains health potential of polyunsaturated (n – 3) fatty acids which play a natural preventive role in cardiovascular disease (Rowayshed et al., 2013).

The pomegranate peel powder contained the most determined minerals at adequate concentration in it were found to be Calcium which consists 338.5mg that benefits for the risk of osteoporosis. The pomegranate peel powder contained a considerable content of iron at level of 5.93mg which also benefits for improving the iron content in the body (Emad et al., 2013).

The determined vitamins naturally occurred in pomegranate peels and are considered one of the most important phytochemicals having the anti-oxidant, anti – microbial and prevents the risk of cancer and therefore has advantage in human nutrition. The vitamin content are vitamin A – 0.164 mg, vitamin C (ascorbic acid) – 12.9 mg, vitamin E – 3.99 mg. It also contains vitamin B1and B2 which is present in trace amounts (Mostafa Aboulfadl et al., 2013).

According to Li et al. (2006), the peel of the pomegranate represents almost 26 – 30% of the fruit. This part of the fruit has the highest antioxidant capacity (92% of the total antioxidant activity of the fruit because of its large content of polyphenols such as punicalagin, flavonoids (anthocyanins, catechins and other complex flavonoids) and hydrolysable tannins (punicalin, pedunculagin, punicalagin, gallic and ellagic acid).

Pomegranate peel provides higher yields of phenolic, flavonoids and pro – anthocyanidins than the pulp. Flavonoid content was significantly greater in the peel than the pulp (59 vs. 17 mg/g), as were pro – anthocyanidins (11 vs. 5 mg/g) (Li et al. 2006).

Component (%)	**Gross Chemical Component (%)**
	Pomegranate Peel Powder (%)
Ash	**3.30**
Moisture	**13.7**
Protein	**3.1**
Fat	**1.73**
Fibre	**11.22**
Carbohydrate	**80. 50**
Total phenolic	**27.92**

(Emad et al., 2013)

Mineral (mg/ 100g)	Pomegranate Waste
	Pomegranate Peel Powder
Calcium	338.5
Pottasium	146.4
Phosphorous	117.9
Sodium	66.43
Iron	5.93
Selenium	1.03
Zinc	1.01
Manganese	0.8
Copper	0.6

(Mostafa Aboulfadl et al., 2013)

Vitamins (mg/ 100g)	Pomegranate Waste
	Pomegranate Peel Powder
Thamine (Vit – B1)	0.123
Riboflavin (Vit – B2)	0.07
L – Ascorbic acid (Vit – C)	12.9
Alpha – tocopherol (Vit – E)	3.99
Retinol (Vit – A)	0.164

(G Rowayshed et al., 2013)

Polyphenols – Phenolic fraction	Content (mg/ 100g dry matter)
Catechins	868.4
Ellagic acid	44.19
Gallic acid	125.8
Resorcenol	12.5
Procatechol	4.17
Para – hydroxy benzoic acid	9.02

Phenol	**242.7**
Vanilline	**3.91**
Caffeic acid	**60.46**
Ferulic acid	**5.89**
P – coumaric acid	**17.64**
Others	**8.20**
Total	**1402.88**

(Mostafa Aboulfadl et al., 2013)

2.4. CHEMICAL PROPERTIES OF POMEGRANATE PEEL

Pomegranate peel contain remarkable amounts of bioactive compounds with potential functional properties. In particular, pomegranate peel has been outlined as a rich, promising source of biomolecules with demonstrated bioactivities, such as antioxidant, antimicrobial, making it suitable to be used as a natural additive in foodstuffs (Ibrahim Kahramanoğlu et al., 2020).

About 50% of the total fruit weight corresponds to the peel, which is an important source of bioactive compounds such as phenolics, flavonoids, ellagitannins, and proanthocyanidin compounds, minerals, mainly potassium, nitrogen, calcium, phosphorus, magnesium, and sodium, and complex polysaccharides (Sreeja Sreekumar et al., 2014).

Pomegranate peels have high levels of numerous phytochemicals. It has been reported that pomegranate peel powder is high in bioactive compounds, mainly phenolic acids, flavonoids,

and hydrolysable tannins. The primary phenolic acids identified from pomegranate peel powder are, ellagic acid, gallic acid, caffeic acid, chlorogenic acid, syringic acid, ferulic acid, vanillic acid, p – coumaric acid, and cinnamic acid (Chunling Liao et al., 2020).

The studies of Chunling Liao, et al., (2020) states that, phenolic acid concentration significantly varies among varieties and is highly dependent upon the geographical location, climatic conditions, and cultivation practices. One of the main parameters defining the concentration of the phenolic acids was noted as the peel colour where the varieties with dark red colour reported to have higher phenolic acids concentration than the light – coloured varieties.

Additional to phenolic acids, pomegranate peel powder are an excellent source of flavonoids. Flavonoid content and composition are also known to vary significantly among varieties and growing conditions. However, it was also noted that the fruit developmental stage influences the flavonoid content and composition (Chunling Liao et al., 2020).

Pomegranate peel is rich in hydrolyzable tannins, mainly punicalin, pedunculagin, and punicalagin. Tannin content is an important factor for fruit acceptability by consumers, as it is associated with astringency (Julia González – Álvarez et al., 2017).

In pomegranate peel, hydrolyzable tannins are mainly found in the form of punicalagin (punicalagin α and β isomers), accounting for about 85% of total tannins. Other tannins detected in pomegranate fruit peels include punicalin, pedunculagin, granatin A, granatin B, corilagin, tellimagrandin, gallagyl hexoside, etc. (José M. Lorenzo et al., 2020).

The concentrations of phenolic acids, flavonoids, and tannins in pomegranate peel powder mainly depend on the extraction method. For example, highest concentrations of tannins identified from methanol extracts, as compared with water and ethanol extracts. Acetone

extracts of pomegranate peels were also noted to have higher antioxidant activity than the water and ethanol extracts (Chunling Liao et al., 2020).

2.5. VALUE ADDED PRODUCT

Value-added products are defined by USDA as having a change in the physical state or form of the product, the production of a product in a manner that enhances its value and the physical segregation of an agricultural commodity or product in a manner that results in the enhancement of the value of that commodity or product (Jennifer Chait, 2020).

The skin of the fruit is usually underutilized and discarded in India. The reason is, lack of popularity of the pomegranate peel which is due to variety of reasons that includes ignorance and lack of knowledge (Sayeeda Fathima, et al., 2013).

According to Pranav D. Pathak et al. (2016), the pomegranate peels (PP) is a valuable source of valuable bioactive compounds, most of which can be converted into value-added products. They also provide an outline on the chemical composition of pomegranate peel and the possible value-added products that can be produced from this commonly discarded agro-waste.

Based on the available evidence, it is obvious that pomegranate peel has a wide variety of applications and thus, developing an efficient system to utilize pomegranate peel adequately will help to completely utilize its potential benefits. The bio-refinery approach shows promising potential for efficient utilisation of pomegranate peel (Bhaskar D. Kulkarni, 2016).

The high antioxidant activity, inhibition of lipid peroxidation, and broad-spectrum antimicrobial efficiency of pomegranate peel play an intrinsic quality foundation for its development as a food preservative (Jing Chen et al., 2020).

In a study, pomegranate peel powder had highest content of ash 5.17 % and crude fibre 15.73 %. Fat content of pomegranate peel powder 3.76 %. Total dietary fibre, insoluble fibre and soluble fibre contents of pomegranate peel powder were 30.98, 16.47 and 14.51 g/100 g, respectively (Tharshini et al., 2016).

Some of the products that have been produced using pomegranate peel powder are idly batter, tea powder. Pomegranate skin powder incorporated in idli and other ready to cook products can also introduced from kids to adults to provide more nutritious meal. It improves vitamin C and protein and to reduce cancer and cholesterol. The product has introduced to all community since it contains unique package of antioxidants especially vitamin C of special mention at an affordable price (Sayeeda Fathima et al., 2013).

2.6. HEALTH BENEFITS OF POMEGRANATE PEEL

Pomegranates are known for their taste as well as incredible health advantages. Just like the fruit, the peel too is loaded with benefits. Pomegranate peels have got higher antioxidants that helps in detoxifying the body ad also boosts the immune system (Debjani Arora, 2016).

Pomegranate peel has been discovered to combat successfully against cancer. A research was done within this topic and revealed in the American Association for Cancer Research conference. They said that a precautionary agent was discovered in pomegranate extracts. This particular agent is what was found to avoid cancers of the skin (Debjani Arora, 2016) .

Vitamin C is essential for good health. Lots of people utilize vitamin supplements to prevent having deficiencies. Deficiency in vitamin C cause numerous serious issues. Rather than wasting money on synthetic supplements, it really is much better to make use of pomegranate peels. They are abundant with Vitamin C and keep the body far from deficiencies. Vitamin C

works well for proper growth, speeds up the healing process of wounds, as well as forms the scar tissue. It will help build body mass by forming the required proteins. Moreover, Vitamin C helps a lot in repairing bones, teeth as well as cartilage and in addition keeps them strong and healthy (Debjani Arora, 2016).

Pomegranate peels include plenty of anti-oxidants which safeguard the low density lipoprotein (LDL) cholesterol. Antioxidants avoid them from getting oxidized. Oxidation of LDL cholesterol leads to oxidative stress. This particular stress leads to diseases of the heart along with other such problems. Antioxidants are required to shield you from this problem. If we intake enough amount of antioxidants, we can reduce the risk of cardio – vascular diseases. Pomegranate peels provide you with the best source for receiving as numerous antioxidants as you possibly can. Pomegranate peel extract reduce blood pressure (Sara Basiri et al., 2015).

Due to its anti – bacterial as well as anti – inflammatory qualities, pomegranate peels are impressive in lessening bone strength and density loss, particularly in menopausal women. Research indicates that consuming products made from pomegranate peels might help enhance bone health and avoid the start of osteoporosis right after menopause (Debjani Arora, 2016).

The peels have got tannins within them which help decrease inflammation of the intestine, swelling of haemorrhoids, tighten up intestinal lining, prevent bleeding throughout diarrhoea and improve digestion (Debjani Arora, 2016).

Additionally, pomegranate peel extract has the capability to treat some chronic diseases due to its anticancer properties such as colon and prostate cancer, melanogenesis (skin cancer), breast cancer and stomach ulcers (Sara Basiri et al., 2015).

It has been reported that pomegranate peels have been used by ancient Egyptians and Indians as a therapeutic agent with medicinal properties against several ailments including cough, diarrhoea, dysentery, dental plaque, inflammation, ulcers, bleeding noses, infertility, and intestinal worms (Ismail et al., 2012).

The phenolic compounds acts as a natural preservative and is used in preserving quality of the meat products by preventing the growth of microbes, retards the lipid and protein oxidation, etc. (Ahlem Chakchouk Mtibaa et al., 2019).

2.7. PHYSICO – CHEMICAL PROPERTIES OF POMEGRANATE PEEL

The pomegranate and their derivative parts contain various phenolic activities. The pomegranate peel had the highest antioxidant activity as compared to other parts of pomegranate fruit. It contains bioactive compounds such as Flavonoids, Polyphenols, Ellagitannins compounds (Gallic acid, Ellagic acid, Punicalagin, Punicalin, luteolin, Quercetin, kaempferol, glycosides, Pedunculagin), minerals (calcium, phosphorus, nitrogen, potassium, magnesium, sodium), and polysaccharide composite (Nishant Kumar, 2018).

Pomegranate peel powder could be considered as a potential functional ingredient in food products which improves their technological properties. Pomegranate peel powder is of great interest not only as a means of improving the functionality of food products, but also as a means to create functional foods with health benefits (Heena et al., 2018).

According to a research the fruit fractions showed anti – microbial effects on *Staphylococcus aureus* and *pseudomonas aeruginosa* but not on *Escherichia coli*. Sun drying of fruit peel

significantly enhanced vitamin C retention and anti – microbial effects which is due to the lower rate of moisture removal associated with low temperature drying (Neeraj et al., 2018).

A recent study by Neeraj et al., 2018, regarding the physicochemical and antioxidant properties of different dried pomegranate peel powder extract using different organic solvents, and investigated Physiochemical and in vitro antioxidant activity, phenolic and flavonoids activity. The various extracts showed varying significant physicochemical properties of pomegranate peel extract. The freeze drying method had higher total phenolic, flavonoid and antioxidant (FRAP – ferric-reducing/antioxidant power) activity in Ganesh varieties of pomegranate peel powder extraction in aqueous, ethanol and methanol respectively. The highest radical scavenging (DPPH) was observed in sun – dried peel powder (Ganesh) extract in acetone followed by ethanol and methanol solvent. The PGP (Plant Growth Promoters) of Bhagwa variety in Methanolic extraction showed the highest antioxidant (FRAP) activity and total phenolic. The tray dried powder of Bhagwa pomegranate peel showed highest radical scavenging (DPPH – 2,2-diphenyl-1-picrylhydrazyl) and total flavonoid in ethanolic extraction. For large scale operation, the freeze-drying method and extraction solvents (ethanol and Methanol) would be a better choice for extraction phenolic and flavonoid content for pharmaceutical use. The next stage after the extraction of phenolic bio-active compounds from pomegranate powder peel extract with suitable methods and other solvents for extract high phenolic, flavonoids, and antioxidant content. Further In vivo and in vitro studies are necessary to determine the application of pomegranate peel powder in new product development, food fortification, micro – encapsulation, medical and food packaging sector.

3. METHADOLOGY

METHADOLOGY

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it we study the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. It is necessary for the researcher to know not only the research methods/techniques but also the methodology. Researchers not only need to know how to develop certain indices or tests, how to calculate the mean, the mode, the median or the standard deviation or chi-square, how to apply particular research techniques, but they also need to know which of these methods or techniques, are relevant and which are not, and what would they mean and indicate and why. Researchers also need to understand the assumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems and others will not. All this means that it is necessary for the researcher to design his methodology for his problem as the same may differ from problem to problem (Mimansha Patel et al., 2019).

The methodology of the study, **'DEVELOPMENT AND POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER'** is discussed through the following stages:

3.1. SELECTION OF POMEGRANATE FRUIT PEEL FOR THE STUDY

The pomegranate which is commonly called as *Punica granatum* is a fruit-bearing deciduous shrub in the family Lythraceae, subfamily Punicoideae that grows between 5 and 10 m (16 and 33 ft) tall. It originated in Persia but the cultivation quickly spread to

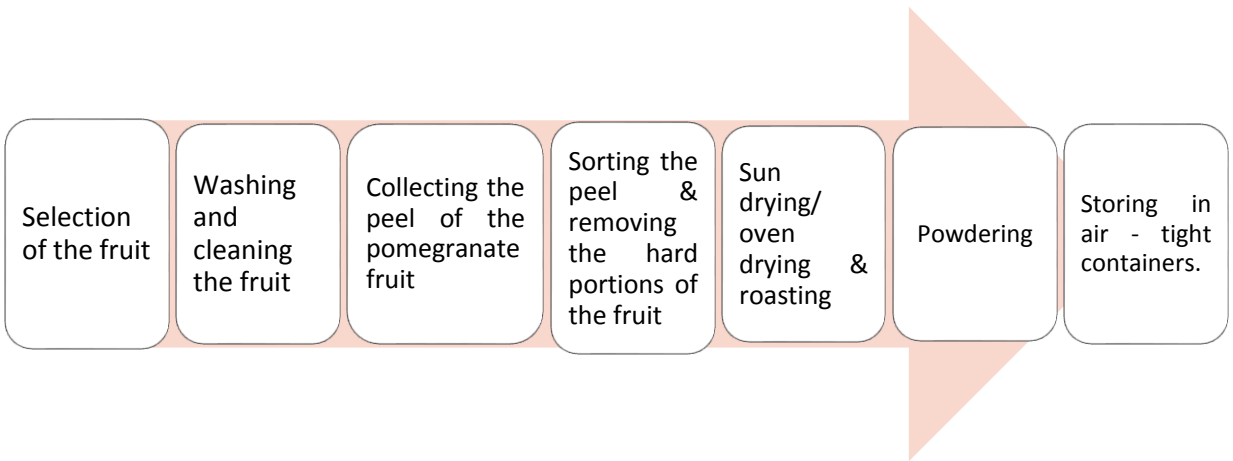
other parts of the world like Mediterranean and extended to Arabia, Afghanistan, India and China, where it was called the "Chinese apple," the alternate appellation.

The pomegranate tree is native from Iran to the Himalayas in northern India & ranks first in pomegranate cultivation in the world. In India, Maharashtra is the leading producer of pomegranate followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu.

Maharashtra is leading with 90 thousand ha area with annual production of 9.45 lakh Mt tones and productivity of 10.5 Mt/ha. Maharashtra state accounts for 78 percent of the total area in India and 84 percent of the total production in the country. The skin of the fruit is generally discarded by the people as they are not aware of the nutritional value of the fruit peel. The skin is rich in phytochemicals antioxidants, antimicrobials & anti – inflammatory substances and are good sources of carbohydrates, fibre, calcium and vitamin – c. Therefore, a study was made mainly focusing on pomegranate skin and food products were developed using the powdered skin of the fruit. Its popularisation is mainly targeted towards adult women with sedentary lifestyle as the osteoporosis is common among women.

3.2 DEVELOPMENT OF THE PRODUCTS USING POMEGRANATE PEEL POWDER (*P. granatum*)

3.2.1. Preparation of the pomegranate peel powder



3.2.2. Selection of recipes for Pomegranate peel powder incorporation

Five suitable recipes were collected for the incorporation of the pomegranate peel powder & among them four ideal recipes were selected. The recipes in which the pomegranate peel powder was incorporated includes Cookies, Nutritive bar,Tart base and Rice laddoo.

3.2.3. Formulation of different combination of products and selecting the best one

The pomegranate peel was exposed through different processes like washing, drying, dehydration & powdering of the peel, etc. before it was used to prepare the recipes that are selected. Each products were prepared with three different variations of 10, 15, 20, 25, 30, 35 & 40 percentage of the peel powder as each products the percentage varies with quantity of other ingredients included. The prepared products were evaluated by the judging panel members using organoleptic method.

3.2.4. Development of pomegranate peel powder incorporated food products

How the product is benefitted to the body depends upon the ingredients included to make the product. The factors like expiry date other ingredients used & the freshness of the fruit should be checked before the preparation of the recipes. The pomegranate or *P. granatum* was washed & the skin was collected by separating the soft & hard portions of the peel. The rind of the fruit can also be used to prepare the recipes. Other ingredients like wheat flour, butter, brown sugar, pomegranate peel powder, eggs, baking soda, hot water, vanilla extract, salt, chocolate chips, salt was placed near. All the ingredients were measured using a weighing balance. Handling and preparation of the food product is done under hygienic conditions with minimum wastage of food materials.

a. Procedure for developing pomegranate peel powder incorporated Cookies

COOKIES:

INGREDIENTS:

1. Wheat flour - 1 ½ cups
2. Pomegranate peel powder - 35g
3. Unsalted Butter (melted) - ½ cup
4. Brown sugar - ½ cup
5. White sugar - ½ cup
6. Egg - 1 no.
7. Baking soda - 1 tsp
8. Vanilla extract - 1tsp
9. Chocolate chips - ½ cup

Figure 4

METHOD OF PREPARATION:

1. Pre – heat the oven at 150 degrees for 10 minutes.
2. Cream the butter, brown sugar & white sugar till it becomes smooth.
3. Add the egg to it followed by vanilla extract and mix well using a spoon or spatula.
4. Dissolve baking soda in 2 teaspoon hot water & add to the mixture. Add salt to taste.
5. Add wheat flour, pomegranate peel powder, chocolate chips, & nuts (if needed) & mix well.
6. Make the desired shape with the dough using a cookie cutter and place it in greased tray.
7. Bake it for about 10 minutes at 150 degrees.
8. Store it in air tight container after it cools down.

Figure 5

Figure 6

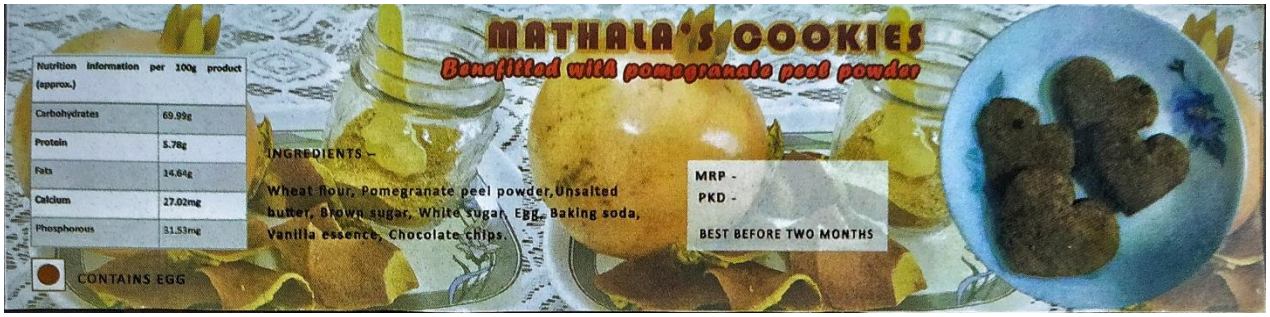


Figure 7

b. Procedure for developing pomegranate peel powder incorporated Nutritive Bars

<u>NUTRITIVE BARS</u>

INGREDIENTS:

1. Oats - ½ cup
2. Jaggery - ½ cup
3. Pomegranate peel powder – 20g

4. Cashew nuts - ¼ cup
5. Almonds - ¼ cup
6. Groundnut - ¼ cup
7. Ghee - 1tbsp

Figure 8

METHOD OF PREPARATION:

1. In a small pan pour one tablespoon ghee.
2. Roast the nuts in the ghee.
3. Add the oats to it & roast everything well.
4. Add the pomegranate peel powder to it & combine well.
5. Add the jaggery to it and allow it to melt.

6. Transfer it to a greased tray.

7. Allow it to cool and then cut it into bars with sharp knife.

8. Store them in air tight container.

Figure 9

Figure 10

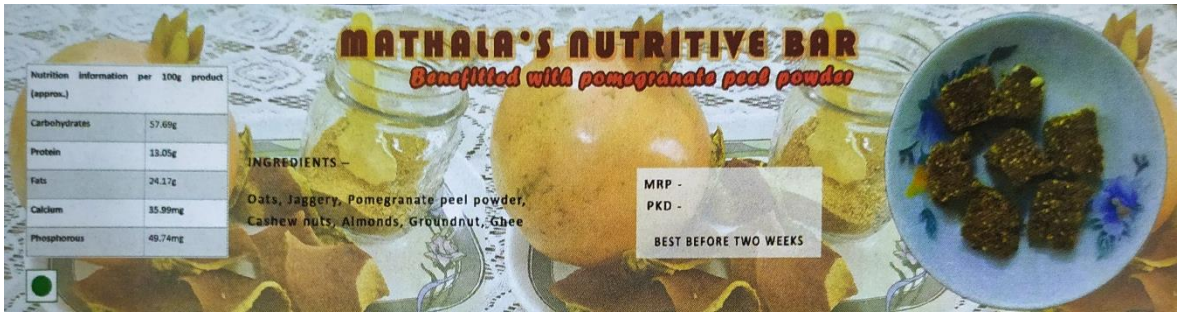


Figure 11

c. Procedure for developing pomegranate peel powder incorporated Rice laddoo

RICE LADDOO

INGREDIENTS:

1. Rice flakes - ½ cup
2. Oats - ½ cup
3. Cashew nuts - ¼ cup
4. Walnuts - ¼ cup
5. Ground nuts - ¼ cup
6. Pomegranate peel powder - 25 g
7. Jaggery – ¼ cup

Figure 12

METHOD OF PREPARATION:

1. In a small pan, roast the rice flakes, oats & nuts.
2. Powder the contents along with the jaggery.
3. Mix the pomegranate peel powder to it & mix well.
4. Add one tablespoon ghee to make the content smooth.
5. Make balls in desired sizes.
6. Store it in air – tight container.

Figure 13

Figure 14

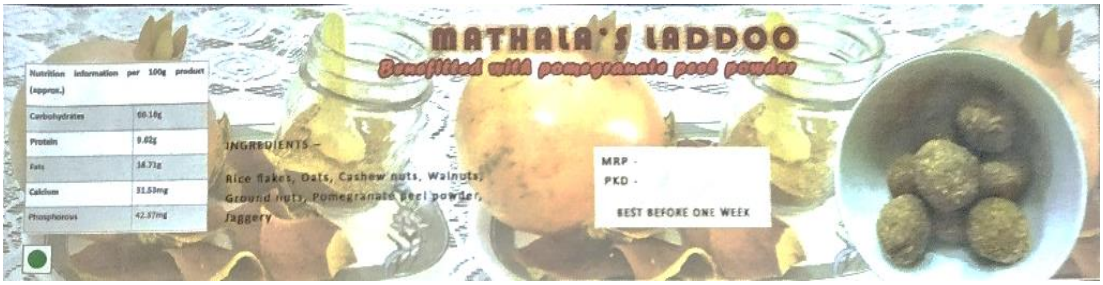


Figure 15

d. Procedure for developing pomegranate peel powder incorporated Tart base

TART BASE

INGREDIENTS:

1. Wheat flour - ½ cup
2. Powdered brown sugar - ¼ cup
3. Butter - 50g
4. Pomegranate peel powder - 10g

Figure 16

METHOD OF PREPARATION:

1. Cream the butter which is kept room temperature.
2. Add brown sugar to it & mix well.
3. Then add the wheat flour & pomegranate peel powder to it & mix well to form a smooth dough.
4. Rest it for 15 minutes.
5. Place it in Tart mould / silicon cupcake mould to make the cup shape.
6. Bake it at 175 degrees for 10 – 15 minutes.
7. Store it in an air – tight container.

Figure 17

Figure 18

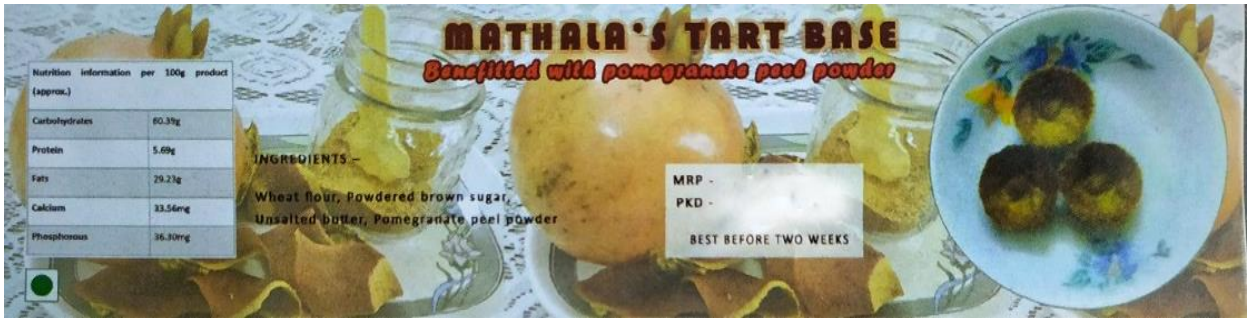


Figure 19

3.2.5. Selection of judging panel

To assess the acceptability of the products through sensory evaluation, a panel of 20 judges was selected. The selection criteria for the panel members were their ability to perceive and recognize the variations in the quality of different food items. For the selection of panel members serial dilution test was used. A small highly sensitive panel would give more reliable results than large less sensitive groups. Ten members who got highest scores were selected as the judging panel.

3.2.6. Organoleptic evaluation of incorporated products

Quality is the ultimate criterion of the desirability of any food product. Organoleptic evaluation is a scientific discipline used to evoke, measure and analyse reactions to those characteristics of products or material as they are perceived by the sense of sight, smell, taste, touch and hearing. The developed products were evaluated by using organoleptic method to assess their sensory qualities.

Figure 20

Figure 21

Figure 22

Figure 23

3.2.7. Standardization & sensory evaluation of the developed products

The pomegranate peel was incorporated with percentages of 10, 15, 20, 25, 30, 35 & 40 to the selected products to form three variations each namely V1, V2, and V3. Triangle test was employed for selecting the best variation out of the three. In this test, a five point score card which evaluates the factors like taste, colour, flavour, texture and appearance were given to the judging panel. Each members of the judging panel tasted and evaluated the products and marked their score in the score card.

3.3. NUTRITIVE VALUE OF FORMULATED RECIPES

The nutrient content of the developed products per 100g were calculated by giving the products to ICAR – Central Institute of Brackish-water Aquaculture laboratory for testing using standard testing procedures with reference to their Carbohydrate, Protein, Fat, Calcium, Phosphorous content.

Figure 24

Figure 25

3.4. EVALUATION OF TIME FOR THE PREPARATION OF POMEGRANATE PEEL POWDER INCORPORATED FOOD PRODUCTS

The time taken for preparing 100g of each products with higher overall acceptability scores were assessed for measuring the easiness with which the products were prepared. It was calculated on the basis of the time taken for preliminary preparations and the time taken for cooking the products.

3.5. POPULARIZATION OF PRODUCTS

Among the four developed products, the one that obtained the highest scores were popularized among the adult women with sedentary lifestyle working in offices in Chennai, Tamil Nadu.

3.5.1. Selection of products for popularization

For the purpose of popularization, two best recipes were selected from the four pomegranate peel powder incorporated products. The two products which got the highest score for overall acceptability when organoleptically evaluated were selected for popularization.

3.5.2. Selection of consumer group for the popularization of products

The pomegranate peel powder incorporated recipes were popularized among adult women with sedentary lifestyle working in offices, through demonstrations and lectures, thus encouraging them to start consuming the products of pomegranate peel powder which have high medicinal and nutritive value, in easier and cost effective ways.

3.5.3. Formulation of tools to identify consumer acceptability

For the process of popularization, questionnaires were prepared for checking the awareness of the women working in offices about pomegranate peel powder incorporated products and to collect the details regarding the extent of knowledge, the consumers attained through the

lecture. A power point presentation was prepared to give awareness about how good is it to include pomegranate peel in the diet.

Figure 26

Figure 27

Figure 28

3.6. SHELF LIFE STUDY

The developed products were analysed for their shelf stability for a period of 3 months. The variations of each prepared products were stored in glass bottles, plastic containers at room temperature and were analysed for their shelf life. During the storage period, the bottles were examined visually for detecting any colour change or microbial deterioration. At the end of each month, one set of each variation of the stored products was evaluated for their sensory qualities also.

3.7. PACKAGING AND LABELLING

The developed products were packed and labelled separately in plastic containers. The containers were sun dried and then the products were packed in it.

4. RESULT AND DISCUSSION

RESULT AND DISCUSSION

The results & discussions of the study, **'DEVELOPMENT & POPULARISATION OF VALUE ADDED FOOD PRODUCTS USING POMEGRANATE PEEL POWDER'** is discussed through the following:

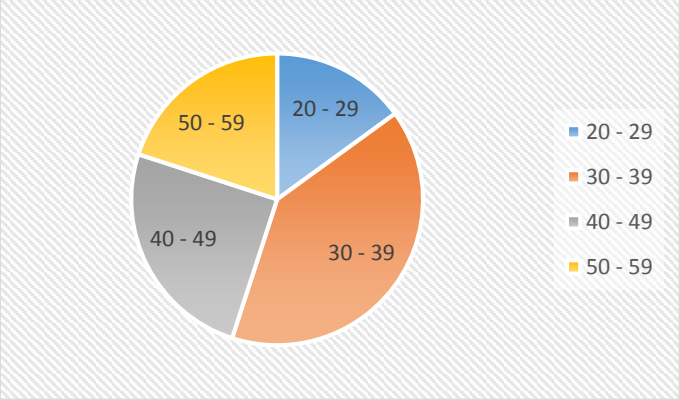
4.1. DEMOGRAPHIC PROFILE OF THE SELECTED SUBJECTS

4.1.1. Age profile of selected subjects

TABLE – 1

Age	Number	Percentage
20 – 29	6	15
30 – 39	16	40
40 – 49	10	25
50 – 59	8	20
Total	40	100

In the age profile of selected subjects for studying the family food habits along with the graphical representation group were depicted in the TABLE – 1. About 15% of subjects were seen in the age group 20 – 29 years, 40% of subjects seen in the age group 30 – 39 years, 25% of subjects in the age group of 40 – 49 years and 20% in the age group 50 – 59 years.



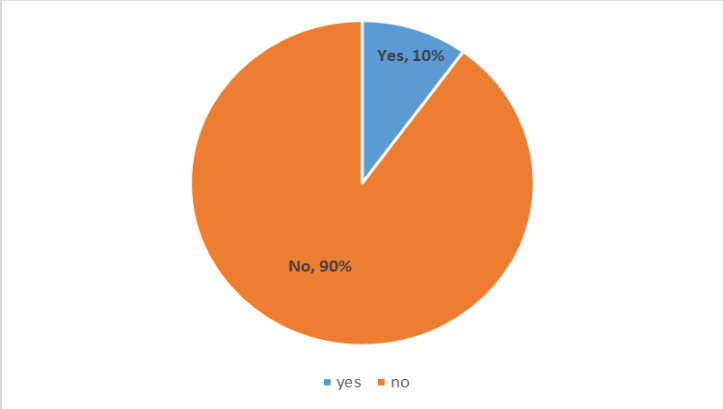
4.2. CULTIVATION OF POMEGRANATE PLANT BY THE SELECTED SUBJECTS

4.2.1 Cultivation of pomegranate tree in kitchen garden

TABLE – 2

RESPONSE	NUMBER	PERCENTAGE
Yes	2	10
No	18	90
Total	20	100

The above table – 2 depicts that majority of 10% subjects had pomegranate tree grown in their yard and remaining 90% of subjects did not cultivate pomegranate tree in their kitchen garden.

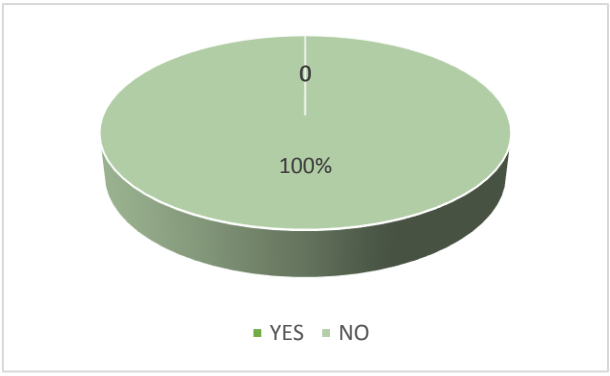


4.3. KNOWLEDGE REGARDING PREPARATION OF POMEGRANATE PEEL POWDER ADDED FOOD PRODUCTS

TABLE – 3

RESPONSE	NUMBER	PERCENTAGE
Yes	0	0
No	20	100

The above TABLE – 3 depicts that 100% of the subjects are unaware of the preparation methods using pomegranate peel powder.



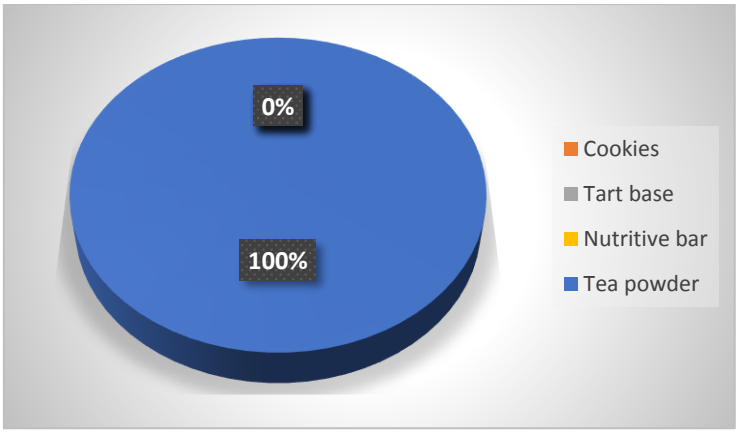
4.4. COLLECTION OF INFORMATION ABOUT AWARENESS OF PRODUCTS PREPARED USING POMEGRANATE PEEL POWDER

4.4.1 Consumption pattern of Pomegranate peel powder food products

TABLE – 4

RESPONSE	NUMBER	PERCENTAGE
Cookies	0	0
Tart base	0	0
Nutritive bar	0	0
Tea powder	1	100
Total	1	100

Eating habits of selected subjects is given in TABLE – 4, where a majority of 100% of subjects preferred tea powder and the rest were unaware about usage of pomegranate peel powder in food products.

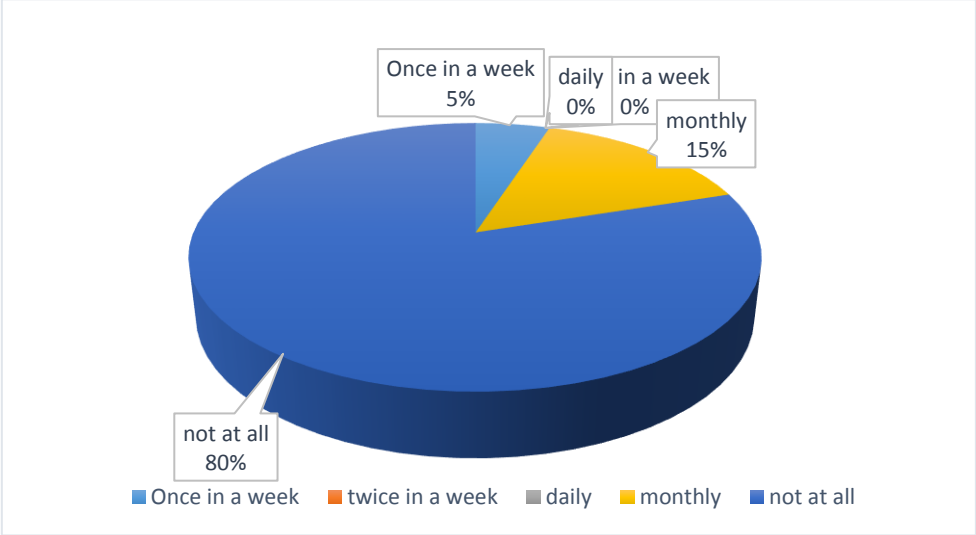


4.4.2. Percentage incorporation of pomegranate fruit in the diet

TABLE – 5

RESPONSE	NUMBER	PERCENTAGE
Once in a week	1	5
Twice in a week	0	0
Daily	0	0
Monthly	3	15
Not at all	16	80
Total	20	100

The incorporation of pomegranate fruit in the diets of the selected subjects are given in the TABLE – 5. Majority of the subjects 80% does not include the pomegranate fruit in their diets. 15% of subjects incorporates monthly and only 5% of the subjects, prefers daily incorporation in their diets.

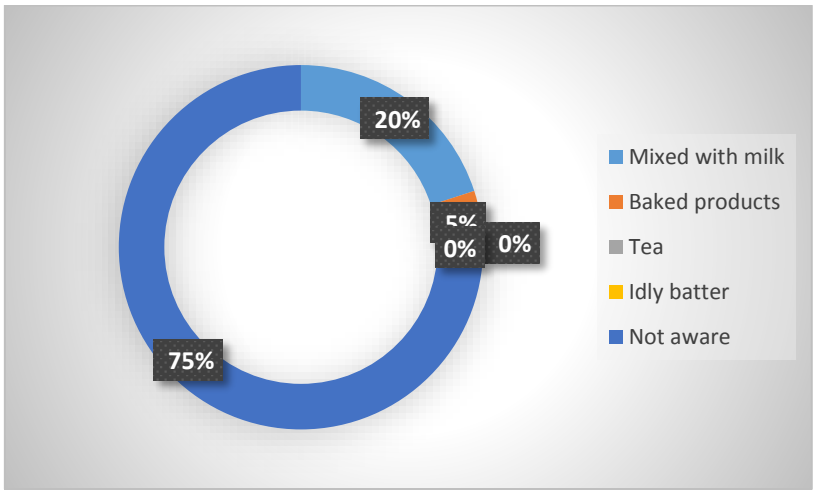


4.4.3. Awareness on common uses of pomegranate peel powder among the selected subjects

TABLE – 6

TYPE OF CONSUMPTION	NUMBER	PERCENTAGE
Mixed with milk	4	20
Baked products	1	5
Tea	0	0
Idly batter	0	0
Not aware	15	75
Total	20	100

The above TABLE – 6 depicts that, about 20% of the subjects consumed pomegranate peel powder with milk. 5% of the subjects consumed in the form of baked products. The rest 75% of the subjects are unaware of the usage of peel powder in the food products.

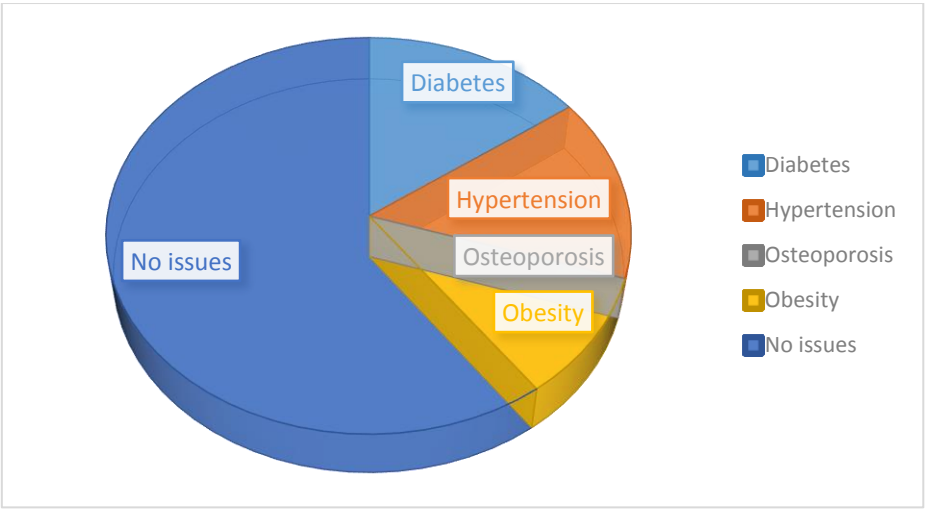


4.4.4. Health issues among the selected subjects

TABLE – 7

HEALTH CONDITION	NUMBER	PERCENTAGE
Diabetes	3	15
Hypertension	3	15
Osteoporosis	0	0
Obesity	2	10
No issues	12	60
Total	20	100

The health issues of selected subjects are depicted in TABLE – 7 and also plotted in the graph. Majority 60% of subjects did not have any health issues. About 15% had diabetes, another 15% had hypertension and only 10% of the subjects had obesity and none had osteoporosis.

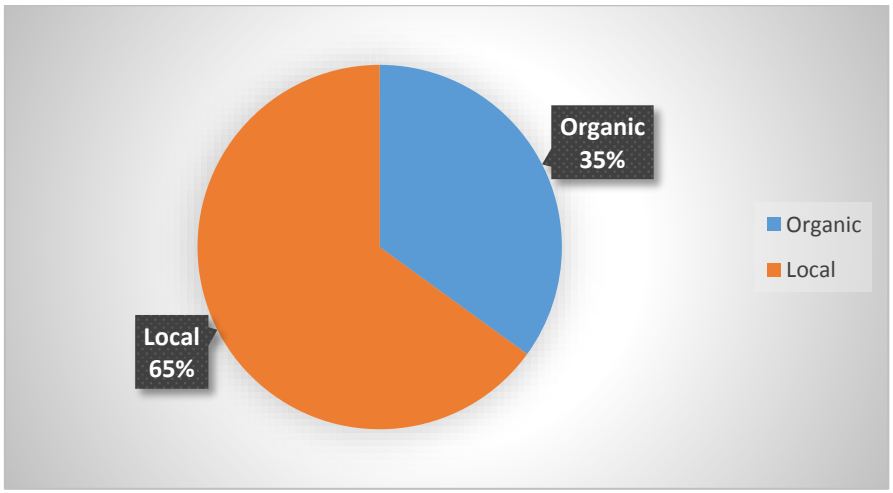


4.4.5. Type of pomegranate fruit preferred by the selected subjects

TABLE – 8

TYPE	NUMBER	PERCENTAGE
Organic	7	35
Local	13	65
Total	20	100

The type of pomegranate fruit preferred by the selected subjects were depicted in the TABLE – 8. Majority of 65% preferred pomegranate that is available locally. The rest, 35% prefers pomegranate that is available in organic shops.

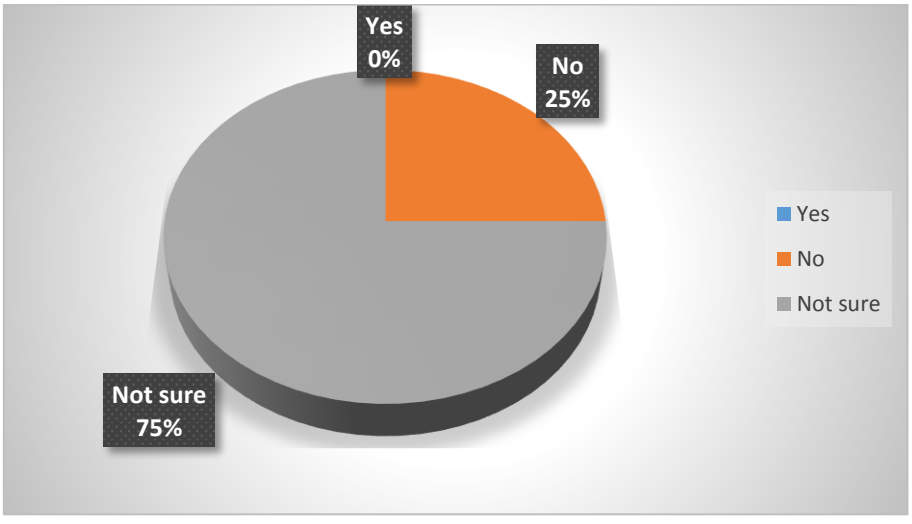


4.4.6. Allergies to pomegranate peel powder

TABLE – 9

RESPONSE	NUMBER	PERCENTAGE
Yes	0	0
No	5	25
Not sure	15	75
Total	20	100

The allergic condition to pomegranate peel powder of selected subjects were depicted in TABLE – 9. It was found that the 25% of the selected subjects are not allergic to pomegranate peel powder and 75% of the subjects are not sure as they never used it before.

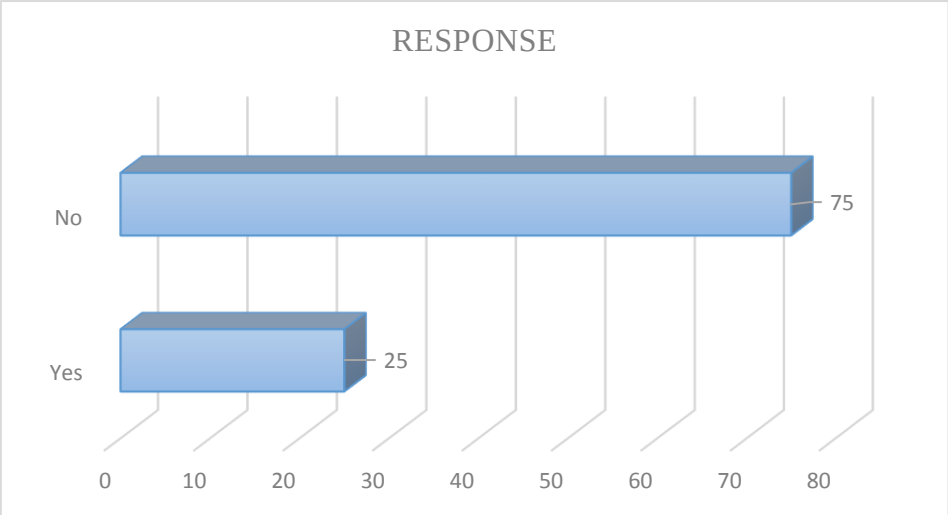


4.4.7. Awareness on health benefits of pomegranate peel powder among the selected subjects.

TABLE – 10

RESPONSE	NUMBER	PERCENTAGE
Yes	5	25
No	15	75
Total	20	100

The above table represents that majority 75% of the subjects were unaware of health benefits of pomegranate peel powder and the remaining 25% of subjects were aware about it.

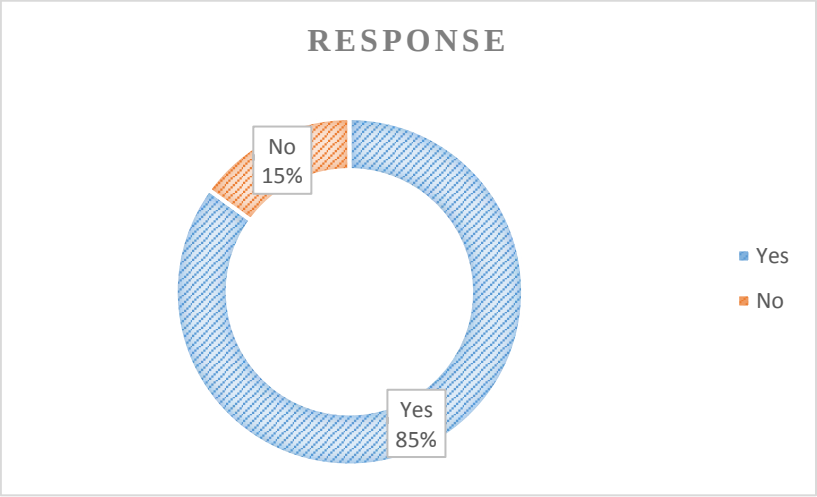


4.4.8. Response to likes and dislikes of pomegranate peel powder added food products by selected subjects

TABLE - 11

RESPONSE	NUMBER	PERCENTAGE
Yes	17	85
No	3	15
Total	20	100

The above TABLE – 11 represents that majority of 85% of the subjects liked the taste of the pomegranate peel added food products and the remaining 15% of the subjects did not like the taste of the products prepared.

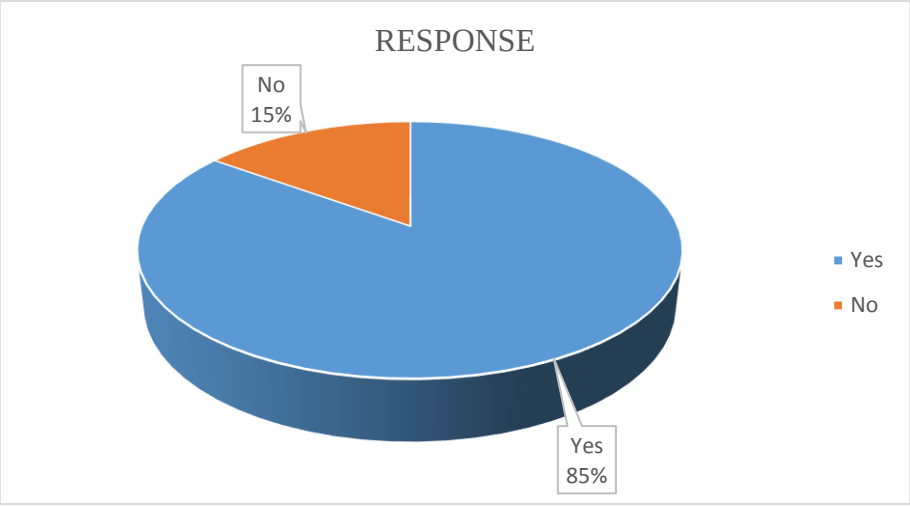


4.4.9. Willingness for purchase of pomegranate peel added food products

TABLE – 12

RESPONSE	NUMBER	PERCENTAGE
Yes	17	85
No	3	15
Total	20	100

From the collected data it is revealed that 85% of the working women at the offices were willing to purchase the products prepared using pomegranate peel powder, if made available in the market.



4.5. OVERALL SENSORY EVALUATION OF DEVELOPED PRODUCTS USING POMEGRANATE PEEL POWDER

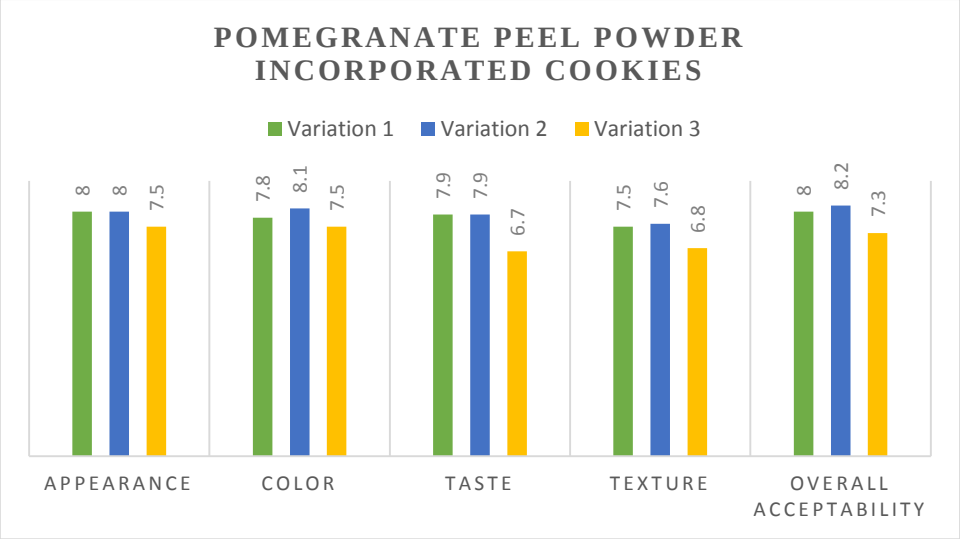
4.5.1. Average mean sensory scores of the developed cookies using pomegranate peel powder

TABLE – 13

Variations/ Parameters	Variation 1 30:192	Variation 2 35:192	Variation 3 40:192
Appearance	8	8	7.5
Colour	7.8	8.1	7.5
Taste	7.9	7.9	6.7
Texture	7.5	7.6	6.8
Overall acceptability	8	8.2	7.3
Total	39.2	39.8	35.8

Wheat flour: Pomegranate peel powder

The organoleptic evaluation by 10 selected panel member along with graphical representation are depicted in TABLE – 13. Among the 3 different variation of cookies prepared, variation 1 – 30:192, variation 2 – 35:192, variation 3 – 40:192, variation 2 – 35:192 ratio cookies was the most acceptable for all the ten panel members. It possessed highest scores in all the organoleptic parameter. Therefore this sample ratio of cookies squash was taken for further standardization and processing of the study.



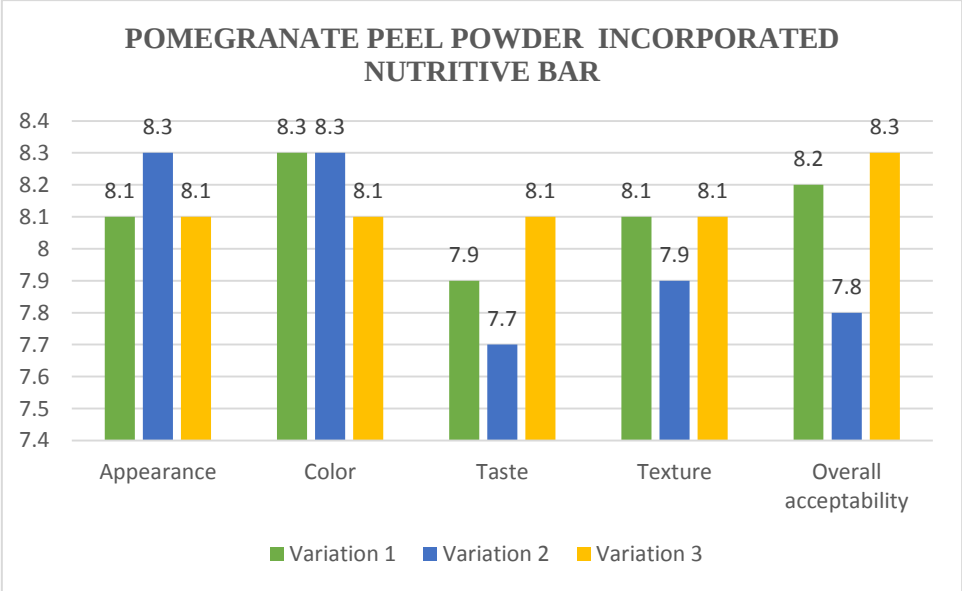
4.5.2. Average mean sensory scores of the developed nutritive bar using pomegranate peel powder

TABLE – 14

Variations/ parameters	**Variation 1 175:10**	**Variation 2 175:15**	**Variation 3 175:20**
Appearance	8.1	8.3	8.1
Colour	8.3	8.3	8.1
Taste	7.9	7.7	8.1
Texture	8.1	7.9	8.1
Overall acceptability	8.2	7.8	8.3
Total	40.6	40	40.7

Oats: Pomegranate peel powder

The organoleptic evaluation by 10 selected panel members are depicted in TABLE - 14 along with graphical representation. Among 3 sample variations kept for evaluation, variation 3 – 175: 20 ratio nutritive bar is the most acceptable among the 3 different variations among all the ten panel members. It possessed highest score in all the organoleptic parameters. Therefore, this sample ratio of pomegranate peel powder incorporated nutritive bar was taken for further standardisation and processing of the study.



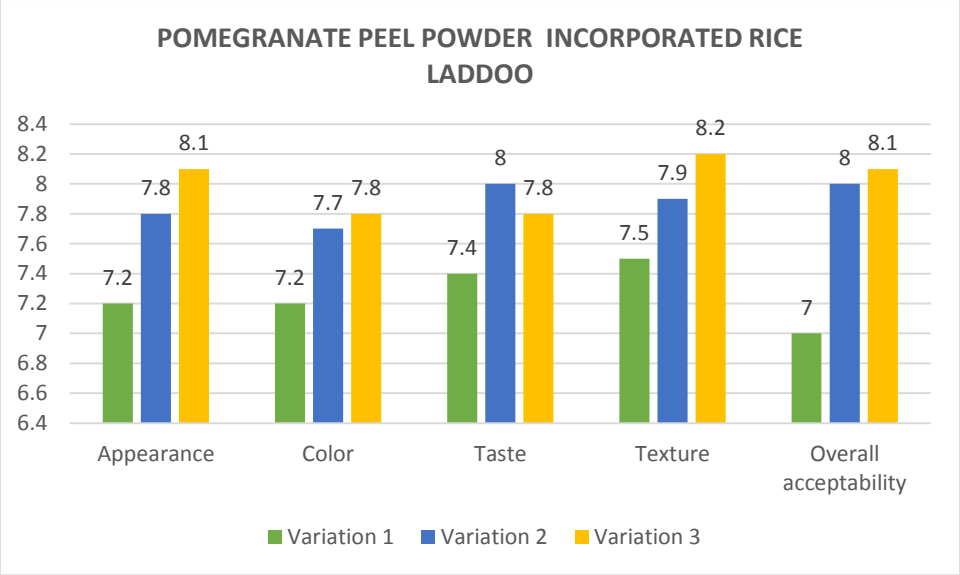
4.5.3. Average mean sensory scores of the developed rice laddoo using pomegranate peel powder

TABLE – 15

Variations/ parameters	**Variation 1 175:15**	**Variation 2 175:20**	**Variation 3 175:25**
Appearance	7.2	7.8	8.1
Colour	7.2	7.7	7.8
Taste	7.4	8	7.8
Texture	7.5	7.9	8.2
Overall acceptability	7	8	8.1
Total	36.3	39.4	40

Rice flakes: Pomegranate peel powder

The organoleptic evaluation by 10 selected panel members are depicted in TABLE - 15 along with graphical representation. Among 3 sample variations kept for evaluation, variation 3 – 175:25 ratio is the most acceptable among the 3 different variations for all the ten panel members. It possessed highest score in all the organoleptic parameters. Therefore, this sample ratio of pomegranate peel incorporated laddoo was taken for further standardisation and processing of the study.



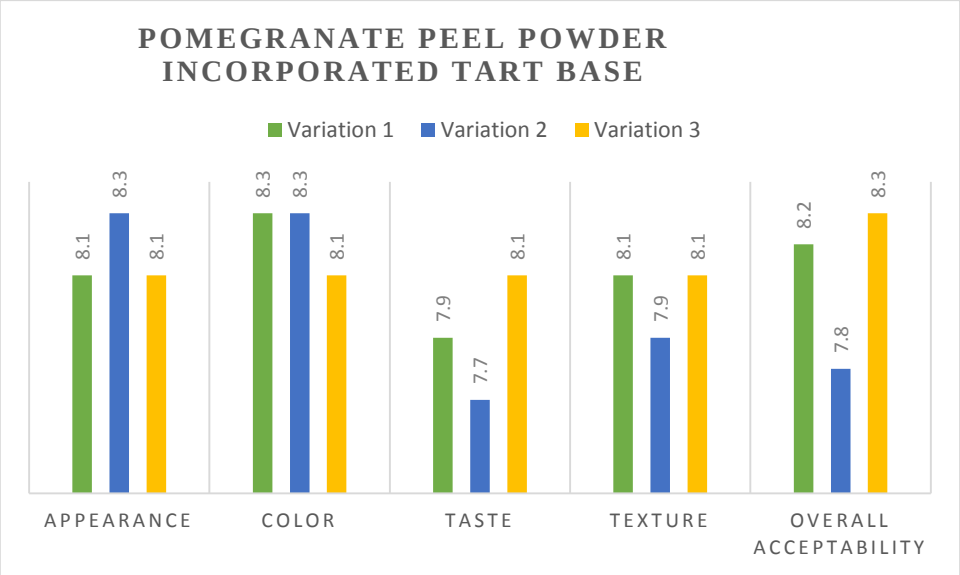
4.5.4. Average mean sensory scores of the developed tart base using pomegranate peel powder

TABLE – 16

Variations/ parameters	**Variation 1 175:5**	**Variation 2 175:10**	**Variation 3 175:15**
Appearance	7.8	7.8	8
Color	7.9	7.8	7.9
Taste	8.1	7.8	8.2
Texture	7.7	7.4	7.5
Overall acceptability	8	7.8	8
Total	39.5	38.6	39.6

Wheat flour: Pomegranate peel powder

The organoleptic evaluation by 10 selected panel members are depicted in TABLE - 16 along with graphical representation. Among 3 sample variations kept for evaluation, variation 3 – 175: 15 ratio is the most acceptable among the 3 different variations for all the ten panel members. It possessed highest score in the all the organoleptic parameters. Therefore, this sample ratio of pomegranate peel powder incorporated tart base was taken for further standardisation and processing of the study.



4.6. FRIEDMAN'S TEST FOR OVERALL ACCEPTABILITY OF POMEGRANATE PEEL POWDER INCORPORATED COOKIES

4.6.1. Friedman's test for overall acceptability of pomegranate peel powder incorporated cookies

TABLE - 17

No. of Panel Members (N)	RANK FOR DIFFRENT VARIATIONS		
	Variation 1	Variation 2	Variation 3
1	8	9	8
2	8	9	6
3	8	9	6
4	8	8	7
5	9	9	8
6	8	8	8
7	8	7	7
8	8	7	7
9	7	8	8
10	8	8	8
Total	21.5	23.5	15

Calculated FM Test Statistics = 3.95

FM Critical value from the table (Friedman's ANOVA by ranks critical value table) = 6.20

The null hypothesis for the test was that the overall acceptability of each sample differ from each other. From the above result, it is clear that the calculated FM statistics is less than the FM critical value and therefore the null hypothesis is accepted.

4.6.2. Friedman's test for overall acceptability of pomegranate peel powder incorporated nutritive bar

TABLE - 18

No. of Panel Members (N)	RANK FOR DIFFRENT VARIATIONS		
	Variation 1	Variation 2	Variation 3
1	9	9	8
2	9	8	8
3	8	8	8
4	7	7	8
5	9	8	9
6	9	8	7
7	7	8	8
8	8	7	9
9	8	7	9
10	8	8	9
Total	21	16.5	22.5

Calculated FM Test Statistics = 1.95

FM Critical value from the table (Friedman's ANOVA by ranks critical value table) = 6.20

The null hypothesis for the test was that the overall acceptability of each sample differ from each other. From the above result, it is clear that the calculated FM statistics is less than the FM critical value and therefore the null hypothesis is accepted.

4.6.3. Friedman's test for overall acceptability for pomegranate peel powder incorporated rice laddoo

TABLE – 19

No. of Panel Members (N)	RANK FOR DIFFRENT VARIATIONS		
	Variation 1	Variation 2	Variation 3
1	8	9	8
2	7	8	9
3	9	8	7
4	7	9	8
5	7	8	8
6	9	8	9
7	6	7	8
8	7	8	7
9	5	7	8
10	5	8	9
Total	14.5	22.5	23

Calculated FM Test Statistics = 4.55

FM Critical value from the table (Friedman's ANOVA by ranks critical value table) = 6.2

The null hypothesis for the test was that the overall acceptability of each sample differ from each other. From the above result, it is clear that the calculated FM statistics is less than the FM critical value and therefore the null hypothesis is accepted.

4.6.4. Friedman's test for overall acceptability for pomegranate peel powder incorporated tart base

TABLE – 20

No. of Panel Members (N)	RANK FOR DIFFRENT VARIATIONS		
	Variation 1	Variation 2	Variation 3
1	8	8	8
2	8	8	6
3	8	7	9
4	8	7	7
5	8	7	9
6	8	9	8
7	8	8	9
8	7	8	9
9	8	8	8
10	9	8	7
Total	20.5	18.5	21

Calculated FM Test Statistics = 0.35

FM Critical value from the table (Friedman's ANOVA by ranks critical value table) = 6.20

The null hypothesis for the test was that the overall acceptability of each sample differ from each other. From the above result, it is clear that the calculated FM statistics is less than the FM critical value and therefore the null hypothesis is accepted.

4.7. NUTRIENT COMPOSITION OF THE BEST POMEGRANATE PEEL POWDER INCORPORATED FOOD PRODUCTS (PER 100g)

TABLE – 21

Nutrients / Food products	Protein (g)	Carbohydrate (g)	Lipid (g)	Calcium (mg)	Phosphorous (mg)
Cookies	5.78	69.99	14.64	27.02	31.53
Nutritive Bar	13.05	57.69	24.17	35.99	49.74
Laddoo	9.62	66.16	18.71	31.53	42.37
Tart Base	5.69	60.39	29.23	33.56	36.30

As per TABLE 21, the product with highest Protein content was Pomegranate peel powder incorporated Nutritive bar (13.05mg). The product which showed lowest protein content was Pomegranate peel powder incorporated Tart base (5.69mg).

Pomegranate peel powder incorporated cookies showed lowest amount of calcium (27.02mg) compared to other products.

The Phosphorous content of the Pomegranate peel powder incorporated nutritive bar was the highest (49.74mg) whereas Pomegranate peel powder incorporated cookies showed only 31.53mg of phosphorous in it.

Among four Pomegranate peel powder incorporated products developed, the Carbohydrates rich product was found to be Pomegranate peel powder incorporated Cookies which contained 69.99mg in it.

The lipid values was highest in Pomegranate peel powder incorporated Tart base (29.23g).

Pomegranate peel powder is rich in Carbohydrates, Protein, Calcium, Phosphorous and also lipids. Hence all the products prepared from Pomegranate peel powder were found to be rich in Carbohydrates, Protein, Calcium, Phosphorous and lipids.

4.8. SHELF LIFE OF POMEGRANATE PEEL POWDER INCORPORATED PRODUCTS (ROOM TEMPERATURE)

TABLE – 22

Product name	**Storage capacity/g**	**Variations**		
		1	**2**	**3**
Cookies	100	1 month	3 months	2 months
Nutritive bar	100	1 month	2 months	3 months
Rice laddoo	100	1 week	2 weeks	3 weeks
Tart base	100	2 weeks	3 weeks	1 month

TABLE – 22 depicts the shelf life qualities of the developed products that were assessed for a period of 2 months at room temperature.

Three variations of all the pomegranate peel incorporated food products (containing 100g products each) were kept for a period of 3 months and examined visually on a daily basis for microbial infestation and noted down the period in which first microbial infiltration was seen. That period was taken as the shelf life of the product under normal room temperature. The products were evaluated organoleptically at the end of each month to find out the changes in their sensory qualities. When a food is considered unsuitable for consumption, it is said to have reached the end of shelf life.

Sugar/jaggery, salt and butter/ghee were used as the major ingredients in the preparation of the products which determined the shelf life of each product.

The products like pomegranate peel powder incorporated cookies (3 months), and nutritive bar (3 months) got the highest shelf life, since these two products contained higher amounts of sugar/jaggery and ghee along with small amounts of salt respectively.

The next product which had highest shelf life was Pomegranate peel powder incorporated Tart base (1 month). High amount of butter and common preservatives like sugar and salt contributed to the longer shelf life of these products.

Pomegranate peel powder incorporated Rice laddoo had lowest shelf life of 3 weeks.

4.9. EVALUATION OF TIME TAKEN FOR THE PREPARATION OF POMEGRANATE PEEL POWDER INCORPORATED PRODUCTS

TABLE – 23

Product name	Amount(g)	Time analysis		
		Preliminary Preparation time (minutes/ day)	Cooking time(minutes)	Total time (minutes)
Cookies	100	3days and 20 minutes	10	3 days and 30 minutes
Nutritive bar	100	15 minutes	20	35 minutes
Rice laddoo	100	10 minutes	15	25 minutes
Tart base	100	15 minutes	10	25minutes

TABLE 23 indicates the time taken for preparing 100g of each Pomegranate peel powder incorporated products. The data depicted in the TABLE 23 revealed that the time taken for cooking Pomegranate peel powder incorporated cookies was highest because of longer period of time used for the preliminary preparation of sun drying of pomegranate peel powder and also mixing of ingredients prior to the preparation of cookies (3 days 30 minutes).

Least time for production i.e., 25 minutes was taken for the preparation of product like Pomegranate peel powder incorporated Tart base. This was because the ingredients were less and also the mixing time as well as the baking time was lower than that of cookies.

5. SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Every part of Pomegranate (Punica granatum) fruit is said to help in the treatment of diseases. In order to meet the objectives of the study, four products were prepared by incorporating Pomegranate peel powder. The products developed are pomegranate peel powder incorporated Cookies, Nutritive bar, Rice laddoo and Tart base. The products were prepared in three variations namely variation 1, variation 2 and variation 3 which contained various proportions of pomegranate peel powder, incorporated in 10 – 20 per cent, 25 - 35 per cent and 40 percent in them along with other ingredients for achieving enhanced quality and adequate quantity of the nutrients in the products.

The selected ten panel members were women staffs working in office in Chennai. The 9 – hedonic scale was prepared to evaluate the sensory qualities of the prepared products. Among the prepared variations, variation 2 of Pomegranate peel powder incorporated cookies (39.2), variation 3 of Pomegranate peel powder incorporated nutritive bar (40.7), variation 3 of Pomegranate peel powder incorporated (40), variation 3 of Pomegranate peel powder incorporated Tart base (39.6), were selected as the best variations of each developed Pomegranate peel powder incorporated products.

The prepared products contained, calories within range of 40 – 63.2 Kcal, carbohydrates within the range of 50 - 70 g, protein within the range of 3.7 – 7.8g and fat within a range of 0.9 – 2g per 100g of each product. They also supplied adequate amount of calcium (20 – 40mg) and phosphorous (30 – 50mg). Pomegranate peel powder incorporated products were found to be rich in nutrients especially calcium and phosphorous, while it supplied normal amount of calorie, carbohydrate, protein and fat. The developed products were analyzed for their shelf life qualities for a period of two months at room temperature. Products like cookies

and nutritive bar got maximum shelf life of two months. Pomegranate peel powder incorporated Tart base had shelf life of one month and rice laddoo had only upto three weeks. In time analysis, pomegranate peel powder incorporated cookies required the most time for preparation (3 days and 30 minutes), while other three products, that is, nutritive bar, rice laddoo and tart base required less time for preparation (25 – 35 minutes). Among the developed products, two of the best product variation with highest overall acceptability scores namely nutritive bar (40.7) and rice laddooo (40) were popularized among the women working staffs in central government office. For the process of popularization, questionnaires were prepared. The responses given by the working staff members showed that they had the interest to cultivate pomegranate plant and also to incorporate its peel powder in their daily diet.

Pomegranate (Punica granatum) is a medicinal fruit. In traditional medicinal system, the fruit was used to treat hypertension, cancer, diabetes, etc. and the peel was used to prevent all these diseases along with osteoporosis, GI disorders, etc. The production and consumption of pomegranate and its peel incorporated recipes, will help to prevent these types of diseases to a remarkable extent. Most of the people are not aware about the nutritional and medicinal importance of the pomegranate peel powder incorporated food products as they are not available in the market. In our country, though people consume pomegranate, the people who consume its peel are very less. Very few people who follow traditional dietary pattern are aware about the benefits of pomegranate peel powder. Hence the current study which highlights the incorporation of pomegranate peel powder into common foods is beneficial, because of the convenience in cultivation of pomegranate tree and the nutritional benefits of both the fruit as well as the peel. It is also less expense and has many medicinal uses.

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BIBILIOGRAPGHY

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APPENDIX

APPENDIX – 1

QUESTINNAIRE TO ELICIT THE FOOD HABITS OF ADULT STAFFS WITH SEDENTARY LIFESTYLE

1. PERSONAL INFORMATION

Name:

Age:

Address:

Phone number: Height……. Weight…….

Occupation:

2. Do you cultivate pomegranate fruit tree in your yard?

Yes ☐ No ☐

3. Do you know how to prepare pomegranate peel powder food products?

Yes ☐ No ☐

4. Which are the pomegranate peel powder food products that you have consumed so far?

Cookies ☐ Tart ☐ Nutritive bar ☐ Tea powder ☐

5. How often do you in-corporate pomegranate peel powder in your diet?

Once in a week ☐ twice in week ☐ daily ☐ Monthly ☐

6. Do you know the health benefits of pomegranate peel powder?

Yes ☐ No ☐

7. Are you allergic to pomegranate peel powder?

Yes ☐ No ☐ Not sure ☐

8. Do you know the nutritional importance of pomegranate peel powder?

Yes ☐ No ☐

If yes, please specify the nutrients

_____

_____

9. Do you like pomegranate peel powder food products?

Yes ☐ No ☐ Not sure ☐

If yes, specify……

10. For what reason do you like pomegranate peel powder?

Taste ☐ Colour ☐ Other ☐

Other please specify……

11. In what form do you consume pomegranate peel powder?

Mixed with milk ☐ Baked products ☐ Tea ☐ Idly batter ☐

12. Do you know the anti-nutritional factors present in pomegranate peel powder?

Yes ☐ No ☐

If yes, specify……

13. Do you have any health problems?

☐ Diabetic

☐ Hypertension

☐ Osteoporosis

☐ Obesity

14. Do you believe that consuming pomegranate peel powder improve hypertension or hyper – lipidemia?

Yes ☐ No ☐

15. Do you know the toxic effect of consuming excess of pomegranate peel powder?

Yes ☐ No ☐

16. Do you know that addition of pomegranate peel powder food products in diet can prevent the risk of Alzheimer's disease?

Yes ☐ No ☐

17. What are the factors that indicate pomegranate peel powder food products of good quality and taste?

Type ☐ Origin ☐ Colour ☐ Freshness ☐

Size ☐ Firmness ☐ Smell ☐ Other ☐

Other (please specify)……

18. What is your perception of the quality of pomegranate fruit available to you?

Very good quality ☐ Good quality ☐

Average quality ☐ Poor quality ☐

19. What type of pomegranate fruit do you prefer?

Organic ☐ Local ☐

20. Why would you consider including pomegranate peel powder from organic pomegranate fruit?

Healthier ☐ Pesticide/chemical free ☐

Sustainable ☐ Tastier ☐ Other ☐

Other please specify

21. Do you know the shelf-life of pomegranate fruit at room temperature?

One or two days ☐ One week ☐

One month ☐ or more ☐

22. Do you know the shelf-life of pomegranate peel powder food products during refrigeration?

One or two days ☐ One week ☐

One month ☐ or more ☐

23. What could be a reason for you to try, a new recipe of pomegranate peel powder fruit?

☐ Better quality perception

☐ Less time for preparation

☐ Bored from the earlier recipe

☐ Other

Other, please specify……

24. If recommended will you prefer to include pomegranate peel powder in the diet?

Yes ☐ No ☐

APPENDIX – 2

SENSORY EVALUATION CARD

NAME OF EVALUATION CARD:

DATE :

PRODUCT NAME :

INSTRUCTION TO FOLLOW

Please rinse your mouth with water before starting.

You may rinse your mouth again at any time during testing if you need to.

Please taste the three sample in order presented from left to right.

You may re – taste the samples once you have tried all of them score the sample.

9 points hedonic score rating card

Sample No.	**Appearance**	**Colour**	**Taste**	**Texture**	**Overall acceptability**
1					
2					
3					

Please evaluate the sample by ticking on any of the number according to your perception

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

SIGNATURE OF THE PARTICIPANT

THANK YOU FOR PARTICIPATION

APPENDIX- 3

NUTRITIVE VALUE CALCULATION FOR POMEGRANATE PEEL POWDER INCORPORATED FOOD PRODUCTS

CALCULATION METHOD

1. Energy

Conversion of energy in kilo joule to kilo calories

1 kcal = 4.184 KJ

= n/Kcal

= n Kcal

Therefore energy in kcal per 100 gm = X

Energy = X/100 x n

= n kcal

2. Protein in 100 gm = X

There total protein = X/100 x n

= n gm protein

3. Fat in 100gm = X

There for total fat = X/100 x n

= n gm fat

4. Carbohydrate in 100 gm = X/100 x n

= n gm carbohydrate

APPENDIX – 4

i. DETERMINATION OF PROTIEN

Objective:

To determine the protein content of the developed products.

Principle

1. **Digestion**
2. **Neutralization**
3. **Titration**

Procedure

1. **Digestion**

The food sample to be analyzed is weighed into a digestion flask and then digested by heating it in the presence of sulfuric acid (an oxidizing agent which digests the food), anhydrous sodium sulfate (to speed up the reaction by raising the boiling point) and a catalyst, such as copper, selenium, titanium, or mercury (to speed up the reaction). Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia, and other organic matter to CO_2 and H_2O. Ammonia gas is not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH_4^+) which binds to the sulfate ion (SO_4^{2-}) and thus remains in solution:

$N(food) \longrightarrow (NH_4)_2SO_4$

2. Neutralization

After the digestion has been completed the digestion flask is connected to a receiving *flask* by a tube. The solution in the digestion flask is then made alkaline by addition of sodium hydroxide, which converts the ammonium sulfate into ammonia gas:

$$(NH_4)_2SO_4 + 2\ NaOH \longrightarrow 2NH_3 + 2H_2O + Na_2SO_4$$

The ammonia gas that is formed is liberated from the solution and moves out of the digestion flask and into the receiving flask - which contains an excess of boric acid. The low pH of the solution in the receiving flask converts the ammonia gas into the ammonium ion, and simultaneously converts the boric acid to the borate ion:

$$NH_3 + H_3BO_3 \text{ (boric acid)} \longrightarrow NH_4^+ + H_2BO_3^- \text{ (borate ion)}$$

3. Titration

The nitrogen content is then estimated by titration of the ammonium borate formed with standard sulfuric or hydrochloric acid, using a suitable indicator to determine the end-point of the reaction.

$$H_2BO_3^- + H^+ \longrightarrow H_3BO_3$$

The concentration of hydrogen ions (in moles) required to reach the end-point is equivalent to the concentration of nitrogen that was in the original food (Equation 3). The following equation can be used to determine the nitrogen concentration of a sample that weighs *m* grams using *x*N HCl acid solution for the titration:

$$\%\,N = \frac{x\ \text{moles}}{1000\ \text{cm}^3} \times \frac{(v_s - v_b)\ \text{cm}^3}{m\ \text{g}} \times \frac{14\ \text{g}}{\text{moles}} \times 100$$

Where *v*s and *v*b are the titration volumes of the sample and blank, and 14g is the molecular weight of nitrogen N. A blank sample is usually ran at the same time as the material being analysed to take into account any residual nitrogen which may be in the reagents used to carry out the analysis.

ii. ESTIMATION OF CARBOHYDRATES

Crude fibre consists largely of cellulose and lignin (97%) plus some mineral matter. It represents only 60% to 80% of the cellulose and 4% to 6% of the lignin. The crude fibre content is commonly used as a measure of the nutritive value of poultry and livestock feeds and also in the analysis of various foods and food products to detect adulteration, quality and quantity.

Objective

To determine the carbohydrate content present in the developed food products.

Principle

During the acid and subsequent alkali treatment, oxidative hydrolytic degradation of the native cellulose and considerable degradation of lignin occur. The residue obtained after final filtration is weighed, incinerated, cooled and weighed again. The loss in weight gives the crude fibre content.

Materials

- Sulphuric acid solution (0.255 ±0.005N) : 1.25g concentrated sulphuric acid diluted to 100mL (concentration must be checked by titration)

- Sodium hydroxide solution (0.313 ±0.005N0 : 1.25g sodium hydroxide in 100mL distilled water (concentration must be checked by titration with standard acid)

Procedure

1. Extract 2g of ground material with ether or petroleum ether to remove fat (Initial boiling temperature 35 -38°C and final temperature 52°C). If fat content is below 1%, extraction may be omitted.
2. After extraction with ether boil 2g of dried material with 200mL of sulphuric acid for 30min with bumping chips.
3. Filter through muslin and wash with boiling water until washing are no longer acidic.
4. Boil with 200mL of sodium hydroxide solution for 30min.
5. Filter through muslin cloth again and wash with 25mL of boiling 1.25% H_2SO_4, three 50mL portions of water and 25mL alcohol.
6. Remove the residue and transfer to ashing dish (Sample weight – W_1).
7. Dry the residue for 2h at 130 ±2°C. Cool the dish in a desiccator and weigh (Muffle weight – W_2).
8. Ignite for 30min at 600 ±15°C in an oven.
9. Cool in a desiccator and reweigh (Oven weight – W_3).

Calculation

$$\text{Crude fibre} = \frac{\text{oven weight} - \text{muffle weight}}{\text{Sample weight}} * 100$$

The carbohydrates is calculated by Nitrogen Free Extraction (NFE) method.

NFE = 100 - % sum of crude ash, moisture, fat, protein and fibre.

iii. DETERMINATION OF FAT

Objective:

To determine the fat content in the developed food products.

Principle:

Crude fat content is determined by extracting the fat from the sample using a solvent, then determining the weight of the fat recovered. The sample is contained in a porous thimble that allows the solvent to completely cover the sample.

The thimble is contained in an extraction apparatus that enables the solvent to be recycled over and over again. This extends the contact time between the solvent and the sample and allows it time to dissolve all of the fat contained in the sample.

In order for the solvent to thoroughly penetrate the sample it is necessary for the sample to be as finely comminute as possible. Before the solvent extraction step can begin the sample must be dried.

Often a moisture analysis is required as well as a fat analysis and this can be achieved by accurately weighting the sample after drying and before extraction, as well as before drying. If a moisture analysis is not required the sample need only be weighed before drying and again after solvent extraction.

In either case the sample must be weighed accurately on an analytical balance at each stage of the analysis. When the sample is being weighed it is important not lose any part of it including any moisture that may weep from the sample during weighting.

Loss of this moisture can be avoided by weighing the sample directly into a pre-dried extraction thimble or alternatively on to a pre-dried filter paper. If a moisture analysis is required, the dried extraction thimble or filter paper also has to be pre-weighed. After weighing, the sample (in the thimble or filter paper) can be placed in the oven for drying. After drying, the sample can be placed directly into the distillation apparatus for extraction.

Equipment:

• Analytical balance (at least 1 mg sensitivity).

• Electrical drying oven to be operated at 102ºC± 1ºC.

• Soxhlet extraction unit comprising: − Round bottom flask, 150 mL − Soxhlet extractor with 60 mL siphoning capacity and condenser. − Cellulose extraction thimbles (28 x 80 mm)

- Fume cupboard
- Heat source, either electric heating mantle, or steam bath 100 mL beaker
- Desiccator with silica gel desiccant
- Glass rod Reagents
- Petroleum spirit boiling point 60-80ºC
- Cotton wool free of fat
- Acid washed sand Procedure Note: Steps 8 – 12 are performed in a fume cupboard.

Procedure:

1. Rinse all glassware with petroleum spirit, drain, dry in an oven at 102ºC for 30 min. and cool in a desiccator.

2. Place a piece of cotton wool in the bottom of a 100 mL beaker. Put a plug of cotton wool in the bottom of an extraction thimble and stand the thimble in the beaker.

3. Accurately weigh 5 g of sample into the thimble. Add 1 - 1.5 g of sand and mix the sand and sample with a glass rod. Wipe the glass rod with a piece of cotton wool and place cotton wool in the top of the thimble. (Addition of sand is not required for analysis of meat meal).

   Dry the sample in an oven at 102ºC for 5 hours. The drying step may be omitted in the analysis of meat meal.

4. Allow the sample to cool in a desiccator.

5. Take the piece of cotton wool from the bottom of the beaker and place it in the 3 top of the thimble. 6. Insert the thimble in a Soxhlet liquid/solid extractor.

7. Accurately weigh a clean, dry 150 mL round bottom flash and put about 90 mL of petroleum spirit into the flask.

8. Assemble the extraction unit over either an electric heating mantle or a water bath.

9. Heat the solvent in the flask until it boils. Adjust the heat source so that solvent drips from the condenser into the sample chamber at the rate of about 6 drops per second.

10. Continue the extraction for 6 hours.

11. Remove the extraction unit from the heat source and detach the extractor and condenser. Replace the flask on the heat source and evaporate off the solvent. (The solvent may be distilled and recovered).

12. Place the flask in an oven at 102ºC and dry the contents until a constant weight is reached (1-2 hours).

13. Cool the flask in a desiccator and weigh the flask and contents.

    Weight of empty flask (g) = W1

    Weight of flask and extracted fat (g) = W2

    Weight of sample = S

    % Crude fat = (W2 – W1) x 100 S

iv. DETERMINATION OF CALCIUM

Objective:

To determine the calcium present in the bilimbi fruit food products.

Applications and limitations:

This method is used to find the calcium content of milk, the hardness of water and the amount of calcium and calcium carbonate in various solid materials. It is a very established, reliable and accurate method but it take time to complete as done manually

Reagents:

NaOH-1 N, Murexide solution (ammonium purpurdate) -0.100mg of murexide with 10g of solid sodium chloride and grinding the mixture to 300-425 microns, Standard EDTA solution = 0.01N

Procedure:

- Weigh accurately 5-10g of the material in previously weighed crucible
- Dry for 2 hours in an air oven maintained at 105±2° C and ignite the divided material in the dish with the flame of a burner for about 1 hour
- Complete the ignition by keeping in a muffle furnace at 600±20°C until grey ash results
- Cool in a desiccator and weigh
- Repeat the process of heating for 30 minutes, cooling and weighing till the difference in mass between two successive weighing is less than 1mg
- This ash is then dissolved in minimum amount of concentrated HCL and made upto 100ml using distilled water.
- Take 50 ml of this sample. Add 1N NaOH solution, a volume sufficient to produce a PH of 12-13
- Add 2-3 drops of the murexide indicator. Titrate against EDTA with continues stirring.
- The end point is indicated by colour change from pink to purple.

Calculation

Calcium = (Titrate value*normality of EDTA*40.08*1000*dilution)/volume taken for test.

APPENDIX – 5

TOOLS DEVELOPED TO CREATE AWARENESS AMONG THE PARTICIPANTS

1. POWERPOINT

POMEGRANATE PEEL POWDER – HEALTH BENEFITS AND RECIPES

SHREYA K P

INTRODUCTION

- Scientific name of pomegranate: ***Punica granatum***.
- Pomegranate peel powder is an easily accessible product if we buy the fruit.
- The skin of the fruit is usually underutilized & discarded in India due to lack of knowledge and ignorance.

HEALTH BENEFITS

- The fruit peel has many health benefits due to properties like:
  - Anti – cancerous
  - Anti - microbial
  - Anti – ulcerous
  - Anti – oxidants, etc.

Due to it's antioxidant properties, it prevents the risk of diseases like CVD, Diabetes, Osteoporosis, Obesity, Cancer, Inflammatory diseases, Intestinal diseases, etc.

- Other health benefits include:
  - Good for irritable bowel syndrome and other GI tract diseases.
  - Fights rashes
  - Cures sore throat and coughs.

NUTRIENT CONTENTS OF THE POMEGRANATE PEEL

- The fruit peels contain:
- Carbohydrates
- Fibre
- Protien
- Fatty acids like palmitic acid, oleic acid, punicic acid, etc.
- Minerals like calcium, phosphorous, potassium, etc.
- Vitamins like vitamin A, C, E etc.
- Antioxidants
- Flavanoids
- Polyphenols like catechins, phenols, gallic acid, etc.

RECIPES THAT CAN BE PREPARED USING POMEGRANATE PEEL POWDER

1. COOKIES

Ingredients:

Wheat flour	- 1 ½ cups
Pomegranate peel powder	- 35g
Unsalted Butter (melted)	- ½ cup
Brown sugar	- ½ cup
White sugar	- ½ cup
Egg	- 1 no.
Baking soda	- 1 tsp
Vanilla extract	- 1tsp
Chocolate chips	- ½ cup

Method of preparation

- Pre – heat the oven at 150 degrees for 10 minutes.
- Cream the butter, brown sugar & white sugar till it becomes smooth.
- Add the egg to it followed by vanilla extract and mix well using a spoon or spatula.
- Dissolve baking soda in 2 teaspoon hot water & add to the mixture. Add salt to taste.
- Add wheat flour, pomegranate peel powder, chocolate chips, & nuts (if needed) & mix well.
- Make the desired shape with the dough using a cookie cutter and place it in greased tray.
- Bake it for about 10 minutes at 150 degrees.
- Store it in air tight container after it cools down.

2. NUTRITIVE BAR

Ingredients:

- Oats - ½ cup
- Jaggery - ½ cup
- Pomegranate peel powder – 20g
- Cashew nuts - ¼ cup
- Almonds - ¼ cup
- Groundnut - ¼ cup
- Ghee - 1tbsp.

Method of preparation

- In a small pan pour one tablespoon ghee.
- Roast the nuts in the ghee.
- Add the oats to it & roast everything well.
- Add the pomegranate peel powder to it & combine well.
- Add the jaggery to it and allow it to melt.
- Transfer it to a greased tray.
- Allow it to cool and then cut it into bars with sharp knife.
- Store them in air tight container.

3. RICE LADDOO

Ingredients:

- Rice flakes - ½ cup
- Oats - ½ cup
- Cashew nuts - ¼ cup
- Walnuts - ¼ cup
- Ground nuts - ¼ cup
- Pomegranate peel powder - 25g
- Jaggery – ¼ cup

Method of preparation:

- In a small pan, roast the rice flakes, oats & nuts.
- Powder the contents along with the jaggery.
- Mix the pomegranate peel powder to it & mix well.
- Add one tablespoon ghee to make the content smooth.
- Make balls in desired sizes.
- Store it in air – tight container.

4. TART BASE

Ingredients:

- Wheat flour - ½ cup
- Powdered brown sugar - ¼ cup
- Butter - 50g
- Pomegranate peel powder - 10g

Method of preparation:

- In a small pan, roast the rice flakes, oats & nuts.
- Powder the contents along with the jaggery.
- Mix the pomegranate peel powder to it & mix well.
- Add one tablespoon ghee to make the content smooth.
- Make balls in desired sizes.
- Store it in air – tight container.

4. TART BASE

Ingredients:

- Wheat flour - ½ cup
- Powdered brown sugar - ¼ cup
- Butter - 50g
- Pomegranate peel powder - 10g

Method of preparation:

- Cream the butter which is kept room temperature.
- Add brown sugar to it & mix well.
- Then add the wheat flour & pomegranate peel powder to it & mix well to form a smooth dough.
- Rest it for 15 minutes.
- Place it in Tart mould / silicon cupcake mould to make the cup shape.
- Bake it at 175 degrees for 10 – 15 minutes.
- Store it in an air – tight container.

THANK YOU

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