DEVELOPMENT AND EVALUATION OF COCONUT BASED READY TO EAT MIXES AND COCONUT FLAKES

HARITHA.T

(16PFN006)

A THESIS SUBMITTED TO THE

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN, COIMBATORE- 641043.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN FOOD SCIENCE AND NUTRITION

APRIL, 2018

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Certified as a Bonafide Research Work

S. Thilakavathy

Signature of the Supervisor

Signature of the Head of the Department

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CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

I. INTRODUCTION

Cocos nucifera L. (Family Arecaceae) commonly known as coconut, is an important fruit crop in the tropical countries. The coconut, Cocos nucifera L., has been described as "the tree of life" (Rana, 2015) or the tree of plenty or the consols of the east (Tyagi *et al*.,2015 and Rasam*et al*., 2016).

It is considered as 'the symbol of tropics' (Rahman *et al.,*2015). Western literature mentioned the Malayalam name "Tenga" for the coconut palm which related to Tamil "Tennai" and believed to have been introduced from Sri Lanka (Athira, 2017).

Coconut (Cocos nucifera L.), popularly known in India as "Kalpa Vrisha", provides mankind with all the necessities of life (Karun*et al*., 2014). The coconut cultivation plays a key role in the economy of many countries where it has been nicknamed "tree of life" or "tree of hundred uses" (koffi *et al.,* 2016).

Coconut palm (Cocosnucifera) is a large palm that grows up to 30 metres(98ft) tall, with pinnate leaves 4-6metres(13-20ft) long and pinnae 60-90cm long: old leaves breaks away cleanly, leaving the trunk smooth . Other parts of the palm include the root, truck, inflorescence and fruit (Ikechukwu *et al.,* 2016 and Ilori and obahiagbon, 2015). Its nut provides a nutritious source of meat, juice, milk, and oil that has fed and nourished populations around the world for generations (Yun*et al.,* 2015).

The coconut palm with its tall slender and uniformly thick stem and massive crown with large number of leaves, bearing bunches of nuts in their axills is one of the most beautiful and useful trees in the world (Deepatharshini and Elango, 2015).

Exocarp, Mesocarp and Endocarp, are the three layers of the fruit (Kotagi *et al.,* 2016). The exocarp and mesocarp parts make up the husk of coconut fruit which is very light in weight. The endocarp part of coconut is heavy and contains shell, nut, embryo and water. Endosperm is a triploid tissue (Sukamto, 2017).

The Philippines has the world's largest agricultural area planted with coconut palms and is second only to Indonesia as the world's top producer of coconut products. (Watson *et al.,* 2015).India is the third largest coconut producing country having an area of about 2.14 million ha with a production of 14911 million tons

(Jaikumaran *et al*., 2016). The four southern states accounts for more than 90 per cent of the total production in the country. More than 30 per cent of the coconut comes from Tamil Nadu followed by Kerala. Karnataka stands at third place in production i.e., one fourth of India's coconut produce come from the Karnataka (Pankaja *et al.,* 2017).

Native to the tropics, the palm seems to have found its way across the continents. The fruit, being light and buoyant, is said to have possibly found its own course across the globe, with the help of marine currents. It can be found as far as Norway in the north, where the people have for centuries ensured that the seed germinated under the right, 'created' conditions. It is believed that the fruit and its palm made their way into Hawaii on account of the deliberate efforts made by Polynesian voyagers. The name '*coconut*', it is believed, was awarded to this tree by Spanish and Portuguese explorers. The name was derived from the Iberian '*El Coco*', which referred to a mythical hairy monster. The kernel and hair around the fruit probably generated this connection. The suffix '*nut*' was added to refer to the seed-bearing palm, just like most other tree seeds are referred to, in English. The name stuck, and today the whole world knows the tree as the coconut palm. (https://gardenerdy.com/history-of-coconut-tree).

There are many varieties that describe for coconut trees, for example “talls”, “dwarfs” or hybrids between them. Many varieties have local names and they refer to their main use or appearance (Zuraida *et al.,* 2017).

The tall coconuts are late flowering, more tolerant to harsh environmental conditions and produce larger nuts. Tall coconuts are most favoured in the plantation scale cultivation around the world (Kamaral *et al.,* 2016). The total number of female flowers per inflorescence in a tall palm usually varies between 20-40 as compared to the dwarf which carries large number of female flowers in one spadix. (Sankaran *et al.,* 2015).

Dwarf coconuts grow to a height of about 10-15m and are autogamous, early flowering and generally produce a large number of small nuts with distinctive colour forms (Oyoo *et al.,* 2015). Dwarf type is mainly self pollinating (with a few exceptions). Dwarf types are usually grown for ornamental and breeding purpose. Dwarf paved the way for the successful breeding programme in coconut all over the world (Nath, 2017).The breeding of coconut palm is mainly based on selection of phenotypic traits and artificial hybridization, involving varietal crosses between Tall and Dwarf forms (Rajesh *et al.,* 2014).

The coconut is an important fruit tree in the tropical regions and the fruit can be made into a variety of foods and beverages (Yong *et al.,* 2009). Coconut has been a traditional food in almost all the countries where it is grown (Dhankhar, 2013). Owing to its versatile uses, the demand for coconut and its product has been on the increase having already attained the premier position. Moreover coconut is an eco-friendly crop which permits co-existence of multi-species of plants. It enriches soil fertility in association with other crops and is quite amenable to organic farming if appropriate intercrops are grown in the interspaces. Due to multifarious uses, the future of the crop is very bright irrespective of the location where it is grown in the world (http://www.sanskritimagazine.com/rituals-and-practices/importance-and-significance-of-coconut).

The fruit of the coconut is highly nutritious; rich in fibre, vitamins and minerals. It is classified as a 'functional food' because it provides many health benefits beyond its nutritional content (Obidoa *et al.,* 2010).Coconut consists of fatty acids that work as source of energy and antimicrobial effects. Some fatty acids are available in large amount in coconut as lauric acid (50%) and capric acid (8%) (Shakeri *et al.,* 2016).

The phytochemical constituents of coconut include phenols (0.19 %), flavonoids (0.53 %), alkaloids (0.29 %), tannins (0.18 %) and saponins (0.35 %). Ascorbic acid (0.08 %), riboflavin (0.27 %), niacin (0.66 %), β-carotenoid (0.03 %) and thiamine (0.18 %) are the vitamins present in coconut. Proximate compositions were moisture (22.33 %), ash (7.76 %), crude protein (11.59 %), crude fibre (12.79 %) and lipids (41.16 %). Mineral constituents detected were calcium (2.87 %), magnesium (0.27 %), potassium (0.53 %), sodium (0.18 %), phosphorus (0.23 %), iron (0.39 %), copper (0.005 %) and zinc (0.007 %) (Igwe *et al.,* 2016).

People from many diverse cultures, languages, religions and races scattered around the globe have revered the coconut as a valuable source of both food and medicine wherever the coconut palm grows, the people have learned of its importance as an effective medicine (Joshua, 2017). CocosnuciferaLinn. (Arecaceae) is a plant possessing a lot of potential as an ingredient in traditional medicines for the treatment of metabolic disorders and particularly as an anti-inflammatory, antimicrobial and analgesic agent (Dua *et* al., 2013).

Coconut oil has nourished millions of people throughout the world for generations. Those populations that use it as their primary source of dietary fat are remarkably free of cardiovascular disease and other common degenerative conditions. In comparison to other fats, coconut oil is easy to digest and improves the absorption of vitamins, minerals, amino acids, and fatty acids, making it an excellent choice for the treatment of malnutrition and for those who have digestive concerns (Fife, 2013).

In traditional medicine around the world coconut is used to treat a wide variety of health problems including the following: abscesses, asthma, baldness, bronchitis, bruises, burns, colds, constipation, cough, dropsy, dysentery, earache, fever, flu, gingivitis, gonorrhoea, irregular or painful menstruation, jaundice, kidney stone, lice, malnutrition, nausea, rash, scabies, scurvy, skin infections, sore throat, swelling, syphilis, toothache, tuberculosis, tumours, typhoid, ulcers, upset stomach, weakness and wounds (https://www.coconutresearchcenter.org).

Coconuts have also been studied for medicinal qualities for heart, liver and kidney disorders. Recently coconut has been reported to reduce the viral load of HIV (Shettigar *et al.,* 2014). It was established that lauric acid from coconut oil has a potent antimicrobial activity and was found to reduce the HIV virus (Pham, 2016). Virgin coconut oil reduces the total cholesterol, triglyceride, phospholipid, low density lipoprotein (LDL) and very low density lipoprotein but could increase the high density lipoprotein (HDL) in the serum and tissues (Subermaniam *et al.,* 2015).

Coconut is used as an 'ethnomedicine' to treat gastrointestinal problems and minor cuts, injuries and swelling (Manikantan *et al.,* 2015).

Coconut products have experienced astonishing growth globally over the past several years. A wide range of coconut products are internationally traded. There are more than 50 unprocessed, semiprocessed or processed coconut products entering the international markets in small and big quantities (Naika*et al*., 2015).

Coconut is a smallholder crop, and millions of rural people depend on it for survival. Its development particularly in postharvest activities could be the base for rural development in the coconut-producing countries. Copra, coconut oil, desiccated coconut (DC), coconut cream, coconut milk, virgin coconut oil, spray-dried coconut milk powder, coconut chips, cream, nata de coco, coconut jam and young tender coconut are the convenience coconut products, and some by-products are coconut fibre, e.g. coir and coir products, mats, matting, brushes, brooms and rubberised coir mattresses, and shell products, e.g. charcoal, activated carbon, etc. (Ghosh, 2015).

Coconut is an indispensible ingredient in many of the traditional cuisines of Southeast Asian countries including India (David and Kofahi, 2016). Historically, coconuts and their extracted oil have served man as important foods for thousands of years (Mahapatra *et al.,* 2015). Coconut enters into the diet of the people in many ways; in the form of tender nuts used for their water, mature nuts for cooking and the preparation of sweetmeats, and oil for home consumption (Amulu *et al*., 2015).

Coconut chips is a value added product of coconut (Cocos nucifera) kernel. It is popular in many parts of the world but not in Asian countries including Sri Lanka. India and Malaysia produce some coconut chips as a nutritious snack with crispy texture and salty taste. Therefore, there is a potential to develop value added kernel chips with some medicinally important spicy extracts to promote locally (Rajakaruna *et.al*., 2014).

Coconut chips can be used as a healthy snack and can be conceived as healthy and nutritious alternatives to potato chips and it can also bring changes to the usual food products already accustomed by the consumers. Coconut chips is another value added product and it add variety to the diet. It is considered as a healthy snack because coconut is rich in dietary fibre that supports the digestive system and helps to feel full to prevent overeating. Coconut chips are really great anytime snack for kids and adults of all ages. Chips improve the shelf life of coconut so that it can be stored for a long time and consumed as a healthy snack for children and adults.

There is a growing demand for the ready-to-eat food category. The food product will get vary from ready to-consume to easy-to-cook and consumers prefer any such kind of food, if they are aware of it. Changes in lifestyle was considered as major factor in going for packed food purchase as well as demand for Convenience and hygienic food products busy life-style and equal participation of women in workforce (Priyadarshini, 2015).

Ready-to-Eat dates back to 1970's and gained popularity since then. The total value of Indian food processing industry is touched US$ 194 billion in 2015, according to Mr. Swapan Dutta, Deputy Director General, and Indian Council of Agricultural Research (ICAR). The food processing industry is one of the largest industries in India and it is ranked fifth in terms of Production, Consumption, Export and Expected growth. Demand for Ready-to-Eat meals has captured a large amount of the food retail market in India. Thus, the emerging change in consumer's perception, socio-economic-political factors has led to change in consumers purchase intention toward Ready-To-Eat Food Products (Hawa *et al.,* 2014).

Ready-to-eat (RTE) products are food products that are not further treated before consumption in such a way that may significantly reduce the microbial load. There is a wide variety of RTE products ranging from simple salads to complex ethnic dishes (Cabedo *et al.,* 2008). Ready-to-Eat (RTE) foods are described as the foods being ready for immediate consumption at the point of sale (Hussain *et al.,* 2015). RTE food is defined as food that can be consumed immediately at the point of sale without further preparation or treatment. It could be raw, partially or fully cooked, and hot, chilled or frozen. RTE food can be of animal and plant origin including fruits, vegetables and bakery products (Lopasovsky*et al.,* 2016).

Ready-to-eat (RTE) foods are foods intended to be consumed as they are. These foods do not require additional cooking and are usually stored in refrigeration or at room. "Ready-to-eat food" means food that is in a form that is edible without additional preparation (Muktawat *et al.,* 2013). .Different terms have been used to describe such ready to eat foods. These include convenient, ready, instant and fast foods (Clarence *et al.,* 2009).

In the present study tall, dwarf and breed varieties of coconut is selected for the development of coconut chips with different flavours and also ready to eat mix powders and are evaluated organoleptically. Also nutrient analysis of three varieties of coconut was carried out followed by the shelf life study of coconut chips and ready to eat mix powders. With this background the objectives of the present study entitled **'Development and evaluation of coconut based Ready To Eat mixes and coconut flakes'** was to

- Identify the coconut variety and develop value added coconut chips

- Development of chips with different flavours
- Comparison of different varieties of coconut chips with that of traditional variety
- Development of ready to eat mix powders
- Evaluate the acceptability of the developed coconut chips and ready to eat mix organoleptically
- Analysis of the nutrients present in the tall, dwarf and breed varieties of coconut
- Determination of shelf life

II. REVIEW OF LITERATURE

The review of literature pertaining to the study entitled **'Development and evaluation of coconut based Ready To Eat mixes and coconut flakes'** is reviewed under the following headings:

A. Coconut-a crop of human sustenance
B. Composition and nutritional characteristics of coconut
C. Health implications of coconut
D. Value addition in coconut and coconut based food product

A. Coconut- a crop of human sustenance

Coconut (Cocos nucifera) is one of the most widely cultivated and used tree in the world and is regarded as one of the most significant of all palms (Yun *et al*., 2015).

Coconut (Cocos nucifera L.) is one of the main woody perennial palms coming under the family Arecaceae (Rajeshkumar *et al.,* 2015). The tree has a robust, cylindrical, vertical stem with a single growing point from where successive leaf production takes place producing a terminal crown (Sridhar *et al*., 2017). It is a perennial tree, which grows to approximately 30 m in height. Its pinnate leaves and pinnae are 4 to 6 m and 60 to 90 m long, respectively (Igwe and Ugwunnaji, 2016).

Coconut palm (Cocos nucifera L.), also known as the 'Tree of Abundance', the 'Tree of Life', or the 'Consols of the East', is an important perennial oil-yielding plantation crop in the tropics (Rasam *et al.,* 2016).

Coconut had been long ago known by the people of Indonesia because Indonesia is an archipelago of tropical climate (Annas, 2015). India is the largest producer of coconut and the crop is mainly cultivated in coastal belt of west and east coast wherein, Kerala, Tamil Nadu, Andhra Pradesh and Karnataka are the major coconut-growing states, accounting for more than 90% of the area and production. (Maheswarappa *et al.,* 2014).

Coconut palms are an iconic symbol of tropical coastal ecosystems worldwide. Yet, this palm is thought to have originally only occurred in scattered populations on islands and coastlines in the equatorial Indian and pacific oceans. Its spread was facilitated through a series of introductions, likely first by Austronesian voyagers over 1500 years ago, who utilized the palm for food and fiber on transoceanic journeys, than by early European explorers, and more recently by 19^{th} century European agricultural entrepreneurs who intensively planted coconut palms for copra production. As a result, coconut palms can now be found as largely monodominant forests across a wide range of tropical coastal environments (young *et al.,* 2016).

Based on the breeding behaviour and the stature, two groups of coconuts, referred to as Tall (Typica) and Dwarf (Nana) have been known the world over (Kamaral *et al*., 2016). The tall type brought fruits in their six years to eight years of age after they have been grown (Tuhumuri *et al*., 2016). The dwarf coconuts are naturally self pollinating and they have common morphological features such as, dwarf stature, slender trunks lacking a root-bole (enlarged base of the stem), drooping frond tips and smaller crowns (Kamaral *et al.,* 2014).

Preetha, 2017 and Chauhan *et al.,* 2017 mentioned that Tender coconut water is the juice in the endosperm of young coconut. The water is one of the nature's most refreshing drinks consumed worldwide for its nutritious and health benefiting properties (Preetha and Chauhan *et al.,* 2017).

An immature coconut between six to nine months, contains about 750 ml of water (Manimuthu *et al.,* 2015).

Coconut water is a rich source of sugars, lipids, vitamins, minerals, amino acids, nitrogenous compounds, organic acids, enzymes, and phytohormones (Ramos and Galvez, 2016). The minerals such as potassium, sodium, calcium, phosphorous, iron, and copper, sulphur and chlorides are present in tender coconut water (Tazeen *et al.,* 2016). The amino acids present in coconut water are serine, glycine, histidine, tyrosine, phenylalanine, isoleucine and leucine (Rojas *et al.,* 2017). Coconut water also contains other ions such as potassium, phosphorus, calcium, magnesium, iron and manganese (Gupta, 2016). Enzymes like catalase, diastase, acid phosphatase dehydrogenase, peroxidase, RNA-polymerases are present in tender coconut water (Sooraj *et al.,* 2016 and Manna *et al*., 2014). Phytohormones like Auxin, cytokinin, and gibberellins and vitamins B1, B2, B3, B5, B6, B7 and B9 (Mordi *et al*., 2015 and Dulay *et al*., 2017).

Coconut water enhances immune function, possesses anti-aging properties, decreased swelling, relieve spasm, root canal irritant (antiviral, antifungal and antimicrobial properties) and storage media for avulsed tooth (Jain *et al.,* 2014).

Coconut milk is the liquid obtained by manual or mechanical squeezing of grated coconut meat with some hot water resulting in rich white liquids that closely look like cows milk (Olanrewaju., 2015).

Coconut milk has the following nutritional properties; protein (3%), fat (17% - 24%), and carbohydrate (2%). It has no cholesterol, contains many vitamins, minerals and electrolytes (Balogun *et al.,* 2016). Vitamin C, E and B vitamins (Aboulfazi *et al.,* 2016) and calcium, iron, phosphorus (Ajeigbe *et al.,* 2017) are the vitamins and minerals present in coconut milk respectaively.

Coconut milk contains high amounts of medium chain saturated fatty acids (MCFAs), especially lauric acid (Patil *et al.,* 2017). It raises blood cholesterol levels by increasing the amount of high-density lipoprotein cholesterol, which is also found in significant amounts in breast milk and sebaceous gland secretions (Rakib *et al.,* 2016).

Coconut oil is one of the most widely used vegetable oils for several hundred years (Seneviratne and jayathilaka, 2016). Virgin coconut oil is the purest form of coconut oil. Virgin coconut oil is obtained from the fresh coconut meat and is extracted by wet process at mild temperatures (Tjin *et al.,* 2016). In another word, Virgin coconut oil refers to an oil that are obtained from fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat and without undergoing chemical refining (Halim *et al*., 2014).

Coconut oil is composed primarily of short and medium chain fatty acids (MCFA) with lauric acid (12:0) and myristic acid (14:0) accounting for approximately 46.5% and 20.5% of the fatty acids content, respectively (Ghazal *et al.,* 2015). The fatty acids contained in virgin coconut oil are caproic acid, caprylic acid, capric acid, lauric acid, myristic acid, stearic acid, Olei acid, linoleic acid and linolenic acid (Rohyami *et al.,* 2017). Coconut oil is a natural plant source, rich in MCFA with lauric acid (C12:0) representing 40–50% of total fatty acids (Luo *et al.,* 2014).

Coconut oil is a source of tocotrienols, capric acid, caproic acid, and lauric acid, which are natural antioxidants. These substances act as scavengers of damaging oxygen free radicals that have been suggested to play an important role in aging, atherosclerosis, cancer, and diabetes mellitus (El-abasy *et al.,* 2016 and Akinnuga *et al*., 2014).

The consumption of coconut oil exhibits anti-inflammatory, analgesic and antipyretic effects, reduces tissue lipid levels and enhances the anti-thrombotic effects associated with inhibition of platelet coagulation, promotes low cholesterol level, increases antioxidant activity (Santana *et al.,* 2016). Virgin coconut oil (VCO) has varied degree of beneficial properties such as antiviral, antibacterial, anti-fungal, anti-inflammatory, antidiabetic, antiobesity, antiulcerogenic, analgesic and antipyretic, and antioxidant properties (Akinnuga *et al.,* 2014).

B. Composition and nutritional characteristics of coconut

I. coconut water

Coconut water is a pleasant tasting drink, rich in amino acids, enzymes, minerals, sugars, cytokinins, auxins and other substances (Kunle-Alabi *et al*., 2017). Coconut (Cocos nucifera) water is the clear liquid inside coconut fruits and contains essential constituents such as sugars, vitamins, minerals and amino acids (Daramola *et al.,* 2016).

The water and flesh young coconuts contain the full range of vitamins. The vitamins such as B6 and B12 are absent in coconut. The mineral content in young coconut water is also high especially magnesium and potassium. Fresh coconut water is very high in electrolytes (Ahuja *et al.,* 2014). Coconut water can replenish the electrolytes of the human body excreted through sweat, such as sodium, potassium, magnesium and calcium, it can serve as an effective rehydration drink (Purohit *et al.,*2017).

In the study conducted by Rukmini et al., 2017, it was found that coconut water is a rich source of nutrients like essential amino acids such as lysine, leucine, cysteine, phenylalanine, tyrosine, histidine, and tryptophan (Rukmini*et al.,* 2017). Coconut water is also a good source of minerals such as potassium, sodium, calcium, phosphorous, iron, vitamin C and vitamin B complex (Costa *et al.,* 2015 and Shah et al., 2015). Coconut water also contains folate (Jesuorsemwen *et al*., 2016).

Due to the absence of fat and low content of carbohydrates, calories and sodium it has a high demand among consumers. Cytokinin present in coconut water has beneficial effects like anti-aging, anti-carcinogenic and anti-thrombotic effects that contributed to various health benefits (Lazim *et al.,* 2015 and Ganguly and Roy, 2014). Tan *et al.,* 2015 found that the presence of natural cytokinin nucleotides in coconut water boosts the benefits of drinking coconut water for its anti-ageing effect (Tan *et al.,* 2015).

Umesha and Narayanaswamy, 2016 evaluated the chemical composition of coconut water obtained from desiccated industries. Here, eight to nine months broken coconuts were used in the processing of DC powders. The mineral concentration of coconut water and residual coconut milk lies between N (0.63 and 0.73 %), P (0.36 and 0.23 %), K (2.36 and 2.56 %), Ca (1.64 and 1.20 %), Na (0.48 and 0.41 %) and micronutrients viz., Fe (93.2 and 91.6 ppm), Cu (17.4 and 17.8 ppm) Zn (20.6 and 22.6 ppm) and Mn (84.0 and 76.2 ppm) were recorded respectively (Umesha and Narayanaswami, 2016).

Coconut water is rich with macronutrient and micronutrient content, i.e. carbohydrate, potassium, sodium, magnesium and chloride (Kailaku *et al.,* 2015). The major minerals like Calcium, magnesium, and potassium and some trace elements like zinc, selenium, iodine, manganese, boron and molybdenum are present in coconut water (Ogunrinola, 2016).

II. coconut kernel

The healthy coconut kernel consists of 13.3% of crude fibre. The chief constituent of coconut kernel is carbohydrate (Appaiah *et al*., 2014). Fresh coconut meat is 35.2 % fat, 3.8 % protein and 40 % moisture. Coconut meat protein had beneficial anti peroxidative and cardioprotective effect (Jin *et al.,* 2015).

Coconut meat contains less sugar and protein of high nutritive value. It is relatively high in minerals such as iron, phosphorus and zinc (Shehu *et al.,* 2014).

The chemical analysis reveals that in every 100 grams of the kernel there are 4.5 grams of protein, 41.6 grams of fat and 13 grams of glucose. The minerals such as calcium and phosphorus are also present in coconut kernel. The nitrogenous substances such as fat, lignin, ash and palm sugar content is also high in coconut kernel (Sharma *et al*., 2017).

Jain et al., 2017 conducted a study to understand the effect of substitution of butter with tender coconut pulp in cookies in terms of its physicochemical and organoleptic properties. The physicochemical analysis of the cookies showed a significant reduction in the fat content and a significant increase in the moisture, protein, fibre and ash content in the cookies made with tender coconut pulp (Jain *et al.,* 2017).

III. coconut oil

Virgin coconut oil is composed of greater than 99% triglycerides, with free fatty acids making up less than 0.2%. Saturated fats account for 89%, with polyunsaturated and monounsaturated fats reported as 7% and 4%, respectively (Shilling *et al.,* 2013). Another study reported that free fatty acids in virgin coconut oil are rich in medium chain fatty acids (MCFAs) in which lauric acid takes the highest percentage about 46–48% (Nguyen *et al.*, 2017).

In another study by Kappally, 2016 the composition of Fatty acids in virgin coconut oil (VCO) was determined by Gas Liquid Chromatography and the composition is as follows. Lauric acid (45% to 52%) , Myristic acid (16% to 21%), Palmitic acid (7% to 10%), Caprylic acid (5% to 10%), Capric acid (4% to 8%), Stearic acid (2% to 4%), Caproic acid (0.5% to 1%) and Palmitoleic acid (in traces) and Unsaturated fats : Oleic acid (5% to 8%) , Linoleic acid (1% to 3%) and Linolenic acid (up to 0.2%) (Kappally, 2016). The main fatty acid in virgin coconut oil is lauric acid ranging from 45.1 to 53.2%, myristic acid from 16.8 to 21%, palmitic 7.5 to 10.5%, stearic acid from 2.0 to 4.0 %, and oleic acid from 5.0 to 10.0% (Rohyami *et al*., 2017).

Coconut oil has a high percentage of phenolic acids, and these are phytochemicals, sometimes also referred to as a polyphenols (Fernando *et al.*, 2015).Virgin coconut oil has been found to contain up to seven times higher concentrations of polyphenols than standard coconut oil, with total polyphenol contents of up to 80 mg gallic acid equivalents/100 g oil reported in virgin coconut oil, although concentrations differ depending on coconut variety (Lockyer and Stanner, 2016).

IV. Coconut milk

Coconut milk is obtained by extracting juice by pressing the grated coconut white kernel (meat) or by passing hot water or milk through grated coconut in which the oil and aromatic compounds are extracted (Belewu *et al.,* 2014).

Venugopal *et al*.,2017 reported that coconut milk contains 27 calorie of energy, 0.4g of fat, 4.5g of carbohydrates, 26mg of calcium, 36mg of phosphorus, 0.7mg of iron, 0.01mg of thiamine, 0.01 mg of riboflavin, 0.4mg of niacin and 2mg of vitamin C (Venugopal *et al.*,2017). Typical compositions of coconut milk directly expelled from coconut kernel (without added water) are protein, 2.6% to 4.4%; water, 50% to 54%; lipids 32% to 40% and ash, 10% to 1.5% (Okafor., 2017).

Coconut milk is highly nutritious, rich in fiber, vitamins and minerals (Zubair, 2017). Coconut milk contains protein, fats, carbohydrate, vitamins (thiamine, riboflavin, niacin and vitamin c), minerals (calcium, phosphorus iron and potassium) and amino acid (isoleucine, leucine, lysine, phenylalanine, tyrosine and cysteine) (Ilori and Obahiagbon, 2015).

C. Health implications of coconut

Conventional health treatments have been practiced and revised for many years, but the recent era has been visualizing a new trend into the medicinal fraternity. The inclination towards an alternative treatment comprising of herbal remedies to treat systematic conditions have been globally accepted. A wide range of herbal extracts have been explored and studied to extricate their health benefits. Among them, coconuts have been used as traditional medicine for many illness (Loomba and Jothi, 2016).

Fernando *et al*., 2015 revealed that trans-zeatin and phtoestrogen and other sex hormones like substances present in coconut water and young coconut juice reduce the risk of alzheimers diseases. The phenolic compounds and hormones (cytokinins) found in coconut may assist in preventing the aggregation of amyloid-b peptide, potentially inhibiting a key step in the pathogenesis of Alzheimer's Diseases (Fernando *et* al., 2015).

Young coconut juice containing beta-sitosterol at a high dose of 100 mL/kgBW delayed Alzheimer's pathologies and prevented neuronal cell death (Payanglee *et al.,* 2017). Coconut oil is composed of medium chain fatty acids (MCFAs). MCFAs are transported via the portal veins to the liver, where they can give rise to ketone bodies, which are thought to be able to compensate as an alternative energy source for the reduced brain glucose uptake in Alzheimer's diseases (Nonaka *et al.,* 2016)

Coconut milk is rich in antioxidants, which prevents free radical damage (Alyaqoubi *et* al., 2015). A glass of coconut milk can be taken like other antioxidants rich foods, such as pecans, raisins and cranberries which may boost the immunity by rebuilding the damaged cells in the body (Kokilavani *et al*., 2017). Another study reveals that virgin coconut oil contains mainly medium-chain triacylglycerol and bioactive phenolic compounds beneficial to health through their scavenging free radicals and toxic oxidants (Famurewa *et al.,* 2017).

In the study by Aggarwal *et al*., 2017 Coconut fights against bacteria such as listeria monocytogenes and heliobacter pylori that cause throat infections, gum disease, ulcers, pneumonia, gonorrhea and urinary tract infections (Aggarwal *et* al., 2017). Coconut oil contains lauric acid, the human body converts lauric acid into monolaurin which is claimed to help in dealing with viruses and bacteria causing diseases such as herpes, influenza, cytomegalovirus and even HIV (Mandapaka *et* al., 2017).

Virgin coconut oil contains high lauric acid content (46-50%) attached to glycerol backbone to form a triglyceride (Silalahi *et al.,* 2014). Virgin Coconut Oil (VCO) has medical potential such as antibacterial, antiviral and antifungal activity resulted from its medium chain fatty acids (MCFAs), especially lauric acid in monoglyceride form such as monolaurin (Rajagukguka *et al.,* 2017).

The lauric acid has been shown to have potential application in obesity treatment as it increases energy expenditure, directly absorbed and burnt as energy in the liver, resulted in early satiety and thus leading to weight loss (Mizan *et al.,* 2015). Coconut oil in the diet is absorbed into the 'portal' blood and carried to the liver in the same way that soluble carbohydrates, such as sugar, are delivered by the insulin mechanism. From the liver, coconut oil is rapidly 'burned', which explains why people eating a substantial amount of coconut in a meal often experience a more noticeable rise in body temperature than after a meal without coconut. Coconut oil thus increases the body's energy needs, sometimes requiring deposited fat to be burned to meet those needs. Far from contributing to obesity, coconut oil can assist weight loss (Foale, 2003).

Babu *et* al., 2014, conducted a study on the mechanism through which saturated fatty acids contribute to Cardiovascular disease (CVD). The study revealed that coconut oil contains a good amount of MCFA, consumption of food rich in MCFA reduces the level of body fat and the cardiovascular disease risk (Babu *et* al., 2014). MCFA are very different from LCFA, because they do not have negative effect on cholesterol and help to lower the risk of both arthrosclerosis and heart diseases (Ndife *et al*., 2014). The presence of L-Arginine in coconut water could have a cardio protective effect through its production of nitric oxide, which favours vasorelaxation (Reddy and Lakshmi, 2014).

Agbafor *et al.*,*2015* conducted a study to evaluate the antioxidant potential of coconut water and its effect on the cardiovascular system in albino rats. There was a significant reduction in total cholesterol, triglycerides and low density lipoprotein, while high density lipoproteins increased significantly in the test animals relative to the control. These results may be due to the chemical constituents of the coconut water (Agbafor *et al*., 2015).

Coconut water is believed to be useful in preventing and relieving many health problems, including dehydration, constipation, digestive problems, fatigue, heatstroke, diarrhea, kidney stones and urinary tract infections (Sanganamoni *et al.,* 2017). Coconut water is recommended as a refreshing drink to patients suffering from cholera and diarrhea to replace the fluid lost from the gastrointestinal tract. It is also prescribed for the management and elimination of kidney and urethral stones, elimination of mineral poisons and enhancement of drug absorption. The electrolytes in coconut water interact synergistically to enhance and ensure peak concentration of drugs in the blood (Igwe*et al.*, *2016*).

Coconut oil is very protective against cancer, because of the ability of unrefined coconut oil to inhibit the growth of cells (olej, 2017). Anticancer properties of the VCO have been reported by Kamalaldin et al. (2015) where the VCO was able to induce apoptosis on lung cancer cell and gaveno toxic effect towards normal fibroblast cell (Kamalaldin *et al.,* 2015).

Lakshmanan *et al.*, 2017 conducted a study on the role of tender coconut water on cancer. Tender Coconut Water (TCW), the liquid endosperm of young coconut fruit is not only rich in nutrients but also has bioactive phytohormones such as zeatin, kinetin and their derivatives. Naturally occurring phytohoromes have antiproliferative properties and are effective in inhibiting growth of selected cancer cell lines. The results suggest that TCW may have anti-tumor effects in the treatment of human liver cancer (Lakshmanan *et al.*, 2017).

The presence of medium chain triglycerides and fatty acids in coconut oil helps in preventing liver diseases because those substances are easily converted into energy when they reach the liver, thus reducing the work load of the liver and also preventing accumulation of fat (Vala and Kapadiya, 2014).

Thomas *et al.*,2017 reported that tender coconut water and coconut petiole shows inhibitory activity against thymoma. This activity is due to the presence of L-Histidine identified from Cocos nucifera with BCL-2 protein (4AQ3) (Thomas *et al.*, 2017).

Coconut water is one of the solutions that can be used to increase the intake of Potassium in order to balance the Sodium levels so that the blood pressure is maintained (Ramayanti *et al.,* 2017).

Young coconut juice containing an estrogen-like hormone, ß-sitosterol, has an effect on accelerating wound healing (Radenahmad *et al.,* 2015). Beta-sitosterol (BS) is a phytosterol as well as it is a natural micronutrient in higher plants and is found in the serum and tissues of healthy individuals at a concentration 800–1000 times lower than that of endogenous cholesterol (Sayeed *et al.,* 2016).

D. Value addition in coconut and coconut based food products

I. Virgin coconut oil

In recent years, new value-added products from coconuts are becoming more popular among the consumers. Among the newly emerging value added products from coconut, newest high value product is the VCO, which is gaining popularity in the western world, USA and other developed countries (Satheesh, 2015).

Coconut is considered as one of the ten most useful trees in the world, and one among the five Devavrikshas (God's trees) known in India, providing food for millions, especially in the tropics. Coconut oil has been used as a cooking medium in South India and Southeast Asia since ancient times. It is of course primary culinary fat in Kerala (Ahuja *et al.,* 2014).

Coconut oil has a long shelf life due to the presence high content of saturated fatty acids and is used in baking industries, processed foods, infant formulas, pharmaceuticals, cosmetics and also as hair oil (kumar, 2013).

Coconut oil cake is a byproduct obtained after oil extraction from dried copra. It contains starch, soluble sugars, proteins, lipids and trace amount of nitrogen (Govarthanan, 2015).

II. coconut water

Coconut water is the most significant derivative from the coconut which is referred to as the clear liquid inside both mature and immature coconuts, the fruits obtained from the coconut palm. Coconut water is a highly demanded drink in the tropics, especially in southeast asia, pacific islands, Africa and the Caribbean (Ganguly and Roy, 2014).

Coconut water is not only a tropical beverage but also a traditional medicine, a microbiological growth medium and a ceremonial gift, and can be processed into vinegar or win (Reddy and Lakshmi, 2014). Coconut water can be used for the production of more value added products. Coconut water is often marketed as the natural alternative for conventional carbonated drinks and is also used for types of products where fruit juices, mineral water, and energy drinks are combined to develop new and healthier beverages (Ramos and Galvez, 2016).

Coconut water widely used as isotonic drink or oral rehydration fluid, because of its excellent rehydration index and blood glucose response, therefore beneficial as after-exercise drink. Reference showed that coconut water is beneficial for rehydration and physical performance recovery equal with that of carbohydrate-electrolyte sports drink, in exercised male subjects. Isotonic drink is carbonated or non carbonated beverage product used for fitness improvement, containing sugar, citric acid and minerals. Not only as thirst quencher, it is also known as sports drink for athletes consumption, to maintain their hydration status, electrolyte and energy while exercising (kailaku *et al*., 2015).

Cuarto and Magsino, 2017 conducted a study aimed to develop wine from young coconut water. Results of the sensory evaluation showed that young coconut wine has a pale light color, powerful aroma and sweet taste. Its taste and color are the most appealing attributes of the young coconut wine. On the other hand, acceptability differences in the quality attributes of aroma and color are comparable, with the commercial wine having a darker color and more powerful aroma which make it more appealing. However, in terms of taste, the young coconut wine is more acceptable due to its sweet taste (Cuarto and Magsino, 2017).

III. Coconut milk

Coconut milk is the aqueous extract of grated coconut kernel. In traditional cooking in the south asian region, grated coconut kernel is hand pressed with water to obtain a viscous white coconut milk known as first extract (FE). The coconut kernel remaining after the first extraction is further extracted with fresh portion of water to obtain second extract (SE) (Nadeeshani *et* al., 2015).

Shana et al., 2015 developed a *dahi* coconut milk supplemented(curd). Coconut milk and cow milk in a ratio of 30:70 resulted in a good quality *dahi*. Two sets of cultures *(Lactococcus lactis MTCC 3041 + Leuconostoc sp. MTCC 10508 and Lc. lactis MTCC 3041 + Lactobacillus plantarum MTCC 5422)* were found to be suitable for fermentation of coconut milk and cow milk blend after 14 and 16 h of incubation at 30 and 37 °C, respectively, with a viable count of lactic acid bacteria was around 150×10^7 cfu/ml. The coconut milk based *dahi* was well accepted in sensory analysis. Coconut flavour profiling of coconut milk *dahi* detected by electronic nose matched well with the sensory analysis (Shana *et al.,* 2015).

IV. Nata de coco

Coconut water is used in the making of the gelatinous dessert ‘nata de coco’ that became popular in Japan and earned for Filipinos a number of jobs (Ahuja *et al.,* 2014).

Nata-de-coco, a bacterial cellulose product, which is usually prepared by Acetobacter xylinum grown in mature coconut water. This product is not high nutrient, less energy and high cellulose content (Huynhxuan, 2017). Nata de coco is a jelly-like food product originates from the Philippines, produced by fermentation of coconut water using Acetobacter xylinum. It consists of natural cellulose fibers and commonly known as Bacterial Cellulose (BC) (Onggo *et al*., 2015).

V. Coconut sap neera (toddy)

Neera is an innovative value added product. As it is not fermented chemically, it does not have any alcoholic content and therefore fresh in its form and hence can be consumed by any age group. Therefore, Neera can be termed as ‘Keramrith’ or ‘Sweet Toddy’ having taste with lots of benefits (Chandran and Francis, 2016).

Cocos nucifera sap is commonly called as cocoti sap. Sap is a juice collected from the cocoti palm plants. After fermentation, cocoti sap is converted into cocoti wine. It is a sweetish, milky white, effervescent alcoholic beverage with evolved CO2 (Chandrasekhar *et al.,* 2014).The inflorescence, when cut, yields a liquid called neera. Palm sugar or jaggery is produced carefully evaporating the liquid in open pots. Neera ferments, usually spontaneously, to give palm vine or toddy which can be distilled to yield liquor known as arrack (Ahuja *et al*., 2014).

Devi *et al.,* 2015 reported that Coconut sap and its sugar is rich in iron, zinc, calcium, sodium and potassium, dietary fiber and inulin. They too possess phytonutrient content such as Polyphenols, flavonoids and anthocyanidin. Clinical trial studies had shown that coconut sap and its sugar has low glycemic Index (Devi *et al.,* 2015). . The sap contains several nutrients that are mostly carbohydrates (sucrose, glucose and fructose). There are also amino acids such as glutamine, vitamins (C, B) and minerals including potassium, phosphorus and iron (Ysidor *et* al., 2015).

Jayasundera and Kulatunga in 2014 carried out a study to convert unfermented coconut sap or the sweet toddy into value added product such as powder form through spray drying using maltodextrin (DE 10) as the drying aid. Three different formulations of sweet toddy: maltodextrin (70%: 30%, 80%: 20% and 90%:10%) were spray dried at inlet and outlet temperatures of 165 oC and 65 oC, respectively. Powder recovery in a pilot scale spray dryer was used as a measure of the ease of spray drying for a given formulation. The best powder recovery (56.35±2.90%) was obtained for thformulation of sweet toddy: maltodextrin in the ratio of 80%:20% (Jayasundera and Kulatunga, 2014).

VI. Coconut flour

Coconut is not only known for providing meat, juice, milk and oil but it is also a good source of flour and it can be used as substitute to wheat flour. Coconut meat flour is a soft flour-like product made from the pulp of coconut and it is actually a by-product made during the coconut milk making process (Igbabul *et* al., 2014).

Coconut flour contains 21.65% protein, 10.45 fibre, 59.77% carbohydrates and 8.42% fat (Gunathilake *et al.,* 2009). It contains carbohydrates, it has very low glycemic index. Furthermore, it also has antimicrobial properties due to its high lauric acid content (Taheri *et al.,* 2010).

Coconut flour from coconut residue, a by-product of the coconut-milk industry, contained 600 g total dietary fibre/kg (560 g insoluble and 40 g soluble fiber/kg). Coconut flour may play a role in controlling cholesterol and sugar levels in blood and prevention of colon cancer. Studies revealed that consumption of high fibre coconut flour increases fecal bulk (Priya and Ramaswamy,2016).

Sujirtha and Mahendran, 2015 aimed to develop nutritionally enriched biscuits and to assess the nutritional, physical, microbial and organoleptic qualities in the formulated biscuits. Defatted coconut flour was blended with wheat flour for making biscuits. Nutritional analysis of coconut flour revealed that it contains 12.6% protein, 13.0% fiber, 9.2% fat, 13.7% sugar, 8.2% ash and 4.2% moisture. Protein, fiber and fat value of coconut flour added biscuits were 10.73%, 11.30% and 22.72% respectively, while the lowest values of 4.98%, 8.26% and 16.86% recorded for the wheat flour biscuits. Results demonstrated that biscuits made up of 40% defatted coconut flour exhibited all the values within an acceptable range (Sujirtha and Mahendran, 2015).

Other processed product from coconut

I. Coconut chips

Rajakaruna *et al.,* 2014 developed value added sweet coconut chips and determined their shelf life, proximate composition and palatability. Four types of coconut chips were prepared by osmotic dehydration. Three types of flavoured sweet coconut chips were evaluated over a sweet coconut chips (without flavours) as the control. Results of two sensory evaluations revealed that ginger flavoured chips were the most palatable and the highest overall acceptable product. The calorific values were obtained by the proximate analysis and those were 464, 468, 458 and 443 kcal/100g for ginger, lemon, cinnamon flavoured chips and control sample respectively. Among the tested, lemon flavoured coconut chip was the best in terms of controlling yeast and mould growth (Rajakaruna *et al.,* 2014).

Singh *et al.,* 2017 developed Milk-coconut sweet by combining different proportions of concentrated buffalo milk (40-60 parts), coconut kernel flakes (20-40 parts), sugar (10-30 parts) on the basis of total weight. The presence of coconut kernel flakes and milk makes milk-coconut sweet a highly nutritious dairy product. Sensory evaluation and colour analysis of the prepared samples revealed that the sweet prepared with 50 parts of milk, 30 parts of coconut flakes and 20 parts of sugar obtained highest scores (Singh *et al.,* 2017).

II. Coconut jam

Coconut jam is a traditional high sugar coconut food product, commonly consumed as desert, bread spread and rich cake topping. An attempt was made to utilize the residual coconut pulp left in the tender coconuts after removal of coconut water. The coconut pulp was mixed with pineapple pulp and guava pulp in different proportions to increase the acceptability of the jam. The prepared coconut jam packed in plastic container and glass bottles and had the shelf life of 180 days at room and refrigerated temperatures (Sindumathi and Amutha, 2014).

Coconut jam was prepared by the mixing of coconut pulp with pineapple pulp in different proportions to increase the acceptability of the jam. An increase in the level of coconut pulp was found to significantly increase the fat content as well as Na, K, and Ca contents in the jam. Texture profile analysis revealed a significant decrease in hardness whereas adhesiveness, springiness, cohesiveness, gumminess, and chewiness increased significantly with an increase in the level of coconut pulp in the jam affecting its setting quality. The jam containing 75 % tender coconut pulp and 25 % pineapple pulp showed a maximum sensory acceptability for the mixed jam (Chauhan *et al.,* 2013).

III. METHODOLOGY

The methodology followed for the present study entitled **'Development and evaluation of coconut based Ready To Eat mixes and coconut flakes'** is presented as follows;

A. Selection of different varieties of coconut
B. Development of coconut chips with different varieties of coconut in different flavours
C. Development of ready to eat mix powder
D. Organoleptic evaluation of chips made from tall, dwarf and breed varieties of coconut with that of traditional variety and Ready To Eat mix powder prepared out of coconut
E. Nutrient analysis of tall, dwarf and breed varieties of coconut
F. Shelf life study of developed chips and ready to eat mix
G. Statistical analysis and interpretation of data

A. Selection of different varieties of coconut

Cocos nucifera L. (Family Arecaceae), commonly known as coconut, is an important fruit crop in tropical countries, recognized to be a "wonder fruit" because every part of it proves to be useful (Arollado *et al.,* 2018).

The coconut palm is regarded in tropical countries as the 'Tree of Life' (Shameer *et al.,* 2017). Coconut, botanically called Cocos nucifera is an early Spanish crop which explorers called Cocos meaning "monkey face", because the tree indentation (eye) on the hairy nut resembles the head of a monkey, nucifera means nut-bearing.(Ubi *et al.,*2016).

According to the Coconut Development Board, India is one of the leading producers of coconut with the cultivation area of 12196 hectares. In particular, India is the third largest coconut producing country, after Indonesia and the Philippines. On an average, 10345 nuts per hectare are being produced annually in India. In India, the four states namely Kerala, Tamil Nadu, Karnataka and Andhra Pradesh account for 99% of the coconut production (Mahadevan *et al.,* 2017).

The coconut for the study was collected from kerala agricultural university, kasargod in kerala.

Kerala Agricultural University (KAU) is the primary and the principal instrumentality of the Kerala state in providing human resources, and skills and technology, required for the sustainable development of its agriculture, defined broadly encompassing all production activities based on land and water, including crop production (agriculture), forestry and fisheries through conducting, interfacing and integrating education, research and extension in these spheres of economic endeavour. It is situated in Vellanikkara, Thrissur, Kerala(WWW.KAU.IN).

The two major varieties of coconut palms are ‘talls’ and ‘dwarfs’. Talls take a longer time to flower (~6 years) but live much longer (~100 years) when compared to dwarfs (~60 years). Talls (var. typica) and dwarfs (var. nana) also differ in their breeding behaviour with the talls being allogamous (cross-fertilizing) and dwarfs being autogamous (self fertilizing). Inter-varietal crosses between a dwarf male parent with a tall female parent (T x D) as well as tall male parent with a dwarf female parent (D x T) and intra-varietal crosses (T x T and D x D) are methodologies followed for the development of hybrids. (preethi et al., 2016).

The tall, dwarf and breed are the three different varieties of coconut. In tall varieties there are different kinds, from which west coast tall have been selected for the study. In dwarf there are two varieties chowghat orange dwarf (COD) and chowghat green varieties (CGD), from which Chowghat green dwarf (CGD) and in breed varieties kerasree breed was selected for the study.

B. Development of coconut chips with different varieties of coconut in different flavours

Selection of coconuts

The first step in the study is the development of coconut chips. From west coast tall variety five coconuts were selected and numbered as T1, T2, T3, T4 and T5. These fivecoconuts were used for making plain coconut chips so marked it as PT1, PT2, PT3, PT4 and PT5. Five coconuts were selected for making sweet coconut chips and marked it as ST1, ST2, ST3, ST4 and ST5. Five coconuts were selected for making spicy coconut chips and marked it as SpT1, SpT2, SpT3, SpT4 and SpT5 respectively.

The whole weight of the coconut with husk, weight of dehusked coconut, shell weight, kernel weight and the water content of tall variety coconut for making plain, sweet and spicy chips were noted.

Chowghat green dwarf was selected and numbered it as D1, D2, D3, D4 and D5. These five coconuts were used for making plain coconut chips so marked it as PD1, PD2, PD3, PD4 and PD5. For making sweet coconut chips five coconuts were selected and marked it as SD1, SD2, SD3, SD4 and SD5. Five coconuts were selected for making spicy coconut chips and marked it as SpD1, SpD2, SpD3, SpD4 and SpD5 respectively.

The whole weight of the coconut with husk, weight of dehusked coconut, shell weight, kernel weight and the water content of dwarf variety coconut for making plain, sweet and spicy chips were taken.

Kerasree coconut was selected as a breed and numbered it as B1, B2, B3, B4 and B5. These five coconuts were used for making plain coconut chips so marked it as PB1, PB2, PB3, PB4 and PB5. For making sweet coconut chips five coconuts were selected and marked it as SB1, SB2, SB3, SB4 and SB5. Five coconuts were selected for making spicy coconut chips and marked it as SpB1, SpB2, SpB3, SpB4 and SpB5 respectively.

The whole weight of the coconut with husk, weight of dehusked coconut, shell weight, kernel weight and the water content of breed variety coconut were noted.

For the comparison of these varieties with that of the traditional or convention tall varieties five coconuts were selected and numbered it as Tr1, Tr2, Tr3, Tr4, Tr5. PTr1, PTr2, PTr3, PTr4 and PTr5 were used for making plain coconut chips and for making sweet coconut chips the coconuts were marked it as STr1, STr2, STr3, STr4 and STr5. The coconuts were marked it as SpTr1, SpTr2, SpTr3, SpTr4 and SpTr5 for making spicy coconut chips.

The whole weight of the coconut with husk, weight of dehusked coconut, shell weight, kernel weight and the water content of traditional tall variety coconut were noted.

All varieties of coconut were sliced and graded according to their sizes like small and medium with a size of 4 cm and 7 cm respectively.

Blanching of the selected coconuts

For making coconut chips all the coconut slices (Tall, dwarf, breed and convention) were blanched by steam blanching method. The process started with boiling of the water, placed a white cloth along the opening side of the half filled vessel and boiled it. When the steam started evaporating, placed the coconut pieces above the white cloth and closed with lid on the vessel and the water was boiled. After 10 minutes the coconut pieces were taken out and immediately immersed in a vessel containing cold water.

Blanching was followed by immersing the coconut pieces in 0.1% of KMS solution. One litre of water was taken in a measuring jar and to this 1g of KMS was added. Immersed the coconut pieces into the solution and kept for 10 minutes inside the solution and after 10 minutes the water was filtered and coconut pieces was completely drained off water and dried (Plate I).

PLATE- I

BLANCHING OF COCONUT PIECES

Development of coconut chips with different flavors

Generally Coconut chips are prepared by using coconut flakes, coconut oil, sugar and salt. To make variations plain, sweet and spicy coconut chips were prepared by using traditional, tall, dwarf and breed varieties of coconut (Plate II and Plate III). The coconut was sliced into thin pieces of length 4 cm and 7 cm and they were graded as small and medium respectively. Small sized coconut pieces and medium sized coconut pieces were used for making coconut chips. Preheat oven to 325°F. Line a large baking sheet with unbleached parchment paper. In a large bowl, mix melted coconut oil and sweetener of choice. Add coconut flakes to this and gently mix until completely flakes are coated with oil and flavours of choice. Sprinkle on little salt to enhance the sweetness and gently mix again.Bake the flakes on prepared baking sheet for five minutes. Flip with a spatula and bake for another 5 – 7 minutes, flipping every 2-3 minutes. The coconut flakes will begin to turn to golden brown. Watch carefully as they burn quickly. Remove, cool completely to allow coconut chips to crisp up. Store in an air-tight glass jar.

PLATE –II

COCONUT CHIPS FROM TRADITIONAL AND TALL VARIETIES OF COCONUT

PLATE –III

COCONUT CHIPS FROM DWARF AND BREED VARIETIES OF COCONUT

Sweet coconut chips

Sweet coconut chips were prepared by using tall, dwarf and breed varieties of coconut. To compare these varieties, traditional tall varieties of coconut were used for making sweet coconut chips and compared with the new varieties. In sweet coconut chips two variations were done. Variation I (S_wSV1) is sweet coconut chips with osmotic dehydration. Variation II (S_wMV_2) is sweet coconut chips without osmotic dehydration.

Osmotic dehydration is an operation used for the partial removal of water from plant tissues by immersion in a hyper-tonic (osmotic) solution. Osmotic dehydration is a process that entails the partial removal of water of food items such as vegetables and fruits. Osmotic dehydration enables fruits and vegetables to be stored for a longer period of time.

Out of tall variety coconut, 50 g of coconut pieces both small and medium were taken. Small coconut pieces were named as variation I (S_wTSV_1).Medium coconut pieces were named as variation II (S_wTMV_2).

For variation I, the sugar syrup was prepared by adding 1kg of sugar to 1 litre of water and added 20ml of ginger extract and 20ml of lemon juice. To this syrup 50g of small coconut pieces (S_wTSV_1) were added and warmed at temperature of 50°c and maintained for 3 hours. Then coconut pieces were drained off the sugar syrup and was placed in a tray and kept it for drying.

In variation II (S_wTMV_2) the sugar syrup was first prepared by dissolving 300g of sugar in 700 ml of water. Mixed well and added 0.3% of citric acid. To the sugar syrup add 50g coconut pieces(S_wTMV_2) and kept for four days or until the sugar syrup reached 60°brix. The brix of the sugar syrup were checked everyday by using refractometer. When the brix comes to 60° the syrup was filtered and washed the coconut pieces with lukewarm water and drained the water completely. The coconut pieces were placed in a tray and kept it for sun drying.

In dwarf, breed and traditional tall variety 50g of small and medium coconut pieces were taken. The procedure for preparing sweet coconut chips for tall variety was followed for dwarf, breed and traditional variety of coconut taking 50 g of coconut pieces and it was named as $S_wDSV_1$and $S_wDMV_2$for dwarf, $S_wBSV_1$and

$S_wBMV_2$for breed and $S_wT_rSV_1$and $S_wTrMV_2$for traditional tall variety respectively (Plate IV).

TRADITIONAL VARIETY

TALL VARIETY

DWARF VARIETY

BREED VARIETY

PLATE-IV

SWEET COCONUT CHIPS

Plain coconut chips

The next step was the preparation of plain coconut chips from tall, dwarf, breed and traditional varieties of coconut.

To prepare plain coconut chips two variations PSV_1, PMV_2 were prepared. In variation I plain coconut chips were prepared by using salt solution with white pepper. In variation II plain coconut chips was prepared with salt solution without using white pepper.

For making plain coconut chips 8% of salt solution was prepared. For making 8% salt solution 80g of salt was added in 1000ml of water.

In variation I (PSV_1), 2 g of white pepper was mixed in 200 ml of the prepared salt solution and then added the small coconut pieces. It was kept for three days. After three days the salt solution containing coconut pieces were filtered and coconut pieces were sundried.

In variation II (PMV_2), 50 g of medium coconut pieces were added to 200 ml of the prepared salt solution and kept for three days. After three days the salt solution was filtered and sun dried the coconut pieces.

In tall, dwarf, breed and traditional variety 50 g of small and medium coconut pieces were taken. This procedure for preparing plain coconut chips was followed for tall, dwarf, breed and traditional variety of coconut taking 50 g of coconut pieces and named as $PTSV_1$ and $PTMV_2$ for tall, $PDSV_1$ and $PDMV_2$ for dwarf, $PBSV_1$ and $PBMV_2$ for breed and $PTrSV_1$and $PTrMV_2$ for traditional tall variety respectively (Plate V).

TRADITIONAL VARIETY

TALL VARIETY

DWARF VARIETY

BREED VARIETY

PLATE-V

PLAIN COCONUT CHIPS

Spicy coconut chips

Spicy coconut chips were prepared by using tall, dwarf, breed and traditional tall varieties of coconut.

In spicy two variations $SpSV_1$ and $SpMV_2$ were prepared. In variation I spicy coconut chips were prepared by using white pepper. In variation II spicy coconut chips were prepared with chilli powder.

In variation I($SpSV_1$), 50 g of small coconut pieces were taken in all varieties. 8% of salt solution was prepared. For making 8% of salt solution 80 g of salt was added in 1000 ml of water. Two g of white pepper was mixed in 200 ml of the prepared salt solution and then added the small coconut pieces. Kept it for three days. After three days the salt solution was filtered and the coconut pieces were sun dried. The initial and final weight of the coconut pieces during the drying period was noted.

After drying, the coconut pieces were placed in a bowl. Five g of white pepper was weighed and mixed with 3 ml of water to make paste. This paste was transferred to the bowl containing dried coconut pieces. Mixed and marinated. Then it was shallow fried.

In variation II ($SpMV_2$), 50 g of medium coconut pieces were taken in all variety. Medium coconut pieces were added to 200 ml of prepared salt solution and kept for three days. The coconut pieces were kept for sun drying after the filtering of salt solution from the coconut pieces. The duration of the drying period was noted.

The coconut pieces were placed in a bowl. Then five g of chilli powder was mixed with 3 ml of water. This paste was applied to coconut pieces. Then it was shallow fried.

In tall, dwarf, breed and traditional variety 50 g of small and medium coconut pieces were taken. This procedure for preparing spicy coconut chips was followed for tall, dwarf, breed and traditional variety of coconut taking 50 g of coconut pieces and named as S_pTSV_1 and S_pTMV_2 for tall, S_pDSV_1 and S_pDMV_2 for dwarf, S_pBSV_1 and S_pBMV_2 for breed and S_pTrSV_1 and S_pTrMV_2 for traditional tall variety respectively (Plate VI).

TRADITIONAL VARIETY

TALL VARIETY

DWARF VARIETY

BREED VARIETY

PLATE VI

SPICY COCONUT CHIPS

C. Development of ready to eat mix powder

Food either raw or cooked, hot or chilled that are ready for immediate consumption at the point of sale without further treatment are generally described as "ready-to-eat (Oranusi *et al.,* 2012).

Six ready to eat mix powders (RTEP)were prepared by using coconut namely coconut and onion RTEP, urad dal coconut RTEP, Avalose coconut RTEP, coriander leaves coconut RTEP and egg coconut RTEP. The recipe and the method followed for preparation of the RTEP is as follows:

I. Coconut and onion Ready To Eat chutney powder

Ingredients

Grated coconut	- 100 g
Small onion	-50 g
Black pepper corns	– 15 g
Ginger, 3 inch piece	– 1 nos chopped
Garlic	– 3 cloves chopped
Curry leaves	– 5 spring
Red chilli powder	– 15 g
Coriander powder	– 10 g
Tamarind	– a small lemon sized ball
Salt to taste	

Method

- Heat a wide pan and add grated coconut and roast until the texture turns dark golden brown in colour by mixing continuously in a medium flame and remove.
- Add shallots, pepper corns, ginger, garlic and curry leaves roast till the moisture evaporate.

- Once it reaches the dark golden brown colour, added red chilli powder, coriander powder and tamarind pieces, salt and stir continuously for about 2-3 minutes in a medium flame.
- Put all the roasted ingredients together and roast again till dark golden brown.
- Remove from heat and allow it to cool completely grind into a coarse powder.

Coconut and onion RTEP contain no added preservatives, artificial flavours or colours. The product is in powder form and can be easily carried while travelling. It is oil-free and suitable for people suffering from diabetes. It is very convenient for elderly people who find it difficult to grind ingredients, or for working professionals who do not have the time to prepare everything from scratch (Plate VII).

II. Urad dal coconut Ready To Eat powder

Ingredients

Grated coconut	- 100 g
Urad dal	- 50 g
Dry red chilli	- 5 no, halved and deseeded
Asafoetida	- 5 g
Oil	- 10 ml

Salt to taste

Method

- In a kadai add the oil and heat.
- Once hot, saute red chillies along with asafoetida.
- Once the colour turns then take it from the kadai and then add the urad dal saute till the colour changes. Remove the dal and allow it to cool.
- In the same pan add the grated coconut, roast until the colour turns dark brown colour.
- Allow all the mixtures to cool down.
- Grind the urad dal, red chilly, asafoetida, just coarsely powder then finally add the coconut, salt and grind it.

- Allow to cool completely.

Urad dal coconut RTEP is normally eaten with riceand ghee. If it's used withdosas andidlies, it's usually mixed with oil. It can also be eaten with rotis and chapatis too (Plate VII).

III. Mixed vegetable coconut Ready To Eat powder

Ingredients

Coconut	-100 g
Grated Beetroot	- 25 g
Grated Carrot	- 25 g
Red chilli powder	- 15 g
Curry leaves	- 2 springs
Salt to taste	

Method

- Peel of the skin of beetroot and carrot and grate them. Sun dried the grated beetroot and carrot for a day till it is free of moisture.
- After sun drying, roast the carrot and beetroot in a pan till it is roasted and dry.
- In another pan add grated coconut and roast until the coconut turns dark brown colour. To this add salt, red chilli powder and curry leaves and roast.
- To this mixture roasted and dried vegetables were added. Grind it and cool.

Mixed vegetable RTEP can be used as side dish for idli and dosa. It is very tasty and healthy accompaniment with an attractive colour. This is a healthy and nutritious side dish for idli or dosa. Best way to make kid to eat vegetable in hidden form (Plate VII).

IV. Avalose coconut Ready To Eat powder

Ingredients

Grated coconut	- 100 g
Raw rice	- 50 g

Cardamom - 4 nos

Dried ginger - 1 medium piece

Cumin seeds - 10 g

Sugar - 25 g

Salt - 5 g

Method

- Soak rice in water for 4-6 hours and drain the water completely.
- Once dried, grind it into a fine powder.
- In a bowl, mix together the rice flour, grated coconut, cardamom, dried ginger, cumin seeds and salt.
- Place a heavy bottomed pan on medium heat.
- Add in the prepared rice mixture and stir continuously till it turns medium golden in colour on low-medium heat.
- Remove from heat; keep stirring for some more time to avoid burning to the bottom of the pan.
- Let it cool completely.Once cooled, add in the sugar and grind it to a coarse powder.

Avalose coconut RTEP is a healthy snack for breakfast and dinner. This powder is better for children. It is very tasty and healthy. Avalose podi is a powdered recipe which can be served with sugar or ripe bananas. Apart from other teatime recipes, avalos podi can be stored for long periods in an airtight container. Roasted raw rice flour, grated coconut and cumin seeds are the ingredients used for making this dish. The presence of jeera provides a unique taste. Back when the bakery recipes were not popular, avalose podi was commonly used as an evening snack in Kerala (Plate VII).

V. Coriander leaves coconut Ready To Eat powder

Ingredients

Grated Coconut - 100 g

Coriander leaves - 15 spring

Ginger - 1 medium piece

Asafoetida - 5 g

Cumin - 5 g

Chilli powder - 15 g

Salt to taste

Method

- Clean the coriander leaves, keep the tender stems and discard the hard mature ones.
- Wash the coriander and let it stand in the colander for about 30 minutes.
- Then spread the leaves and stems on a clean kitchen towel and dry in shade until all the moisture from the leaves has gone.
- Once they are dry, roughly chop and set aside.
- In a pan added grated coconut, and roast until the coconut turns dark brown in colour.
- Once it reaches dark brown in colour, add dried coriander leaves, ginger, asafoetida, cumin, salt and chilli powder.
- Let it cool completely. Once cooled grind it.

Coriander leaves coconut RTEP is the best accompaniment for south Indian dishes like dosa, vada, uttapam. This powder can stay good for few weeks if stored properly (Plate VII).

VI. Egg coconut Ready To Eat powder

Ingredients

Coconut - 100 g

Egg - 3

Ginger - 1 medium piece

Coriander leaves - 4-5 spring

Curry leaves - 5 spring

Red chilli powder - 15 g

Vinegar - 3 ml

Salt to taste

Method

- In a pan added grated coconut and roast until the texture turns dark golden brown in colour by mixing continuously in a medium flame.
- In another pan roast ginger, coriander leaves, curry leaves, red chilli powder. The roasted ingredients are added to the pan containing grated coconut.
- To this mixture added 2 tablespoon of vinegar and salt to taste.
- In another pan break the egg and saute the egg till it gets cooked and then add the egg to the above mixture.
- Removefrom heat. Grind into coarse powder.

Egg coconut RTEP is good for children who feel difficulty to consume egg alone (Plate VII).

PLATE-VII

READY TO EAT MIX POWDER

E. Organoleptic evaluation of coconut chips and ready to eat mix powder

Quality has been defined as degree of excellence and includes such things as taste, appearance, and nutritional content. Quality is the composite of characteristics that have significance and make for acceptability (Potter *et al.,* 1996).

Sensory analysis allows the description of profiles, the determination and quantification of the organoleptic characteristics of a product and the monitoring of quality control. All these applications indicate that a human sensory panel is necessary to check the specific properties of the standard samples against the properties of real products to detect differences (Georgiou *et al.,* 2017).

Formulation of score card

Sensory evaluation was assessed on the basis of Nine Point Hedonic Scale rating to determine the preference in colour, flavour, taste and overall acceptability (Miah *et al*., 2017).

The hedonic scale comprises a series of nine verbal categories ranging from 'dislike extremely' to 'like extremely' and is described as such in various sensory texts. For subsequent quantitative and statistical analysis, the verbal categories are generally assigned numerical values, ranging from 'like extremely' as 9 to 'dislike extremely' as 1. Here, a scale like traditional 9-point hedonic scale which comprised of a series of labels, will be called a 'words only' scale. A hedonic scale which is purely numerical and which may only have labels at each end and sometimes in the middle, will be called a 'numbers only scale' (wichchukit. And Mahony, 2014).

Hedonic rating scale: like extremely-9, like very much-8, like moderately-7, like slightly-6, neither like nor dislike-5, dislike slightly-4, dislike moderately-3, dislike very much-2, dislike extremely-1

Sensory evaluation of the coconut chips and ready to eat mix powders were done in the foods laboratory of the Food science and nutrition department in Avinashilingam Institute for Homescience and Higher education for women, Coimbatore. The score card for sensory evaluation of the recipes is given in Appendix II.

Appearance

Appearance factors include size, shape, wholeness, different forms of damage, gloss, transparency, colour and consistency (Potter *et al.,* 2007). Appearance covers not only colour but also the shape, size of portion, greasiness, transparency, brightness and so on, all of which must watch a person's expectations of that food or product (Sethi *et al.,* 2005).

Colour

Colour is the single most important product-intrinsic sensory cue when it comes to setting people's expectations regarding the likely taste and flavour of food and drink.(Spence *et al.,* 2015).Colour reflects the acceptance of food. The first impression of food is formed by its appearance, which includes colour, shape and aroma. The colour of food is one way to judge its quality (Mudambi *et al.,* 2008).

Flavour

Flavour is a combination of both taste and smell and is largely subjective and therefore hard to measure. Flavour factors include both sensations perceived by the tongue which include sweet, salty, sour, bitter and aromas perceived by the nose. The flavour of a given food is determined by both the mixture of salt, sour, bitter, sweet tastes and by the endless number of compounds which give food characteristic aromas. Thus, the flavour of the food is quite complex and has not been completely described for most foods (Potter *et al*., 2007).

Texture

Texture has been defined as the attribute of a substance resulting from a combination of physical properties and perceived by the senses of touch, sight and hearing. The physical properties include size, shape, number, nature and conformation of structural elements. Thus texture encompasses those properties of food, which are perceived by the kinaesthetic and tactile senses in the mouth (Sethi *et al.,* 2005).

Taste

Taste is the deciding index for foods likes and dislikes, as it is a natural response of people to taste foods that are pleasing to the eyes and smell good (Sethi *et al.,* 2005). Taste sensations are the sum-total of the sensation created by food when it is put in the mouth. The sensation of taste is perceived when taste receptors are stimulated(Mudambi *et al.,* 2008).Taste principally serves two functions: it enables the evaluation of foods for toxicity and nutrients while helping us decide what to ingest and it prepares the body to metabolize foods once they have been ingested (Breslin *et al.,*2013).

F. Nutrient analysis of tall, dwarf and breed varieties of coconut

Nutrition analysis refers to the process of determining the nutritional content of foods and food products. The nutrient content of tall, dwarf and breed varieties was carried out by biochemical analysis. Carbohydrate, protein, fat, fibre, calcium and nitrogen was determined in order to analyze the nutrient content of different varieties of coconut (Plate VIII).

The nutrient content of tall, dwarf and breed varieties of coconut were analyzed in the nutrition laboratory, department of Food Science and Nutrition, Avinashilingam Institute For Homescience And Higher Education For Women, Coimbatore. The procedure for the analysis of moisture, carbohydrate, nitrogen, fat, fibre and calcium is given in Appendix III. The analyzed nutrients are followed:

Moisture

Estimation of moisture is one of the most often performed determination in food analysis. Moisture is lost when food is heated out much higher than the temperature of boiling water or by allowing to stand overnight over dehydrating agent or by heating (Raghuramulu *et al.,* 2003).

Carbohydrate

In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This forms a green coloured product with phenol and has absorption maximum at 490nm (Dubois *et al.,* 1953 and krishnaveni *et al.,* 1984).

Nitrogen

The given sample is digested with concentrated sulphuric acid in a macrokjeldahl flask when nitrogen gets converted to ammonium sulphate. Ammonia is liberated by the action of strong alkali in a macrokjeldhal steam distillation apparatus. This nitrogenous substance is converted to ammonium borate by absorbing 2% of boric acid and is titrated against N/70 sulphuric acid. The volume of acid required to bring the test sample to the colour of the blank gives the acid equivalent to the ammonia (Raghuramulu *et al.,* 2003).

Fat

Ether extraction of the crude fat in vegetable products is carried out in a continuous extractor that is an apparatus in which the ether, after dissolving a portion of the fat of the material and discharging into the extraction flask, is volatized, condensed and again allowed to act on the material. The steps in the process were repeated continuously and automatically until the extraction is complete.

Fibre

The term 'crude fibre' ordinarily meant in agriculture and food analysis is the organic residue consisting of largely of cellulose that is left after other carbohydrates and proteins have been removed by successive treatment with boiling acids and alkalies. The crude fibre obtained in this way is not cellulose but contain distinct properties of hemicellulose and nitrogenous substances. These however are not sufficient to prevent the results from being reasonably accurate and comparable (Raghuramulu *et al.,* 2003).

Calcium

Calcium is determined by precipitating it as calcium oxalate and titrating the oxalate solution in dilute sulphuric acid against standard potassium permanganate (Raghuramulu *et al.,* 2003).

ESTIMATION OF FAT

ESTIMATION OF NITROGEN

ESTIMATION OF TOTAL CARBOHYDRATE

PLATE-VIII

NUTRIENT ANALYSIS OF COCONUT VARIETY

G. Shelf life study of developed chips and ready to eat mix

Shelf life the time limit within which the progress of individual events determines reactive changes imperceptible on the sensorial, or otherwise still acceptable in terms of safety of use. (cirillo., 2015).

Shelf life is defined as the period between manufacture and retail purchase or consumption of a food product during which the product is of satisfactory quality. Shelf life is defined as the time during which the food product will remain safe, be certain to retain the desired sensory, chemical, physical and microbiological characteristics and comply with any label declaration of nutritional data when stored under the recommended conditions (Subramaniam., 2016).

Shelf life is the period of time under defined conditions of storage after manufacture or packing, for which a product will remain safe and be fit for use. In other words, during this period, it should retain its desired sensory, chemical, physical, functional or microbiological characteristics and comply with any label declaration of nutrition information when stored according to the recommended condition (Dominic man., 2015).

Shelf life analysis

Microbial analysis was carried out to find the shelf life of coconut chips and ready to eat mix powder. The ready to eat mix powder was stored in a container and their shelf life was determined. Peroxide value method was selected to study the microbial load in coconut chips. The microbial analysis was carried out in a period of 30 days at room temperature. The microbial analysis was analyzed in the Nutrition laboratory of the Food Science and Nutrition department in avinashilingam university, Coimbatore.

Shelf life analysis of coconut chips using peroxide value- Aocs method

The sample is treated in solution with a mixture of acetic acid and a suitable organic solvent and then with a solution of potassium iodide. The liberated iodine is titrated with a standard solution of sodium thiosulfate.

Peroxides and similar products which oxidize potassium iodide under the conditions of the test will contribute to the peroxide value. Variations in procedure may affect the results. Peroxide values are expressed either in milliequivalents of peroxide/kg or millimoles of peroxide/l. (Appendix IV).

H. Statistical analysis and interpretation of data

The data obtained for sensory attributes of the developed recipes with three variations was analyzed statistically and interpreted. The data was consolidated and tabulated in which mean, standard deviation and ANOVA were computed.

The null hypothesis (H_0) of the study is there is no significant difference between the coconut chips prepared from different varieties of coconut.

The alternative hypothesis (H_1) of the study is there is significant difference between the coconut chips prepared from different varieties of coconut.

The research design and protocol of the study was submitted for scrutinisation and approval to the Institutional Human Ethics Committee and ethical clearance approval was obtained. The Ref. No. is AUW/ IHEC/ FSN -17-18/XPD/04 (Appendix I).

The methodology followed in the present study is represented in Figure I.

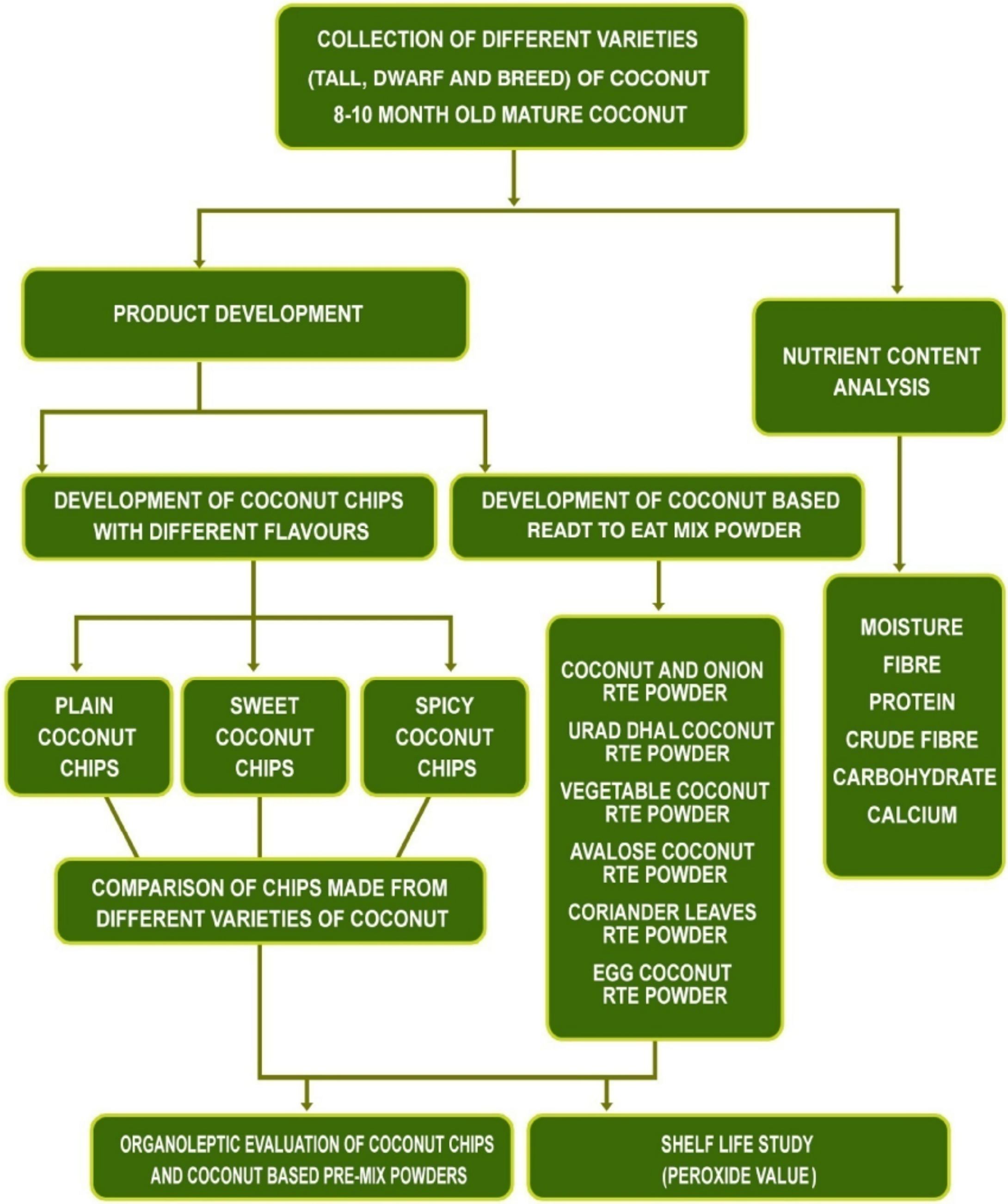


FIGURE I

RESEARCH DESIGN

IV. RESULTS AND DISCUSSION

The results pertaining to the study **'Development and evaluation of coconut based Ready To Eat mixes and coconut flakes'** is presented under the following headings:

A. Development of coconut chips with different varieties of coconut in different flavours and ready to eat coconut mix powder
B. Organoleptic evaluation of coconut chips and ready to eat mix powder
C. Nutrient analysis of tall, dwarf and breed varieties of coconut
D. Shelf life study of developed chips and ready to eat mix

A. Development of coconut chips with different varieties of coconut in different flavours

Table I presents coconuts physical parameters like whole weight of the coconut, weight of dehusked coconut, shell weight, kernel weight and the water content of tall, dwarf, breed and convention/traditional varieties of coconut.

TABLE- I

PHYSICAL PARAMETERS OF VARIETIES OF COCONUT

Varieties of coconut	Whole weight of the coconut (g)	Whole weight of dehusked coconut (g)	Shell weight (g)	Kernel weight (g)	Coconut water (ml)
Convention / traditional variety	884.40±2.70	507.00±7.00	122.20±2.68	152.60±5.98	58.80±1.92
Tall variety	948.20±7.56	432.82±67	144.00±1.58	282.80±1.92	50.80±8.00
Dwarf variety	992.20±2.28	452.80±1.92	117.00±1.58	279.60±2.190	50.80±8.00
Breed variety	976.80±1.30	563.60±3.36	143.80±1.30	74.08±3.66	52.00±1.58

The whole weight of traditional, tall, dwarf and breed variety of coconut were 884.40±2.70, 948.20±7.56, 992.20±2.2 and 976.80±1.30 gm respectively. The weight of dehusked traditional, tall, dwarf and breed varieties of coconut were 507.00±7.00, 432.82±67, 452.80±1.92 and 563.60±3.36 gm respectively. Tall variety has more shell weight of 144.00±1.58 gm as compared to that of traditional, dwarf and breed which has a shell weight of 122.20±2.68, 117.00±1.58 and 143.80±1.30 gm respectively. The kernel weight is more in tall variety (i.e) 282.80±1.92 gm and less in breed variety (i.e) 74.08±3.66 gm. The mean weight of coconut water in traditional, tall, dwarf and breed coconuts were 58.80±1.92, 50.80±8.00, 50.80±8.00 and 52.00±1.58gms respectively.

B. Organoleptic evaluation of coconut chips and ready to eat mix powder

I. Organoleptic evaluation of plain coconut chips

Table II and Figure II presents the mean acceptability scores of plain coconut chips with white pepper flavour.

TABLE - II

MEAN ACCEPTABILITY SCORE OF PLAIN COCONUT CHIPS WITH PEPPER FLAVOUR (PSV_1)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety ($PTrSV_1$)	7.90±0.30	8.53±0.50	7.86±0.34	8.43±0.50	8.43±0.50	8.03±0.31
Tall variety ($PTSV_1$)	7.70±0.46	8.16±0.37	8.26±0.44	7.66±0.47	8.03±0.18	7.76±0.43
Dwarf variety ($PDSV_1$)	7.73±0.44	8.26±0.44	7.66±0.47	8.53±0.50	8.03±0.85	7.83±0.37
Breed variety ($PBSV_1$)	7.46±0.50	7.86±0.34	7.73±0.58	7.56±0.67	7.73±0.52	7.56±0.50
ANOVA	.003	.000	.000	.000	.000	.000

The coconut chips prepared from traditional variety scored the highest scores of 7.90±0.30 for appearance followed by dwarf, tall and breed variety with scores of 7.73±0.44, 7.70±0.46 and 7.46±0.50 respectively. The colour of traditional variety of coconut chips scored highest score of 8.53±0.50 followed by dwarf, tall, and breeds with scores of 8.26±0.44, 8.16±0.37 and 7.86±0.34 respectively. The flavour of traditional coconut chips scored the highest score of 7.86±0.34 followed by breed, dwarf and tall with scores of 7.73±0.58, 7.66±0.47 and 7.33±0.47 respectively. The texture of the dwarf variety had the highest score of 8.53±0.50 followed by traditional, tall and breed with scores of 8.43±0.50, 7.66±0.47, and 7.56±0.67 respectively. Traditional variety of coconut chips scored the highest scores of 8.43±0.50 for taste and the least scores of 7.73±0.52 obtained for breed variety. The overall acceptability of the traditional coconut chips had the highest score of 8.03±0.31 followed by dwarf, tall, and breed with scores of 7.83±0.37, 7.76±0.43 and 7.56±0.50 respectively.

From the above Table II, it is observed that the p value is less than 0.05. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of Plain Coconut Chips with white pepper flavor in Appearance, Color, flavor, texture, taste and overall acceptability.

Table III and Figure II presents the mean acceptability scores of plain coconut chips prepared without adding white pepper.

TABLE - III

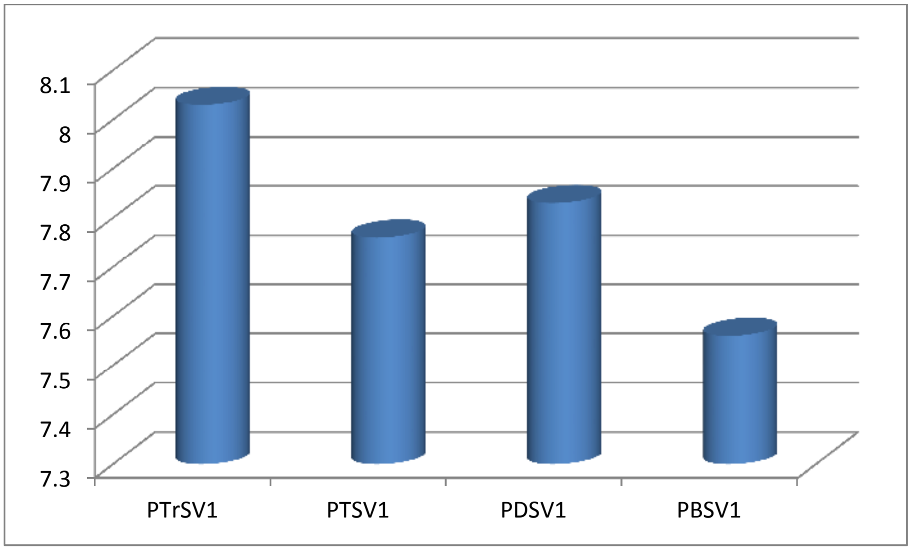
MEAN ACCEPTABILITY SCORE OF PLAIN COCONUT CHIPS (PMV_2)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety ($PTrMV_2$)	8.00	8.43±0.50	7.00	6.96±0.66	6.90±0.30	7.00
Tall variety ($PTMV_2$)	7.33±0.47	8.13±0.34	6.63±0.49	6.93±0.25	6.53±0.50	6.56±0.56
Dwarf variety ($PDMV_2$)	7.20±0.40	8.33±0.47	6.70±0.46	6.60±0.49	5.50±0.50	6.33±0.47
Breed variety ($PBMV_2$)	7.30±0.59	8.23±0.43	6.73±0.44	6.46±0.50	5.80±0.84	6.16±0.37
ANOVA	.000	.060	.004	.000	.000	.000

The coconut chips prepared from traditional variety scored the highest scores of 8.00 for appearance followed by tall,breed and dwarf variety with scores of 7.33±0.47, 7.30±0.59 and 7.20±0.40 respectively. The colour of traditional coconut chips scored highest score of 8.43±0.50 followed by dwarf, breeds and tall with scores of 8.33±0.47, 8.23±0.43 and 8.13±0.34 respectively. The flavour of traditional coconut chips scored the highest score of 7.00 followed by breed, dwarf and tall with scores of and 6.73±0.44, 6.70±0.46 and 6.63±0.49 respectively. The texture of the traditional had the highest score of 6.96±0.66 followed by tall, dwarf and breed with scores of 6.93±0.25, 6.60±0.49 and 6.46±0.50 respectively. The taste of the traditional had the highest score of 6.90±0.30 followed by tall, breed and dwarf with scores of 6.53±0.50,5.80±0.84 and 5.50±0.50 respectively. The overall acceptability of the traditional variety had the highest score of 7.00 followed by tall, dwarf and breed with scores of 6.56±0.56, 6.33±0.47 and 6.16±0.37 respectively.

From the Table III it is observed that the p value is less than 0.05 for appearance, color, flavor, taste, texture and overall acceptability. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of Plain Coconut Chips.

OVERALL ACCEPTABILITY OF PLAIN COCONUT CHIPS WITH PEPPER FLAVOUR (PSV_1)



OVERALL ACCEPTABILITY OF PLAIN COCONUT CHIPS (PMV_2)

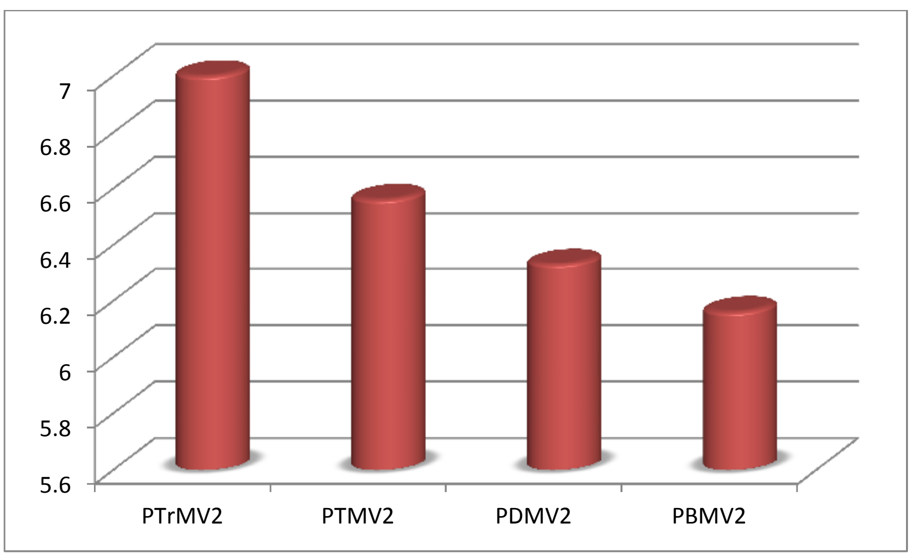


FIGURE II

OVERALL ACCEPTABILITY OF PLAIN COCONUT CHIPS

II. Organoleptic evaluation of Sweet coconut chips

Table IV and Figure III presents the mean acceptability scores of Sweet coconut chips prepared by osmotic dehydration method.

TABLE – IV

MEAN ACCEPTABILITY SCORE OF SWEET COCONUT CHIPS- OSMOTIC DEHYDRATION METHOD (S_wSV1)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety ($S_wT_rSV_1$)	8.76±0.43	8.80±0.40	8.66±0.47	8.76±0.43	8.76±0.43	9.00
Tall variety (S_wTSV_1)	8.46±0.50	8.10±0.30	7.60±0.49	8.16±0.53	7.66±0.47	7.63±0.49
Dwarf variety (S_wDSV_1)	8.76±0.43	8.93±0.25	8.66±0.47	8.46±0.50	8.83±0.37	8.63±0.49
Breed variety (S_wBSV_1)	7.63±0.49	7.63±0.49	8.13±0.73	8.46±0.62	7.86±0.62	7.00
ANOVA	.000	.000	.000	.000	.000	.000

The traditional and dwarf variety of coconut chips scored the highest and same scores of 8.76±0.43 for appearance followed by tall and breed variety with scores of 8.46±0.50 and 7.63±0.49 respectively. The colour of dwarf variety of coconut chips scored highest score of 8.93±0.25 followed by traditional, tall and breeds with scores of 8.80±0.40, 8.10±0.30 and 7.63±0.49 respectively. The flavour of traditional and dwarf variety of coconut chips scored the highest and same score of 8.66±0.47 followed by breed and tall with scores of 8.13±0.73 and 7.60±0.49 respectively. The texture of the traditional had the highest score of 8.76±0.43. Dwarf and breed variety obtained the same scores of 8.46±0.50 and the least scores of 8.16±0.53 was obtained in tall variety. The taste of dwarf variety had the highest score of 8.83±0.37 followed by traditional, breeds and tall with scores of 8.76±0.43, 7.86±0.62 and 7.66±0.47 respectively. The overall acceptability of the traditional had the highest score of 9.00 followed by dwarf, tall and breed with scores of 8.63±0.49, 7.63±0.49 and 7.00 respectively.

Table IV and Figure III presents the mean acceptability scores of Sweet coconut chips without osmotic dehydration.

From the table IV it is observed that the p value is less than 0.05 for appearance, colour, flavor, texture, taste and overall acceptability. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of Sweet coconut chips.

TABLE - V

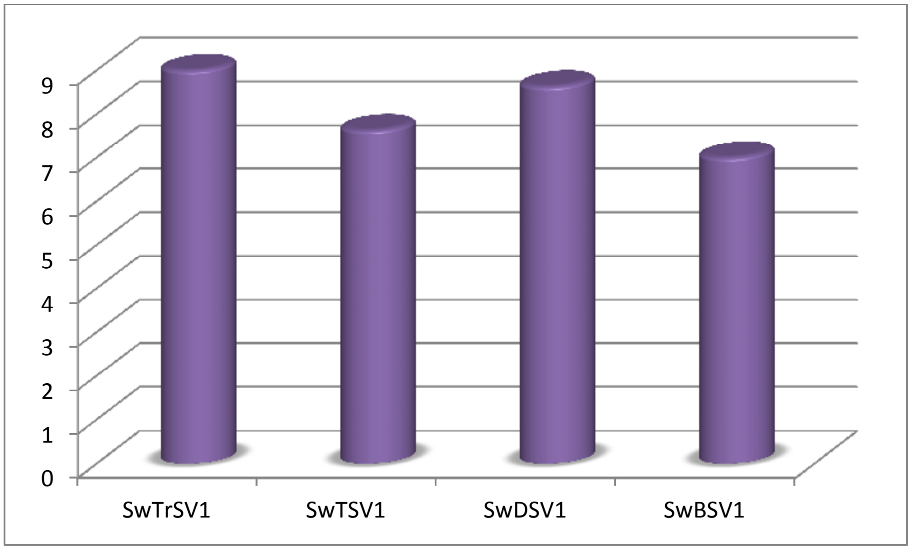
MEAN ACCEPTABILITY SCORE OF SWEET COCONUT CHIPS (S_wMV_2)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety (S_wTrMV_2)	8.53±0.62	8.20±0.66	8.50±0.50	8.46±0.57	8.60±0.56	8.50±0.86
Tall variety (S_wTMV_2)	8.46±0.77	8.43±0.50	8.40±0.85	8.33±0.66	8.36±0.49	8.26±0.44
Dwarf variety (S_wDMV_2)	7.83±0.37	7.60±0.49	8.00	7.50±0.50	7.63±0.49	7.63±0.49
Breed variety (S_wBMV_2)	8.13±0.34	7.96±0.18	7.30±0.46	7.23±0.43	7.43±0.50	7.53±0.50
ANOVA	.000	.000	.000	.000	.000	.000

The coconut chips prepared from traditional variety scored the highest scores of 8.53±0.62 for appearance followed by tall, breed, and dwarf variety with scores of 8.46±0.77, 8.13±0.34 and 7.83±0.37 respectively. With regard to the colour tall variety of coconut chips scored highest score of 8.43±0.50 followed by traditional, breed and dwarf with scores of 8.20±0.66, 7.96±0.18 and 7.60±0.49 respectively. The flavour of traditional coconut scored the highest score of 8.50±0.50 followed by tall, dwarf and breed with scores of 8.40±0.85,8.00 and 7.30±0.46 respectively. The texture of the traditional coconut variety had the highest score of 8.46±0.57 followed by tall, dwarf and breed with scores of 8.33±0.66, 7.50±0.50 and 7.23±0.43 respectively. The taste of traditional scored the highest score of 8.60±0.56 followed by tall, dwarf and breeds with scores of 8.36±0.49, 7.63±0.49 and 7.43±0.50 respectively. The overall acceptability of the traditional variety had the highest score of 8.50±0.86 followed by tall, dwarf and breed with scores of 8.26±0.44, 7.63±0.49 and 7.43±0.50 respectively.

From the Table V it is observed that the p value is less than 0.05. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of Sweet coconut chips in appearance, colour, flavor, texture, taste and Overall Acceptability.

OVERALL ACCEPTABILITY OF SWEET COCONUT CHIPS- OSMOTIC DEHYDRATION METHOD (S_wSV1)



OVERALL ACCEPTABILITY OF SWEET COCONUT CHIPS (S_wMV_2)

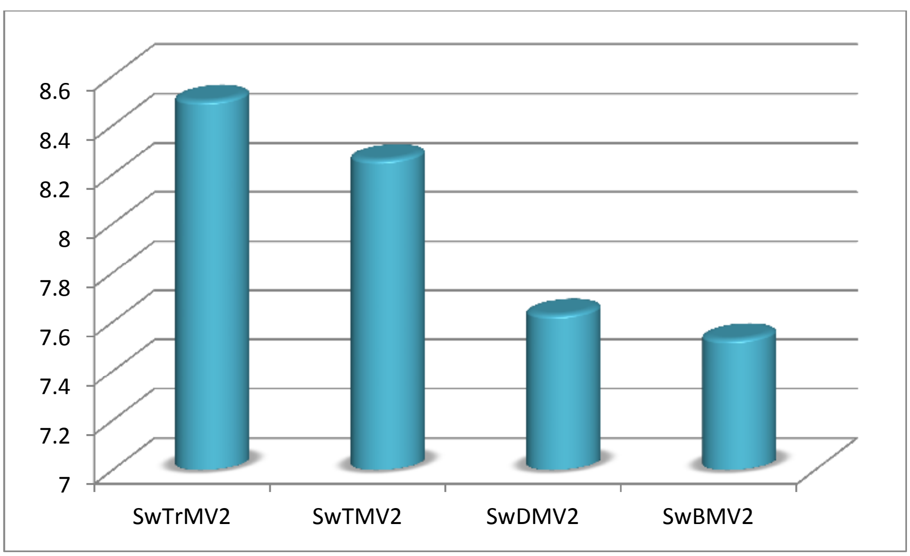


FIGURE III

OVERALL ACCEPTABILITY OF SWEET COCONUT CHIPS

III. Organoleptic evaluation of Spicy coconut chips

Table VI and Figure IV presents the mean acceptability scores of Spicy coconut chips prepared by adding white pepper powder.

TABLE - VI

MEAN ACCEPTABILITY SCORE OF SPICY COCONUT CHIPS- WHITE PEPPER FLAVOUR ($SpSV_1$)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety (S_pTrSV_1)	7.90±0.75	8.00	8.36±0.49	7.66±0.47	8.16±0.37	8.20±0.48
Tall variety (S_pTSV_1)	7.40±0.49	7.26±0.44	7.40±0.49	7.43±0.50	8.00	7.00±0.45
Dwarf variety (S_pDSV_1)	7.63±0.61	7.43±0.50	7.86±0.50	7.40±0.67	7.13±0.34	7.43±0.50
Breed variety (S_pBSV_1)	7.73±0.58	7.50±0.50	8.00	7.50±0.93	8.33±0.47	8.00
ANOVA	.020	.000	.000	.002	.000	.000

The traditional variety of coconut chips scored the highest scores of 7.90±0.75 for appearance followed by breed, dwarf and tall with scores of 7.73±0.58, 7.63±0.61 and 7.40±0.49 respectively. The colour of the chips of traditional variety had a highest score of 8.00 followed by breed, dwarf and tall with scores of 7.50±0.50, 7.43±0.50 and 7.26±0.44 respectively. The flavour of traditional variety scored the highest score of 8.36±0.49 followed by breed, dwarf and tall with scores of 8.00, 7.86±0.50 and 7.40±0.49 respectively. With regard to texture also the traditional variety only had the highest score of 7.66±0.47 followed by breed, tall and dwarf with scores of 7.50±0.93, 7.43±0.50 and 7.40±0.67 respectively. The taste of breed variety of coconut scored the highest score of 8.33±0.47 followed by traditional, tall and dwarf with scores of 8.16±0.37,8.00 and 7.13±0.34 respectively. The overall acceptability of the chips prepared out of traditional variety coconut had the highest score of 8.20±0.48 followed by breed, dwarf and tall with scores of 8.00, 7.43±0.50 and7.00±0.45 respectively.

From the table VI it is observed that the p value is less than 0.05. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of spicy Coconut Chips in appearance, colour, flavor, texture, taste and overall acceptability.

Table VII and Figure IV presents the mean acceptability scores of Spicy coconut chips with chilli powder taste and flavour.

TABLE - VII

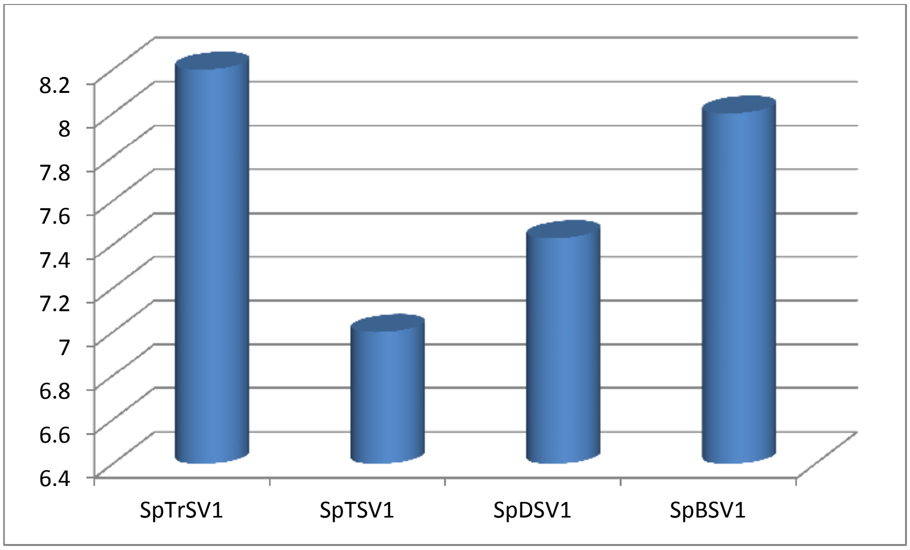
MEAN ACCEPTABILITY SCORE OF SPICY COCONUT CHIPS- CHILLI POWDER ($SpMV_2$)

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard/ Traditional variety (S_pTrMV_2)	8.03±0.55	7.86±0.34	8.36±0.49	8.06±0.58	8.76±0.43	8.33±0.47
Tall variety (S_pTMV_2)	7.56±0.50	7.60±0.56	7.66±0.47	7.33±0.75	7.03±0.85	7.20±0.61
Dwarf variety (S_pDMV_2)	7.80±0.40	7.73±0.63	8.13±0.81	7.70±0.53	8.26±0.44	8.23±0.43
Breed variety (S_pBMV_2)	7.60±0.62	7.66±0.80	7.63±0.80	7.53±0.86	7.56±0.89	7.33±0.60
ANOVA	.003	.376	.000	.001	.000	.000

The coconut chips prepared from traditional coconut variety scored the highest scores of 8.03±0.55 for appearance followed by dwarf, breed and tall variety with scores of 7.80±0.40, 7.60±0.62 and 7.56±0.50 respectively. The colour of traditional variety scored highest score of 7.86±0.34 followed by dwarf, breed and tall with scores of 7.73±0.63, 7.66±0.80 and 7.60±0.56 respectively. The flavour of traditional variety only scored the highest score of 8.36±0.49 followed by dwarf, tall and breed with scores of 8.13±0.81, 7.66±0.47 and 7.63±0.80 respectively. The texture of the traditional variety had the highest score of 8.06±0.58 followed by dwarf, breed and tall with scores of 7.70±0.53, 7.53±0.86 and 7.33±0.75 respectively. The taste of traditional scored the highest score of 8.76±0.43 followed by dwarf, breed and tall with scores of 8.26±0.44, 7.56±0.89 and 7.03±0.85 respectively. With regard to the overall acceptability, the chips prepared from traditional variety coconut had the highest score of 8.33±0.47 followed by dwarf, breed and tall with scores of 8.23±0.43, 7.33±0.60 and 7.20±0.61 respectively.

From the Table VII it is observed that the p value is less than 0.05. Hence, the null hypothesis is rejected at 5% level of significance. (i.e.) there is significant difference between the ranks of the various types of spicy Coconut Chips in appearance, colour, flavor, texture, taste and overall acceptability.

MEAN ACCEPTABILITY SCORE OF SPICY COCONUT CHIPS- WHITE PEPPER FLAVOUR ($SpSV_1$)



MEAN ACCEPTABILITY SCORE OF SPICY COCONUT CHIPS- CHILLI POWDER ($SpMV_2$)

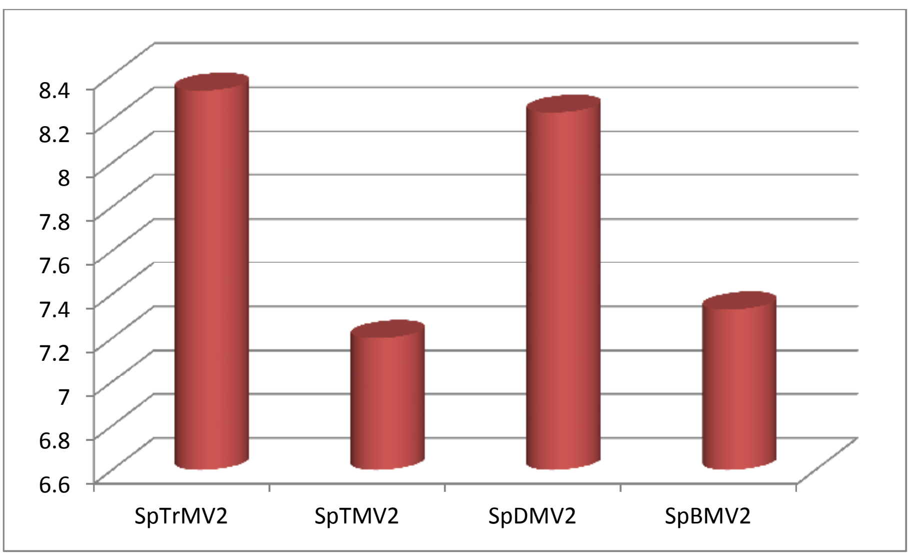


FIGURE IV

OVERALL ACCEPTABILITY OF SPICY COCONUT CHIPS

IV. Organoleptic evaluation of Ready To Eat mix powders

Table VIII and Figure V presents the mean acceptability scores of Ready To Eat Mix powders

TABLE - VIII

MEAN ACCEPTABILITY SCORE OF READY TO EAT MIX

Organoleptic charecteristics	I	II	III	IV	V	VI
Appearance (Mean±SD)	8.36±0.49	8.00	8.96±0.18	8.60±0.49	8.73±0.44	6.66±0.47
Colour (Mean±SD)	8.53±0.50	8.50±0.50	8.66±0.47	8.26±0.44	8.63±0.49	7.73±0.44
Flavour (Mean±SD)	8.00±0.74	8.56±0.50	7.36±0.49	7.40±0.49	8.00	6.70±0.46
Texture (Mean±SD)	8.36±0.49	8.63±0.49	7.93±0.82	8.56±0.50	8.16±0.46	8.40±0.49
Taste (Mean±SD)	8.86±0.34	8.63±0.49	7.50±0.50	8.70±0.46	7.43±0.50	6.66±0.47
Overall acceptability (Mean±SD)	9.00	8.53±0.50	7.73±0.44	9.00	8.00	7.26±0.44

I-Coconut and onion RTEP, II. Urad dal coconut RTEP, III- Mixed vegetable coconut RTEP, IV- Avalose coconut RTEP, V- Coriander leaves coconut RTEP, VI- Egg coconut RTEP

With regard to the acceptability scores of the different coconut incorporated powders, the appearance of the mixed vegetable coconut RTEP had the maximum score of 8.96±0.18. The appearance of the Egg coconut RTEP had the minimum score of 6.66±0.47. While the mean score obtained for appearance was 8.36±0.49, 8.00, 8.60±0.49, 8.73±0.44 for other powders I, II, IV and V respectively.

When colour of the RTEP was evaluated, colour of the mixed vegetable coconut RTEP scored the maximum scores of 8.66±0.47 and the minimum scores of

7.73±0.44 was obtained in egg coconut RTEP. The mean scores of other powders I, II, IV, V was 8.53±0.50,8.50±0.50, 8.26±0.44, 8.63±0.49 respectively.

When flavour of the powder was evaluated, urad dal coconut RTEP was highly acceptable with a score of 8.56±0.50. The flavour of I, III, IV, V and VI was 8.00±0.74, 7.36±0.49, 7.40±0.49, 8.00, 6.70±0.46 respectively.

With regard to the texture of I, II, III, IV, V, VI powders it was was 8.36±0.49, 8.63±0.49, 7.93±0.82, 8.56±0.50, 8.16±0.46 and 8.40±0.49 respectively. The maximum score was obtained for urad dal coconut RTEP and the minimum scores were obtained for mixed vegetable coconut RTEP.

The taste of coconut and onion RTEP had the maximum score of 8.86±0.34. The avalose coconut RTEP was also acceptable with a score of 8.70±0.46. The taste of II, III, V and VI was 8.63±0.49, 7.50±0.50, 7.43±0.50 and 6.66±0.47 respectively.

The coconut and onion RTEP and avalose coconut RTEP scored the maximum score of 9.00 for overall acceptability. While the other powders namely II, III, V and VI had the mean scores of 8.53±0.50, 7.73±0.44, 8.00 and 7.26±0.44 respectively.

C. Nutrient analysis of tall, dwarf and breed varieties of coconut

Nutrient analysis refers to the process of determining the nutritional content of foods and food product. Nutrient content of food products are analysed by qualitative and quantitative methods. The standard procedures are used to analyse the carbohydrate, protein, fat, vitamins and minerals.

Table IX and Figure VI presents the data on nutrient content of tall, dwarf and hybrid varieties of coconut.

TABLE - IX

NUTRIENT CONTENT OF 100 g OF TALL, DWARF AND BREED VARIETIES OF COCONUT

Coconut varieties	Moisture (%)	Crude fibre (g)	Total carbohydrate (g)	Protein (g)	Fat (g)	Calcium (mg)
Tall variety	37.3±2.5	13.3±1	29.50±3.27	6.25±0	11.00±1.00	25.00±4.35
Dwarf variety	42.00±1	12.00	18.66±3.32	17.8±1	7.66±0.57	14.00±2.00
Breed variety	44.00±3.6	10.00±2	28.66±1.15	6.25±0	16.00±1.00	18.00±2.00

Table IX shows the nutrient present in the selected varieties of coconut. From the table it is evident that high amount of moisture (i.e) 44.00±3.6 percent was present in the breed variety when compared to other varieties. With regard to crude fibre content, tall variety retained more fibre (i.e) 13.3±1 g followed by dwarf variety 12.00 g and least amount of fibre was present in breed variety (i.e) 10.00±2 g. The total carbohydrate content of tall, dwarf and breed variety were 29.50±3.27, 18.66±3.32 and 28.66±1.15 g respectively. The amount of protein present was 6.25±0 g for both tall and breed variety, while dwarf variety had the highest protein content of 17.8±1 g. Tall variety has 25.00±4.35 mg of calcium followed by breed variety 18.00±2.00 mg and the least quantity of calcium was 14.00±2.00 mg present in dwarf variety.

OVERALL ACCEPTABILITY OF READY TO EAT MIX

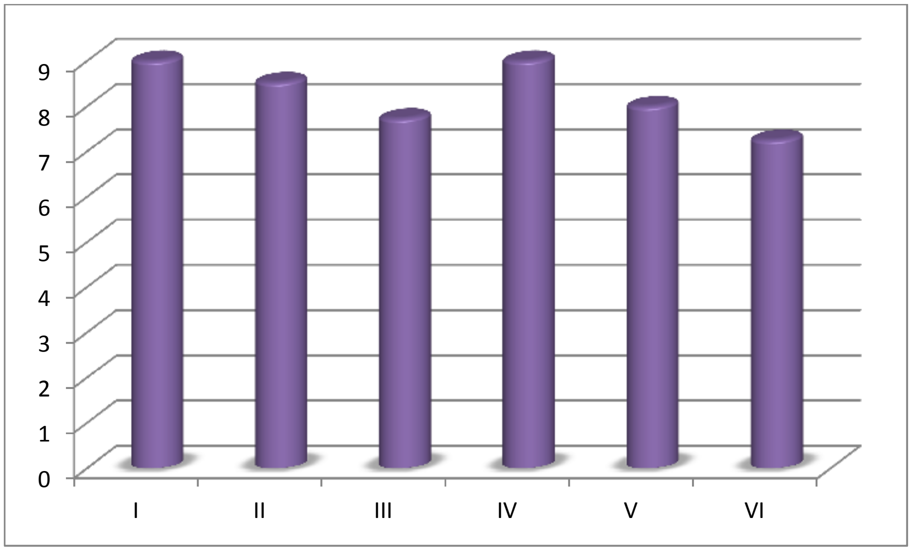


FIGURE V

OVERALL ACCEPTABILITY OF READY TO EAT MIX

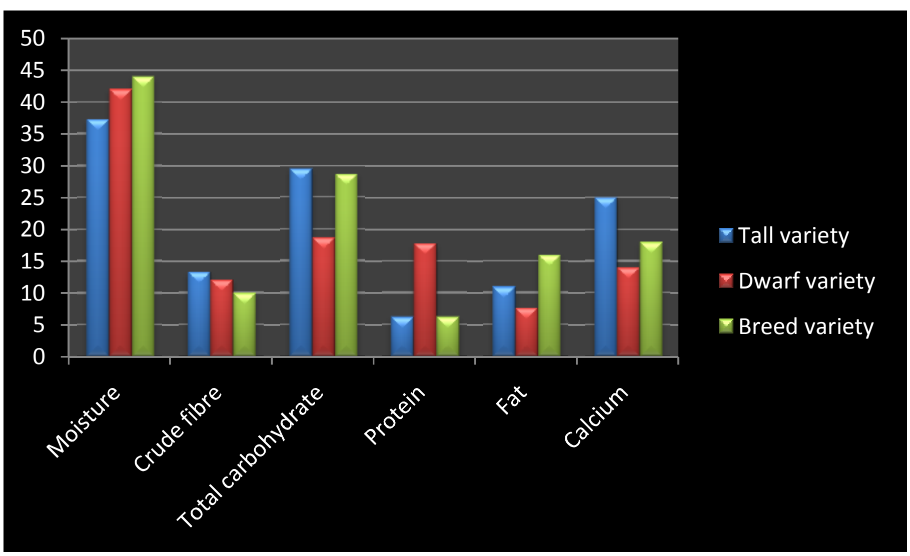


FIGURE VI

NUTRIENT CONTENT OF COCONUT VARIETY

D. Shelf life study of developed chips and ready to eat mix

Table X presents the data on the shelf life analysis of Ready To Eat mix.

TABLE - X

SHELF LIFE ANALYSIS OF READY TO EAT MIX

RTEP	Initial Date	Final Date	Shelf Life
Coconut and onion RTEP	10.02.2018	12.03.2018	30 days
Urad dal coconut RTEP	10.02. 2018	22.02.2018	40 days
Mixed vegetable coconut RTEP	10.02. 2018	2.03.2018	20 days
Avalose coconut RTEP	10.02.2018	11.04.2015	60 days
Coriander leaves coconut RTEP	10.02. 2018	6.04.2016	55 days
Egg coconut RTEP	10.02. 2018	25.02.2018	15 days

Microbial study was carried out for six Ready To Eat mix Powders namely Coconut and onion RTEP, Urad dal coconut RTEP, Mixed vegetable coconut RTEP, Avalose coconut RTEP, Coriander leaves coconut RTEP and Egg coconut RTEP. Shelf life study was carried out for a period of 60 days at room temperature. The avalose coconut RTEP had the maximum shelf life of 60 days when compared to other Ready To Eat mix. Egg coconut RTEP and mixed vegetable coconut RTEP had less shelf life of 15 and 20 days respectively. Coriander leaves coconut RTEP had shelf life of 55 days. Coconut and onion RTEP and urad dal coconut RTEP had 30 and 40 days of shelf life respectively. From the analysis avalose coconut RTEP had good shelf life than the other Ready To Eat Mix. And it was found that coriander leaves coconut RTEP showed low level of contamination with good keeping quality for 55 days. Egg coconut RTEP got the minimal shelf life because of the highest moisture content.

Table XI presents the data on the peroxide value analysis of coconut chips

TABLE - XI

SHELF LIFE ANALYSIS OF COCONUT CHIPS

Days	Traditional variety coconut chips (meq/Kg)	Tall variety coconut chips (meq/Kg)	Dwarf variety Coconut chips (meq/Kg)	Breed variety Coconut chips (meq/Kg)
5th day	9.0	7.50	5.50	7.0
10th days	9.80	8.50	6.0	7.80
16th day	10.50	8.98	7.0	8.50
21st day	12.0	10.0	9.0	10.0
26th day	14.0	12.80	12.0	11.0
31st day	18.0	15.0	14.0	13.0

The peroxide value (PV) is the most common parameter used to characterize oils and fats, a product with peroxide value between 1 and 5 meq/kg is classified at low oxidation state; that between 5 and 10 meq/kg at moderate oxidation and above 10 meq/kg is classified at high oxidation state. The peroxide values (PVs) of the samples were measured at 5 days intervals.

The PV was carried out for coconut chips from traditional, tall, dwarf and breed varieties of coconut. Peroxide value of traditional, tall, dwarf and breed coconut chips was analysed on the 5th, 10th, 16th, 21st, 26th, and 31st days and this showed significant difference.

At the end of 31st day the PVs were 18.0,15.0,14.0 and 13.0 for traditional, tall, dwarf and breed respectively. The initial peroxide value of traditional coconut chips was high as compared to that of tall, dwarf and breed variety of coconut chips. The PV obtained for tradition coconut chips showed that 18.0 meq/Kg which is classified at high oxidation state. The PV obtained for tall, dwarf and breed coconut chips were 15.0, 14.0 and 13.0 which are classified at high oxidation state but less than that of the peroxide value obtained in the traditional coconut chips. From the peroxide value analysis coconut chips had good shelf life of more than 30 days.

V. SUMMARY AND CONCLUSION

Coconut is most widely cultivated tree in the world. Coconut belongs to the family of arecaceae. Coconut plays an important role in the economy of the country. Coconut is highly nutritious because it is rich in fibre, vitamins and minerals. Beyond its nutritional content it provides health benefits. There are many varieties of coconut. The most common varieties of coconut are tall, dwarf and breed varieties of coconut.

The present study entitled '**Development and evaluation of coconut based Ready To Eat mixes and coconut flakes**' was aimed at evaluation of coconut chips prepared from different varieties of coconut and RTE mixes. The different varieties of coconut included tall, dwarf and breed. Coconut chips are prepared by using these three varieties and it was compared with that of the standard namely convention/ traditional variety of coconut. Formulation of RTE coconut mixes namely coconut and onion RTEP, urad dal coconut RTEP, Avalose coconut RTEP, coriander leaves coconut RTEP and egg coconut RTEP was prepared. The developed recipes were subjected to organoleptic evaluation by 30 semi-trained panel members. The study protocol was approved by institutional ethical committee Avinashilingam University and the approval number was AUE/ IHEC/ FSN -17-18/XPD/04. The organoleptic scores of the recipes were statistically analyzed from mean and standard deviation to find the best acceptable recipe.

The salient findings of the study are summarized below:

- Three varieties of coconut were selected for the preparation of coconut chips. These three varieties were compared with that of convention/ traditional variety of coconut.
- Physical parameters like whole weight of the coconut, weight of dehusked coconut, shell weight, kernel weight and the water content of tall, dwarf, breed and convention/traditional varieties of coconut were taken. The weight of dehusked traditional, tall, dwarf and breed varieties of coconut were 507.00±7.00, 432.82±67, 452.80±1.92 and 563.60±3.36 gm respectively. Tall variety has more shell weight of 144.00±1.58 gm as compared to that of traditional, dwarf and breed which has a shell weight of 122.20±2.68, 117.00±1.58 and 143.80±1.30 gm respectively. The kernel weight is more in tall variety (i.e) 282.80±1.92 gm and less in breed variety (i.e) 74.08±3.66 gm. The

mean weight of coconut water in traditional, tall, dwarf and breed coconuts were 58.80±1.92, 50.80±8.00, 50.80±8.00 and 52.00±1.58gms respectively.

- The organoleptic evaluation of plain coconut chips with white pepper prepared from tall, dwarf, breed and traditional varieties of coconut revealed that traditional variety of coconut chips scored the highest scores of 8.43±0.50 for taste and the least scores of 7.73±0.52 obtained for breed variety. The overall acceptability of the traditional coconut chips had the highest score of 8.03±0.31 followed by dwarf, tall, and breed with scores of 7.83±0.37, 7.76±0.43 and 7.56±0.50 respectively.
- The mean acceptability scores of plain coconut chips prepared without adding white pepper showed that the overall acceptability of the traditional variety had the highest score of 7.00 followed by tall, dwarf and breed with scores of 6.56±0.56, 6.33±0.47 and 6.16±0.37 respectively.
- The mean value obtained for the preparation of sweet coconut chips by osmotic dehydration method revealed that the taste of dwarf variety had the highest score of 8.83±0.37 followed by traditional, breeds and tall with scores of 8.76±0.43, 7.86±0.62 and 7.66±0.47 respectively. The overall acceptability of the traditional had the highest score of 9.00 followed by dwarf, tall and breed with scores of 8.63±0.49, 7.63±0.49 and 7.00 respectively.
- The sweet coconut chips without osmotic dehydration method was prepared from traditional variety scored the highest score of 8.50±0.86 for overall acceptability followed by tall, dwarf and breed with scores of 8.26±0.44, 7.63±0.49 and 7.43±0.50 respectively.
- The spicy coconut chips with white pepper flavor showed that the overall acceptability of the chips prepared out of traditional variety of coconut had the highest score of 8.20±0.48 followed by breed, dwarf and tall with scores 8.00, 7.43±0.50 and 7.00±0.45 respectively.
- The spicy coconut chips with chilli powder prepared from traditional coconut scored the highest score of 8.33±0.47 for overall acceptability followed by dwarf, breed and tall with scores of 8.23±0.43, 7.33±0.60 and 7.20±0.61 respectively.
- With regard to the acceptability scores of the different coconut incorporated powders, the appearance of the mixed vegetable coconut RTEP had the maximum score of 8.96±0.18. The appearance of the Egg coconut RTEP had the minimum score of 6.66±0.47. While the mean score obtained for

appearance was 8.36±0.49, 8.00, 8.60±0.49, 8.73±0.44 for other powders I, II, IV and V respectively. The taste of coconut and onion RTEP had the maximum score of 8.86±0.34. The avalose coconut RTEP was also acceptable with a score of 8.70±0.46. The taste of II, III, V and VI was 8.63±0.49, 7.50±0.50, 7.43±0.50 and 6.66±0.47 respectively. The coconut and onion RTEP and avalose coconut RTEP scored the maximum score of 9.00 for overall acceptability. While the other powders namely II, III, V and VI had the mean scores of 8.53±0.50, 7.73±0.44, 8.00 and 7.26±0.44 respectively.

- The nutrient present in the selected varieties of coconut revealed that high amount of moisture (i.e) 44.00±3.6 percent was present in the breed variety when compared to other varieties. With regard to crude fibre content, tall variety retained more fibre (i.e) 13.3±1 g followed by dwarf variety 12.00 g and least amount of fibre was present in breed variety (i.e) 10.00±2 g. The total carbohydrate content of tall, dwarf and breed variety were 29.50±3.27, 18.66±3.32 and 28.66±1.15 g respectively. The amount of protein present was 6.25±0 g for both tall and breed variety, while dwarf variety had the highest protein content of 17.8±1 g. Tall variety has 25.00±4.35 mg of calcium followed by breed variety 18.00±2.00 mg and the least quantity of calcium was 14.00±2.00 mg present in dwarf variety.
- Shelf life study of RTEP showed that the avalose coconut RTEP had the maximum shelf life of 60 days when compared to other Ready To Eat mix. Egg coconut RTEP and mixed vegetable coconut RTEP had less shelf life of 15 and 20 days respectively. Coriander leaves coconut RTEP had shelf life of 55 days. Coconut and onion RTEP and urad dal coconut RTEP had 30 and 40 days of shelf life respectively. From the analysis avalose coconut RTEP had good shelf life than the other Ready To Eat Mix. And it was found that coriander leaves coconut RTEP showed low level of contamination with good keeping quality for 55 days. Egg coconut RTEP got the minimal shelf life because of the highest moisture content.
- Peroxide value of traditional, tall, dwarf and breed coconut chips was analysed on the 5th, 10th, 16th, 21st, 26th, and 31st days and this showed significant difference. At the end of 31st day the PVs were 18.0, 15.0, 14.0 and 13.0 for traditional, tall, dwarf and breed respectively. The initial peroxide value of traditional coconut chips was high as compared to that of tall, dwarf and breed

variety of coconut chips. The PV obtained for tradition coconut chips showed that 18.0 meq/Kg which is classified at high oxidation state. The PV obtained for tall, dwarf and breed coconut chips were 15.0, 14.0 and 13.0 which are classified at high oxidation state but less than that of the peroxide value obtained in the traditional coconut chips. From the peroxide value analysis coconut chips had good shelf life of more than 30 days.

BIBLOGRAPHY

- Aboulfazil, F., Shori,A.B., Baba, A.S. (2016). Effects of the replacement of cow milk with vegetable milk on probiotics and nutritional profile of fermented ice cream. *Food science and technology.* volume 70 pp261-270.
- Agbafor, K.N., Elom, S.O., Ogbanshi, M.E., Oko A.O., Uraku, A.J., Nwankwo, V.U.O., Ale, B.A. And Obiudu, K.I. (2015). Antioxidant Property And Cardiovascular Effects Of Coconut (Cocos Nucifera) Water. *International Journal Of Biochemistry Research And Review.* 18(3): 221-248.
- Aggarwal,B., Lamba, H. S., Sharma, P., Ajeet.. (2017). Various Pharmacological Aspects of Cocos nucifera - A Review. *American Journal of Pharmacological Sciences.* 5(2): 25-30.
- Ahuja, S.C., Ahuja, S. and Ahuja, U. (2014). Coconut – History, Uses, and Folklore. *Asian Agri-History.*18(3): (221–248).
- Ajeigbe, K.O., Owonikoko,W..M., Egbe. V., Iquere, I., Adeleye.G. (2017). Gatroprotective and mucosa hemostatic activities of coconut milk and water on experimentally induced gastropathies in male wistar rats. *Tissue and cell.*49(5): 528-536.
- Akinnuga, A.M., Jeje, S.O., Bamidele, O and Sunday V.E. (2014). Dietary Consumption of Virgin Coconut Oil Ameliorates Lipid Profiles in Diabetic Rats. *Physiology Journal*.pp1-5.
- Alves, N.F.B., Alves, N., Porpino, S., Monteiro, M., Queiroz, T., Montenegro, K., Braga, V. (2013). Coconut oil supplementation reduces blood pressure and oxidative stress in spontaneously hypertensive rats. 8(4):P68.
- Alyaqoubi, S., Abdullah, A., Samudi, M., Abdullah, N., Addai, Z.R. and Musa, K.H. (2015). Study of antioxidant activity and physicochemical properties of coconut milk (Pati santan) in Malaysia. *Journal of Chemical and Pharmaceutical Research* 7(4):967-973.
- Amulu, N.F., Mbah, G.O., Onyiah, M.I., Ude, C.N. (2015). Effects of Process Parameters on the Yield of Oil from Coconut Fruit. *International Journal of Nutrition and Food Engineering.* volume 9 issue 3.
- Annas, A. Market of Indonesian Virgin Coconut Oil. *Scientific Journal of PPI-UKM.* pp251- 254.

- Appaiah, P., Sunil, L., Kumar, P.K.P., Krishna, A. G.G. (2015). Composition of Coconut Testa, Coconut Kernel and its Oil. *Journal of the American Oil Chemists' Society.*
- Arollado, E.C., Samaniego, A.A., Cena, R.B., Agapito, J.D., Tomagan, L.B., Kerstin Mariae G. Ponsaran, Richelle Ann M. Manalo, Gerwin Louis T. Dela Torre. (2018). Cocos nucifera L. endosperm promotes healing of excised wound in BALB/c mice. *Marmara pharmaceutical journal* 22(1): 103-109.
- Athira, K. Survey. (2017). Identification and Estimation of Damage in Major Diseases of Coconut. *International Journal of Current Microbiology and Applied Sciences.* 6(12): 416-423.
- Babu, A.S., Veluswamy, S.K., Arena, R., Guazzi, M., Lavie, C.J.(2014). Virgin Coconut Oil and Its Potential Cardioprotective Effect. *Clinical focus: thrombosis and cardiovascular medicine.* 126(7): 76-83.
- Balogun, M.A., Kolawole, F.L., Joseph, J. K., Adebisi, T.T., Ogunleye, O.T. (2016). Effect of fortification of fresh cow milk with coconut milk on the proximate composition and yield of warankashi, a traditional cheese. *Croat. J. Food Sci. Technol*. 8(1): 10-14.
- Belewu, M.A., Lawal, M. A., Kadijat Abdulsalam, K. (2014). Date-coconut drink: physico-chemical and sensory qualities. *Journal of science and technology* 9(2).
- Boemeke, L., Marcadenti, A., Busnello, F.M., Gottschall, C.B.A. (2015). Effects of Coconut Oil on Human Health. *Open Journal of Endocrine and Metabolic Diseases.* vol 5 pp 84-87.
- Breslin. P.A.S. (2013).An evolutionary perspective on food and human taste. Current biology. 23(9): 409-418.
- Cabedo.L.., L. Picart I Barrot, And TeixidoA. (2008). Prevalence of Listeria monocytogenes and Salmonella in Ready-to-Eat Food in Catalonia, Spain. *Journal of Food Protection.* 71(4): 855–859.
- Chandran, D and Francis, P. (2016). Awareness, Perception and Satisfaction towards Neera Health Drink: Consumers Perspective. *Bonfring International Journal of Industrial Engineering and Management Science.* 6(3): 103-107.
- Chandrasekhar, K., Sreevani, S and Kumari, J.P. (2014). Identification of e.coli nissle 1917 proteins by using 2-d gel electrophoresis under the influence of cocos nucifera sap and wine. *International Journal of Pharmaceutical Sciences and Research.* 5(7): 1-8.

- Chauhan, O. P., Archana, B. S., Singh, A., Raju, P. S., Bawa, A. S. (2013). Utilization of Tender Coconut Pulp for Jam Making and Its Quality Evaluation During Storage. *Food and Bioprocess Technology*. 6(6): 1444–1449.
- Chauhan, S.K., Kumar, R and Nadanasabapathi, S. (2017). Turbidimetric Assay of nisin in tender coconut Water*. Defence Life Science Journal.* 2(2): 212-215
- Cirillo, G., Spizzirri, U.G., Lemma, F. (2015). Functional polymers in food science. *From technology to biology.* Food packaging *Scriviner publishing..*volume 1.
- Clarence, S. Y., Obinna. C.N. and Shalomn, C. (2009). Assessment of bacteriological quality of ready to eat food (Meat pie) in Benin City metropolis, Nigeria. *African Journal of Microbiology Research.* 3(6): 390-395.
- Costa, H.B., Souza, L.M., Soprano, L.C., Oliveira, B.G., Ogwa, E.M., Adriana M. N Korres, A.M.N., Ventura, J.A., Romao, W. (2015). Monitoring the physicochemical degradation of coconut water using ESI-FT-ICR MS. *Food chemistry. 174: 139-146.*
- Cuarto, P.M. and Magsino, R.F. (2017). Development of Young Coconut (Cocosnucifera) Wine. *Asia Pacific Journal of Multidisciplinary Research.* volume 5 issue 2.
- Danezis, G.P., Tsagkaris, A.S., Camin, F., Brusic, V., Georgio, C.A. (2016). Food authentication: Techniques, trends & emerging approaches. *Trends in analytical chemistry.* 85: 123-132.
- Daramola, J.O., Adekunle, E.O., Oke, O.E., Onagbesan, O.M., Oyewusi, I.K., Oyewusi, J.A. (2016). Effects of coconut (Cocos nucifera) water with or without egg-yolk on viability of cryopreserved buck spermatozoa. *Anim. Reprod., Belo Horizonte*. 13(2): 57-62.
- David, W. and Kofahi, D. (2016). Food culture of south east asia perspective of social science and food science. APEK.
- Deepatharshini, D and Elango, A. (2015). Antifungal activity of leaf extract of eichhorinia crassipes against ganoderma lucidum causing basal stem rot disease in coconut tree. *World journal of pharmacy and pharmaceutical sciences.* 4(06): 859-864.
- Devi, N.S., Hariprasad, T., Ramesh, K., Merugu, R. (2015). Antioxidant Properties of Coconut Sap and its Sugars. *International Journal of pharmtech Research.* 8(1): 160-162.

- Dhankhar, P. (2013). A Study on Development of Coconut Based Gluten Free Cookies. *International Journal of Engineering Science Invention.* 2(12):10-19.
- Dianne Q.C., Ramos and Lorina A. Galvez. (2016). Development and Process Optimization of Blended Beverage from Coconut Water and Sweetpotato. *Philippine Journal of Arts, Sciences, and Technology* Volume 1 pp34–40.
- Dua, K., Sheshala, R., Ling, T.Y., Ling, S.H and Gorajana, A. (2013). Anti-Inflammatory, Antibacterial and Analgesic Potential of Cocos Nucifera Linn. : A Review. *Anti-Inflammatory & Anti-Allergy Agents in Medicinal Chemistry. .*12(2): 1-7.
- Dua, K., Sheshala, R., Ling, T.Y., Ling, S.H, Gorajana, A. (2013.) anti-inflammatory, antibacterial and analgesic potential of cocos nucifera linn: a review. *Antiinflamm Antiallergy Agents Med Chem.* 12(2):158-64.
- Dulay, R.M.R., Rivera, A.G.C., Garcia, E.J.B (2017). Mycelial growth and basidiocarp production of wild hairy sawgill *Lentinus strigosus*, a new record of naturally occurring mushroom in the Philippines. *Biocatalysis and agricultural biotechnology.* Vol 10, pages 242-246.
- El-Abasy, M.A., Abdelhady, D.H., Kamel, T. and Shukry, M. (2016). Ameliorative Effect of Coconut Oil on Hematological, Immunological and Serum Biochemical Parameters in Experimentally infected Rabbits. *Alexandria Journal of Veterinary Sciences.* 50(1): 36-48.
- Famurewa, A.C., Nwankwo, O.E., Folawiyo, A.M., Igwe, E.C., Epete, M.A and Ufebe, O.G.. (2017).Repeatedly heated palm kernel oil induces hyperlipidemia, atherogenic indices and hepatorenal toxicity in rats: the beneficial role of virgin coconut oil supplementation. *Acta Sci. Pol. Technol. Aliment.*16(4): 451–460.
- Fernando, W. M. A. D. B., Ian J. Martins., Goozee, K. G., Brennan,C.S., Jayasena. V and Martins R. N. (2015). The role of dietary coconut for the prevention and treatment of Alzheimer's disease: potential mechanisms of action. *British Journal of Nutrition.*vol 114 pp1–14.
- Fife, B. (2013). Coconut oil miracle. 5th edition. *Published by the penguin group.*
- Foale, M. (2003).The coconut odyssey the bounteous possibilities of the tree of life. *Australian centre for international agricultural research.*
- Ganguly, S. and Roy, S. (2014). Health benefits of coconut: a review. *International journal of pharmacy and life sciences.* 5(1): 3228-3229.

- Gerard G. Dumancas, G.G., Viswanath, L.C.K., de Leon, A.R., Ramasahayam, S., Maples, R., Koralege, R.H., Perera, U.D.N., Langford, J., Shakir, A and Castles, S. (2016). Health benefits of virgin coconut oil. pp 1-33.
- Ghazal, M.N., Morsy, W. A., Ramadan, N.A., Ali, W. A. H. (2015). Effect of different dietary levels of coconut oil as a source of medium chain fatty acids on some reproductive traits of rabbit does. *Egypt. Poult. Sci.* 35(1): 195-214.
- Ghosh K. (2015). Postharvest, Product Diversification and Value Addition in Coconut. pp 125-165.
- Govarthanana, M., Seoa, Y.S., Kui-Jae Leea, Ik-Boo Junga, Ho-Jong Jub, Jae Su Kimb, Min Choa, Seralathan Kamala-Kannana and Byung-Taek Oha. (2016). Low-cost and eco-friendly synthesis of silver nanoparticles using coconut (Cocos nucifera) oil cake extract and its antibacterial activity. *Artificial cells, nanomedicine, and biotechnology.* pp1-5.
- Gowthami, P., Muthukumar, K. and Velan, M. (2015). Utilization of coconut oil cake for the production of lipase using bacillus coagulans VKL1. *Biocontrol science.* 20(1): 125-133.
- Gunathilake, K. D. P. P., .Yalegama, C., Kumara, A. A. N. (2009). Use of coconut flour as a source of protein and dietary fibre in wheat bread. *Asian Journal of Food and Agro-Industry*. 2(3): 382-391.
- Gupta, A. (2016). Asymbiotic Seed Germination in Orchids: Role of Organic Additives. *International Advanced Research Journal in Science, Engineering and Technology.*3(5): 143-147.
- Halim, D.S., Abdullah, N.A., Alam, M.K., Siti Nuraini Bt Samsee, May, T.S. (2014). Comparison of the Effectiveness between Virgin Coconut Oil (VCO) and Triamcinolone for Treatment of Minor Recurrent Aphthous Stomatitis (RAS).*International Medical Journal.*21(3): 319-320.
- Hawa, A., Kanani, H., Patel, M., Taneja, N., Maru, P., Kaliwala,S., Gopani,S., Sharma, S., Sharm, S., Patel, S. (2014). A study on consumer purchase intention towards ready-to-eat food in Ahmedabad.*Asian journal of management research*. 5(2): 202-209.
- Hussain, I., Mahmood,M.S., Siddique, F and Sarwar, A. (2015). Bacteriological Examination of Some Ready-To-Eat Foods in Faisalabad with Special Reference to Listeria monocytogenese. *Scholar’s Advances in Animal and Veterinary Research*. 2(1): 64-69.

- Igbabul, B. D., Bello, F. A and Ani, E. C. (2014). Effect of fermentation on the proximate composition and functional properties of defatted coconut (Cocos nucifera L.) Flour. *Sky Journal of Food Science.* 3(5): 034 – 040.
- Igwe, C.U., Iheme, C.I., Alisi, C.S., Nwaogu, L.A., Ibegbulem, C.O., Ene, A.C. (2016). Lipid profile and atherogenic predictor indices of albino rabbits administered coconut water as antidote to paracetamol overdose. *Journal of Coastal Life Medicine.* 4(12): 974-979.
- Igwe, O. U., Ugwunnaji, I. P. (2016). Phytochemistry, Antioxidant and Antimicrobial Studies of Endosperm Tissues of Cocos nucifera L. *International journal of chemical, material and environmental research.* 3(4): 78-83.
- Ikechukwu, G.A. (2016). Development of an Improved Motorized Nmanu Akuoyibo (Coconut Oil) Extracting Machine for Employment Generation in Nigeria. Vol 2 p19-21.
- Ilori, E. G and Obahiagbon, F. I. (2015). Nutrient content evaluation of derived liquid and lyophilized milk from different varieties of coconut (cocos nucifera). *J. Chem. Soc. Nigeria.* 40(1): 133-135.
- Indra, S., Gani, R.A., Syam, A.F., Shatri, H. (2015). Effect of coconut milk supplementation to nutritional status parameters in liver cirrhosis patients. *The Indonesian Journal of Gastroenterology, Hepatology and Digestive Endoscopy*. 16(2): 78-85.
- Jaikumaran, U., Joseph, S., Preman, P.S., Unnikrishnan, C., Jitha, K. J., Joseph, C.J. (2016). Design and development of sitting type coconut palm climbing device – "Kera Suraksha Coconut Climber". *Journal of Tropical Agriculture.* 54 (1): 136-143.
- Jain, N., Rajwar, Y.C., Batra, M., Singh, H.P., Bhandari, R., Agarwal, P. (2014). Dentistry: Turning towards Herbal Alternatives: A Review. *Scholars Journal of Applied Medical Sciences (SJAMS*) 2(1C):253-257.
- Jayasundera, M. and Kulatunga, R. (2014). Spray drying of unfermented coconut sap or sweet toddy into an amorphous powder. *Annals. Food Science and Technology.* volume 15 issue 2.
- Jesuorsemwen; E.B., Ebikere; I.I., Ozede, I.N., Eghomwanre, A.F. (2016). Hematobiochemical changes of lead Poisoning and amelioration with Coconut (Cocos nucifera L.) Water in wistar albino rats.*Journal of applied science environment and management.* 20(1): 89-94.

- Jin, B., Zhou, X., Li,B., Lai, W and Li, X. (2015). Influence of In vitro Digestion on Antioxidative Activity of Coconut Meat Protein Hydrolysates. *Tropical Journal of Pharmaceutical Research*.14(3): 441-447.
- Kailaku, S.I., Syah, A.N.A., Setiawan, RB. and Ahmad Sulaeman, A. (2015). Carbohydrate-Electrolyte Characteristics of Coconut Water from Different Varieties and its Potential as Natural Isotonic Drink. *International journal on advanced science engineering and information technology.* 5(3): 2088-5334.
- Kamalaldin, N.A., Sulaiman, S.A., Yusop, M..R and Yahay, B. (2017). Does Inhalation of Virgin Coconut Oil Accelerate Reversal of Airway Remodelling in an Allergic Model of Asthma? *Hindawi International Journal of Inflammation.* pages 11.
- Kamaral, L.C.J., Perera, S.A.C.N., Perera, K.L.N.S. and Dassanayaka, P.N. (2014). Genetic Diversity of the Sri Lanka Yellow Dwarf Coconut Form as Revealed by Microsatellite Markers. *Tropical Agricultural Research.* 26(1): 131 – 139.
- Kamaral, L.C.J., Perera, S.A.C.N., Perera, K.L.N.S. and Dassanayaka, P.N. (2016). Sri Lanka Yellow Semi Tall; A new addition to the coconut (Cocos nucifera L.) classification in Sri Lanka Cocos. Vol 22 pp49-55.
- Kapila, N., Seneviratne and Jayathilaka, N. (2016). Coconut Oil: Chemistry and Nutrition.*Lakva Publishers* pp1-142.
- Kapilan, R., Kailayalingam, R., Mahilrajan, S., Srivijeindran, S. (2015). Determination of Efficient Fermentation Inhibitor of Sweet Sap of Cocos Nucifera and Optimization of Concentration for Quality Outputs in Northern Sri Lanka. *International Journal of Scientific Research in Agricultural Sciences.* 2(7): 166-174.
- Kappally, S., Shirwaikar, A. and Shirwaikar, A. Coconut oil – a review of potential application.(2015) *Hygeia: journal for drugs and medicine.* 7(2): 34-41.
- Karun, A., Sajini,K..K., Niral, V., Amarnath, C.H., Remya, P., Rajesh, M.K., Samsudeen, K., Jerar, B. A. and Engelmann, F. (2014). Coconut (cocos nucifera l.).*Pollen cryopreservation.* 35(5): 407-417.
- Kilcast, D and Subramaniam, P. (2000). The stability and shelf-life of food. *Published by Woodhead Publishing Limited.*
- Koffi, E.Z., Saraka, Y., Louis, K.K.J. (2016). Morphological Diversity among 18 Genitors of Vanuatu Tall (VTT) Coconut (Cocos nucifera L.) Population used in

Crosses for Hybrids Resistant to Lethal Yellowing Disease Selection at Port-Bouët, Côte d'Ivoire. *Greener Journal of Agricultural Sciences.*6 (4): 134-144.

- Kotagi, S., Sham Sundar K. M., Nagarajappa, D. P. (2016). Application of Cocos nucifera for Removal of Chromium and Lead from Aqueous Solution. *International Research Journal of Engineering and Technology. (IRJET)* 3(8): 1927-1933.
- Kumar, A and Singh, S.S. (2017). Preparation and quality assessment of Chhana Podo prepared by using buffalo, coconut and soy milk. *The Pharma Innovation Journal.* 6(11): 809-814.
- Kunle-Alabi, O.T., Akindele, O.O., Odoh, M.I., Oghenetega, B.O. and Yinusa Raji (2017). Comparative effects of coconut water and N-Acetyl cysteine on the hypothalamo-pituitary-gonadal axis of male rats.*Songklanakarin J. Sci. Technol.* 39 (6), 759-764.
- Lakshmanan, J., Zhang, B., Jaganathan, V., Motameni, A and Harbrecht, B.G. (2017). Tender coconut water inhibits the growth of human liver cancer cell line HepG2.*The FASEB Journal.* 31(1): 790.45.
- Laurence (2014) coconut oil and the heart. pp1-26.
- Lazim, M.I.M., Badruzaman, N.A., Peng, K.S. and Long, K. (2015). Quantification of Cytokinins in Coconut Water from Different Maturation Stages of Malaysia's Coconut (Cocos nucifera L.) Varieties. *Food processing and technology.* 6(11): 6-11.
- Lockyer, S and Stanner, S. Coconut oil – a nutty idea? (2016). *British Nutrition Foundation Nutrition Bulletin.* v. 41, pp42 –54.
- Loomba, S., Jothi, V. (2016). Cocos nucifera: its properties and contribution to dentistry. *International journal of scientific study.* vol 01 issue 03.
- Lopasovsky, L., Terentjeva, M., Kunova. S., Zelenakova, L., Kacaniova, M. (2016). Microbiological quality of ready-to-eat foods produced in Slovakia. *Journal of microbiology, biotechnology and food science.* 5(1): 31-35.
- Luo a L, Xueb M, Vachot C, Geurdenc I, Kaushik S. (2014). Dietary medium chain fatty acids from coconut oil have little effects on postprandial plasma metabolite profiles in rainbow trout (Oncorhynchus mykiss). *Aquaculture.* pp24–31.
- Mahadevan, V., Smruthi G. and Vadivel, V. (2017). Optimization of recovery of antioxidants from the coconut shell using Response Surface Methodology. *Journal of biomedical and therapeutic sciences.* 4(1): 27-33.

- Maheswarappa, H.P., Thomas, G.V., Gupta, A., Bhat, R., and Palaniswami, C. (2014). Productivity and nutrient status of coconut (Cocos nucifera) as influenced by integrated nutrient management with vermicomposted coconut leaves. *Indian Journal of Agronomy.* 59(3): 455-459.
- Man, C.M.D (2013). *shelf life*. 2nd edition. Wiley Blackwell.
- Manna, K., Khana, A., Dasa, K.R. D., Kesha, S.B., Dasa, U., Ghosha, S., Deyb, R.S., Sahac, K.D., Chakrabortyd, A., Chattopadhyaya, S., Deya, S.N., Chattopadhyay, D. (2014). Protective effect of coconut water concentrate and its active component shikimic acid against hydroperoxide mediated oxidative stress through suppression of NF-Kb and activation of Nrf2. *Journal of ethnopharmacology* 155: 132-146.
- Mandapaka, R.T., Jakkula. S.N. and Kanumuru, V.L. (2017). Coconut Oil's Consumption Boon to Human Health – A Review. *EC Nutrition* 6(3): 105-108.
- Manikantan, M.R., Arivalagan, M., Mathew, A.C. and Hebbar, K.B. (2015). Effect of processing parameters on recovery of hot process virgin coconut oil and co-products utilization. *Journal of Plantation Crops.* 43(2): 21-27.
- Manimuthu, M., Saranya, A., Pandi, S.N and Rajendran, S. (2015). Role of Coconut Water on Microbial Population of Anaerobic Digester. *International Journal of Current Microbiology and Applied Sciences.* 4(10): 945-950.
- Mannekote, J.K and Kailas, S.V. (2014). Value added products from Coconut oil. *Indian Coconut Journal.* pp38-40.
- Miah, M.Y., Bhattacharjee, S., Sultana, A., Bhowmik, S., Sarker, A.K., Paul, S.C., Zaman, S.I.A. (2017). Evaluation of amino acid profile of jackfruit (Artocarpus heterophyllus) seed and its utilization for development of protein enriched supplementary food. *Journal of Noakhali Science and Technology University (JNSTU),* 1(1): 77-84.
- Mikołajczak, N. (2017). Coconut oil in human diet – nutrition value and potential health benefits. *Journal of Education, Health and Sport.* 7(9):307-319.
- Mizan, A.A.B., Ayob, M.K, Maaruf, A.G., Yusof, M.M and Izreen I. (2015). Crystallization and Melting Profiles of Blends of Palm Mid Fraction, Virgin Coconut Oil and Canola Oil as Cocoa Butter Substitutes as Determined Using Differential Scanning Calorimeter and Pulse Nuclear Magnetic Resonance Techniques. *American-Eurasian J. Agric. & Environ. Sci.* 15 (7): 1419-1423.

- Mordi, J.C., euzuegbu, U., Opajobi, A.O., Ojieh, A.E. Hepatoprotective effects of palm oil and coconut water in the serum of Wistar rats exposed to cadmium chloride contaminated diet. *An International Journal of the Nigerian Society for Experimental Biology.* 27(2): 79–84.
- Muktawat, P. and Varma, N. (2013). Impact of Ready to Eat Food Taken By Single Living Male and Female. *International Journal of Scientific and Research Publication.* 3(11): 1-3.
- Nadeeshani, R., Wijayaratna, U.N., Prasadani, W.C., Ekanayake, S., Seneviratne, K.N., Jayathilaka, N. (2015). Comparison of the Basic Nutritional Characteristics of the First Extract and Second Extract of Coconut Milk.*International Journal of Innovative Research in Science, Engineering and Technology.* 4(10): 9516-9521.
- Naika, A., Madhusudhanb, M.C., Raghavaraoa, K.S.M.S and Subbac.D. (2015). Downstream Processing for Production of Value Added Products from Coconut. *Current Biochemical Engineering.* 2: 168-180.
- Nath, J.C., Deka, K.K., Saud, B.K. and. Maheswarappa, H.P. (2017). Performance of coconut hybrid MYD × WCT in the Brahmaputra valley region of Assam. *Indian journal of horticulture* 74(2): 173-177.
- Ndife, J., Idoko, F., Garba, R. (2014). Production and quality assessment of functional yoghurt enriched with coconut. *International Journal of Nutrition and Food Sciences.* 3(6): 545-550.
- Nguyen, V.T.A., Le, T.D., Phan, H.N., and Tran, L.B. Antibacterial Activity of Free Fatty Acids from Hydrolyzed Virgin Coconut Oil Using Lipase from Candida rugosa. *Hindawi Journal of Lipids*. pp1-7.
- Nonaka, Y., Takagi, T., Inai, M., Nishimura, S., Urashima, S., Honda, K., Aoyama, T. and Terada, S. (2016). Lauric acid stimulates ketone body production in the KT-5 astrocyte cell line. *Journal of oleo science*. 65(8): 693-699.
- OBIDOA, Onyechi; JOSHUA, Parker Elijah and EZE, Nkechi J. (2009). Phytochemical Analyses of Cocos Nucifera L. *Arch Pharm Sci and Res* 1(1): 87-96.
- Ogunrinola, O.O, Fajana, O.O., Williams, B.O., Ogedengbe, E., Onifade, A.A., Ekeocha, F.C., Shasore, K.O. (2016). The Therapeutic Potential of Cocos nucifera Water on Cadmium-Induced Lipid Toxicity in Male Rat. *International Journal of Scientific Research in Environmental Science and Toxicology.* 1(1): 1-6.

- Okafor, D. C., Ijioma, B. C., Ofoedu, C. E., Nwosu, J. C., Onyeka, E. U., Ihediohanma, N. C., Okafor, T. I. (2017). Effect of Heat and Chemical Treatments on Physico-Chemical and Sensory Properties of Coconut Milk-Orange Beverage. *Asian Journal of Agriculture and Food Sciences* 05(02): 45- 55
- Olanrewaju, T.O., Bello, K.I., Lawal, A.O., Jeremiah, I.M. and Onyeanula, P.E. Development and Performance Evaluation of a Coconut Milk Extracting Machine. Www.seetconf.futminna.edu.ng. pp661-667.
- Onggo, D., Putri, O.K. and Aminah, M. (2015). Utilization of nata de coco as a matrix for preparation of thin film containing spin crossover iron (II) complexes. *Materials Science and Engineering.* 79 pp1-5.
- Oranusi, U.S and Braide, W. (2012). A study of microbial safety of ready-to-eat foods vended on highways: Onitsha-Owerri, south east Nigeria. *International Research Journal of Microbiology.* 3(2): 066-071.
- Othaman, M.A., Shaiful Adzni Sharifudin, S.A., Mansor, A., Ainaa Abd Kahar,A.A., Kamariah Long, K. (2014). Coconut water vinegar: new alternative with improved processing technique. *Journal of Engineering Science and Technology.* 9(3): 293 – 302.
- Oyoo, M.E., Najya, M., Githiri, S.M., Ojwang, P.O., Muniu, F.K., Masha, E. and Owuoche, J.O. (2015). In-situ morphological characterization of coconut in the coastal lowlands of Kenya. *African journal of plant science.* 9(2): 65-74.
- Panda, A and Malaya K Misra..(2011). Ethnomedicinal survey of some wetland plants of south Orissa and their conservation. *Indian journal of traditional knowledge.* 10(2): 296-303.
- Pankaja, H.K., Channakeshava, S., Balaji, J. and Krishnareddy, G.S. (2017). Impact of Training Programme on Coconut Growers in Hassan District, India. *International Journal of Current Microbiology and Applied Sciences.* 6(11): 68-74.
- Patil, U., Benjakul, S., Prodpran, T., Senphan, T. and Cheetangdee, N. (2017). A comparative study of the physicochemical properties and emulsion stability of coconut milk at different maturity stages. *Ital. J. Food Sci.* volume 29 pp145- 157.
- Payanglee, K., Chonpathompikunlert, P., Panityakul, T. and Radenahmad, N. (2017). Beneficial effects of young coconut juice on preserving neuronal cell density, lipid, renal and liver profiles in ovariectomized rats. A preliminary study.*Songklanakarin J. Sci. Technol.* 39 (2), 237-243.
- Pham, L.J. (2016). Coconut (cocos nucifera). *Industrial oil crops* pages 231-242.

- Potter, N.N., Hotchkiss, J.H. (2007). *Food science.* Fifth edition. CBS publishers and distributors. pp 91-112.
- Preetha, P., Venugopal, A.P., Varadharaju, N. and Kennedy, Z.J. (2017). Inactivation of Escherichia coli in Tender Coconut (Cocos Nucifera L.) Water by Pulsed Light Treatment. *International Journal of Current Microbiology and Applied Sciences.* 6(7): 1453-1461.
- Preethi, P., Rajesh, M.K., Rahul, C.U., Jerard, B.A., Samsudeen, K., Thomas, R.J. and Karun, A. (2016). Identification and utilization of informative EST-SSR markers for genetic purity testing of coconut hybrid. *Journal of Plantation Crops.* 44(2): 77-84.
- Priya, S.R and Ramaswamy, L. (2016). Physical, chemical and microbial properties of cookies developed using coconut products. *International Journal of Recent Scientific Research.* 7(3): 9670-9674.
- Priyadarshini, V. (2015). Purchasing practice of the consumers towards ready to eat food product. *Asian journal of homescience.* 10(2): 290-295.
- Purohit, S.R., Behera, R.K., Mishra, B.K. (2017). Thermal processing of tender coconut water: A colour preservation approach. *Food and Applied Bioscience Journal.* 5(2): 82–92.
- Radenahmad, N., Suwansa-ard, S., and Sayoh, I. (2015). Young coconut juice accelerates cutaneous wound healing by downregulating macrophage migration inhibitory factor (MIF) in ovariectomized rats: Preliminary novel findings. *Songklanakarin J. Sci. Technol.* 37 (4), 417-423.
- Raghuramulu, N., Nair. K.M., Kalyanasundaram, S. (2003). *A manual of laboratory techniques.* National institute of nutrition. Indian council of medical research. Second edition.
- Rahman, S., Gangaraj, K.P., Naganeeswaran, S. and Rajesh, M. K. (2015). Transcriptome-based reconstruction of gibberellic acid biosynthetic pathway in coconut (Cocos nucifera L.). *Research Journal of Biotechnology.* 10(10): 56-63.
- Rajagukguka, H., Syukurb, S., Ibrahimc, S and Syafrizayantid. (2017). Beneficial Effect of Application of Virgin Coconut Oil (VCO) Product from Padang West Sumatra, Indonesia on Palatoplasty Wound Healing. *American Scientific Research Journal for Engineering, Technology, and Sciences.* 34(1): 231-236.

- Rajakaruna, R.K.G., Mahindarathne, M.G.P.P. and Samaranayake, H.A.E.(2014). Development of flavoured - sweet coconut chips. *Food, nutrition and livestock.* Vol. 18, 4th & 5th 2014.
- Rajesh, M.K., Rijith, J., Rahman, S., Preethi, P., Rachana, K.E., Sajini, K.K. and Karun. A. (2014). Estimation of out-crossing rates in populations of West Coast Tall cultivar of coconut using microsatellite markers. *Journal of Plantation Crops* 42(3):277-28.
- Rajeshkumar, P.P., Thomas, G.V., Gupta, A., Gopal, M. (2016). Diversity, richness and degree of colonization of arbuscular mycorrhizal fungi in coconut cultivated along with intercrops in high productive zone of Kerala, India. *Diversity, richness and degree of colonization.* 2016.
- Rakib, RH., Yesmin, M., Hemayet, A., Kabir. A. and Islam, N. (2016). Effect of fortification of skim milk with coconut milk on the proximate composition and manufacture of dahi, a traditional sweet curd. *Asian J. Med. Biol. Res.* 2 (2), 247-252.
- Ramayanti,E.D., Kusumaningtyas, S.R. (2016).The effect of consumption coconut water againts blood pressure in elderly hypertensive.
- Rana, M. N., Das, A. K. and Ashaduzzaman, M. (2015). Physical and mechanical properties of coconut palm (Cocos nucifera) stem. *Bangladesh journal of scientific and industrial research.* 50(1): 39-46.
- Rasam. D. V., Gokhale, N. B., Sawardekar, S. V. and Patil, D. M. (2016). Molecular characterisation of coconut (Cocos nucifera L.) Varieties using ISSR and SSR markers. *The Journal of Horticultural Science and Biotechnology.* Pages 1-6.
- Reddy, E.P. and Lakshmi, T.M. (2014). Coconut Water - Properties, Uses, Nutritional Benefits in Health and Wealth and in Health and Disease: A Review. *Journal of Current trends in CliniCal MediCine and laboratory biochemistry.* 2(2): 6-18.
- Rohyami, Y., Anjani,R.D. and Purwanti, N. The Influence of Saccharomyces cerevisiae Enzyme Ratio on Preparation Virgin Coconut Oil for Candidate in-House Reference Materials.
- Rojas, M.L., Trevilil, J.H., Funcia, E.D.S., Gut, J.A.W., Augusto, P.E.D. (2017). Using ultrasound technology for the inactivation and thermal sensitization of

peroxidase in green coconut water. *Ultrasonics sonochemistry.* Vol 36 pages 173-181.

- Rukmini, J.N., Manasa, S., Rohini, C., Sireesha, L.P., Ritu, S. and Umashankar, G.K. (2017).Antibacterial Efficacy of Tender Coconut Water (*Cocos nucifera* L) on *Streptococcus mutans*: An *In-Vitro* Study. *Journal of international society of preventive and community dentistry* 7(2): 130–134.
- Sanganamoni, S., Mallesh, S., Vandana, K. and Rao, P.S. (2017). Thermal Treatment of Tender Coconut Water – Enzyme Inactivation and Biochemical Characterization. *International Journal of Current Microbiology and Applied Sciences.* 6(5): 2919-2931.
- Sankaran, M., Damodaran, V., Jerard, B.A., Abirami, K. and Dam Roy S. Multiple Spicata Coconut (MSC): A Rare Type of Coconut in Andaman Islands.*Transcriptomics.* 3(2): 2.
- Santana, L.F., Cordeiro, K.W., Soares, F.L.P and Freitas, K.D.C. (2016). Coconut oil increases HDL-c and decreases triglycerides in wistar rats. *Acta Scientiarum. Health Sciences.* 38(2): 185-190.
- Satheesh, N. Review on production and potential applications of virgin coconut oil. (2015). Annals. *Food Science and Technology.* 16(1).
- Sayeed, M.S.B., Karim, S.M.R., Sharmin, T. and Morshed, M.M. (2016). Critical Analysis on Characterization, Systemic Effect, and Therapeutic Potential of Beta-Sitosterol: A Plant-Derived Orphan Phytosterol. *Medicines* 3(4): 29.
- Sethi, M and Rao, E.S. (2005). *Food science experiments and applications.* First edition. CBS publishers and distributors. pp191-194.
- Shah, N.S., Shah, P.S., Rana, V.A. (2015). Dielectric and electrical properties of coconut water and distilled water in the frequency range 20 Hz to 2 MHz at different temperatures. 21(12): 3217-3222.
- Shakeri, M., Oskoueian, E., Najafi, P. (2016). Impact of Diet Supplemented by Coconut Milk on Corticosterone and Acute Phase Protein Level under High Stocking Density. *Journal of the Faculty of Veterinary Medicine Istanbul University.* 42(1): 26-30.
- Shameer, K.S., McCormick, A.C., Subaharan, K. and Nasser, M. (2017). Volatile organic compounds in healthy and Opisina arenosella Walker (Lepidoptera: Oecophoridae) infested leaves of coconut palms. *Entomon.* 42(2): 121-132 (2017).

- Shana., Sridhar, R., Roopa, B.S., Varadaraj, M.C., Vijayendra, S.V.N. (2015). Optimization of a novel coconut milk supplemented *dahi* - a fermented milk product of Indian subcontinent. *Journal of food science and technology.* 52(11): 7486-7492.
- Sharma,G., Sunita,M., Madhvi, D. (2017). Product Development from Tender Green Coconut and Its Organoleptic Testing and Sensory Evaluation. *International Journal of Advance Research, Ideas and Innovations in Technology.* 3(6): 821-827.
- Shehu, K. And Tafinta, I. Y. (2014). Identification of fungi associated with fruit rot of coconut (cocosnuciferal.) In Sokoto State, North-Western Nigeria. *Journal of Zoological and Bioscience Research.* 1(1): 20-23.
- Shettigar, R., Lala, R., Nandvikar, N.Y. (2014). Evaluation of antimicrobial activity of coconut husk extract. *Annals of Applied Bio-Sciences.* Vol. 1 pp24-27.
- Shilling, M., Matt, L., Rubin, E., Visitacion, M.P., Haller, N.A., Grey, S.F and Woolverton, C.J. (2013). Antimicrobial Effects of Virgin Coconut Oil and Its Medium-Chain Fatty Acids on Clostridium difficile. *Journal of medicinal food* 16(12): 1079–1085.
- Silalahi, J., Yademetripermata, Effendy De Lux Putra. (2014). Antibacterial activity of hydrolyzed virgin coconut oil. *Asian journal of pharmaceutical and clinical research.* 7(2): 90-94.
- Sinaga, S.M., Margata, L. and Silalahi, J. (2015). Analysis of Total Protein and Non Protein Nitrogen in Coconut Water and Meat (Cocos Nucifera L.) By using Kjeldahl Method. *International Journal of pharmtech Research.* 8(4): 551-557.
- Sindumathi, G., Amutha, S. (2014). Processing and quality evaluation of coconut based jam. *Journal Of Environmental Science, Toxicology And Food Technology.* 8(1): 10-14.
- Sooraj, S.J., Vaisakh, V.S., Raj, P. S. S., Jyothish, J.S., Cheriyan, J., Chandran. V.V. (2016). Development of a new Coconut Dehusking and Cutting Machine. *International Journal of Scientific and Engineering Research.* 7(4):421-425.
- Soorya Parathodi Illam, Arunaksharan Narayanankutty and Achuthan C. Raghavamenon.(2018). Polyphenols of Virgin coconut oil prevent prooxidant mediated cell death. *Toxicology Mechanisms and Methods.*
- Spence, C.(2015).On the psychological impact of food colour.

- Sridhar, N., Surendrakumar, A. and Selvakumar, C. (2017). Performance Evaluation and Modification of Coconut Tree Climber. *International Journal of Current Microbiology and Applied Sciences.* 6(12): 1195-1201.
- Subermaniam, K., Saad, Q.H.M., Kamisah, Y., Othman, F. (2015). Effects of Virgin Coconut Oil on the Histomorphometric Parameters in the Aortae and Hearts of Rats Fed with Repeatedly Heated Palm Oil. *International Journal of Bioscience, Biochemistry and Bioinformatics.* 5(2): 120-131.
- Sujirtha, N., Mahendran, T. (2015). Use of Defatted Coconut Flour as a Source of Protein and Dietary Fibre in Wheat Biscuits. *International Journal of Innovative Research in Science, Engineering and Technology.* 4(8): 7344-7352.
- Sukamto, L.A. (2017). Histological analysis of cultured in vitro coconut endosperm. *Biotropia.* 24(1): 1-8.
- Sumati, R., Mudambi., Rao, S.M., Rajagopal, M.V. (2008). Food science. Second edition new age international publishers. Pp69-74.
- Taheri, J. B., Espineli, F. W.; Lu, H.; Asayesh, M.; Bakhshi, M.; Nakhostin, M. R.; Hooshmand, B. (2010). Antimicrobial effect of coconut flour on oral microflora: an *in vitro* study. *Research Journal of Biological Sciences*. 5(6): 456-459.
- Tan, T. C., Cheng, L. H., Bhat, R., Rusul, G. And Easa, A. M.(2015). Effectiveness of ascorbic acid and sodium metabisulfite as anti-browning agent and antioxidant on green coconut water (Cocos nucifera) subjected to elevated thermal processing. *International Food Research Journal.* 22(2): 631-637.
- Tazeen, N.H., Vardharaju and Chandraseka V. (2016). Influence of Ozonation on the Some Physicochemical Properties of Tender Coconut Water. *Advances in Life Sciences.* 5(10): 4153-4159.
- Thomas, T., Krishnakumar, K., Dineshkumar, B., John, A. (2017). Coconut products and its pharmaceutical applications: a review. *Current Research in Drug Targeting.* 7(1): 1-4.
- Tjin, L.D., Setiawan, A.S., Rachmawati, E. (2016). Exposure time of virgin coconut oil against oral Candida albicans. *Padjadjaran Journal of Dentistry.* 28(2): 89-94.
- Tuhumuri, E., Sancayaningsih, R.P., Setiaji, B and Usman, S. (2016). The Quality of the Harvesting Coconut (Cocos nucifera L. ‘Tall Type’) in Sasi Kelapa Culture in Namrole of South Buru, Indonesia. *Published by the American institute of physics.*

- Tyagi, N., Hooda, V., Hooda, A. and Malkani, S. (2015). Evaluation of antidiabetic potential of ethanolic and aqueous extract of cocos nucifera endocarp. *World journal of pharmacy and pharmaceutical sciences.* 4(07): 1112-1120.
- Ubi, W., Ubi, G.M., Ubi, M.W., Okweche, T. (2016). Amino acids profiles of two coconut (Cocos nucifera) progenies as influenced by breaking of primary dormancy. *International Journal of Academic Research and Development* 1(7): 37-39.
- Umesha, S. and Narayanaswamy, B. (2016). Growth Promoting Substances and Mineral Elements in Desiccated Coconut Mills (DC) Coconut Water. *International Journal of Current Microbiology and Applied Sciences* 5(4): 532-538.
- Vala, G. S., Kapadiya, P. K. (2014). Medicinal Benefits of Coconut Oil. *International Journal of Life Sciences Research* 2(4): 124-126).
- Venugopal, A., Rinu, K. A., Joseph, D. (2017). Cocos Nucifera: It's Pharmacological Activities. *World journal of pharmaceutical science.*5(8): 195-200.
- Watson, G.W., Adalla, C.B., Shepard, B.M and Carner, G.R. (2015). Aspidiotus rigidus Reyne (Hemiptera: Diaspididae): a devastating pest of coconut in the Philippines. *Agricultural and Forest Entomology.* 17: 1–8.
- Wichchukit, S. and Mahony. M.O. (2014).The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. *Society of Chemical Industry.*
- Yong, J.W.H., Liya Ge, Yan Fei Ng and Tan, S.N. (2009). The Chemical Composition and Biological Properties of Coconut (Cocos nucifera L.) Water. *Molecules.* vol 14, pp5144-5164.
- Young H.S., Miller-ter Kuile, A., Mccauley, D.J., and Dirzo, R. (2017). Cascading community and ecosystem consequences of introduced coconut palms (Cocos nucifera) in tropical island. *Canadian Journal of zoology* volume 95 issue 3.
- Ysidor, K.N.G., Jean-Louis, K.K., Roger, K.B., Rachel, A.R., Joelle, O.D.M., Emmanuel, I.A.U and Marius, B.G.H. (2015). Changes in the physicochemical parameters during storage of the inflorescence sap derived from four coconut (cocos nucifera L.) varieties in cote d ivoire. *Americal journal of experimental agriculture.* 5(4): 352-365.
- Yun, M.S., Zzaman, W., Yang, T.A. (2015). Effect of Superheated Steam Treatment on Changes in Moisture Content and Colour Properties of Coconut

Slices. *International journal on advanced science engineering and information technology* 5(2): 2088-5334.

- Zubair, S., Sarfaraz, S., Naveed, S. and Sarwar, G. Evaluation of Effect of Coconut Milk on Anxiety. (2017).*Journal of Analytical and Pharmaceutical Research.* 6 (4): 1-5.
- Zuraida, A. R., Sentoor, K.G., Ahmad, N., Farhanah, M., Syahirah, S., Ayu, N.O. (2017). Regeneration of in Vitro Shoot and Root Structure through Hormone Manipulation of Coconut (MATAG F2) Zygotic Embryos. *American Journal of Plant Sciences.* 8: 340-348.

Web sites

- http://www.sanskritimagazine.com/rituals-and-practices/importance-and-significance-of-coconut.
- https://www.coconutresearchcenter.org.
- WWW.KAU.IN.
- http://www.gamutonline.net.
- http://edis.ifas.ufl.edu/fs156.
- (https://gardenerdy.com/history-of-coconut-tree).

APPENDIX I

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam
Institute for Home Science and Higher Education for Women
University
(Estd. u/s 3 of UGC Act 1956)

Chairman
Dr. S. Ramalingam
Principal, PSG Institute
of Medical Sciences
& Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Associate Professor,
Department of Food Service
Management & Dietetics

Members
Dr. S. Kowsalya
Dr.P.R.Padma
Mr. K.Arulmoli (Legal Expert)
Dr. N.S. Rohini
Dr.A. Saraswathy
Mrs. V. Mangayarkarasi
Dr.Subhashini K. Sripathi
Mrs. S. Radha Devi
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

19th March 2018

To
Ms. T.Haritha
Department of Food Science and Nutrition
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Haritha,

Ref: Your proposal No. IHEC/17-18/FSN/04 "Development of Coconut Flakes with Different Flavours and Ready To Eat Mix and Assessing the Nutrient Content" submitted for approval of the IHEC on 14th December.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/17-18/FSN/04 "Development of Coconut Flakes with Different Flavours and Ready To Eat Mix and Assessing the Nutrient Content" submitted by you. The Approval number for the same is AUW/ IHEC/ FSN -17-18/XPD/04.

We wish you all the best in your research endeavours.

Regards,

Dr.S.Uma Mageshwari
Member Secretary

APPENDIX II

SCORE CARD FOR SENSORY EVALUATION

Name:

Class:

Date:

Score card based on nine point hedonic scale

9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like or dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

Criteria	**Standard**	**Variation I**	**Variation II**	**Variation III**
Appearance				
Colour				
Flavour				
Texture				
Taste				
Overall acceptability				

Comments: signature of the judge

APPENDIX III

DETERMINATION OF MOISTURE CONTENT

AIM:

To determine the moisture content of the given food sample and calculate the percentage of moisture content.

APPARATUS:

Low- flat bottomed dishes, asbestos, analytical balance, weight box, tongs, desiccators and electric oven.

PROCEDURE:

Heated a pair of weighing bottles at 100°c in an oven and labelled A and B. Placed on an asbestos sheet for 2 minutes and then transferred them to a desiccators where they remained for half an hour. Recorded their weights in an analytical balance. Repeated this procedure till two successive weights obtained constant (with maximum difference of 0.0002g). Weighed definite amounts of food material (2g) in each dish and placed in an electric oven thermostatically controlled at 100-105°c. Heated for a stipulated time (2 hours), cooled in a desiccators for half an hour and weighed. This was also weighed till successive weighings showed no further loss.

ESTIMATION OF NITROGEN

AIM:

To determine the amount of nitrogen present in the given sample.

REAGENTS:

1. N/70 Sulphuric acid
2. 40% sodium hydroxide
3. 2% boric acid (in warm water)
4. Digestion mixture: a mixture of copper sulphate and potassium sulphate in the ratio 2:98
5. Concentrated sulphuric acid
6. Mozazaga indicator: A mixture of bromocresol green and methyl red indicator in 95% alohol in the ratio 4:1 (80mg and 20mg in 100 ml alcohol).

PROCEDURE:

0.5g of the sample was taken into the digestion flask. To this added 15 ml of concentrated sulphuric acid and a pinch of digestion mixture as a catalyst. Kept at boiling gently over a heating mantle. After digestion, the flask was cooled and the contents were transferred to a 100 ml standard flask and made upto the mark with distilled water. The whole apparatus was washed with distilled water and allowed to back suck. 10 ml of boric acid was taken in a conical flask. A drop of indicator was added to it and kept under the condenser. The tip of the condenser was well below the liquid. 5 ml of the digested blank was added into the distillation chamber through the funnel. Then added 10 ml of 40% Sodium hydroxide.Washed the funnel with 2 to 3 ml of distilled water. Closed the tap and steam was generated. Steam entered the distillation chamber and drove all the ammonia which is in turn absorbed by boric acid. Solution was pinkish white in colour, turned blue. Steam was passed for 5 minutes and then the conical flask was lowered and the tip of the condenser washed. The boric acid solution containing liberated ammonia was titrated against N/70 sulphuric acid, The end point was the appearance of pale permanent pink colour. Between each estimation the apparatus was washed. The experiment was repeated to get concordant values.

DETERMINATION OF FIBRE CONTENT

AIM:

To determine the fibre content of the given food sample.

APPARTUS:

Weighing balance, beaker, glass rod, funnel, muslin cloth, burner and wire gauze.

REAGENTS:

1. 0.255N Sulphuric acid: 0.9 ml of sulphuric acid in 99.1 ml of water.
2. 0.313N sodium hydroxide: 0.8g sodium hydroxide in 99.2 ml water.
3. Ether
4. Alcohol

PROCEDURE:

5g of the sample was weighed into a 500 ml beaker and 200 ml of boiling 0.255N sulphuric acid was added. the mixture was boiled for 30 minutes, keeping the volume constant by adding water at frequent intervals (a glass rod inserted in the beaker helps smooth stirring and boiling). At the end of the period, the mixture was filtered through a muslin cloth and the residue was washed with hot water till free from acid. The mixture was the transferred to a beaker containing 200 ml of boiling 0.313N sodium hydroxide. After boiling for 30 minutes (keeping the volume constant as before) the mixture was filtered through a muslin cloth. The residue was washed with hot water till free from alkali followed by washing with some alcohol and ether. It was then transferred into a crucible, dried overnight at 80-100°c and weighed. The crucible was heated in a muffle furnace at 600°c for 2-3 hours. Cooled and weighed again. The difference in the weight represents the weight of the fibre.

ESTIMATION OF CALCIUM

AIM:

To estimate the amount of calcium present in the given sample.

APPARTUS:

Beaker, burette, pipette, flask and standard flask

REAGENTS:

1. Ammonium oxalate: ammonium oxalate was dissolved in 200 ml of water till it was saturated.
2. 0.001N oxalic acid: 0.0063g oxalic acid crystals weighed and dissolved in 100 ml of distilled water.
3. 0.01N potassium permanganate: o.316g of potassium permanganate was dissolved in 1000 ml of distilled water.
4. Strong ammonia
5. Glacial acetic acid. 2N sulphuric acid: 5.5 ml of sulphuric acid was dissolved in 94.5 ml of distilled water.

PROCEDURE:

Ash from the ignited sample was dissolved in hydrochloric acid and made upto the 100 ml. 10 ml of the ash solution was pipette out in a conical flask and 90 ml of distilled water was added to it. Added 2 drops of methyl red indicator. It was made strongly alkaline by adding ammonia and kept for boiling. 20 ml of saturated ammonium oxalate was added to the solution, 10 ml each time to ensure complete precipitation directly. When it was hot, a few drops of acetic acid was added to render the medium acidic. The precipitation was allowed to settle overnight. The next morning the solution was filtered with whatman No.40 filter paper. The precipitate was washed first with ammoniacal water and then with hot water several times until it was free from chloride. To test it 5 ml of the washing was collected, in a test tube and a drop of silver nitrate solution was added. the washing was continued till there was no precipitate with silver nitrate or calcium chloride solution. The filter paper was collected in a flask by making a hole in the filter paper. To this, 2 ml of 2N sulphuric acid was added. the solution was heated to 60-80°c and when still hot was titrated against N/100 potassium permanganate solution. From the volume potassium permanganate solution used up the milligrams of calcium present in 100g of the sample was calculated.

ESTIMATION OF FAT CONTENT

AIM:

To determine the fat content of the food stuff

REAGENT:

Petroleum ether

PROCEDURE:

The soxhlet flask was weighed to consecutive weights. 5g of the moisture free sample was placed into an extraction thimble and placed in an extractor which was fixed into a soxhlet flask. Poured sufficient amount (150 ml) of pertroleum ether so as to permit siphon acting the thimble and the contents were allowed to soak in ether for 24 hours. The entire set up was kept over an electric water bath and the extractor was connected to the condenser. The nozzle of the condenser was always plugged with moistened the cotton. The temperature was maintained at 60°c. A steady steam of water in the condenser was maintained. The ether evaporated rose up but owing to the condenser arrangement it fell back into the condenser extractor. When the extractor get filled with ether, it was siphoned back into the flask. This went on till the ether that get collected in the extractor was free from any yellow colour indicating the presence of fat. The soxhlet flask was then disconnected and ether was evaporated in a water bath maintained at 60°c. When the ether in the flask was evaporated, the flask was weighed again to get concordant values. From the difference in weight, the fat content was calculated.

PHENOL SUPLHURIC ACID METHOD FOR TOTAL CARBOHYDRATE

PRINCIPLE

In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This forms a green colored product with phenol and has absorption maximum at 490nm.

MATERIALS

» Phenol 5%: Redistilled (reagent grade) phenol (50g) dissolved in water and diluted to one liter.

» Sulphuric acid 96% reagent grade.

» Standard Glucose: Stock – 100mg in 100mL of water. Working standard – 10mL of stock diluted to 100mL with distilled water.

PROCEDURE

1. Weigh 100mg of the sample into a boiling tube.
2. Hydrolyse by keeping it in boiling water bath for 3 hours with 5mL of 2.5 N-HCl and cool to room temperature.
3. Neutralise it with solid sodium carbonate until the effervescence ceases.
4. Make up the volume to 100mL and centrifuge.
5. Pipette out 0.2, 0.4, 0.6, 0.8 and 1mL of the working standard into a series of test tube.
6. Pipette out 0.1 and 0.2mL of the sample solution in two separate test tubes. Make up the volume in each tube to 1mL with water.
7. Set a blank with 1mL of water.
8. Add 1mL of phenol solution to each tube.
9. Add 5mL of 96% sulphuric acid to each tube and shake well.
10. After 10min shake the content in the tubes and place in a water bath at 25-30°C for 20min.
11. Read the color at 490nm.
12. Calculate the amount of total carbohydrate present in the sample solution using the standard graph.

APPENDIX IV

PEROXIDE VALUE- ACOS METHOD

APPARTUS:

1. Balance capable of weighing to the nearest 0.1 mg.
2. 250 ml. glass stoppered Erlenmeyer flasks.
3. 10 ml Class B Burette, graduated in 0.05 divisions, with a tolerance of ±0.04 ml.
4. Mohr pipette capable of containing 1 ml with a tolerance of ±0.04 ml.
5. 2-graduated cylinders capable of containing 50 ml.
6. Dispensing device, capable of dispensing 1 ml.

REAGENTS AND SOLUTIONS

1. Acetic Acid - chloroform solution (480ml Acetic Acid and 320ml Chloroform).
2. Saturated Potassium Iodide solution. Store in the dark.
3. Sodium thiosulfate solution, 0.1N. Commercially available.
4. 1% Starch solution. Commercially available.
5. Distilled or deionized water

METHOD:

Conduct a blank determination of the reagents daily. Weigh 5.00 (±0.05)g of sample into a 250 ml glass stoppered Erlenmeyer flask. Record the weight to the nearest 0.01g. By graduated cylinder, add 30 ml of the acetic acid - chloroform solution. Swirl the flask until the sample is completely dissolved (careful warming on a hot plate may be necessary). Using 1 ml Mohr pipette, add 0.5 ml of saturated potassium iodide solution. Stopper the flask and swirl the contents of the flask for exactly one minute. Immediately add by graduated cylinder, 30 ml of either distilled or deionised water, stopper and shake vigorously to liberate the iodine from the chloroform layer.

Fill the burette with 0.1N sodium thiosulfate. If the starting color of the solution is deep red orange, titrate slowly with mixing until the color lightens. If the solution is initially a light amber color, go to the next step. Using a dispensing device, add 1 ml of starch solution as indicator. Titrate until the blue gray color disappears in the aqueous (upper layer). Note: for Doe-120, titrate until the lower layer has a "milky" appearance. Accurately record the mls of titrant used to two decimal places.