Standardisation of Chia Seed (*Salvia Hispanica*) Incorporated Recipes and Analysis of Nutrient Content

K. Indhu

(15PFN004)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641043

In Partial Fulfilment of the Requirement for the

Degree of Master of Science in Food Science and Nutrition

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Acknowledgment

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I INRODUCTION

Chia (*Salvia hispanica L.*) is an annual herbaceous plant belonging to the Lamiaceae or Labiatae family (Segura-Campos *et al.*, 2014). Chia is an annual herb, native to Mexico and Northern Guatemala which blooms in summer season. The name Salvia originates from the Latin word Salvare, meaning "the healer" (Coorey *et al.*, 2012).

Salvia hispanica L., commonly known as Chia, is an oilseed plant that was once used by the Aztecs not only as a foodstuff, but also as an offering to the gods. This seed is a natural source of omega-3 and omega-6 (α-Linolenic acid), fibre (+30 per cent), proteins of high biological value, and natural antioxidants that protect the seed against certain adverse conditions (Craig, 2004).

Chia seeds began to be used in human food around 3500 BC, and acquired importance as a staple crop in central Mexico between 1500 and 900 BC (Cahill, 2003; Ayerza and Coates, 2005**).** Aztecs and Mayans used the seeds for the preparation of various medicines, food and paintings. It was one of the main crops of pre-Columbian societies, surpassed only by corn and beans.

This seeds have a small, oval and flatted shape and they measure between 2 and 2.5 mm length, 1.2 and 1.5 mm width and 0.8 to 1 mm of thickness. Its colour varies from dark brown to black, sometimes grey or even white. The dry and clean seed can be kept for years because it has antioxidants that prevent the deterioration of essential oils. One of the main properties of this seed is that it is natural source of omega –3 (corresponding to 75 per cent of the total seed oil) and omega –6. It also has significant concentrations of natural antioxidants, primary and synergistic such as chlorogenic acid, caffeic acid, quercetin and kaempferol, soluble and insoluble fibre, vitamins and minerals. The seed also has significant amount of dietary fibre compared with other fruits and seeds. When the seed is placed in water, it exudes a mucilaginous polysaccharide that surrounds it. This mucilage has interesting properties for food, care and pharmaceutical industries. It has been reported that when mucilage from chia is consumed, it aids digestion while the whole seed is a nutritive food (Nieman *et al.*, 2009)

The plant produces small white and dark seeds. Most of the chia population that is commercially grown today contains a low percentage of white seeds. Their shapes are oval and in general, the white seeds are somewhat larger than the black ones (Ixtaina *et al.*, 2011).

Insoluble fibre is found in the seed's outer coating and works like an intestinal sweeper. The outside of the chia seed is covered with invisible tiny fibres standing on end, which trap the liquid to cause a layer of gel to form around the seed. The liquid is removed slowly by the digestive system, which keeps the colon hydrated while releasing the electrolytes and nutrients, keeping food moist is a way to prevent constipation and diverticulitis (Jonathan Landsman, 2012).

According to Ixtaina *et al.* (2008) and Marineli *et al.* (2014), chia has been investigated and recommended for use due to its high percentage of fatty acids which are beneficial to health, proteins, antioxidants and dietary fibre.

Chia seeds contain a good balance of essential amino acids, so the body should be able to make use of the protein in them. Chia seeds are high in quality protein much higher than most plant foods. Protein is the most weight loss friendly macronutrient and can drastically reduce appetite and cravings (Sandoval- Oliveros *et al.*, 2013).

Chia seed is composed of protein (15–25 per cent), fats (30–33 per cent), carbohydrates (26–41 per cent), dietary fibre (18– 30 per cent), and ash (4-5 per cent), it also contains a high amount of vitamins, minerals, dry matter (90–93 per cent) and antioxidants. The seed contains from 25 per cent to 40 per cent oil with 60 per cent of it comprising (omega) ω-3 alpha linolenic acid and 20 per cent of (omega) ω-6 linoleic acid (Ali *et al.*, 2012).

Salvia hispanica L. (chia) seeds are a promising source of antioxidants due to the presence of polyphenols, chlorogenic and caffeic acids, myricetin, quercetin, kaempferol as well as essential fatty acids (Reyes-Caudillo *et al.*, 2008).

Chia seeds are an excellent source of healthy polyunsaturated fats, especially omega-3 fatty acids, which are not made by the body and must be obtained from foods. The three main omega-3 fatty acids are: Alpha-LinolenicAcid (ALA), Eicosa

Pentaenoic Acid (EPA) and Docosa Hexaenoic Acid (DHA). ALA comes from plants, vegetable oils, nuts and seeds. EPA and DHA come from fish and fish oils. Our body converts ALA to EPA and DHA, which have the most potent health benefits (examples: reducing risk factors for heart disease, including high cholesterol and high blood pressure, and important roles in cognition and eyesight) (Ricardo and Coates,2005).

Heavy metal analysis showed that chia seed contains them at safe levels, not exceeding the maximum metal levels for food safety, and the seed is also free from mycotoxins (Bresson *et al.*, 2009). Another key feature of chia seed is that it does not contain gluten (Bueno *et al.*, 2010). Recent studies on chia seeds have focused on phytochemicals and their extractions from the seed.

Adkins and Kelley (2010) review found that numerous epidemiological studies have demonstrated the benefits of dietary omega-3 PUFAs on cardiovascular health. Intervention studies have established that omega-3 is beneficial for both primary and secondary prevention of cardiovascular disease.

In recent years, chia seeds have been included in the human diet due to the health benefits associated with their composition (Borneo *et al.*, 2010; Ixtaina *et al.*, 2011; Capitani *et al.*, 2012).Chia helps to prevent cardiovascular diseases, inflammatory and nervous system disorders, and diabetes, among others (Vuksan*et al.*, 2007). Unsaturated Omega-3 fatty acids are nutritionally important for good health and are beneficial for individuals suffering from heart disease, diabetes and immune response disorders (Al-Sheraji *et al.*, 2013).

Functional foods have received heavy attention in recent years as components of healthy lifestyle changes. The term “functional” is used to refer to a food that is regularly consumed to provide physiological benefits or to reduce the risk of chronic disease in addition to its basic nutritional functions. Many new foods contain bioactive functional compounds including fibre, prebiotics, probiotics, oligosaccharides, phytochemicals, antioxidants, and other substances that confer functional properties or beneficial effects on human health (Mcclements *et al.*, 2007)

Various active ingredients including essential fatty acids and phenolic compounds have been identified in chia seed. There are many factors that may cause

variations in the concentrations of the active compounds in chia seed. One of them is the cultivation area of the plant itself. Differences in the environment, climate changes, availabilities of nutrient, year of cultivation, or soil conditions play crucial roles to the variations (Dubois *et al.*, 2007).

The major market growth for Poly Unsaturated Fatty Acids in the future appears to be related to increasing the content of PUFAs in the human diet through dietary supplements (Ward and Singh, 2005). Therefore, the incorporation of seeds such as chia in the diet, which contain high contents of these fatty acids, is particularly desirable. However, a major challenge to the development of enriched food products is presented by the multiple acceptance criteria: product freshness, sensory characteristics, appearance, storage conditions, ease of preparation and safety standards, which must be achieved, despite the addition of an active ingredient and nutritional benefits(Drusch and Mannino, 2009).

The chia seed supports healthy colon activity while helping eliminate toxic wastes. Chia seeds have a fibre content of more than 36 per cent and the remarkable ability to absorb ten times its weight in water, making it a wonderful way to stay hydrated. By hydrating the colon – it makes it easier for your digestive system to move food through the gut and be eliminated in a timely manner (Jonathan Landsman, 2012).

Dry chia seeds can also be added whole or ground to smoothies and juices, mixed into yogurt or oatmeal, or sprinkled on top of a salad. If you're adding the seeds to a drink or a "wet" dish like oatmeal, they'll swell up slightly while you eat, but they'll retain a slight crunch (Azeona *et al.*, 2008). When added to the diets of pigs and chickens, chia seed boosted the levels of Omega-3 fatty acids and reduced the amount of cholesterol found in the meat and eggs (Ayerza *et al.*, 2002; Azeona *et al.*, 2008; Coates *et al.*, 2009)

Rekha Battalwar (2015) Studies have shown that chia seeds (especially if they are milled) can increase blood levels of ALA and EPA, but not DHA which is a problem (Nieman *et al.*, 2012; Jin *et al.*, 2012). In two studies, a diet with chia seeds, soy protein and oats has been shown to lower LDL cholesterol and triglycerides,

increase HDL cholesterol and reduce inflammation (Vazquez Manjarrez N *et al.,* 2014; Guevara-Cruz M *et al.*, 2012)

The Food and Nutrition Board of the National Institute of Medicine suggests that men under the age of 50 consume 38 grams of chia seed per day and women under the age of 50 consume 25 grams of chia seed per day. For adults over 50 years age, the recommendation of chia seed for men is 30 grams per day and for women is 21 grams per day. Most people are not consuming even half of that recommendation in a day.

The easiest way to increase fibre intake is to increase your consumption of plant-based foods like fruits, vegetables, nuts, seeds and unprocessed grains. Just one ounce of chia seeds provides 10 grams of fibre, almost half the daily recommendation for a woman over 50.

Hence the present study entitled "**Standardization of Chia Seed Incorporated Recipes and Analysis of Nutrient Content**" was conducted with the following objectives:

- Develop and standardisation of chia seed incorporated recipes.
- Conduct acceptability trials for the selected recipes.
- Determine the nutrient content of the selected recipes.

II REVIEW OF LITERATURE

The review of literature pertaining to the present study entitled "Standardization of chia seed (*Salvia hispanica* L,) incorporated recipes and Analysis of Nutrient Content" Is presented under the following headings:

2.1 Chia Seed - History and Botanical description

2.2 Nutritional information about chia seed

2.3 Health Benefits about chia seed

2.4 Acceptability of Chia seed incorporated recipes

2.5 Role of chia seed in specific recipes

2.1. CHIA SEED - HISTORY AND BOTANICAL DESCRIPTION

Chia is native to the central valleys of Mexico and northern Guatemala, where the species of the Labiatae family are concentrated, and scientific observations can be found in one of the twelve volumes of the Florentine Codex, written by Fray Bernardino de Sahagun at the time of the conquest of America between1548 and 1580. Chia seeds began to be used in human food around 3500 BC, and acquired importance as a staple crop in central Mexico between 1500 and 900 BC (Cahill, 2003; Ayerza and Coates, 2005)

Chia seed, Salvia hispanica, was first cultivated by the Aztecs as an important food crop in the pre-Columbian times. In Mayan, chia is the word for "strength". Mayan warriors consumed chia seed to last on long hunts, because it contains large levels of proteins, fibre, polyunsaturated fatty acids and antioxidants (Dorsey-Kockler, 2011).

Chia (*Salvia hispanica* L.) is an annual plant of the family Lamiaceae. In pre-Columbian times, its seeds were one of the staple foods of Central American civilizations. Chia seeds are composed of proteins (15–20 g/100 g), lipids (30–33 g/100 g), ash (4–5 g/100 g) and carbohydrates (26–41 g/100 g) and have a high fibre content (18–30 g/100 g). These seeds contain a large amount of antioxidants, minerals and vitamins (Ixtaina *et al.*, 2008).

In the 1980's, chia seeds became very popular with children and were grown on clay animal figurines known as Chia Pets. Today, chia seed are cultivated in Mexico, Guatemala, Australia, Bolivia, Argentina and Ecuador (USDA, 2010).

These seeds are small and oval, approximately one mm in diameter and contain a mild nutty flavour. They are speckled with brown, gray, black and white colours. The majority of the seeds are black (90 per cent) while the remaining are white (10 per cent). Chia seeds can be consumed in four different forms; whole, ground, flour or oil. The most common and recommended consumption is the whole chia seed. Whole chia seeds can be added directly to any type of food indry form or used within recipes as a gel. When chia seeds are mixed with water in a 1:6 or 1:8 ratio, they obtain gelatinous properties that can be added to foods such as puddings and smoothies (Dorsey-Kockler, 2011).

A chia gel can be used as a fat replacer in many types of recipes. For example, one-fourth cup of oil can be replaced with a chia gel containing one-fourth cup water and one tablespoon of chia seeds. Ground chia is another way to consume chia seed, which is theoretically more bioavailable, but no studies have been conducted to confirm this (Dorsey-Kockler, 2011).

The seeds of chia, corn, beans and amaranth formed the main components of the diet of the Pre-Columbian peoples of the Americas, diets that, compared with their modern counterparts, met the dietary requirements established today by the Food and Agriculture Organization and the World Health Organization (FAO, 2011).

2.1.1. Botanical and taxonomic description

The chia plant belongs to the Lamiaceae family, which in turn is part of the mint family (Hentry *et al.*, 2009). Its taxonomic description is as follows:

Kingdom:Plantae

Subkingdom:Tracheobionta – Planta vascular

Super division: Spermatophyta– Planta de semillas

Division: Magnoloiphyta – Planta con Flores

Class: Magnoliopsida - Dicotiledónea

Subclass: Asteridae

Order: Lamiales

Family: Lamiaceae

Genera: Salvia

Specie:Hispanica

Chia (*Salvia hispanica* L.) is an annual herb that blooms during the summer months. The seeds are oval, smooth and shiny, and are mottle-colored with brown, grey, dark red and white, and are generally found in groups of four (Ayerza and Coates, 2005, USDA, 2008).

2.2. NUTRITIONAL INFORMATION ABOUT CHIA SEED

Chia Seeds (*Salvia hispanica* L.) contain oil amounts varying between 32-39per cent, with the oil offering the highest known natural percentage of alpha-linolenic fatty acid (60- 63 per cent). Alpha-linolenic acid is an essential fatty acid acting in the human body as a substratum for the transformation into EPA and DHA through the action of desaturation and elongation enzymes. The seeds also contain someomega-6 essential fatty acids and exhibit a favourable omega-3 to omega-6 ratio of 3:1. Modern diets contain too few omega-3 fatty acids. The seeds possess 19-23 per cent protein and the amino acids of chia protein have no limiting factors in the adult diet (i.e., they are a complete protein source providing all of the essential amino acids in an appropriate balance) (www.natural healthy choice.ca)

According to the USDA National Nutrient Database, one ounce of chia seeds (approximately 28 grams) contains 138 calories, 8 grams of fat, and 12 grams of carbohydrate, 10 grams of fibre and 5 grams of protein. Eating one ounce of chia seeds per day would provide 18 per cent of daily calcium needs, 27 per cent of phosphorus, 30 per cent of manganese and smaller amounts of potassium, zinc and copper.

Chia seeds are rich source of healthy fats, dietary fibre, protein, and several minerals. The total calories in 1 tablespoon of chia seeds is 69 calories. They also contain a high amount of antioxidants (Valdivia-Lopez and Tecante, 2015). One Tablespoon of chia seeds contains 60 calories, 4.5g of fat, 5g of carbohydrate, 5 g of fibre, and 3 g of protein. Chia is one of the most significant natural sources of omega-3, the main effect of which is to reduce the level of triglycerides, moderately increasing blood levels of HDL cholesterol and lowering levels of LDL cholesterol. By preventing the formation of clots and plaques in the arteries, it helps to prevent cardiovascular disease. The seed is rich in fibre, making it ideal for the proper functioning of the intestine, and contains highly nutritious proteins, more than traditional cereals. It provides a good source of B vitamins plus minerals such as calcium, magnesium, phosphorus, zinc, potassium and others (De Tucci, 2006).

Nutritional composition of chia seed is listed below in Table I:

TABLE I

NUTRITIONAL COMPOSITION OF CHIA SEED

Nutrient per 100 g		**Nutrient per 100 g**	
Energy (Kcal.)	486	Cholesterol (mg)	0
Proteins (g)	16.54	Carbohydrate (g)	42.12
Total fat (g)	30.74	Total dietary Fibre (g)	34.4
Fatty acids, total saturated (g)	3.33	Folate (µg)	49
Fatty acids, total mono unsaturated (g)	2.309	Vitamin A	54 Iu
Fatty acids, total polyunsaturated (g)	23.67	Vitamin C (mg)	1.6
Fatty acids Omega-3 (g)	17.83	Phosphorus (mg)	860
Iron (mg)	7.72	Calcium (mg)	631

Source: USDA Nutrient Database for standard Reference, Release 24 (2011)

2.2.1. Antioxidants

Chia seed contain antioxidants, which help to fight free radicals in our body. Chia seed has a number of compounds that can act as antioxidants, an asset that makes the seed even more attractive. Among the most important are the flavonols, chlorogenic acid and caffeic acid, as well as its content of myricetin, quercetin and

kaempferol (Taga *et al.*, 1984). These compounds are primary and synergic antioxidants and make a proportionally greater contribution to the antioxidant activity of chia (Fernández *et al.*, 2006).

Chia seeds are an extremely good source of antioxidants. According to a research paper by Dolores Alvardado from the University of the Valley of Guatemala, chia seeds have an antioxidant rating of over 1900, expressed as Vitamin C Equivalent Antioxidant Capacity (milligrams of vitamin C per 100 grams). With this antioxidant rating, chia seeds beat many common food sources of antioxidants including blackberries, grapes, pineapple, mango, noni fruit and carambola. Nutrients and phytochemicals that contribute to the antioxidant capacity of chia seeds include flavonoids (such as quercetin, myricetin, kaempferol), phenolic acids (such as caffeic acid), lignin and vitamins C and E (Dolores, 2015)

2.2.2.Omega 3 fatty acids

Omega-3 and omega-6 Fatty Acids are essential polyunsaturated fatty acids (PUFAs). Alpha Linolenic Acid (ALA) and Linoleic Acid (LA) are the major long chain Fatty acids belonging to the omega-3 and omega-6 groups respectively. LA and ALA are required for structural integrity of cell membranes as well as being precursors for longer chain FAs which are required for eicosanoid compounds, prostaglandins and leukotriene's (Mann and Truswell, 2007).

Linoleic Acid is converted to arachidonic acid in the body, while ALA is metabolized to yield the long chain fatty acid Eicosa Pentaenoic acid (EPA), which further undergoes elongation, desaturation and alpha oxidation to produce Docosa Hexaenoic acid (Adkins and Kelley, 2010).

Metabolism of dietary LA to arachidonic acid uses the same enzymes (delta 6 desaturase elongase delta5 desaturase) as in the synthesis of DHA from ALA. As this pathway is shared by the two FAs, they compete for the same enzymes, which means a high ratio of LA to ALA in the diet reduces the amount of ALA converted to EPA and DHA (Adkins and Kelley, 2010; Mann and Truswell, 2007). Thereby reducing the possible chances to convert ALA to EPA and DHA, which are the compounds beneficial to humans, hence, a diet of high ALA is beneficial.

2.2.3. Fibre

Chia seeds produce between 36 and 40 g of dietary fibre per 100 g, equivalent to 100 per cent of the daily recommendations for the adult population; the defatted flour possesses 40 per centfibre, 5 per cent of which is soluble and forms part of the mucilage (Reyes-Caudilloetal., 2008).One tablespoon (Tbsp) of chia seeds contains one-sixth of our daily fibre needs. A high- fibre diet keeps the digestive system healthy and can reduce cholesterol.

2.2.4.Minerals

Chia seeds are a good source of manganese, phosphorus, magnesium, calcium, and iron. These minerals play a role in bone and teeth health, protein turnover, and utilization of other nutrients in our body.

The lipid content in chia seeds varies from 25per cent to 40 per cent, with 60 per cent of the total lipids made up of ALA (ω-3) and 20 per cent composed of linoleic acid (ω-6) (Bres-son *et al.* 2009). When the oil is extracted from the chia seed, what remains is a significant concentration of dietary fibre (33.9g/100g) and protein (17g/100g) (Ayresa and Coates 1999; Craig and Sons 2004).

2.3. HEALTH BENEFITS ABOUT CHIA SEED

According to Ayerza and Lauria (2002), Chia is a flowering plant belonging to the mint family. Its seeds are cultivated and respected around the world thanks to their high nutritional content. These seeds were consumed for hundreds of years, and were possibly a staple in the diet of the Aztec and Mayan people long ago.

Functional foods have gained tremendous attention world- wide over the past few years due to the wave of healthy lifestyle changes. One of the reasons for the interest to shift to a healthier lifestyle is the increasing number of people suffering from Cardio Vascular Diseases (CVDs), high blood pressure, obesity, diabetes, and other related diseases. These conditions are commonly due to inactive lifestyle and poor diet where the food consumed daily contains high amounts of Saturated Fatty Acids (SFAs).

Omega-3 Fatty Acids Chia seeds are an excellent source of healthy polyunsaturated fats, especially omega-3 fatty acids, which are not made by the body and must be obtained from foods. The three main omega-3 fatty acids are: Alpha-Linolenic Acid (ALA), Eicosa Pentaenoic Acid (EPA) and Docosa Hexaenoic Acid (DHA). ALA comes from plants, vegetable oils, nuts and seeds. EPA and DHA come from fish and fish oils. Our body converts ALA to EPA and DHA, which have the most potent health benefits (Ayerza and Coates, 2011).

Of total dietary fibre, the greatest fraction (53.45g/100g) comprises insoluble fibre, which plays a role in satiety and proper bowel function (Vazquez *et al.*, 2008). Rich in magnesium and phenolic compounds (mainly quercetin and kaempferol), chia seed offers significant antioxidant capacity (Lee 2009; Caudillo *et al.*, 2008), while its calcium and potassium content suggests it may be helpful in controlling High Blood Pressure (HBP) (Vuksan *et al.*, 2007).

The seeds are an excellent source of vitamins like niacin, riboflavin, thiamine, folic acid. Niacin is an important B-complex vitamin found abundantly in chia, nearly more than twice the amount in sesame seed 100 g of chia provide about 8.83 mg or 55per cent of daily-required levels of niacin. Niacin helps to reduce LDL-cholesterol levels in the blood. In addition, it enhances GABA activity inside the brain which in turn helps to reduce anxiety and neurosis(http://wellnessmama.com).

The seeds are good sources of many essential minerals. Calcium, phosphorous, iron, manganese, and magnesium are particularly concentrated in chia. Many of these minerals have a vital role in bone mineralization, red blood cell production, enzyme synthesis, as well as regulation of cardiac and skeletal muscle activities (Nutritiondata.com).

The phenolic compounds found in chia seeds may decrease the invasiveness of cancer cells and improve the clinical outcomes (Segura-Campos *et al.*, 2014).

The seeds still are a major dietary staple in South and Central America today, as they are good sources of fibre and protein, and have an extremely high concentration of essential fatty acids even more omega-3s than salmon. They also contain potassium, calcium, iron, phosphorus, and manganese, while being low in

cholesterol and sodium, and have a high concentration of antioxidants (Melissa, 2012).

Puig and Haros (2011) reported that because of the nutritional properties of chia, its consumption can promote proper intestinal functioning, decrease blood cholesterol and glucose levels and decrease the incidence of diseases related to metabolic syndrome.

Chia seeds are rich in antioxidants (phenolic compounds). Six Antioxidants are substances found in foods, which inhibit ("anti-") a process called oxidation ('-oxidant") in the body's cells. Oxidation is a chemical reaction that produces free radicals. Free radicals cause destruction of our body's cells and antioxidants stop them. Studies have shown antioxidants reduce the risk of heart disease and cancer (Bobroff, 2013)

Chia seeds contain a number of beneficial plant compounds. The main ones are listed below (Melissa Romero 2012).

- **Chlorogenic acid:** An antioxidant that may lower blood pressure
- **Caffeic acid:** This substance is abundant in many plant foods, and may help fight inflammation in the body.
- **Quercetin:** A powerful antioxidant that may reduce the risk of heart disease, osteoporosis and certain forms of cancer
- **Kaempferol:** An antioxidant that has been associated with decreased risk of cancer and other chronic diseases.

Clean and dry chia seeds have a very long shelf life, as their antioxidants protect the fats in the seeds from damage.

A study published in the "British Journal of Nutrition" showed that chia seeds as a dietary fat source can lower triglycerides and cholesterol levels while increasing HDL or "good" cholesterol. The study also found that when substituting chia seeds for other fat sources, such as corn oil, the ALA was able to prevent high triglyceride levels and reduce central obesity (Crisosto, C. H and Metheney, P., 2005).

The unique combination of soluble and insoluble fibre helps to slow the body's conversion of food into sugar. Preliminary research shows that chia seeds could help people with diabetes control their blood sugar levels and protect their hearts. Animal studies show that chia-rich diets lower LDL cholesterol and triglyceride levels, while increasing HDL cholesterol. The white-seeded variant of chia, called "Salba" also helped control blood sugar, in addition to maintaining blood pressure and C-reactive protein (Skerrett, 2010).

Animal studies conducted by have indicated chia's potential help to preserve heart health. An animal study published in February 2012 found that chia seeds, as a source of the essential fatty acid "a-linolenic acid (ALA)," when fed to rats on a high-carb, high-fat diet, reduced cardiac and liver inflammation and improved insulin sensitivity and glucose tolerance (Poudyal *et al.*, 2012).

Early animal studies have also indicated that adding chia to the diet may help to normalize blood fats and cholesterol levels. In one study published in 2009, researchers fed rats a high-sugar diet for three months, then substituted chia seed for the source of fat in the diet from month 3-5 in half the animals. The dietary chia seeds prevented the onset of high lipids and fats in the blood, and helped to reduce abdominal fat (Chicco*et al.*, 2009).

Though few studies have been done, early animal research has suggested that chia may have a protective benefit against cancer. Research from Argentina, for example, showed that chia seeds inhibited growth and metastasis of tumours in rats (David Sax, 2012).

Because they are so nutrient-dense for their size, chia seeds make great energy foods for long runs, hikes, and other endurance efforts. The high protein content, along with the slow-burning combination of fibre, keeps you going for hours. In fact, according to a Bloomberg article, chia seeds have become the "stimulant of choice" among Wall Street investors and traders because they're healthier than coffee, cheaper and more legal than cocaine, and less juvenile than the 5-hour energy drink (Espada*et al.*, 2007).

According to Espada *et al (*2007), Chia has a reputation for helping to maintain and restore intestinal health, though so far it doesn't appear that there are

any scientific studies on the subject. Most likely, it is because of the unique fibre content in the seeds that people are experiencing this benefit. In today's world of over-processed foods and white flour, rich sources of soluble and insoluble fibre are difficult to find. Chia seeds help to promote regularity, and are easily digested. It digests slowly, and helps keep the colon hydrated. Many patients swear by it for preventing diverticulitis (inflammation of the colon)

Essential fatty acids are known to help and maintain the function of brain cell membranes and neurotransmitters. Omega-3 fatty acids, in particular, contain Docosa Hexaenoic acid (DHA), which is used exclusively by the brain and nervous system. They also contain Eicosa Pentaenoic acid (EPA), which has shown in studies to help to relieve low-grade inflammation associated with clinical depression. Chia seeds are a powerhouse source of essential fatty acids-a natural brain food (Chicco*et al.*, 2009).

Chia contains less than half the sodium of flax seed, per serving. This is important to those with high blood pressure and concerned about sodium intake. As a plant-based source of Omega-3, Chia is cholesterol-free (Megan Ware, 2015).

Chia Seed reduces blood glucose swings and supports conditions of hypoglycaemia and diabetes. Chia's soluble fibre exerts a stabilizing influence on blood glucose levels by regulating the rate at which complex carbohydrates are digested and assimilated in the body. This creates steady, stable blood glucose levels...which also means steady, high energy levels (Jin *et al.*, 2014).

Chia thereby is an ideal food for individuals having gluten sensitivity, carbohydrate intolerance, hypoglycaemia, Celiac Disease, Crohn's Disease, or for anyone wishing to avoid common gluten-containing grains like corn, barley, and wheat (simple carbohydrates including high gluten foods are implicated in obesity and blood glucose instability, and generally provide poor nutrient-density) (Alex Lewis, 2015).

Rekha and Vaidehi Shah (2015) Studies have shown that the four different levels of whole chia flour (5 per cent, 10 per cent, 12 per cent, and 15 per cent) were incorporated to produce chia chip. There were no significant differences in appearance, colour, flavour and overall liking between a commercial chip sample and the 5 per cent chia chips. The chemical analysis indicated that all four trial chips are

excellent sources of omega-3 and the baking process has a limited impact on their nutritional profile. For optimal consumer acceptance and nutritional benefits, the incorporation of 5per cent chia is recommended. With limited chia based food products currently available, a chia chip would be a well-accepted and healthy alternative to the common unhealthy chips (Coorey *et al.* 2012).

As a source of protein, Chia seed is digested and absorbed very easily. This results in rapid transport to the tissues and utilization by the cells. This efficient assimilation makes the Chia very effective during periods of rapid growth, as in children and adolescents. Chia is also helpful for the growth and regeneration of tissue during pregnancy and lactation, and for regeneration of muscle tissue for athletes, weight lifters etc. (Reyes-Caudillo *et al.*, 2011)

2.3.1. Medical Use

Additionally, and due to its high content of omega-3 and omega-6, various studies (Bushway *et al.*, 1981; Ayerza and Coates, 2001; Ayerza and Coates, 2001; Fernandez *et al.*, 2008) have attributed the following medicinal properties to the seed:

- Helps to reduce cholesterol.
- Inhibits blood clotting and promotes tissue regeneration.
- Helps to reduce the digestion time of carbohydrates, so assisting the control of blood sugar levels.
- Helps to prevent brain diseases, depression and epilepsy.
- Improves the immune system.

2.4. ACCEPTABILITY OF CHIA SEED INCORPORATED RECIPES

Chia seeds are from the desert plant *Salvia hispanica*, a member of the mint family, and can be eaten raw or added to dishes. Consumers add chia to baked goods, breads, porridges, smoothies, and can be ground and added to water or milk. The seeds can be purchased at local health food stores or online. The familiar chia hair or sprouts can also be eaten and added to salads, sandwiches, and other dishes (Guevara-Cruz *et al.*, 2012).

Numerous claims can be found in the media concerning chia. Chia being an excellent source of fibre, omega-3 fatty acids, protein, and antioxidants are some of the proposed claims. The media also claims that chia can help to cut cravings, balance blood sugar levels, improve cardiovascular disease, lower cholesterol, triglycerides, blood pressure, and can promote weight loss. This exceptional list of health benefits really peaked the researchers to find out the real scoop concerning chia seed (Ricardo and Coates, 2005).

Native to Mexico and grown in Central and South America, chia is a Mayan word for "strength," and the seed was a staple of ancient Aztec and Mayan diets. Its mildly nutty flavour can be enjoyed raw, soaked in fruit juice (known in Mexico as "Chia Fresca"), in baked goods, oatmeal and puddings, or even as an egg substitute (one tablespoon mixed with three tablespoons of water yields a gel that is the equivalent of one egg) (Andrews and Jennifer 2009).

Gluten and grain-free, chia provides these additional benefits:

- Contains more Omega-3 per gram than salmon
- Excellent source of fibre (two tablespoons provide a third of the U.S. Recommended Daily Intake)
- Rich in antioxidants
- High in minerals that help to prevent hypertension while aiding energy metabolism (U.S. RDI 18per cent calcium, 35per cent phosphorus, 24per cent magnesium, and about 50per cent manganese)
- Slows down the conversion of carbohydrates into simple sugars
- Has been shown to lower triglycerides and "bad cholesterol" while increasing HDL ("good") cholesterol
- Easier to digest

A study conducted by Nieman and Colleagues concluded that ingestion of 50g/d of chia seeds for 12 weeks did not influence body mass, composition, or disease risk factors in overweight/obese men and women (Nieman *et al.*, 2009).

Chia can be used in several ways. Aztecs and Mayans happen to drink chia mixed in hot water and prepare thin gruel. In the present day, in Mexico, chia seeds

are consumed in many novel ways. Chia fresco or agua de chia is a refreshing summer drink made of ground chia, lemon juice and sugar (Reyes-Caudillo *et al.*, 2008).

Toasted seeds can be added to bread, cookies, muffins, etc. Sprinkle whole or ground chia over yogurt, fruit smoothies, milkshakes, etc.

The incorporation of seeds such as chia in the diet, which contain high contents of these fatty acids, is particularly desirable. However, a major challenge to the development of enriched food products is presented by the multiple acceptance criteria: product freshness, sensory characteristics, appearance, storage conditions, ease of preparation and safety standards, which must be achieved, despite the addition of an active ingredient and nutritional benefits (Drusch and Mannino, 2009).

2.4.1. An Ideal Super Food

Chia is an Excellent Functional Food for Most People, including individuals exhibiting food allergies, food sensitivities, or food and chemical hypersensitivity. One study found no evidence of allergic response to chia, even among individuals having peanut and tree nut allergies. Plus, chia is an ideal super food because it is portable, won't easily spoil (i.e., protected by natural antioxidants), and safely can be stored for extended periods; chia can be eaten raw, but also remains fresh after grinding; and even after being ground and mixed with water, chia (as a gel) can keep for up to 2 weeks in the refrigerator (www.natural healthy choice.ca).

The gelatinous characteristic of these seeds is an attribute used to make other foods more nutritious. It aids in making chia seeds mix in easily with sauces (barbecue, tartar and marinades), sandwich dressings (mayonnaise, ketchup, mustard), jams, jellies, ice cream drinks, smoothies, yogurts and nut butters (Kevin Gianni, 2012).

Since the seeds absorb significant amounts of water, the lower calorie and nutritious chia gel gives you a "filled up" feeling. For many, this means eating smaller quantities and ingesting fewer calories. The regular consumption of chia seeds has been a successful weight-loss strategy for many (Borneo *et al.*, 2010).

Chia gel adds a very slight nutty flavour to sauces, beverages or foods. Chia seeds can be ground into a powder for use as a nutritious ingredient or they can be roasted and added to soups, stews and salads. Chia seeds can be kept for long periods of time if stored in a cool, dry area (www.naturalhealthychoice.ca).

2.5. ROLE OF CHIA SEED IN SPECIFIC RECIPES

Chia seed (*Salvia hispanica*) is an ancient oilseed used by Mayas and Aztecs as foodstuff. This seed is a natural source of omega-3 fatty acids (α-linolenic acid), soluble and insoluble fibres, and proteins in addition to other important nutritional components, such as vitamins, minerals, and natural antioxidants. Chia can be considered as "functional food" because apart from contributing to human nutrition, chia helps to increase satiety index, prevent cardiovascular diseases, inflammatory and nervous system disorders, and diabetes, among others (Loreto *et al.*, 2013)

The third form of consuming chia seed is chia flour which is de-oiled chia seeds. Chia flour contains fibre, protein, and antioxidants, but loses all of the omega 3 benefits due to the refining process. Lastly, there is chia oil which contains opposite nutrients of chia flour, because it has omega 3, but loses all fibre, protein and antioxidants during the processing. Nutrient composition and health significance. Chia seeds are an adequate source of proteins, fibre, polyunsaturated fatty acids and antioxidants. Their protein content is 20 per cent by weight and contains all the essential amino acids. In 2 tablespoons of chia seeds, there is 4 grams of protein and 11 grams of fibre (42 per cent DV) (Dorsey-Kockler, 2011).

The fibre content in chia seed is27 per cent by weight which is much larger than other grains (3-18 per cent). Twelve percent of the total fibre content is soluble and 88 per cent is insoluble (Dorsey-Kockler, 2011).

The polyunsaturated fatty acids found within chia seeds are known as omega 3. There are three forms of omega 3; ALA (Alpha linolenic Acid), EPA (Eicosa Pentanoic acid) and DHA (Docosa HexanoicAcid). Alpha linolenic acid is found in plants sources with chia seeds being one of these top sources, and EPA/DHA are found in marine sources. The conversion rate of ALA to EPA/DHA is 0.2-15 per cent (Kris-Ehterton, 2002; Tweed, 2012).

With this conversion, chia seeds can offer just as much EPA/DHA as marine sources, but without the fishy flavours. Physicians specializing in Integrative medicine recommend a daily consumption of 2-3 g of ALA (Tweed, 2012).

The most common antioxidants found within chia seed are chlorogenic acid, caffeic acid, myricetin, quercetin (only found in black chia), and kaempferol. The large level of antioxidants contained in chia seeds greatly reduces the risk of rancidity of both whole and ground chia seeds.

Use chia seeds in foods, not as a supplement, but as an alternative to processed grains like white bread because it is a much healthier whole grain that is great-tasting in foods like muffins (http://www.webmd.com)

2.5.1. Absorbency

Chia seeds absorb the moisture surrounding them, such as water, juices, or dairy products. When soaked in these liquids, the seeds become sticky and have a gelatinous texture. They are easy to add to any dish or recipe just beware that more liquid is sometimes needed because of the seed's high absorbency (Guevara-Cruz M 2012).

2.5.2. Thickener

The absorbency of chia seeds is so high that they can replace cornstarch or other thickeners in recipes (http://wellnessmama.com).

2.5.3. Egg substitute

Chia seeds are good to use as an egg replacement. For every one egg in a recipe, substitute 1 Tablespoon of chia seeds and 3 Tablespoon of water (http://wellnessmama.com).

2.5.4. Raw seeds

Chia seeds have a nutty flavour to them, but are not overpowering. This gives them the amazing ability to go unnoticed in recipes and dishes, adding fibre and healthy fats to virtually anything. Try sprinkling raw chia seeds onto vegetables, yogurt, or cereal (Alfredo 2009).

2.5.5. Oatmeal

When cooking steel-cut oatmeal, add 1 Tablespoon of chia seeds into the mix for every ¼ cup of oatmeal. The oats will grow twice the size and will contain an additional 5 g of fibre/serving. This creates a feeling of fullness to start the morning off right (Alfredo 2009).

2.5.6. Smoothies

An easy way to increase the volume, fibre, and texture of smoothies is to add 1 or 2 tablespoon of chia seeds (http://wellnessmama.com).

When chia seeds are added to water and allowed to sit for 30 minutes, they form a gel. Chia seed gum, a slimy material, begins to form in the solution. The structural component responsible for their gelatinous quality in liquid is the water-soluble fibre of chia seeds. There is much interest in the characteristics of chia seeds and chia seed gum for use as a thickening or emulsifying agent in food products (Segura-Campos *et al.*, 2014).

III METHODOLOGY

The methodology pertaining to the study "**Standardisation of chia seed (*Salvia hispanica L,)* incorporated recipes and Analysis of Nutrient Content"** is presented as follows:

3.1. Selection of the Value Added Ingredient

3.2. Development or Formulation of the Recipes

3.3. Organoleptic Evaluation

3.4. Nutrient Content of the Selected Recipes

3.5. Evaluation of the Recipes

3.1. SELECTION OF THE VALUE ADDED INGREDIENTS

Chia Seed, a popular South American staple, is the ultimate seed for wellness and health. Chia seeds have been around for thousands of years but have been becoming more popular due to their potent health benefits. They are high in omega-3 fatty acids, fibre, protein, calcium, antioxidants and many other essential vitamins and minerals (Vuksan *et al.,*2010).

Chia seed (*Salvia hispanica* of the family *Lamiaceae*) is an oilseed native to southern Mexico and northern Guatemala, and a dietary supplement that is used for its Dietary Fibre component, and has traditional usage as a food product (roasted seeds being referred to as *chiapinolli)* in Columbia where it was consumed for energy. Chia appears to be classified as a grain product, and due to its physical properties it is sometimes used as an egg/oil substitute in bakery products (Jeong *et al.,*2010).

Chia seeds compose almost of all the essential nutrients such as protein, omega-3 fatty acids, antioxidants, dietary fiber, vitamins and minerals essential for optimum growth and development in good proportions. Chia is a great natural source of antioxidants, including chlorogenic acid, caffeic acid, myricetin, quercetin and flavonols.

According to Lacey and Kevin (2011),oranges, whose flavor may vary from sweet to sour, are commonly peeled and eaten fresh or squeezed for juice.The thick

bitter rind is usually discarded, but can be processed into animal feed by desiccation, using pressure and heat. It also is used in certain recipes as a food flavoring or garnish. The outermost layer of the rind can be thinly grated with a zester to produce orange zest. Zest is popular in cooking because it contains oils and has a strong flavor similar to that of the orange pulp. The white part of the rind, including the pith, is a source of pectin and has nearly the same amount of vitamin C as the flesh and other nutrients.

Rice flour is a particularly good substitute for wheat flour, which causes irritation in the digestive systems of those who are gluten-intolerant. Rice flour is also used as a thickening agent in recipes that are refrigerated or frozen since it inhibits liquid separation (Richard, 2006).

Peanuts are used to help to fight malnutrition are high-protein, high-energy, and high-nutrient peanut-based pastes developed to be used as a therapeutic food to aid in famine relief (Kochert, 2006). The above mentioned ingredients were used for various recipes with chia seed.

3.2. DEVELOPMENT OR FORMULATION OF THE RECIPES

The first and foremost step in the study was to develop chia seed incorporated recipes. Recipes including snacks items and appetizer were suitable for the incorporation of chia seed. Hence incorporating chia seed by various proportion to the selected recipes namely groundnut chikki, laddu, pakoda, kozhukattai and fruit punch were done.

The organoleptic evaluation was carried out for all the five chia seed incorporated recipes namely standard and three variations given below.

the composition of chia seed incorporated recipes

I) Chikki (5%, 10% and 15% chia seed incorporation respectively)
II) Kozhukattai (5%, 10% and 15% chia seed incorporation respectively)
III) Pakoda (5%, 10% and 15% chia seed incorporation respectively)
IV) Laddu (5%, 10% and 15% chia seed incorporation respectively)
V) Fruit punch (5%, 10% and 15% chia seed incorporation respectively)

The methodology and preparation of the selected recipes are given below:

3.2.1. Chikki Preparation

Ingredient

Peanuts	-	100g
Jaggery powder	-	50g cup
Ghee	-	1 tsp to grease

Method

- Chikki preparation starts with roasting peanuts. In a heavy bottom wok or pan add the peanuts, roast them on medium heat. Keep on stirring the peanuts for even roasting. As you roast brown spots appear on peanuts, they turn crisp and shred their skin. Switch off the flame at this stage.
- Let the roasted peanuts cool down to room temperature. You can rub the peanuts between your palms and remove the skin from peanuts. I find it easier to remove the skin when they are still warm.
- Once the peanuts are ready, heat the same wok with jaggery and 2 tsp of water. Cook in low flame, jaggery dissolves in water and starts bubbling. Continue cooking and stirring the syrup. Keep a small bowl with some water and check the consistency of syrup by dropping few drops of jaggery syrup in water. If that drop of jaggery turns hard, brittle and can break with snap sound, then jaggery syrup is done. Switch off the flame.
- Include roasted peanuts in to jaggery syrup, combine well. Transfer this mixture on to greased plate, pat it using flat spatula. You can also cover it with parchment paper and roll using rolling pin. Rolling helps the peanut brittles to obtain even surface.
- Let the peanut brittle to cool down completely, then using a sharp knife cut them in to desired size. You can pat the bottom of the plate over floor to remove the peanut chikki.
- Addictive candiment peanut brittle/chikki is ready. Store them in airtight container and it lasts for more than fortnight.

Using the above procedure by incorporating chia seed the variations were done and evaluated.

3.2.2. Rice Kozhukattai Preparation

Ingredient

Rice Flour	-	70g
Jaggery	-	50g
Water	-	200ml
Grated coconut	-	1 tbsp
Cardamom powder	-	A tiny pinch
Oil	-	Just to grease

Method

- Soak jaggery in 1 and 1/4 cup water, crush it well. Strain to remove impurities and take the syrup in a heavy bottomed pan or preferably non-stick pan and heat up the syrup. Add cardamom powder.
- Simmer the flame and add rice flour and mix well. It will all come together so soon so act quickly. Keep mixing continuously to avoid lumps. It will be all done in few mins so keep stirring. Once you mix, it will start coming together and form a mass. At this stage add coconut and stir well. You can see the dough change its texture, it will look more like a clay in texture that is the right stage. Switch off and let it cool down. Keep covered.
- When it's still warm, make kozhukattai shapes. Grease your hands with oil then take a small portion and make cylindrical shapes and press it with your fingers to get the impression. Repeat the same for the entire mixture. You can even make small balls. Then arrange it in a steamer plate and steam it for 10mins.

3.2.3. Pakoda Preparation

Ingredient

Besan/Gram Flour	-	70 g
Ginger	-	10 g
Onion	-	50 g
Green Chilli	-	10 g
Coriander Leaves	-	5 g
Ajwain/Carom Seeds	-	5 g
Cumin Seeds	-	3g
Water	-	As required to make a thick flowing batter
Salt	-	To taste
Oil	-	For deep frying the pakodas

Method

- Mix all the ingredients listed above except oil in a mixing bowl. Stir with a spoon or wired whisk, to make a smooth and lump free batter.
- Heat oil in a kadai or pan. When the oil become medium hot, drop spoon full of the batter in the oil.
- Fry the pakodas in oil till golden and crisp. Drain the pakodas on paper towels to remove excess oil.
- Serve the pakodas hot with coriander chutney or tomato sauce.

3.2.4. Laddus Preparation

Ingredient

Groundnut	-	50 g
Bajra	-	10 g
Dates	-	30 g
Jaggary	-	20 g
Ghee	-	To taste

Method

- In a large food processor fitted with an “S” blade, process the walnuts and coconut until crumbly. Add in the dates, bajra, groundnut and process again until a sticky, uniform batter is formed.

- Scoop the dough by heaping tablespoons, then roll between your hands to form balls. Arrange them on a baking sheet lined with parchment paper, then place in the freezer to set for at least an hour before serving. Store the balls in a sealed container in the fridge for up to a week, or in the freezer for an even longer shelf life.

3.2.5. Fruit Punch Preparation

Ingredients

Orange Juice	-	1 Cup
Fresh Lemon Juice	-	¼ Cup
Grape Juice	-	2 Cups
Ice Cubes		

Method

- In a large glass container, stir fruit juices together.
- Refrigerate for at least 2 hours. Just before serving, pour over ice cubes in punch bowl. Add ice cold ginger ale. Taste and adjust to your liking; add a little lemon juice for tartness, or some sugar or honey to sweeten.
- Garnish with mint leaves.
- Sometimes we add frozen fruit to the punch bowl at the very last minute. After the fruit thaws and the punch is gone, the fruit may be served over ice cream or topped with whipped cream.

The chia seed incorporated recipes were evaluated by ten semi trained taste panel members using nine point hedonic scale. The appearance, flavour, texture, colour and overall acceptability were scored for all the recipes along with the standard recipe. A nine point score system ranging from 9- like extremely to 1- dislike extremely was used for the evaluation. The acceptability trials were carried out three consecutive days to obtain significant and appropriate result for the best acceptable recipes. The recipe secured maximum score was considered as highly acceptable.

Score card used for the organoleptic evaluation is given in Table II.

TABLE II

SCORE CARD FOR EVALUATION OF RECIPES

Criteria	**Trial 1**	**Trial 2**	**Trial 3**
Colour			
Appearance			
Flavour			
Texture			
Taste			
Overall Acceptability			
Total			

The above attributes were rated on a nine point hedonic scale indicating the following scores:

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

Name of the recipes :

NAME :

CLASS :

DATE :

Samples for presentation must be from homogenous lot. Careful sampling of the food is necessary for sensory evaluation. Samples to be tested should prepared by identical methods. All samples should be at the same temperature optimum level and kept constant during test. Stainless spoons can be used for tasting the sample.

Samples are presented with 3 to 5 digit code markings to obscure the identity of the samples. The order of presentation should also be randomized within each test session.

3.3. ORGANOLEPTIC EVALUATION

In a recent study by Laureate *et al.* (2006), considering the influence of tradition in sensory acceptability aspects should be followed by familiarity and tradition linked with the consumption of meal. Human being eats foods because of the pleasure and enjoyment of eating as well the necessity of obtaining energy and nutrients. The main contributions to human‘s enjoyment of eating foods are the three sensory factors perceived and appreciate by human senses appearance, flavour and aroma and texture (Bourne, 2012).

Sensory quality should be considered as a Key factor in food acceptance because consumers seek food with certain sensory characteristics. The acceptance of a food will depend on whether it responds to consumer needs and on the degree of satisfaction that it is able to provide (Heldman, 2004).

Preparation and the sensory evaluation of the incorporated recipes were done in the foods laboratory of the Food Science and Nutrition department at Avinashilingam Institute for Home science and Higher education for Women University, Coimbatore.

Food acceptability and choice depends on sensory properties of the food which are perceived during chewing and swallowing. Overall sensory quality of the product can be evaluated descriptive analysis (Barylko and Matuszewska, 2010).

The chemical and physical properties of food are perceived by a person in terms of different sensory attributes such as the foods, appearance, taste, flavour and texture. Within a particular culture there is usually a significant degree of consensus there could be substantial differences between individuals. These differences will partly lead to differences in food acceptance, preference and choice (Civille and Setsam, 2010).

Taste keeps a person wanting to come back try the product again or deters them from doing so. Sensory attributes and perceptions play a major role acceptance of a product (Masoodi *et al*., 2012).

Chia Seed Inncorporated Kozhukattai

Sensory Evaluation of *Pakoda*

Sensory Evaluation of Fruit Punch

PLATE I – Organoleptic Evaluation of the Recipes

Five food products were selected i.e. chikki, laddus, pakoda, fruit punch and kozhukattai. 10 panel members rated the products. Each of the 4 samples of the 5 products were labelled as code A, code B, code Cand code D respectively. However, the amount of chia seeds were shuffled and were not disclosed to the panel members. Black colour chia seeds were used in these products (Plate I).

The research design and the procedures used in the study were submitted for scrutinization and approval to the Institutional Ethical Committee and Ethical Clearance approval No AUW/IHEC/FSN -16 - 17/XMT-08 was obtained. The Ethical clearance certificate given by the Institutional Ethical Committee and Ethical Clearance is given in Appendix I.

3.3.1. Colour and appearance

Colour and appearance attract the consumer to a product and can help in impulse purchases. At the point of purchase the consumer uses appearance factors to provide an indication of freshness and flavor quality. External appearance of a whole fruit is used as an indicator of ripeness, although it can be a misleading one (Shewfelt, 2010). Consumers have a preferred colour for a specific item (Crisosto *et al*., 2005).

3.3.2. Flavour

Flavour is a primitive sense and more highly developed and complex than taste and plays an important role in food acceptance. Since fresh-cut fruits are more likely to be consumed without other ingredients, they must be sweet without the presence of off flavors. Since sweetness increases with ripening and ripe fruits deteriorate more rapidly, most fruits are harvested before full sweetness has been achieved. Sweetness does not increase in coated, cut cantaloupe during storage (Eswaranandam *et al*., 2007), and it is unlikely that significant increases in sweetness will occur in other fresh-cut fruits after packaging.

3.3.3. Texture

Texture is a sensory manifestation of structure and mechanical properties of food. The universal textural characteristics are crisp or crunchy, tender, smooth, creamy, firm and juicy. Certain characteristic such as hard and softy may be right for some product in circumstances are not in others and disliked in other products under other circumstances.

3.3.4. Taste

Taste is also a highly individual aspect because fundamental taste preferences may be a result of biological factors, which account for innate preferences for sweet tastes and aversion for bitter taste. However, it is not only consumer's biological aspects that influence their sense of taste, but the environment and cultural influences as well. People from different regions and cultural backgrounds have different tastes as they are conditioned to accept the tastes of foods which are introduced to them and eaten in that region and culture (Grewal, 2007).

3.4. NUTRIENT CONTENT OF THE SELECTED RECIPES

3.4.1. Importance of Nutrient Analysis

Food analysis is the discipline dealing with the development, application and study of analytical procedures for characterizing the properties of foods and their constituents. The estimation of nutrient intake from food consumption requires reliable data on food composition. These data are also the fundamentals of food-based dietary guidelines for healthy nutrition, containing the necessary information on food sources for different nutrients. Furthermore, food composition tables can provide information on chemical forms of nutrients and the presence and amounts of interacting components, and thus provide information on their bioavailability. For some nutrients such as vitamin A, vitamin E and niacin, the concept of equivalence has been introduced to account for differences in the availability and biological activity of different chemical forms (Pomeranz and Meloan, 2008).

According to Nielsen (2006), the composition of a food largely determines its safety, nutrition, physicochemical properties, quality attributes and sensory characteristics. Most foods are compositionally complex materials made up of a wide variety of different chemical constituents. Their composition can be specified in a

number of different ways depending on the property that is of interest to the analyst and the type of analytical procedure used: specific atoms (*e. g.,*Carbon, Hydrogen, Oxygen, Nitrogen, Sulfur, Sodium, etc.); specific molecules (*e. g.,*water, sucrose, tristearin, b-lactoglobulin), types of molecules (*e. g.,*fats, proteins, carbohydrates, fiber, minerals), or specific substances (*e. g.,*peas, flour, milk, peanuts, butter).

3.4.2. Moisture

The moisture content was estimated by drying known weight of sample in an oven at 100 – 105°C followed by cooling in a desiccator. The process of heating and cooling was repeated till a constant weight was achieved.

$$\text{Moisture percentage} = \frac{\text{Initial Weight - Final Weight}}{\text{Weight of the Sample}} \text{x100}$$

3.4.3. Energy

The gross energy is the amount of heat produced from unit feed when it is completely burnt down to its ultimate oxidation products ($CO_2$and H_2O). The feed is burnt is a closed container (Bomb calorimeter) and heat produced from it is measured (AOAC, 1995).

The known weight of the sample is completely burnt in the apparatus permits the heat developed by the combustion to be absorbed by a water. By determining the rise of temperature, it is possible to calculate within close limits, the number of heat units liberated. Bomb Calorimeter is the instrument is used to determine the amount of energy released from the food stuff. It is based on the principle of direct calorimetry.

3.4.4. Protein

Protein was estimated by kjeldahl nitrogen distillation method(Plate II).The method consists of heating a substance with sulphuric acid, which decomposes the organic substance by oxidation to liberate the reduced nitrogen as ammonium sulphate. In this step potassium sulphate is added to increase the boiling point of the medium (from 337 °C to 373 °C). Chemical decomposition of the sample is complete when the initially very dark-coloured medium has become clear and colourless.

The solution is then distilled with a small quantity of sodium hydroxide, which converts the ammonium salt to ammonia. The amount of ammonia present, and thus the amount of nitrogen present in the sample, is determined by back titration. The end of the condenser is dipped into a solution of boric acid. The ammonia reacts with the acid and the remainder of the acid is then titrated with a sodium carbonate solution by way of a methyl orange pH indicator.

3.4.5. Fat

Fat estimation was done by ether extraction in a soxhlet apparatus. It was originally designed for the extraction of a lipid from a solid material. Typically, a Soxhlet extraction is used when the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. It allows for unmonitored and unmanaged operation while efficiently recycling a small amount of solvent to dissolve a larger amount of material (*Harwood, Laurence et al., 2004).*

3.4.6. Mineral Estimation

From the ash solution obtained, mineral like iron, calcium, and phosphorus were estimated.

A) Iron

The food sample upon ignition gets oxidized to ferric iron in which reacts with ammonium thiocyanate or potassium thiocyanate to give a red colour (Wong's method). The colour which is a measure of the concentration is measured calorimetrically and the results were expressed as milligrams per 100 grams of sample.

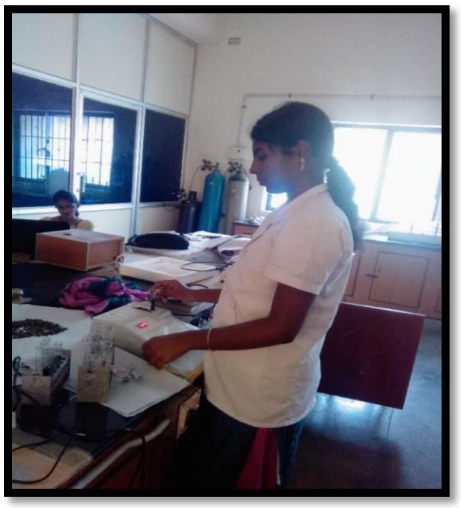
B) Calcium

From the ash obtained calcium was determined gravimetrically by precipitation it as calcium oxalate and dissolving the precipitate in hot dilute sulphuric acid which was titrated against standard potassium permanganate solution. The calcium content in the sample was expressed as milligrams per 100 grams of sample(Plate II).

C) Phosphorus

Ash solution when treated with ammonium molybdate, phosphor molybdic acid is formed. Phosphomolybdic acid is reduced by the addition 1, 2, 4 amino naphthol sulphonic acid reagent to produce a blue colour which is apparently a mixture of oxidise of molybdenum. The intensity of the colour developed is the measure of phosphorus present, which was expressed as milligrams per 100 grams of sample (Plate II).

Nitrogen Distillation



Phosphorus Estimation

Calcium Estimation

PLATE II : Analysis of Nutrients

3.5. EVALUATION OF THE RECIPES

Quality is the ultimate criterion of the desirability of any food product. Food quality can be evaluated by sensory and objective methods. When the quality of food product is assessed by means of human sensory organs the evaluation is said to be sensory or subjective (Wang R *et al* 2007).

A ten semi trained panel members was selected for sensory evaluation. Nine point hedonic rating scale were used for the sensory evaluation of food products. Nine point hedonic tests were used to judge the food products on the basis of overall acceptability. In this test the panellist were asked to measure the degree of pleasurable and unpleasurable experience of food products on a nine point hedonic rating scale from “like extremely” to “dislike extremely”.

The recipes prepared in three variations and repeated three consecutive days for the evaluation. Ten panel members were selected for the evaluation of the recipes. Chia seed were incorporated individually at 5, 10, 15 per cent level in the selected products. The acceptability trials were carried out thrice to obtain significant and appropriate result for the best acceptable recipes. The recipe secured maximum score was considered as highly acceptable

Hence the present study was conducted with the aim of incorporating chia seed in different five recipes and evaluated with the help of nine point hedonic rating scale. Sensory analysis was conducted by 10 trained panel members thrice on sensory attributes such as appearance, colour, flavour, taste, texture and overall acceptability. Within the 5 products 5 gram sample was best accepted in all the products (chikki, fruit punch, laddu, kolzhukattai and pakoda) respectively.

Overall the 5 products like laddu, pakoda, chikki, fruit punch and kozhukattai, the chia seed pakoda was highly acceptable compared to other products.

Research Design

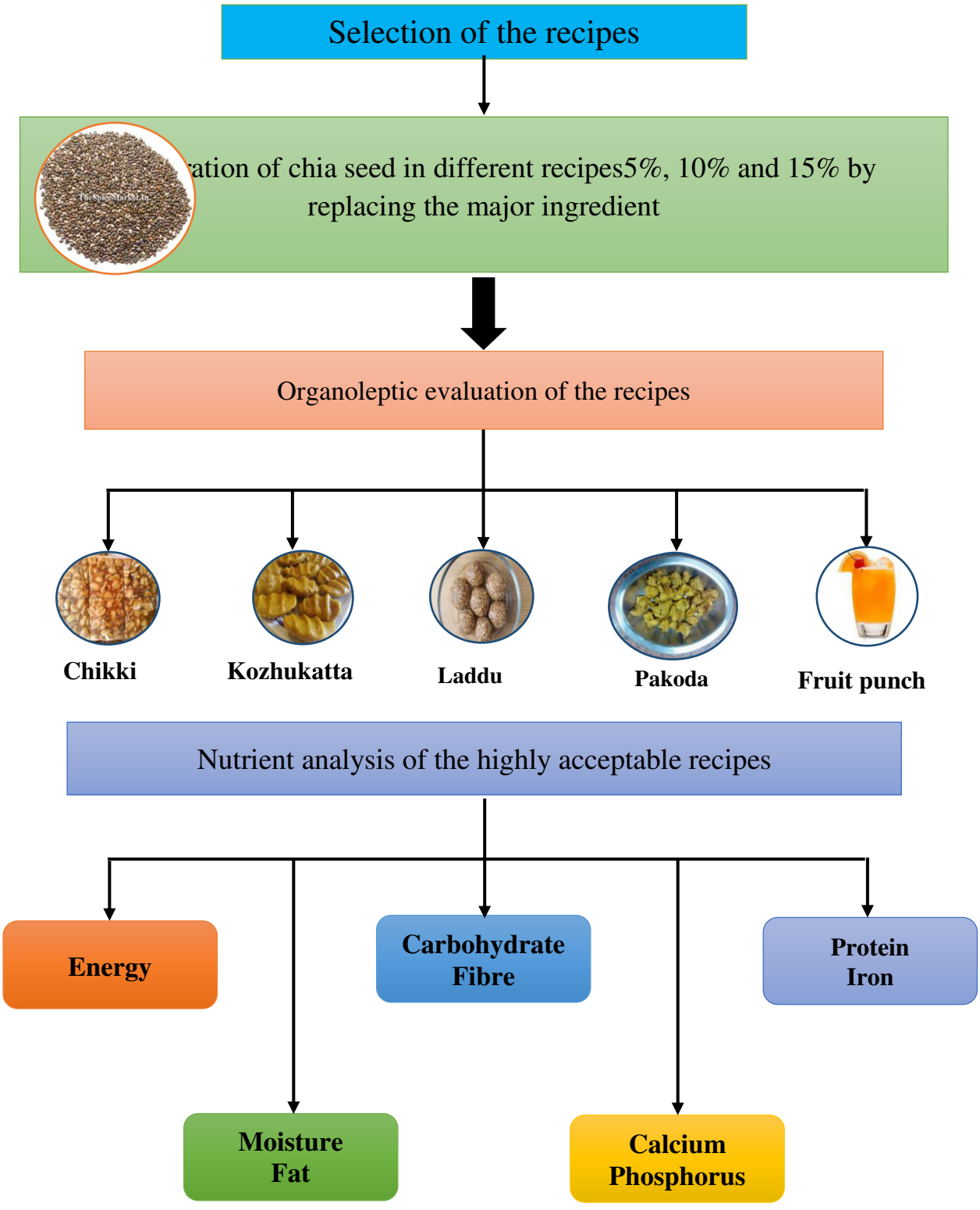


Figure 3.1 : Research Design

IV RESULTS AND DISCUSSION

The results and discussion pertaining to the topic, "Standardisation of chia seed (*salvia hispanica*) incorporated recipes and Analysis of Nutrient Content" is discussed below:

4.1 Organoleptic evaluation of selected recipes.

4.2 Evaluation of the highly acceptable recipes.

4.3 Nutrient analysis of the acceptable recipes.

4.1. ORGANOLEPTIC EVALUATION OF SELECTED RECIPES

- **Mean Acceptability Score Obtained for the Chikki Standard**

Chikki was prepared by incorporating chia seed and the mean acceptability scores obtained are given in the following Table.

TABLE III

MEAN ACCEPTABILITY SCORES OF CHIKKI (STANDARD)

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.9±0.81	8.4±0.48	8.5±0.5	8.6±0.43
Appearance	8.9±0.81	8.2±0.87	8.2± 0.4	8.4±0.52
Flavour	8.5±0.56	8.2± 0.78	8.2±0.78	8.3±0.70
Taste	8.5±0.53	8.4±0.5	8.6±0.8	8.5±0.61
Texture	8.7±0.71	8.6±0.91	8.5±0.45	8.6±0.55
Overall acceptability	8.6±0.81	8.4±0.66	8.6±0.72	8.5±0.56

Maximum Score - 9

The above table depicts about the chikki prepared with standard recipe. The colour of the chikki prepared during the first trial showed the score of 8.9 followed by second and third trial with the mean scores of 8.4 and 8.5 respectively. The appearance of the chikki standard for third trial had the highest score of 8.3 whereas first and second trial showed a mean score of 8.9 and 8.2 respectively. The mean

scores of the standard for the first trial, second and third trial were 8.5, 8.4, and 8.6 respectively for taste. Second and third trial had the same scores of 8.2 each for flavour followed by first trial with the mean scores of 8.5. For the texture of first trial showed the highest score of 8.7 followed by second and third trial with score of 8.6 and 8.5 respectively. The overall acceptability of first and third trial had the same score of 8.0 and second trial had least score of 8.4. With regard to the average score obtained for texture it was of 8.6 and for flavour it was recorded a minimum score of 8.3.

- **Mean Acceptability Score Obtained for the Chikki Variation I (Five Per Cent Chia Seed Incorporated)**

Table IV shows the mean acceptability scores of five per cent chia seed incorporated chikki.

TABLE IV

MEAN ACCEPTABILITY SCORES OF FIVE PER CENT CHIA SEED INCORPORATED CHIKKI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.0±0.56	8.2±0.63	8.3±0.48	8.17±0.55
Appearance	7.9±0.66	8.3±0.45	8.3±0.45	8.17±0.52
Flavour	7.8±0.76	8.3±0.45	8.1±0.53	8.07±0.58
Taste	8.0±0.67	8.4±0.48	8.1±0.53	8.17±0.56
Texture	8.0±0.81	8.4±0.48	8.2±0.4	8.2±0.56
Overall acceptability	7.9±0.66	8.5±0.5	8.2±0.4	8.2±0.52

Maximum Score - 9

Chikki was prepared by incorporating chia seed at five per cent levels by replacing the groundnut used for the standard recipe. The appearance of the variation I showed the mean scores of 7.9, 8.3 and 8.3 respectively. Followed by for first trial, second trial and third trial, with the maximum score of 9. The colour of the chikki

variation I for third trial had the highest score of 8.3 whereas first and second trial showed a mean score of 8.0 and 8.2 respectively. The mean scores of the chikki prepared with 5 per cent incorporation of the chia seed recorded the score for first trial, second and third trial were 8.0, 8.4, and 8.1 respectively for taste. Second trial had the highest score of 8.3 for flavour followed by first trial and third trial with mean scores of 7.8 and 8.1 respectively. For the texture of the chikki variation I for second trial showed the highest score of 8.4 followed by first and third trial with scores 8.0 and 8.2. The overall acceptability score for second trial had the maximum score of 8.5 whereas first trial and third trial had scores 7.9 and 8.2.

- **Mean Acceptability Score Obtained for the Chikki Variation II (10 Per Cent Incorporated)**

Table V shows the mean acceptability scores of 10 per cent chia seed incorporated chikki.

TABLE V

MEANACCEPTABILITY SCORES OF 10 PER CENT CHIA SEED INCORPORATED CHIKKI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	6.6±0.5	6.7±0.64	6.6±0.8	6.6±0.64
Appearance	6.9±0.5	6.6±0.8	7.2±0.6	6.9±6.9
Flavour	6.4±0.6	6.6±0.91	7.3±0.9	6.7±0.80
Taste	6.7±0.4	6.7±0.64	7.3±0.64	6.9±0.56
Texture	6.7±0.4	6.6±0.8	7.1±0.53	6.8±0.57
Overall Acceptability	6.8±0.4	6.6±0.8	7±0.44	6.8±0.54

Maximum Score - 9

Chikki was prepared by incorporating chia seed at 10 per cent levels by replacing the groundnut from the standard recipe. With regard to the colour the average score obtained was only 6.6 for the maximum score of nine. The same way

the average score for appearance was (6.9) flavour 6.7, taste 6.9 and texture only 6.8 out of nine. The overall acceptability score was recorded as 6.8. For all the attributes chikki prepared in the first and second trial secure all most the same score, in the case of third trial the score was little bit better when compared to other two trials.

- **Mean Acceptability Score Obtained for the Chikki Variation III(15 Per Cent Incorporated)**

Table VI shows the mean acceptability scores of 15 per cent chia seed incorporated chikki.

TABLE VI

MEAN ACCEPTABILITY SCORES OF 15 PER CENT CHIA SEED INCORPORATED CHIKKI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	6.3±0.69	6.8±0.74	6.5±0.80	6.5±0.74
Appearance	6.5±0.51	6.9±0.83	6.6±0.66	6.6±0.66
Flavour	6.4±0.84	7.1±0.7	6.3±0.45	6.6±0.66
Taste	6.5±0.69	6.6±0.91	6.3±0.45	6.4±0.68
Texture	6.7±0.42	7.1±0.94	6.4±0.84	6.7±0.73
Overall Acceptability	6.5±0.57	7±0.89	6.4±0.84	6.6±0.76

Maximum Score - 9

Chikki variation III was prepared by incorporating chia seed at 15 per cent levels by replacing the groundnut into the standard recipe. The score obtained for the colour of the second trial had the highest score of 6.8 followed by the first trial and the third day with the mean score of 6.3 and 6.5. The appearance of the chikki variation III received the highest score of 6.9 whereas first and third trial showed a mean score of 6.5 and 6.6 respectively. The mean scores of the variation III for first trial, second and third trial were 6.4, 7.1, and 6.3 respectively for flavour. For the attribute taste the score obtained was 6.5, 6.6 and 6.3 respectively for the three

consecutive days. With regard to the texture of the chikki variation III for the second trial showed the highest score of 7.1 followed by first and third trial with scores 6.7 and 6.4. The overall acceptability score obtained for the second trial was 7.0 whereas first trial and third trial had the scores 6.5 and 6.4 respectively.

- **Mean Acceptability Scores Obtained for the Fruit Punch Standard**

Table VII showed the mean acceptability scores of fruit punch standard are given in the following Tables

TABLE VII

MEANACCEPTABILITY SCORES OF FRUIT PUNCH (STANDARD)

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.6±0.91	8.7±0.79	8.3±0.67	8.5±0.79
Appearance	8.2±0.77	8.4±0.63	8.2±0.65	8.2±0.68
Flavour	8.6±0.8	8.3±0.89	.7±0.96	8.5±0.88
Taste	8.6±0.66	8.4±0.99	8.4±0.83	8.46±0.82
Texture	8.7±0.45	8.2±0.88	8.5±0.59	8.4±0.64
Overall Acceptability	8.6±0.44	8.5±0.91	8.6±0.59	8.5±0.64

Maximum Score - 9

The above Table describe about the standard of fruit punch. The appearance of the first and third trial had the same score of 8.2 followed by the second trial with the mean score of 8.4. The colour of the fruit punch standard for second trial had the highest score of 8.7 whereas first and third trial showed a mean score of 8.6 and 8.3. The mean scores for second and third trial had same score of 8.4 and first trial had the highest score of 8.6 for taste. Third trial had the highest score of 8.7 for flavour followed by first and second trial with the mean scores of 8.6 and 8.3 respectively. For the texture of the fruit punch for the first trial shown the highest score of 8.7 followed by second and third trial with the scores 8.2 and 8.5. The overall

acceptability of first and third trial had the same score of 8.6 whereas second trial had the least scores 8.4.

- **Mean Acceptability Scores Obtained for the Five Per Cent Chia Seed Incorporated Fruit Punch Variation I**

Table VIII shows the mean acceptability scores of five per cent chia seed incorporated fruit punch.

TABLE VIII

MEAN ACCEPTABILITY SCORES OF FIVE PER CENT CHIA SEED INCORPORATED FRUIT PUNCH

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.0±0.89	8.3±0.48	8.6±0.5	8.3±0.62
Appearance	8.4±0.66	8.2±0.59	8.2±0.67	8.2±0.64
Flavour	8.0±0.77	7.8±0.67	8.2±0.88	8.0±0.77
Taste	7.9±1.13	8.1±0.63	8.0±0.70	8.0±0.82
Texture	7.9±0.94	8.0±0.70	7.9±0.96	7.9±0.86
Overall Acceptability	8.2±0.74	8.5±0.63	8.6±0.61	8.4±0.66

Maximum Score - 9

The above Table depicts about the five per cent chia seed incorporated fruit punch (variation I). With regard to the colour the average score obtained was only 8.6 for the maximum score of nine. The same way the average score for appearance was (8.4) flavour 8.2, taste 8.1 and texture only 7.9 out of nine. The overall acceptability score was recorded as 8.6. For all the attributes fruit punch prepared in the first and second trial secure all most the same score, in the case of third trial the score was little bit better when compared to other two trials.

- **Mean Acceptability Scores Obtained for the 10 Per Cent Chia Seed Incorporated Fruit Punch**

Table IX shows the mean acceptability scores of 10 per cent chia seed incorporated fruit punch.

TABLE IX

MEAN ACCEPTABILITY SCORES OF 10 PER CENT CHIA SEED INCORPORATED FRUIT PUNCH

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.3±0.48	8.2±0.67	8.3±0.48	7.9±0.54
Appearance	7.5±0.5	8.0±0.65	8.3±0.48	7.9±0.54
Flavour	7.2±0.07	7.9±0.96	7.8±0.86	7.6±0.96
Taste	7.2±0.87	7.4±0.83	8.0±0.70	7.5±0.8
Texture	7.4±0.66	7.9±0.59	8.2±0.59	7.8±0.61
Overall Acceptability	7.3±0.64	8.0±0.59	8.0±0.53	7.7±0.58

Maximum Score – 9

Fruit punch was prepared by incorporating chia seed at 10 per cent levels by replacing the orange into the standard recipe. The appearance of the variation II showed the mean scores of 7.5, 8.0 and 8.3 respectively. Followed by for first trial, second and third trial, with the maximum score of 9.The colour of the fruit punch variation II for third trial had the highest score of 8.3 whereas first and second trial showed a mean score of 7.3 and 8.0 respectively. The mean scores of the fruit punch prepared with 10 per cent incorporation of the chia seed recorded the score for first trial, second and third trial were 7.2, 7.4, and 8.0 respectively for taste. Second trial had the highest score of 7.9 for flavour followed by first and third trial with mean scores of 7.2 and 7.8 respectively. For the texture of the fruit punch for third trial showed the highest score of 8.2 followed by first and second trial with scores 7.4 and

7.9. The overall acceptability score for second and third trial had the same score of 8.0 whereas first trial with the mean scores of 7.3.

- **Mean Acceptability Scores Obtained for the 15 Per Cent Chia Seed Incorporated Fruit Punch Variation III**

Table X shows the mean acceptability scores of 15 per cent chia seed incorporated fruit punch

TABLE X

MEAN ACCEPTABILITY SCORES OF 15 PER CENT CHIA SEED INCORPORATED FRUIT PUNCH

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.1±0.7	7.7±0.79	8.4±0.50	7.7±0.66
Appearance	7.3±0.64	7.4±0.63	8.2±0.70	7.6±0.65
Flavour	6.7±0.64	7.3±0.89	8.3±0.63	7.4±0.72
Taste	6.6±0.48	7.4±0.99	7.6±0.63	7.2±0.70
Texture	6.6±0.48	7.2±0.88	8.0±0.8	7.2±0.72
Overall Acceptability	7.1±0.53	7.4±0.91	8.0±0.59	7.5±0.67

Maximum Score - 9

Fruit punch variation III was prepared by incorporating chia seed at 15 per cent levels by replacing the orange into the standard recipe. The score obtained for the colour of the third trials had the highest score of 8.4 followed by the first trial and the second trial with the mean score of 7.1 and 7.4. The appearance of the fruit punch III received the highest score of 8.2 whereas first and second trial showed a mean score of 7.3 and 7.4 respectively. The mean scores of the variation III for first trial, second trial and third trial were 6.7, 7.3 and 8.3 respectively for flavour. For the attribute taste the score obtained was 6.6, 7.2 and 8.0 respectively for the three consecutive days.

With regard to the texture of the fruit punch variation III for the third trial showed the highest score of 8.0 followed by first and third trial with scores 6.6 and 7.2. The overall acceptability score obtained for the third trials was 8.0 whereas first and second trial had the scores 7.1 and 7.4 respectively.

- **Mean Acceptability Scores Obtained for the Pakoda Standard**

Table XI showed the mean acceptability scores of standard pakoda are given in the following Tables

TABLE XI

MEAN ACCEPTABILITY SCORES OF PAKODA (STANDARD)

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.3±0.45	8.4±0.50	8.6±0.5	8.4±0.48
Appearance	8.2±0.63	8.4±0.50	8.2±0.67	8.2±0.60
Flavour	8.5±0.5	8.2±0.67	8.2±0.88	8.3±0.68
Taste	8.4±0.48	8.5±0.63	8.0±0.70	8.3±0.60
Texture	8.4±0.48	8.3±0.61	7.9±0.96	8.2±0.68
Overall Acceptability	8.4±0.51	8.4±0.50	8.6±0.61	8.4±0.53

Maximum Score – 9

The appearance of the second trial had the highest score of 8.4 followed by the first and third trial with same mean score of 8.2. The colour of the pakoda for the third trial had the highest score of 8.6, whereas first and second trial showed a mean score of 8.3 and 8.4. The mean scores of the taste for second trial had the highest score of 8.5 when compared to first and third trial. First trial` had the highest score of 8.5 for flavour followed by first trial and second trial had same score of 8.2. For the texture of first trial showed the highest score of 8.4 followed by second and third trial with the mean scores of 8.3 and 7.9. The overall acceptability of the pakoda standard for the third trial had the same scores of 8.6 when compared to first and second trial.

- **Mean Acceptability Scores Obtained for the Five Per Cent Chia Seed Incorporated Pakoda**

Table XII shows the mean acceptability scores of five per cent chia seed incorporated pakoda.

TABLE XII

MEAN ACCEPTABILITY SCORES OF FIVE PER CENT CHIA SEED INCORPORATED PAKODA

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.3±0.48	7.9±0.96	7.8±0.86	8.0±0.76
Appearance	8.3±0.48	7.4±0.83	8.0±0.70	7.9±0.67
Flavour	8.1±0.73	7.9±0.59	8.2±0.59	8.0±0.63
Taste	8.0±0.44	8.2±0.67	8.0±0.53	8.0±0.54
Texture	8.1±0.53	8.0±0.65	8.3±0.48	8.1±0.55
Overall Acceptability	8.2±0.4	8.0±0.59	8.0±0.53	8.0±0.50

Maximum Score - 9

Pakoda was prepared by incorporating chia seed at five per cent levels by replacing the Bengal gram flour into the standard recipe. The appearance of the first trial had the highest score of 8.3 followed by the second and third trial with the mean score of 7.4 and 8.0. The colour of the first trial had the highest score of 8.3, whereas second and third trial showed a mean score of 7.9 and 7.8. The mean scores of the taste for first and third trial had the same score of 8.0 and second trial with the mean score of 8.2. Third trial` had the highest score of 8.2 for flavour followed by first and second trial had the mean score of 8.1 and 7.9. For the texture of third trial showed the highest score of 8.3 followed by first and second trial with the mean scores of 8.1 and 8.0. The overall acceptability of the second and third trial had the same mean score of 8.0 and first trial had the highest score of 8.2.

- **Mean Acceptability Scores Obtained for the 10 Per Cent Chia Seed Incorporated Pakoda**

Table XIII shows the mean acceptability scores of 10 per cent chia seed incorporated pakoda.

TABLE XIII

MEAN ACCEPTABILITY SCORES OF 10 PER CENT CHIA SEED INCORPORATED PAKODA

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.6±0.49	7.8±0.6	7.7±0.64	7.7±0.57
Appearance	7.3±0.45	7.5±0.92	7.3±0.64	7.3±0.67
Flavour	7.4±0.48	7.8±0.6	7.9±0.3	7.7±0.46
Taste	7.7±0.45	7.6±1.11	7.9±0.3	7.7±0.62
Texture	7.5±0.5	8±0.89	7.9±0.3	7.8±0.56
Overall Acceptability	7.6±0.48	7.8±0.74	7.7±0.64	7.7±0.62

Maximum Score -9

Pakoda was prepared by incorporating chia seed at 10 per cent levels by replacing the Bengal gram flour into the standard recipe. The colour of the second trial had the highest score of 7.8 followed by the first and third trial with the mean score of 7.6 and 7.7. The appearance of the second trial had the highest score of 7.5, whereas first and third trial had a same mean score of 7.3 and 7.3. The mean scores of the taste for first trial, second trial and third trial with the mean score of 7.7, 7.6 and 7.9 respectively. Third trial` had the highest score of 7.9 for flavour followed by first and second trial had the mean score of 7.4 and 7.8. For the texture of second trial showed the highest score of 8.0 followed by first and third trial with the mean scores of 7.5 and 7.9. The overall acceptability of the second trial had the highest scores of 7.8 followed by first and third trial with the mean scores of 7.6 and 7.7 respectively.

- **Mean Acceptability Scores Obtained for the 15 Per Cent Chia Seed Incorporated Pakoda**

Table XIV shows the mean acceptability scores of 15 per cent chia seed incorporated pakoda.

TABLE XIV

MEAN ACCEPTABILITY SCORE OF 15 PER CENT CHIA SEED INCORPORATED PAKODA

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	6.6±0.66	6.7±0.64	6.6±0.8	6.6±0.70
Appearance	6.5±0.80	6.6±0.48	6.6±0.48	6.5±0.58
Flavour	6.3±0.45	6.7±0.64	6.7±0.64	6.5±0.57
Taste	6.3±0.45	6.2±0.87	6.3±0.45	6.2±0.59
Texture	6.3±0.45	6.7±0.64	6.6±0.91	6.5±0.66
Overall Acceptability	6.3±0.45	6.6±0.8	6.5±0.69	6.4±0.64

Maximum Score – 9

The above Table depicts about the 15 per cent chia seed incorporated pakoda (variation III). With regard to the colour the average score obtained was only 6.6 for the maximum score of nine. The same way the average score for appearance was (6.5) flavour 6.5, taste 6.2 and texture only 6.5 out of nine. The overall acceptability score was recorded as 6.4. For all the attributes pakoda prepared in the first and second trial secure all most the same score, in the case of second trial the score was little bit better when compared to other two trials.

- **Mean Acceptability Scores Obtained for the Kozhukattai Standard**

Kozhukattai was prepared by incorporating chia seed at different proportions and the mean acceptability scores obtained are given in the following Tables.

TABLE XV

MEAN ACCEPTABILITY SCORES OF KOZHUKKATTAI (STANDARD)

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.4±0.54	7.4±0.48	7.7±0.4	7.4±0.54
Appearance	8.6±0.62	7.3±0.64	7.7±0.64	7.6±0.62
Flavour	8.6±0.41	7.4±0.48	7.9±0.3	7.6±0.41
Taste	8.7±0.52	7.6±0.48	7.9±0.3	7.7±0.52
Texture	8.5±0.64	7.2±0.74	7.8±0.4	7.5±0.64
Overall Acceptability	8.6±0.6	7.4±0.66	7.8±0.4	7.6±0.6

Maximum Score -9

The above Table represents about the kozhukattai prepared with standard recipe. The colour of the kozhukattai prepared during the first trial showed the score of 8.4 followed by second and third trial with the mean scores of 7.4 and 7.7 respectively. The appearance of the kozhukattai standard for first trial had the highest score of 8.6 whereas second and third trial showed a mean score of 7.3 and 7.7 respectively. The mean scores of the standard for first trial, second trial and third trial were 8.7, 7.6, and 7.9 respectively for taste. First trial had the highest mean score of 8.6 and second and third trial with the mean scores of 7.4 and 7.9 for flavour. For the texture of first trial showed the highest score of 8.5 followed by second and third trial with the score of 7.2 and 7.8 respectively. The overall acceptability of first trial had the highest score of 8.6 and second and third trial had least score of 7.8 and 7.4. With regard to the overall acceptability score obtained for first trial had the highest score of 8.6 followed by second trial and third trial with the mean score of 7.4 and 7.8 respectively.

- **Mean Acceptability Scores Obtained forthe Five Per Cent Chia Seed Incorporated Kozhukattai Variation I**

Table XVI shows the mean acceptability scores of five per cent chia seed incorporated kozhukattai.

TABLE XVI

MEAN ACCEPTABILITY SCORES OF CHIA SEED INCORPORATED KOZHUKATTAI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.5±0.92	7.6±0.66	7.9±1.13	7.6±0.90
Appearance	8.0±0.89	8.0±0.44	8.2±0.4	8.0±0.57
Flavour	7.6±1.11	7.6±0.91	7.7±0.64	7.6±0.88
Taste	7.7±1.18	7.6±0.8	7.7±0.64	7.6±0.87
Texture	7.8±0.6	8.0±0.77	8.2±0.74	8.0±0.70
Overall Acceptability	7.8±0.74	8.0±0.44	8.0±0.44	7.9±0.54

Maximum Score - 9

Kozhukattai was prepared by incorporating chia seed at five per cent levels by replacing the rice flour used the standard recipe. The colour of the third trial had the highest score of 7.9 followed by the first and second trials with the mean score of 7.5 and 7.6 respectively. First and second trials had the same scores of 8.0 each for appearance followed by third trial with mean scores of 8.2. The mean scores for first and third trials had the same for 7.7 and second trial were 7.6 for taste. For the texture of third trial showed the highest score of 8.0 followed by first and second trials with the score of 7.8 and 8.0 respectively. The overall acceptability of second and third trials had the same score of 8.0 and first trial had least score of 7.8.

- **Mean Acceptability Scores Obtained for the 10 Per Cent Chia Seed Incorporated Kozhukattai**

Table XVII shows the mean acceptability scores of 10 per cent chia seed incorporated kozhukattai.

TABLE XVII

MEAN ACCEPTABILITY SCORES OF 10 PER CENT CHIA SEED INCORPORATED KOZHUKATTAI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.3±0.9	7.2±1.07	7.2±0.6	7.2±0.85
Appearance	7.2±0.6	7.4±0.66	7.3±0.64	7.3±0.63
Flavour	7.3±0.64	7.5±0.5	7.5±0.80	7.4±0.64
Taste	6.9±0.94	7.1±0.53	7.3±0.9	7.1±0.79
Texture	7.1±0.53	7.3±0.45	7.3±0.45	7.2±0.47
Overall Acceptability	7.0±0.44	7.2±0.74	7.4±0.48	7.2±0.55

Maximum Score - 9

Kozhukattai was prepared by incorporating chia seed at 10 per cent levels by replacing the rice flour used the standard recipe. The colour of the second and third trial had the same score of 7.2 followed by the first trial with the mean score of 7.3. The appearance of second trial had the highest score of 7.4 followed by first and third trials with the mean score of 7.2 and 7.3 respectively. Second and third trial had the same scores of 7.5 each for flavour followed by first trial with mean scores of 7.3. The mean scores for second and third trials had the same for 7.3 and first trial were 7.1 for texture. For the taste of third trial showed the highest score of 7.3 followed by first and second trials with score of 6.9 and 7.1 respectively. The overall acceptability of third trial had the highest score of 8.4 and first and second trials with the mean score of 7.0 and 7.2 respectively

- **Mean Acceptability Scores Obtained for the 15 Per Cent Chia Seed Incorporated Kozhukattai**

Table XVIII shows the mean acceptability scores of 15 per cent chia seed incorporated kozhukattai.

TABLE XVIII

MEAN ACCEPTABILITY SCORES OF 15 PER CENT CHIA SEED INCORPORATED KOZHUKATTAI

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	6.6±1.01	6.2±0.87	6.3±0.45	6.3±0.77
Appearance	6.7±0.64	6.6±1.01	6.6±0.91	6.6±0.85
Flavour	6.6±0.91	6.3±0.64	6.5±0.69	6.4±0.74
Taste	6.2±0.87	6.6±0.8	6.4±0.84	6.4±0.83
Texture	6.3±0.64	6.7±0.64	6.7±0.42	6.5±0.56
Overall Acceptability	6.6±0.8	6.6±0.8	6.5±0.51	6.5±0.70

Maximum Score - 9

The above Table depicts about the 15 per cent chia seed incorporated kozhukattai (variation III). With regard to the colour the average score obtained was only 6.3 for the maximum score of nine. The same way the average score for appearance was 6.6, flavour 6.4, taste 6.4 and texture only 6.5 out of nine. The overall acceptability score was recorded as 6.6. For all the attributes kozhukattai prepared in the first and second trial secure all most the same score, in the case of first and second trials the score was little bit better when compared to other two trials.

- **Mean Acceptability Scores Obtained for Laddu Standard**

Laddu was prepared by incorporating chia seed at different proportions and the mean acceptability scores obtained are given in the following Tables

TABLE XVIX

MEAN ACCEPTABILITY SCORES OF LADDU (STANDARD)

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	8.3±0.78	8.4±0.48	8.4±0.48	8.3±0.58
Appearance	8.2±0.74	8.5±0.5	8.4±0.48	8.3±0.57
Flavour	8.2±0.74	8.4±0.48	8.0±0.77	8.2±0.66
Taste	8.5±0.5	8.4±0.48	8.4±0.66	8.4±0.54
Texture	8.2±0.4	8.4±0.51	8.2±0.74	8.2±0.55
Overall Acceptability	8.4±0.48	8.4±0.51	8.2±0.74	8.3±0.57

Maximum Score - 9

The above Table describes about the laddu standard. The colour of the second and third trial had the same score of 8.4 followed by the first trial with the mean score of 8.3. The appearance of second trial had the highest score of 8.5 followed by first and third trials with the mean score of 8.2 and 8.4 respectively. The flavour for second trial had the highest score of 8.4 followed by first and third trials with the mean score of 8.2 and 8.0 respectively. First, second and third trials had the mean scores of 8.2, 8.4 and 8.0 respectively. The mean scores for first and third trials had the same for 8.2 and second trial were 8.4 for texture. For the taste of second and third trials showed the same score of 8.2 followed first trial with score of 8.5. The overall acceptability of first and second trials had the same score of 8.4 followed by the third trial with the mean score of 8.2.

- **Mean Acceptability Scores Obtained for the Five Per Cent Chia Seed Incorporated Laddu**

Table XX shows the mean acceptability scores of five per cent incorporated laddu.

TABLE XX

MEAN ACCEPTABILITY SCORES OF FIVE PER CENT CHIA SEED INCORPORATED LADDU

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.9±0.53	7.7±0.45	8.0±0.89	7.8±0.62
Appearance	7.8±0.04	7.5±0.5	7.7±0.92	7.6±0.48
Flavour	7.9±0.3	7.7±0.45	7.8±0.45	7.7±0.4
Taste	7.7±0.64	7.6±0.48	7.7±1.18	7.6±0.76
Texture	7.9±0.3	7.7±0.78	7.8±0.6	7.8±0.56
Overall Acceptability	7.9±0.3	7.7±0.78	7.8±0.74	7.8±0.60

Maximum Score - 9

Laddu was prepared by incorporating chia seed at 5 per cent levels by replacing the groundnut and dates used the standard recipe. The colour of the first trial had the highest score of 7.9 and followed by second and third trials with the mean score of 7.7 and 8.0 respectively. The appearance of first trial had the highest score of 7.8 followed by second and third trials with the mean score of 7.5 and 7.7 respectively. For the flavour of first trial showed the highest score of 7.9 followed by second and third trials with score of 7.7 and 7.8 respectively. First and third trials had the same scores of 7.7 each for taste followed by second trial with mean scores of 7.6. The mean scores for first trials showed highest score of 7.9 when compared to second and third trials for texture. The overall acceptability of first trial showed the highest score of 7.9 followed by second and third trials with the mean score of 7.7 and 7.8 respectively.

- **Mean Acceptability Scores Obtained for the 10 Per Cent Chia Seed Incorporated Laddu**

Table XXI shows the mean acceptability scores of 10 per cent chia seed incorporated laddu.

TABLE XXI

MEAN ACCEPTABILITY SCORES OF 10 PER CENT CHIA SEED INCORPORATED LADDU

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	7.6±0.48	7.7±1.18	7.3±0.45	7.5±0.70
Appearance	7.4±0.48	7.5±0.5	7.3±0.48	7.4±0.48
Flavour	7.2±0.74	7.3±0.45	7.4±0.5	7.3±0.56
Taste	7.3±0.64	7.4±0.9	7.5±0.5	7.4±0.68
Texture	7.4±0.66	7.2±0.6	7.3±0.45	7.3±0.57
Overall Acceptability	7.4±0.66	7.4±0.48	7.6±0.48	7.4±0.54

Maximum Score - 9

Laddu was prepared by incorporating chia seed at 10 per cent levels by replacing the groundnut and dates used the standard recipe. The colour of the second trial had the highest score of 7.7 followed by first and third trials with the mean score of 7.6 and 7.3 respectively. The appearance of second trial had the highest score of 7.5 followed by first and third trials with the mean score of 7.4 and 7.3 respectively. The mean scores for third trial showed the highest score of 7.4 followed by first and second trials with the mean score of 7.2 and 7.3 respectively for flavour. For the taste of third trial showed the highest score of 7.5 followed by first and second trials with score of 7.3 and 7.4 respectively. The overall acceptability of first and second trials had the same scores of 7.4 each for followed by third trial with mean scores of 7.6.

- **Mean Acceptability Scores Obtained for the 15 Per Cent Chia Seed Incorporated Laddu**

Table XXII shows the mean acceptability scores of I5 per cent chia seed incorporated laddu

TABLE XXII

MEAN ACCEPTABILITY SCORES OF 15 PER CENT CHIA SEED INCORPORATED LADDU

Criteria	Trial 1	Trial 2	Trial 3	Average Scores
	Scores (Mean±SD)			
Colour	6.9±0.83	6.7±0.51	6.6±0.91	6.7±0.75
Appearance	6.8±0.74	6.5±0.51	6.9±0.94	6.7±0.73
Flavour	7.1±0.7	6.5±0.69	7.1±0.53	6.9±0.64
Taste	6.6±0.91	6.7±0.42	6.6±0.91	6.6±0.74
Texture	7.1±0.94	6.5±0.51	6.3±0.64	6.6±0.69
Overall Acceptability	7.0±0.89	6.5±0.51	6.6±0.8	6.7±0.73

Maximum Score - 9

The above Table depicts about the 15 per cent chia seed incorporated laddu (variation III). With regard to the colour the average score obtained was only 6.7 for the maximum score of nine. The same way the average score for appearance was 6.7, flavour 6.9, taste 6.6 and texture only 6.6 out of nine. The overall acceptability score was recorded as 7.0. For all the attributes kozhukattai prepared in the second trial secure all most the same score, in the case of first trial the score was little bit better when compared to other two trials.

4.2. EVALUATION OF THE HIGHLY ACCEPTABLE RECIPES

- **Mean Acceptability Score of Standard and Chia Seed Incorporated Chikki**

The mean acceptability score gained by chia seed incorporated chikki is shown in Table XXIII and Figure 2.

TABLE XXIII

MEAN ACCEPTABILITY SCORE OF STANDARD AND VARIATIONS IN CHIKKI

Criteria	Standard	Variation I	Variation II	Variation III
	Scores (Mean±SD)			
Colour	8.6±0.43	8.1±0.55	6.6±0.64	6.5±0.74
Appearance	8.4±0.52	8.1±0.52	6.9±6.9	6.6±0.66
Flavour	8.3±0.70	8.0±0.58	6.7±0.80	6.6±0.66
Taste	8.5±0.61	8.1±0.56	6.9±0.56	6.4±0.68
Texture	8.6±0.55	8.2±0.56	6.8±0.57	6.7±0.73
Overall Acceptability	8.5±0.56	8.2±0.52	6.8±0.54	6.6±0.76

Maximum Score -9

Chikki was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the groundnut present in the standard recipe. Chikki incorporated with 5 per cent, 10 per cent and 15 per cent were taken as variation I, variation II and Variation III respectively. The score obtained for the standard in every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for five per cent chia seed incorporated chikki seems to be nearer to the scores received by the standard preparation of chikki. Chikki prepared with 10 per cent and 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was revealed that chikki prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent and 15 per cent of chia seed is not acceptable because of the unacceptable taste and flavour.

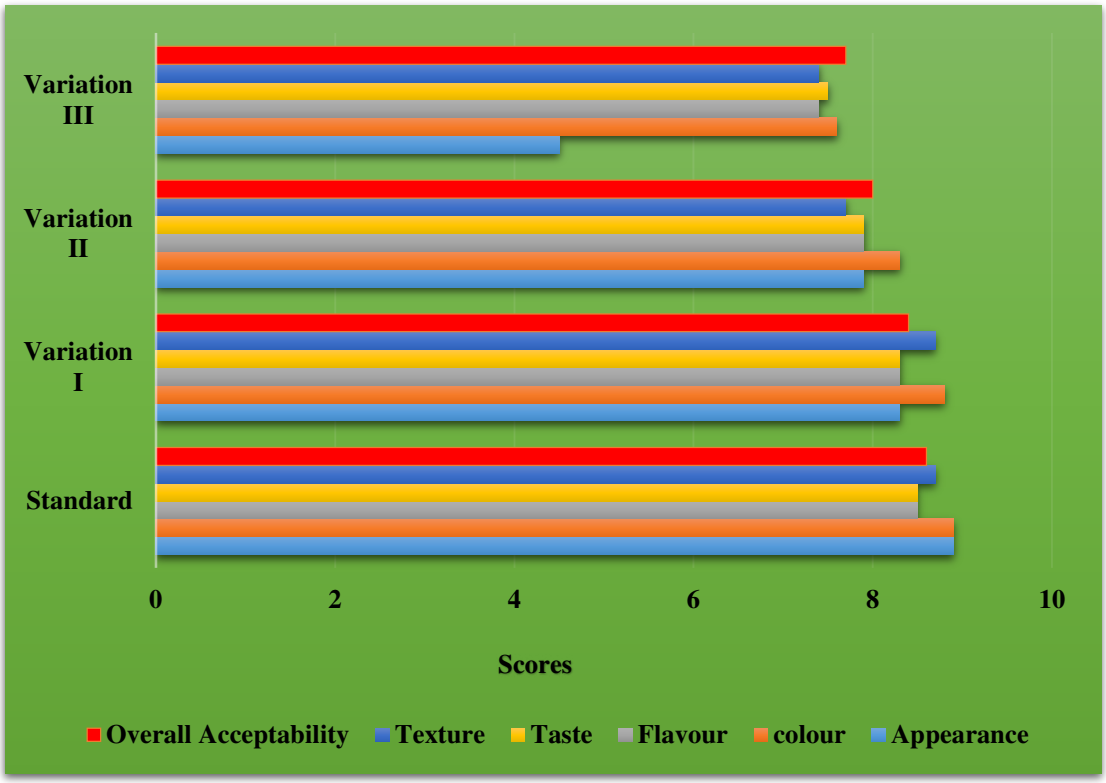


Figure 2 : Mean Acceptability Score of Standard and Variations in Chikki

- **Mean Acceptability Scores of Standard and Chia Seed Incorporated Fruit Punch**

The mean acceptability score gained by chia seed incorporated fruit punch is shown in Table XXIV and Figure 3.

TABLE XXIV

MEAN ACCEPTABILITY SCORE OF STANDARD AND VARIATIONS IN FRUIT PUNCH

Criteria	Standard	Variation I	Variation II	Variation III
	Scores (Mean±SD)			
Colour	8.6±0.91	8.3±0.62	7.9±0.54	7.7 ±0.66
Appearance	8.2±0.77	8.2±0.64	7.9±0.54	7.6 ±0.65
Flavour	8.6±0.8	8.0±0.77	7.6±0.96	7.4 ±0.72
Taste	8.6±0.66	8.0±0.82	7.5±0.8	7.2 ±0.70
Texture	8.7±0.45	7.9±0.86	7.8±0.61	7.2 ±0.72
Overall Acceptability	8.6±0.44	8.4±0.66	7.7±0.58	7.5 ±0.67

Maximum Score – 9

Fruit punch was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the orange present in the standard recipe. The score obtained for the standard in every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for variation I seems to be nearer to the scores received by the standard preparation of fruit punch. Fruit punch prepared with 10 per cent and 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was revealed that fruit punch prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent and 15 per cent of chia seed is not acceptable because of the unacceptable taste and flavour

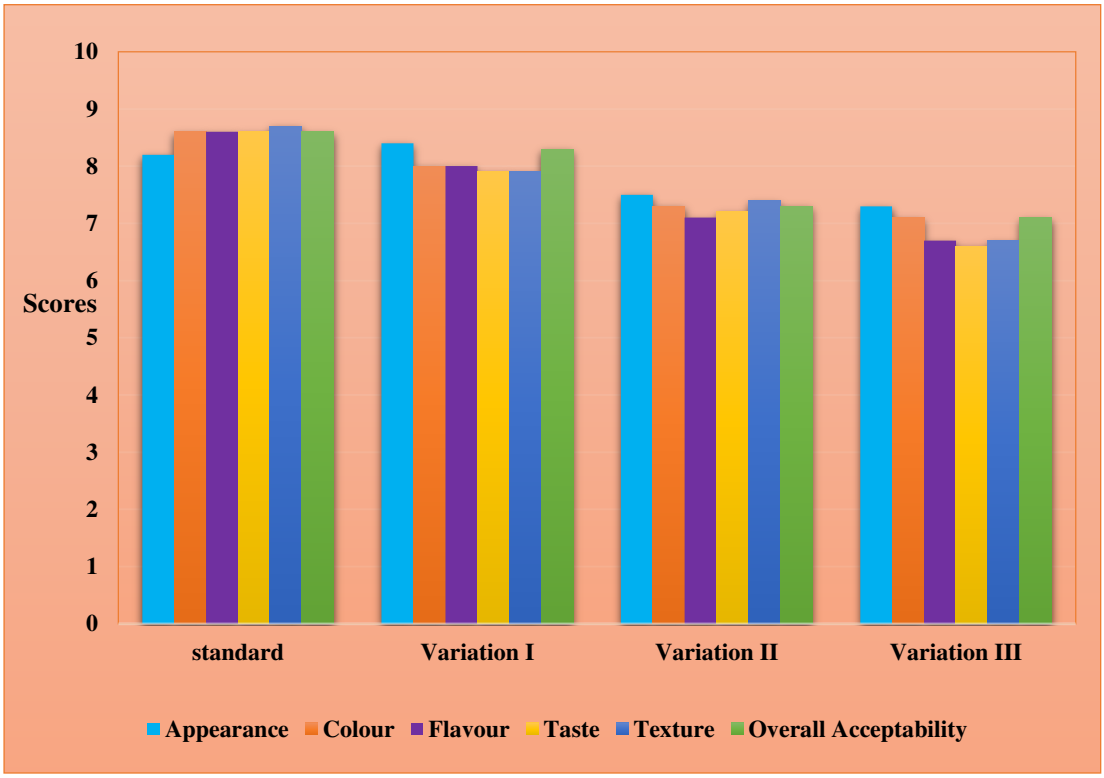


Figure 3 : Mean Acceptability Score of Standard and Variations in Fruit Punch

- **Mean Acceptability Scores of Standard and Chia Seed Incorporated Pakoda**

The mean acceptability score gained by chia seed incorporated pakoda is shown in Table XXV and Figure 4

TABLE XXV

MEAN ACCEPTABILITY SCORE OF STANDARD AND VARIATIONS IN PAKODA

Criteria	Standard	Variation I	Variation II	Variation III
	Scores (Mean±SD)			
Colour	8.4±0.48	8.0±0.76	7.7±0.57	6.6 ±0.70
Appearance	8.2±0.60	7.9±0.67	7.3±0.67	6.5 ±0.58
Flavour	8.3±0.68	8.0±0.63	7.7±0.46	6.5 ±0.57
Taste	8.3±0.60	8.0±0.54	7.7±0.62	6.2 ±0.59
Texture	8.2±0.68	8.1±0.55	7.8±0.56	6.5 ±0.66
Overall Acceptability	8.4±0.53	8.0±0.50	7.7±0.62	6.4 ±0.64

Maximum Score – 9

Pakoda was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the Bengal gram flour present in the standard recipe. Pakoda incorporated with 5 per cent, 10 per cent and 15 per cent were taken as variation I, variation II and Variation III respectively. The score obtained for the standard in every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for variation I seems to be nearer to the scores received by the standard preparation of pakoda. Pakoda prepared with 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was discovered that pakoda prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent is reasonably acceptable and 15 per cent of chia seed is not acceptable because of the unacceptable taste.

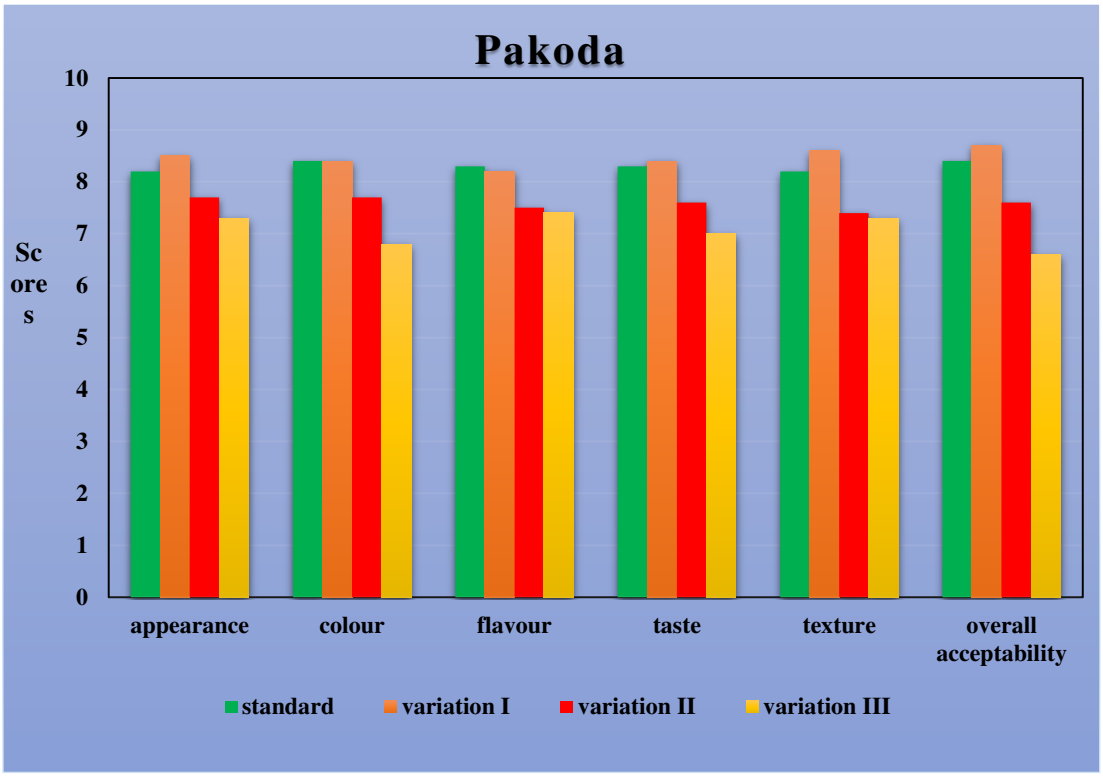


Figure 4 :Mean Acceptability Score of Standard and Variations in Pakoda

- **Mean Acceptability Scores of Standard and Chia Seed Incorporated Kozhukattai**

The mean acceptability score gained by chia seed incorporated kozhukattai is shown in Figure 5 and Table XXVI.

TABLE XXVI

MEAN ACCEPTABILITY SCORE OF STANDARD AND VARIATIONS IN KOZHUKATTAI

Criteria	Standard	Variation I	Variation II	Variation III
	Mean score			
Colour	8.4±0.54	7.6±0.90	7.2±0.85	6.3±0.77
Appearance	8.6±0.62	8.0±0.57	7.3±0.63	6.6±0.85
Flavour	8.6±0.41	7.6±0.88	7.4±0.64	6.4±0.74
Taste	8.7±0.52	7.6±0.87	7.1±0.79	6.4±0.83
Texture	8.5±0.64	8.0±0.70	7.2±0.47	6.5±0.56
Overall Acceptability	8.6±0.6	7.9±0.54	7.2±0.55	6.5±0.70

Maximum Score – 9

Kozhukattai was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the rice flour present in the standard recipe. Kozhukattai incorporated with 5 per cent, 10 per cent and 15 per cent were taken as variation I, variation II and Variation III respectively. The score obtained for the standard in every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for variation I seems to be nearer to the scores received by the standard preparation of kozhukattai. Kozhukattai prepared with 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was discovered that kozhukattai prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent is reasonably acceptable and 15 per cent of chia seed is not acceptable because of the unacceptable taste and flavour.

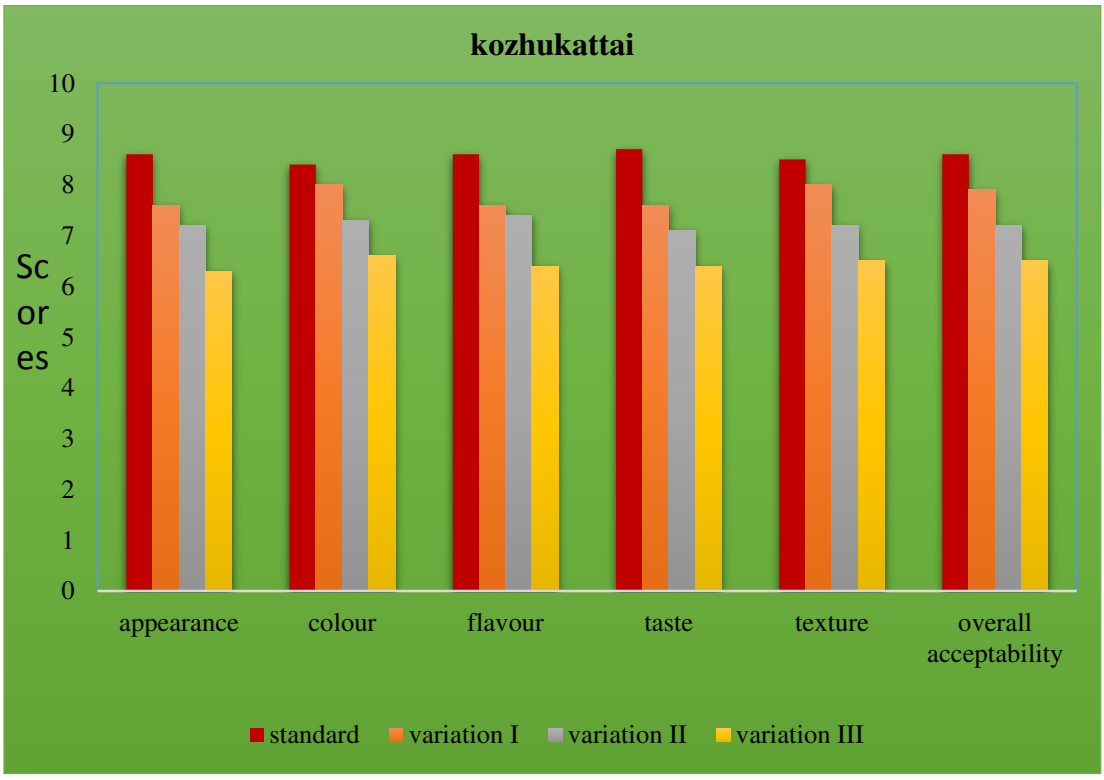


Figure 5 :Mean Acceptability Score of Standard and Variations in Kozhukattai

- **Mean Acceptability Scores of Standard and Chia Seed Incorporated Laddu**

The mean acceptability score gained by chia seed incorporated laddu is shown in figure VI and Table XXVII.

TABLE XXVII

MEAN ACCEPTABILITY SCORE OF STANDARD AND VARIATIONS IN LADDU

Criteria	Standard	Variation I	Variation II	Variation III
	Scores (Mean±SD)			
Colour	8.3±0.58	7.8±0.62	7.5±0.70	6.7±0.75
Appearance	8.3±0.57	7.6±0.48	7.4± 0.48	6.7±0.73
Flavour	8.2±0.66	7.7±0.4	7.3±0.56	6.9±0.64
Taste	8.4±0.54	7.6±0.76	7.3±0.68	6.6±0.74
Texture	8.2± 0.55	7.8±0.56	7.3±0.57	6.6±0.69
Overall Acceptability	8.3±0.57	7.8±0.60	7.4±0.54	6.7±0.73

Maximum Score – 9

Laddu was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the groundnut and dates present in the standard recipe. Laddu incorporated with 5 per cent, 10 per cent and 15 per cent were taken as variation I, variation II and Variation III respectively. The score obtained for the standard in every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for variation I seems to be nearer to the scores received by the standard preparation of laddu. laddu prepared with 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was discovered that laddu prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent is reasonably acceptable and 15 per cent of chia seed is not acceptable because of the unacceptable taste and flavour.

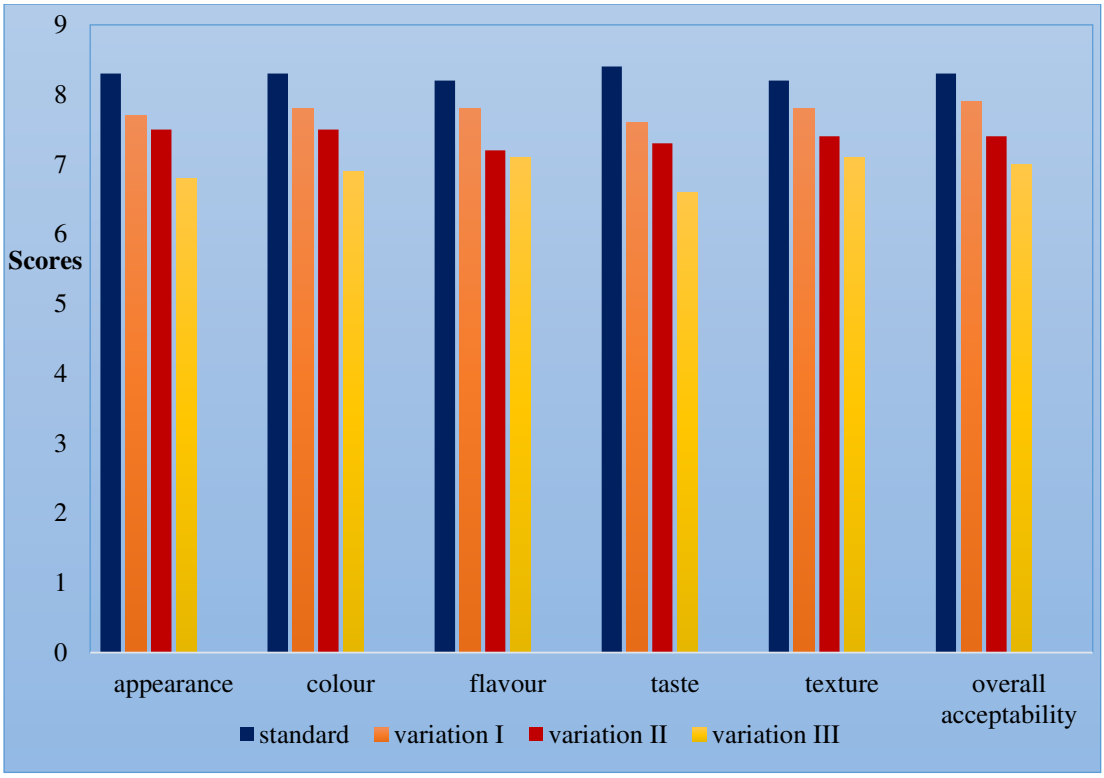


Figure 6 : Mean Acceptability Score of Standard and Variations in Laddu

4.3. NUTRIENT ANALYSIS OF THE ACCEPTABLE RECIPES

Nutrient analysis were carried out for the highly acceptable recipes received maximum score in the organoleptic evaluation. Nutrients like protein, fat, carbohydrate, iron, calcium, phosphorus and energy analysed were using the standard procedure, after analysis the values for the nutrient were computed and presented in the formulating table for various recipes.

- **Nutrient Content of Standard and Chia Seed Incorporated Chikki**

Table XXVIII describes the nutrient content of the chikki.

TABLE XXVIII

NUTRIENT CONTENT OF STANDARD AND FIVE PER CENT INCORPORATED CHIKKI (PER 100 g)

S.No	Nutrients	Standard Chikki	5% Chia Seed Incorporated Chikki
1.	Energy (Kcal)	315.0	358.0
2.	Moisture (%)	15	10.4
3.	Protein (g)	11.7	12.1
4.	Fat (g)	16	18.4
5.	Carbohydrates (g)	31.2	36.4
6.	Iron (mg)	11.3	12.3
7.	Calcium (mg)	148	194
8.	Phosphorus (mg)	224	285
9.	Crude Fibre (g)	0	1.5

The finding of the analysis indicated that the energy content was 315.0 kcal in the standard chikki while for the 5 per cent incorporated chia seed chikki it was 358.0 kcal. It was observed that the energy content of the five per cent incorporated chikki was higher than the standard. The moisture content of the standard it was 15 per cent and five per cent incorporated chia seed chikki it was 10.4 per cent.

Protein content was found to be 11.7 g per 100 g in the standard chikki while for the five per cent incorporated chia seed chikki it was found to be 12.1 g per 100 g. Fat content was found to be 16 g per 100 g in the standard and five per cent incorporated chia seed chikki it was found to be 18.4 g per 100 gr. The carbohydrate content was found to be 31.2 g per 100 g in standard chikki and 36.4 g per 100 g in five per cent incorporated chia seed chikki. Crude fibre is present in the five per cent chia seed incorporated fruit punch 1.5 g per 100 g and the standard chikki is not contain the crude fibre.

Calcium content was found to be 148 mg per 100 g in standard and 194 mg per 100 g in five per cent incorporated chia seed chikki. Phosphorus content in standard chikki was found to be 224 mg per 100 g and 285 mg per 100 g in the five per cent incorporated chia seed chikki. The five per cent chia seed incorporated chikki showed 11.3 mg of iron per 100 g when compared to standard with 12.3 mg. with regards to nutrient content not much difference was noted between the two recipes.

- **Nutrient Content of Standard and Chia Seed Incorporated Fruit Punch**

The Table XXVIX showed the nutrient content of the fruit punch

TABLE XXVIX

NUTRIENT CONTENT OF STANDARD AND FIVE PER CENT CHIA SEED INCORPORATED FRUIT PUNCH (PER 100 g)

S.No	Nutrients	Standard Fruit Punch	5 % Chia Seed Incorporated Fruit Punch
1.	Energy (Kcal)	59.0	95.0
2.	Moisture (%)	94.8	88.5
3.	Protein (g)	3.8	4.6
4.	Fat (g)	0.9	3.1
5.	Carbohydrates (g)	9.0	12.1
6.	Iron (mg)	4.0	5.6
7.	Calcium (mg)	80	124
8.	Phosphorus (mg)	40	118
9.	Crude Fibre (g)	1.8	3.2

In comparing the analysis indicated that the five per cent chia seed incorporated fruit punch it was observed that the energy content was 59.0 kcal in fruit punch standard while 95.0 kcal for five per cent chia seed incorporated fruit punch is higher than standard fruit punch. Moisture content of the fruit punch standard found to be 94.5 % and 88.5 % for the five per cent chia seed incorporated fruit punch. Protein

content of fruit punch standard was analysed and found to be 3.8 g per 100 g while for the five per cent chia seed incorporated fruit punch was found to be 4.6 g per 100 g. fat content was found to be 0.9 g per 100 g in the standard and five per cent chia seed incorporated fruit punch it was contains 3.1 g per 100 g. carbohydrate content was found to be 9.0 g per 100 g of standard fruit punch and 12.1 g per 100 g in five per cent chia seed incorporated fruit punch.

Calcium content was found to be 80 mg per 100 g in standard and 124 mg per 100 g in five per cent chia seed incorporated fruit punch. Standard fruit punch it was contains 40 mg of phosphorus per 100 g and 118 g per 100 mg in five per cent chia seed incorporated fruit punch. Crude fibre present in the standard fruit punch it was contains 18 g per 100 g and 3.2 g per 100 g in five per cent chia seed incorporated fruit punch.

- **Nutrient Content of Standard and Five Per Cent Chia Seed Incorporated Pakoda**

Nutrient content of the standard and five per cent chia seed incorporated pakoda are given in Table XXX.

TABLE XXX

NUTRIENT CONTENT OF STANDARD AND FIVE PER CENT CHIA SEED INCORPORATED PAKODA (PER 100 g)

S.No	Nutrients	Standard Pakoda	5% Chia Seed Incorporated Pakoda
1.	Energy (Kcal)	301.0	308.0
2.	Moisture (%)	16	8
3.	Protein (g)	9.4	13.2
4.	Fat (g)	3.0	8.4
5.	Carbohydrates (g)	59.0	45
6.	Iron (mg)	7.2	8.7
7.	Calcium (mg)	192	239
8.	Phosphorus (mg)	169	228
9.	Crude Fibre (g)	0.6	2.0

The finding of the analysis indicated that the energy content was 301.0 kcal in the standard pakoda while for the five per cent chia seed incorporated pakoda it was recorded 308.0 kcal observed that the energy content of the five per cent chia seed incorporated pakoda was higher than the standard. Moisture content of the standard it was 16 per cent and five per cent chia seed incorporated pakoda it was 8 per cent.

Protein content of standard pakoda was found to be having 9.4 g per 100 g while for the five per cent chia seed incorporated pakoda it was found to be 13.2 g per 100 g. Fat content was found to be 3 g per 100 g in the standard and five per cent chia seed incorporated pakoda it was found to be 8.4 g per 100 g. Carbohydrate content was found to be 59 g per 100 g in standard pakoda and 45 g per 100 g in five per cent chia seed incorporated pakoda. Crude fibre is present in the five per cent chia seed incorporated pakoda 2.0 g per 100 g it was higher than the standard pakoda 0.6 g per 100 g.

Calcium content was found to be 192 mg per 100 g of standard and 239 mg per 100 g of 5 per cent chia seed incorporated pakoda. Phosphorus content in standard pakoda was found to be 169 mg per 100 g and 228 mg per 100 g in the five per cent chia seed incorporated pakoda. The five per cent chia seed incorporated pakoda showed 8.7 mg of iron per 100 g when compared to standard with 7.2 mg.

- **Nutrient Content of Standard and 5 Per Cent Chia Seed Incorporated Kozhukattai**

Table XXXI describes the nutrient content of the standard and 5 per cent chia seed incorporated kozhukattai.

The nutrient content of the standard kozhukattai was analysed and found to be 297.0 kcal, 30% moisture, 3.9 g of protein, 1.1 g of fat, 68.1 g of carbohydrates, 3.6 mg of iron, 88 mg of calcium and 152 mg of phosphorus. Crude fibre is present in the 5 per cent chia seed incorporated kozhukattai 2.6 g per 100 g it was higher than the standard kozhukattai 1.2 g per 100 g.

The nutrient content of variation I with five per cent incorporation of chia seed was found to be highest with 357 kcal of energy, 33.4 % of moisture, 6.6 g of protein, 4.3 g of fat, 73.3 g of carbohydrates, 4.1 mg of iron, 112 mg of calcium and 247 mg of phosphorus. For the nutrient analysis the five per cent chia seed incorporated kozhukattai had the little bit excess amount of nutrients when compared to standard recipe.

TABLE XXXI

NUTRIENT CONTENT OF STANDARD AND 5 PER CENT CHIA SEED INCORPORATED KOZHUKATTAI (100g)

S.No	Nutrients	Standard	5 % Chia Seed Incorporated
1.	Energy (Kcal)	297.0	357.0
2.	Moisture (%)	30	33.4
3.	Protein (g)	3.9	6.6 g
4.	Fat (g)	1.1	4.3
5.	Carbohydrates (g)	68.1	73.3 g
6.	Iron (mg)	3.6	4.1
7.	Calcium (mg)	88	112
8.	Phosphorus (mg)	152	247
9.	Crude Fibre (g)	1.2	2.6

- **Nutrient Content of Standard and Five Per Cent Chia Seed Incorporated Laddu**

Table XXXII describes the nutrient content of the standard and five per cent chia seed incorporated laddu.

The nutrient content of the standard and five per cent chia seed incorporated laddu was analysed to be the energy content was 318 kcal in the standard laddu while for the five per cent incorporated chia seed laddu it was 357 kcal observed that the

energy content of the five per cent chia seed incorporated laddu was higher than the standard. The moisture content of the standard it was 8.5 per cent and five per cent chia seed incorporated laddu it was 6.3 per cent.

TABLE XXXII

NUTRIENT CONTENT OF STANDARD AND 5 PER CENT CHIA SEED INCORPORATED LADDU (100g)

S.No	Nutrients	Standard	5 % Chia Seed Incorporated
1.	Energy (Kcal)	318.0	357.0
2.	Moisture (%)	8.5	6.3
3.	Protein (g)	9.6	12.1 g
4.	Fat (g)	11.4	13.6
5.	Carbohydrates (g)	44.3	46.8
6.	Iron (mg)	9.6	10.8
7.	Calcium (mg)	112	148
8.	Phosphorus (mg)	228	269
9.	Crude Fibre(g)	0.8	2.2

Protein content was found to be 9.6 g per 100 g in the standard laddu while for the five per cent chia seed incorporated laddu it was found to be 12.1 g per 100 g. The fat content was found to be 11.4 g per 100 g in the standard and 5 per cent chia seed incorporated laddu it was found to be 13.6 g per 100 g. Carbohydrate content was found to be 31.2 g per 100 g in standard laddu and 36.4 g per 100 g in 5 per cent chia seed incorporated laddu. The five per cent chia seed incorporated laddu showed 9.6 mg of iron per 100 g when compared to standard with 10.8 mg per 100 g.

Calcium content was found to be 44.3 mg per 100 g of standard and 148 mg per 100 g in five per cent chia seed incorporated laddu. Phosphorus content in standard laddu was found to be 228 mg per 100 g and269 mg per 100 g in the five per

cent chia seed incorporated laddu. Crude fibre was found to be 0.8 g per 100 g of standard laddu is lower when compared to five per cent chia seed incorporated laddu it was 2.2 g per 100 g.

V SUMMARY AND CONCLUSION

The summary and conclusion pertaining to the topic, "**Standardisation of chia seed incorporated recipes and analysis of nutrient content"** is discussed below

The seeds still are a major dietary staple in South and Central America today, as they are good sources of fibre and protein, and have an extremely high concentration of essential fatty acids even more omega-3 than salmon. They also contain potassium, calcium, iron, phosphorus, and manganese, while being low in cholesterol and sodium, and have a high concentration of antioxidants.

The unique combination of soluble and insoluble fibre helps to slow the body's conversion of food into sugar. Preliminary research shows that chia seeds could help people with diabetes control their blood sugar levels and protect their hearts. Essential fatty acids are known to help maintain the function of brain cell membranes and neurotransmitters. Omega-3 fatty acids, in particular, contain docosa hexaenoic acid (DHA), which is used exclusively by the brain and nervous system.

Chia seeds can be eaten raw, or added to drinks and foods. When soaked in water, they form a gel that can be used in baking, and they also thicken smoothies and oatmeal, while being a crunchy addition to yogurt.

Hence the present study was undertaken with an objective to develop of chia seed incorporated recipes compare with the standard and conduct acceptability trials and also to determine the nutrient content of the selected recipes.

The present study was under taken to make easily consumable, affordable high protein and nutrient dense recipes prepared from different concentration of chia seed. The chia seed also have therapeutic significance which helps. First part of the study was selection of ingredients. The recipes were listed among five recipes and their acceptability trials are conducted. On the second part of the study different recipes were prepared with incorporation of 5 per cent, 10 per cent and 15 per cent of chia seed along with other ingredients. Standard and three variations were prepared for all the recipes. Organoleptic evaluation was done by conducting intake trials using nine point hedonic rating scale with the help of 10 semi trained panel members having good description and good communication power selection.

Salient Findings of the Study

- The sensory evaluation of chikki resulted with a maximum score of 8.4 for the appearance of standard followed by variation I, variation II and variation III with the mean scores of 8.1, 6.9 and 6.6 respectively. The colour of the standard showed the maximum score of 8.6 followed by variation I, variation II and variation III with the mean scores of 8.1, 6.6 and 6.5 respectively. Standard score maximum for taste of chikki with the mean score of 8.5 followed by the variation I, variation II, variation III scoring 8.1, 6.9 and 6.4 respectively. The flavour of the standard showed the maximum score of 8.3 and variation III had the least with 6.6 out of nine. For the texture of standard showed the maximum score of 8.6 followed by variation I, variation II and variation III with the mean scores of 8.2, 6.8 and 6.6 respectively. The mean scores of overall acceptability showed that standard scored the highest with a score of 8.5 followed by variation I, variation II and variation III with a score of 8.2, 6.8 and 6.6 respectively.
- From the sensory evaluation it was concluded that among the three variations, five per cent of chia seed incorporated recipe received maximum score and the scores are near to the standard and considered as highly acceptable products.
- The nutrient content of the chikki standard were contain 314.8 kcal Energy per 100 g, 15 per cent moisture, 11.7 g protein, 16 g fat, 31.2 g carbohydrates, 11.3 mg of iron, 148 mg of calcium and 224 mg of phosphorus per 100 grams.
- Five per cent chia seed incorporated chikki was found to be having 358.0 kcal of Energy, 10.4 per cent of moisture, 12.1 g of protein, 18.4 g of fat, 36.4 g of carbohydrates, 12.3 mg of iron, 194 mg of calcium and 285 mg of phosphorus per 100 grams.
- The appearance of standard fruit punch and five per cent chia seed incorporated fruit punch with the same score of 8.2 followed by the variation II and variation III with the score of 7.9 and 7.6. Evaluation score for the colour of standard recorded highest with a score of 8.6 followed by the variation I, variation II and variation III with the mean score of 8.3, 7.9 and 7.7 respectively. The mean score for flavour of the fruit punch was highest for standard with a score of 8.6 followed by variation I, variation II and variation III with the scores of 8.0, 7.6 and 7.4 respectively. The texture of the standard

had the highest score of 8.7 followed by variation I, variation II and variation III with the scores of 7.9, 7.8 and 7.2 respectively. For the taste the standard had the highest score of 8.7 when compared to others. Overall acceptability of the fruit punch standard had the highest score of 8.6 out of nine followed by variation I, variation II and variation III with the mean score of 8.4,7. 7 and 7.5 respectively.

- With regards to the nutrient content of the standard fruit punch contains 59.0 kcal of Energy, 94.8 per cent moisture, 3.8 g protein, 0.9 g fat, 9.0 g carbohydrates, 4 mg of iron, 80 mg of calcium and 40 mg of phosphorus per 100 grams. For the five per cent chia seed incorporated fruit punch found to be 99.0 kcal of Energy, 88.5 per cent of moisture, 4.6 g of protein, 3.1 g of fat, 12.1 g of carbohydrates, 5.6 mg of iron, 124 mg of calcium and 118 mg of phosphorus per 100 grams.
- Organoleptic scores obtained by the standard pakoda for every attributes was closed to the maximum score (9) allotted for each criteria and also for the overall acceptability the scores recorded for each attributes for five per cent chia seed incorporation seems to be nearer to the scores received by the standard preparation of pakoda. Pakoda prepared with 15 per cent incorporation with chia seed has been shown lesser score for the attributes like colour, appearance, flavour, taste, texture and overall acceptability. From the Table it was discovered that pakoda prepared with five per cent incorporation in chia seed is highly acceptable because of the score obtained for various attributes. Incorporation of 10 per cent is reasonably acceptable and 15 per cent of chia seed is not acceptable because of the unacceptable taste.
- The nutrient content of the pakoda standard contains 301.0 kcal of Energy, 16 per cent moisture, 9.4 g protein, 3 g fat, 59 g carbohydrates, 7.2 mg of iron, 192 mg of calcium and 169 mg of phosphorus per 100 grams. For the five per cent chia seed incorporated pakoda found to be 308.4 kcal of Energy, 8 per cent of moisture, 13.2 g of protein, 8.4 g of fat, 45 g of carbohydrates, 8.7 mg of iron, 239 mg of calcium and 228 mg of phosphorus per 100 grams.
- Kozhukattai was prepared by incorporating chia seed at 5, 10 and 15 per cent levels by replacing the rice flour using the standard recipe. With regards to the colour of the standard had the highest score of 8.4 followed by variation I,

variation II and variation III with mean scores of 7.6, 7.2 and 6.3 respectively. The mean score for the standard, variation I, variation II and variation III had 8.6,8. 0, 7.3 and 6.6 for appearance. For the texture variation III had a least score of 6.5 and standard had the highest score of 8.5. For the taste standard had the highest score of 8.7 when compared to others. The overall acceptability of the fruit punch standard had the highest score of 8.6 followed by variation I, variation II and variation III with the mean scores of 7.9, 7.2 and 6.5 respectively.

- The nutrient content of the kozhukattai standard were contain 297.0 kcal Energy, 30 per cent moisture, 3.9 g protein, 1.1 g fat, 68.1 g carbohydrates, 3.6 mg of iron, 88 mg of calcium and 152 mg of phosphorus per 100 grams. For the five per cent chia seed incorporated kozhukattai found to be 357.0 kcal of Energy, 33.4 per cent of moisture, 6.6 g of protein, 4.3 g of fat, 73.3 g of carbohydrates, 4.1 mg of iron, 112 mg of calcium and 247 mg of phosphorus per 100 grams.
- The appearance of the laddu standard had the highest score of 8.3 followed by the variation I, variation II and variation III with mean scores of 7.6, 7.4 and 6.7 respectively. For the colour of the variation III had the least score of 6.7 and standard had the highest score of 8.3 when compared to variation I and variation II. The taste of the standard showed highest score of 8.4 followed by variation I, variation II and variation III with the scores of 7.6, 7.3 and 6.6 respectively. The texture of the standard shown the maximum score of 8.2 followed by variation I, variation II and variation III with the mean score of 7.8, 7.3 and 6.6 respectively. For the flavour standard shown highest score of 8.2 followed by variation I, variation II and variation III. The overall acceptability of the fruit punch standard had the highest score of 8.3 when compared to variation I, variation II and variation III.
- The nutrient content of the laddu standard were contain 318.0 kcal Energy, 8.5 per cent moisture, 9.6 g protein, 11.4 g fat, 44.3 g carbohydrates, 9.6 mg of iron, 112 mg of calcium and 148 mg of phosphorus per 100 grams. For the five per cent chia seed incorporated laddu found to be 357.0 kcal of Energy, 6.3 per cent of moisture, 12.1 g of protein, 13.6 g of fat, 46.8 g of

carbohydrates, 10.8 mg of iron, 228 mg of calcium and 269 mg of phosphorus per 100 grams.

Conclusion

From the results it was concluded that for recipes chikki, fruit punch, pakoda, kozhukattai and laddu for selected in the present study three variations with the standard was prepared. The variation I is incorporated with five percent of chia seed whereas in variation II and variation III chia seed was incorporated with 10 percent and 15 percent respectively compared with the standard. With these above variations variation I i.e. five percent incorporation of chia seed in all the recipes are highly acceptable by the sensory panel members. Within the five products five per cent chia seed incorporation was best accepted in all the products like chikki, fruit punch, pakoda, kozhukattai and laddu. From the above five recipes the chia seed pakoda was highly acceptable with maximum score when compared to other products.

For the nutrient analysis, the five per cent chia seed incorporated products (chikki, fruit punch, pakoda, kozhukattai and laddu) had the little bit excess amount of nutrients when compared to standard recipes. People can develop recipes by incorporating chia seed to improve the fibre content and also it will help to maintain the body weight and also cholesterol level.

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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. P. R. Padma
Professor, Department of
Biochemistry, Biotechnology and
Bioinformatics

Members
Dr. S. Premakumari
Mr. K.Arulmoli (Legal Expert)
Dr. A. Saraswathy
Mrs. V. Mangayarkarasi
Dr. S. Kowsalya
Dr. N.S. Rohini
Dr.Subhashini K. Sripathi
Mrs. S. Radha Devi
Mrs. Judith Justin

3rd February 2017

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

Dear Madam,

Ref: Your proposal No. IHEC/16-17/FSN-08 entitled "Standardisation of chia seed *(Salvia hispanica)* incorporated recipes and analysis of nutrient content" submitted for approval of the IHEC

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/16-17/FSN-08 entitled "Standardisation of chia seed *(Salvia hispanica)* incorporated recipes and analysis of nutrient content" submitted by you. The Approval number for the same is AUW/IHEC/FSN-16-17/XMT-08.

We wish you all the best in your research endeavours.

Regards,

3/4/17

Dr.P.R.Padma
Member Secretary

Institutional Human Ethics Committee

ANNEXURE II

ESTIMATION OF NITROGEN

AIM

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

PRINCIPLE

The given sample is digested with concentrated sulphuric acid in a macro kjeldahl flask when nitrogen gets converted to ammonium sulphate. Ammonia is liberated by the action of strong alkali in a macro kjeldahl stream distillation apparatus. This nitrogenous substance is converted to ammonium borate by absorbing 2% boric acid and is titrated against N/70 H_2SO_4. The volume of acid required to bring the test sample to the colour of the blank gives the acid equivalent to the ammonia.

REAGENTS

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

PROCEDURE

1. 0.5 g of the sample was taken into the digestion flask. To this added 15ml of concentrated sulphuric acid and a pinch of digestion mixture as a catalyst. Kept at boiling gently over a heating mantle.

2. After the digestion, the flask was cooled and the contents were transferred to a 100ml standard flask and made up to the mark with distilled water.
3. The whole apparatus was washed with distilled water and allowed to back suck.
4. 10ml of boric acid was taken in a conical flask. A drop of indicator was added to it kept under the condenser.
5. The tip of the condenser was well below the liquid.
6. 5ml of the digested blank was added into the distillation chamber through the funnel. Then added 10ml of 40% NaOH. Washed the funnel with 2 to 3ml of distilled water.
7. Closed the tap and steam was generated.
8. Steam entered the distillation chamber and drove all the ammonia which is in turn absorbed by boric acid.
9. Solution was pinkish white in colour, turned blue.
10. Steam was passed for 5 min and then the conical flask was lowered and the tip of the condenser washed.
11. The boric acid solution containing the liberated ammonia was titrated against N/70 H_2SO_4.
12. The end point was the appearance of pale permanent pink colour.
13. Between each estimation, the apparatus was washed.
14. The experiment was repeated to get concordant values.

DETERMINATION OF FAT CONTENT

AIM

To determine the fat content of the food stuff.

PRINCIPLE

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 material and discharging into the extraction flask, is volatized, condensed and again allowed to act on the material. The steps in the process are repeated continuously and automatically until the extraction is complete.

The soxhlet extraction used depends on the intermittent action of a glass siphon. The ether gradually condenses into the extraction tube containing the material until it rises to the top when it is discharged into the extraction flask.

REAGENT

Petroleum ether (60-80˚C boiling point)

PROCEDURE

The soxhlet flask was weighed to consecutive concordant weights. 2g of the moisture free sample was packed into an extraction thimble and placed in an extractor which was fixed into a soxhlet flask. Poured sufficient amount (150ml) of petroleum ether so as to permit siphon action. The thimble and the contents were allowed to soak in ether for 24 hours. The entire set up was kept over an electric bath and the extractor was connected to the condensor. The nozzle of the condensor was always plugged with moistened cotton. The temperature was maintained at 60˚C. A steady stream 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 got filled with ether, it was siphoned back into the flask. This went on till the ether that got 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 weighed again to get concordant values. From the difference in weight, the fat content was calculated.

ESTIMATION OF CARBOHYDRATE BY ANTHRONE METHOD

AIM

To estimate the amount of carbohydrate present in the given food sample

PRINCIPLE

Carbohydrates are hydrolysed into simple sugar using dilute Hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxyl methyl furfural. This compound forms with anthrone, a green colour product within absorption maximum at 630nm.

REAGENTS

1. 2.5N HCl
2. Anthrone reagent: Dissolved 200mg anthrone in 100ml of ice cold H_2SO_4 prepared fresh before use.
3. Stock standard: dissolved 100mg of glucose in 100ml of water
4. Working standard: 10ml of stock standard solution is diluted in 100ml of distilled water.

PROCEDURE

1. Weigh 100mg of sample in a boiling tube.
2. Hydrolyse by keeping it in boiling water bath. Boiled for 3hours with 5ml of 2.5HCl and cool to room temperature.
3. Neutralize it with solid sodium carbonate until effervescence ceases.
4. Makeup the volume to 100ml and centrifuge collect the supernatant and 0.5ml is taken for analysis.
5. Prepared the standard. Makeup the volume to 1ml in all the test tubes by adding water.
6. Then add 4ml of anthrone reagent and heat to 8minutes.
7. Cool rapidly and read the colour at 630nm.
8. Draw the graph. From the graph, calculate the amount of carbohydrate present in the sample tube.

ESTIMATION OF IRON

AIM

To estimate the amount of iron present in 100g of the given food sample.

PRINCIPLE

The food sample is oxidized with ignition or oxidation. Iron as ferric iron reacts with ammonium thiocyanate or with potassium thiocyanate to give ferric thiocyanate which is red in colour. The colour which is a measure of the concentration is measured calorimetrically.

APPARATUS

Volumetric flask, test tubes, klett, pipettes.

REAGENTS

1. Stock iron solution: Dissolved 0.0702g (70.2mg of reagent grade crystalline ferrous ammonium sulphate (Mohr's salt) in 100ml of distilled water)
2. Working standard: A working solution is prepared in 100ml volumetric flask by adding 10ml of the stock solution and is diluted to the mark with distilled water.
3. Saturated potassium persulphate solution: 7-8g of reagent grade potassium persulphate was taken in 100ml of distilled water in a glass stopper flask and shook well. The undissolved crystal settles to the bottom and compensates the loss by decomposition.
4. 3N Potassium thiocyanate: 146g of reagent grade potassium thiocyanate was dissolved in distilled water and diluted to 500ml with distilled water. It was filtered if turbid. 20ml of pure acetone was added to improve the keeping quality. Deterioration will be evident from the rapid fermentation of a yellow colour in the blank. It was stored in a brown bottle.
5. 30% H_2SO_4**:** 30ml of concentrated H_2SO_4 was added to 70ml of distilled water.

PROCEDURE

2g of the sample was ashed by ignition. When ashing had been completed 5ml of concentrated HCl was added and made up to 100ml with distilled water in a volumetric flask.

Different samples of the solution were taken (1- 5ml) corresponding to 10-50γ in a series of test tubes. 1ml of 30% H_2SO_4, 1ml of potassium persulphate and 1.5ml of potassium thiocyanate was added to all the test tubes. This was made up to 10ml with distilled water. A blank was prepared by adding the reagents except the standard or the unknown solution. It was allowed for 20 minutes for the colour development and the intensity was read at 530 - 540μ filter in the colorimeter.

ESTIMATION OF CALCIUM

AIM

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

PRINCIPLE

Calcium is determined by precipitating. it as calcium oxalate and titrating the oxalate solution in dilute sulphuric acid against standard potassium permanganate**.**

APPARATUS

Beaker, burette, pipette, flask and standard flask.

REAGENTS

1. AMMONIUM OXALATE: Ammonium oxalate was dissolved in 200ml of distilled water till it saturated.
2. 0.01N OXALIC ACID : 0.063 g oxalic acid crystals were weighed and dissolved in 100ml of distilled water.
3. 0.01N POTASSIUM PERMANGANATE: 0.316g of potassium permanganate was dissolved i.e. 1000ml of distilled water
4. STRONG AMMONIAs
5. GLACIAL ACETIC ACID
6. 2N SULPURIC ACID**:** 5.5ml of sulphuric acid was dissolved in 94.5ml of distilled water.

PROCEDURE

Ash from the ignited sample was dissolved in hydrochloric acid and made up to the 100ml.10ml of the ash solution was pipetted out in a conical flask and 90ml 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.

20ml of saturated ammonium oxalate was added to the solution, 10ml each time to ensure complete precipitation directly. When it was hot, a few drops of acetic acid were added to render the medium acidic. The precipitate 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 5ml 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 2ml of 2N sulphuric acid added. This solution was heated to 60-80˚c and when still hot was titrated against N/10 potassium permanganate solution. From the volume of potassium permanganate solution used up the milligrams of calcium present in 100g of the sample was calculated.

ESTIMATION OF PHOSPHORUS

AIM

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

PRINCIPLE

When the solution is treated with acid ammonium molybdate, Phosphomolybdic acid is formed. This is reduced by the addition of 1, 2, 4 amino napthol sulphonic acid reagent, to produce a blue colour which is apparently a mixture of oxides of molybdenum. The intensity of the colour developed is the measure of phosphorus present.

APPARATUS

Measuring cylinder, klett, test tubes, and pipette.

REAGENTS

1) Ammonium Molybdate solution – I :
   Dissolved 25g of the reagent grade ammonium molybdate in about 200ml of water and transferred into a one liter volumetric flask containing 500ml of 10N sulphuric acid and then made up to the mark with water and mixed. This solution is stable indefinitely.

2) Ammonium Molybdate solution- II:
   Dissolved 25g of the reagent grade ammonium molybdate in about 200ml of water and transferred into a one litre volumetric flask containing 300ml of 10N sulphuric acid and then made up with water to one litre. This solution is stable indefinitely.

3) 1,2,4 Aminonapthol Sulphonic Acid Reagent (ANSA)
   Placed 195ml of 15 % sodium bisulphate solution in a volumetric flask and added 0.5g of 1,2,4 aminonapthol sulphonic acid was added and then 5ml of 20% sodium sulphite was added. Put the stopper and shook until the powder was dissolved. If the solution was not complete, added more 20% sodium

sulphite (1ml at a time) with shaking but avoided excess. This solution was transferred to a brown glass bottle and stored in a refrigerator.

4) Stock Standard Phosphorus Solution:

35.1mg of pure potassium dihydrogen phosphate was weighed and dissolved in water. Added 10 ml of 10N sulphuric acid and made up to 100ml with water.

5) Working Standard:

Working standard was prepared by diluting 10ml of stock standard to 100ml. One ml of this solution contains 8μg of phosphorus.

PROCEDURE

0.1ml of the ash solution was taken in two test tubes. 1ml of ammonium molybdate - II and 0.4ml of 1, 2, 4 amino napthol sulphonic acid was added and the volume was made up to 10ml with distilled water. For standard 1,2,3,4 & 5ml of standard solution and add 1ml of ammonium molybdate –I & 0.4ml of amino napthol sulphonic acid was taken and made up to 10ml. All the tubes containing 10ml of the solution was mixed well and allowed to stand for 15 min. simultaneously a blank was prepared by mixing 8.6ml of water, 1ml of ammonium molybdate – I and 0.4ml of amino napthol sulphonic acid. The colour developed was read in a colorimeter using a red filter of wavelength 660 mμ.