STANDARDISATION OF MILLETS AND GREENS BASED ICECREAM

SHALINI K
(21PFD027)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore – 641 043

In Partial Fulfilment of the Requirements for the

Degree of Master of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

MAY, 2023

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Signature of the Supervisor **Signature of the Head of the Department**

CERTIFICATE

This is to certify that the thesis entitled, "**Standardisation of Millets and Greens Based Icecream**" submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore in partial fulfilment of the requirements for the award of the degree of Master of Science in Food Service Management and Dietetics, is a record of original research work done by **Ms. K. Shalini** with Register Number 21PFD027 during the period of this study under the supervision and Guidance of **Dr. S. Thilagamani,** Assistant Professor (SG), Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641 043, Tamil Nadu , India.

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Introduction

1. Introduction

Icecream is a sweetened food mixture that is typically eaten as a dessert or a snack. Water, fat, milk solids not fat (MSNF), sweeteners, emulsifiers, stabilisers, and flavourings are the seven main food ingredient categories that make up icecream. Icecream can be divided into several classes based on the ingredients used. (Konstantas *et al*., 2019). Customers of all ages enjoy dairy products like icecream. The main elements affecting ice's textural qualities are those that determine the product's marketability. An aerated dairy treat that has been frozen before serving is called icecream. It is made up of a network of microcrystalline liquid and solid phases. In addition to the air cells that are trapped in the liquid phase, this phase also contains proteins, fat globules, stabilisers, sugar, and soluble and insoluble salts. It is a complicated physicochemical and colloidal system made up of numerous complex elements that can have both beneficial and detrimental effects on the structure of icecream. By increasing viscosity and restricting the movement of free water molecules, stabilisers and emulsifiers both improve the smoothness of icecream, but using too much of either can reduce melting and whipping ability. (Syed *et al*., 2018)

Egg yolks are very nutrient dense and have a variety of uses. They include a number of substances that have the ability to emulsify, most notably about 9 percentage lecithin. They are used in the production of icecream in a variety of forms, including pasteurised fresh egg yolk, frozen pasteurised egg yolk with sugar, and dehydrated egg yolk. Around 0.5 to 3 percentage of egg yolk solids are used. Firmer icecream, faster whipping, less change in overrun percentage when unloading a batch freezer, improved appearance while the icecream is melting, and slightly improved texture are just a few of the benefits of egg yolk. (Alfaifi and Stathopoulos 2010)

In order to prevent the icecream mix from separating (an oil in water emulsion), hydrocolloids increase viscosity and water retention, control ice crystal growth or formation during processing, control recrystallization phenomena during storage, and produce charged films at the interfaces (in the case of charged hydrocolloids) so the individual particles or droplets tend to repel each other. The latter measures protect the structure by reducing melting at the point of consumption. In icecream production, hydrocolloids are utilised at quantities of 0.2 to 0.5 percentage. (Varela *et al*., 2014)

Icecream has become a dish that people enjoy regardless of their age. (Kingsley *et al*., 2020). The process of making icecream involves simultaneously freezing and shearing the icecream mixture, which results in the formation of ice crystals, air bubbles, and a thick serum phase. Ice crystal amount and size have a significant impact on how ice feels on the tongue, how it melts, and how easily it may be spooned. (Scholten 2015). Icecream's sensory properties and storage stability must not be compromised by the deletion, reduction, or addition of common or exotic components to the recommended recipe. (Genovese *et al*., 2022)

The processing of agricultural raw materials and the production of food are two of the most significant functions of the food industry in Italy and the European Union as a whole. Therefore, foods are now meant not merely to sate hunger and give the body with the nutrients it needs, but also and particularly to avoid diseases linked to poor nutrition and to enhance both physical and mental wellbeing. The food industry has been impacted by technological and economic changes in society, manufacturing, and food processing, which in turn had a significant impact on the entire food supply chain, up until the distribution of food to end consumers. As a result, businesses have been forced to focus heavily on producing food products that satisfy the demands of consumers. (Bigliardi and Galati 2013)

A further factor in the utilisation of finite natural resources is the production of food, which includes freshwater, fossil fuels, land, and mineral fertiliser. About 70 percentage of freshwater is used for agricultural purposes, and of that, 25 percentage is used to produce food that is not intended for human consumption. Dairy products and vegetables have the highest energy density in the trash. The necessity of raising food quality and lowering food losses throughout the complete supply chain is one of the process' largest problems for scientists and business professionals.

New ideas for organising and managing the supply chain must therefore be created and put into practise. Current initiatives to promote the sustainability of the food supply chain include developing new, cutting edge methods for food traceability and shelf life management. However, there has been a significant increase in food production recently. The food output increased, especially because of higher yields brought on by irrigation, fertiliser use, and the expansion of agricultural production regions. At the moment, more food being harvested than is required to feed the entire world's population. (Richter and Bokelmann 2016)

Along with the healthcare, electricity, and communication sectors, among others, food is seen as a crucial component of a country's infrastructure; as a result, normal operations should be maintained to provide food for the populace during the pandemic. The global coronavirus pandemic has presented this industry with a number of new challenges, including the disruption of the supply chain and the impact it has on the food systems, meeting the high market demand, safeguarding its workforce, and absenteeism while upholding a high standard of food safety and consumer confidence. (Barichello 2020)

In order to support the food industry at this unique moment, numerous guidance documents and tools have been created on the local, national, and international levels, in both the commercial and public sectors, and are regularly updated in light of new information. Free COVID 19 self assessment checklists have been produced by the American Institute of Baking International (AIB), the Institute for Food Safety at Cornell University, and the CDC or OSHA (Occupational Safety and Health Administration).

To manage workplace and occupational dangers, the National Institute for Occupational Safety and Health of the USA (NIOSH) defines five hierarchies. Beginning with the most effective controls, the hierarchy is sorted from least to most effective. According to this advice, there are benefits and drawbacks to each sort of control measure when taking into account cost, effectiveness, and ease of implementation. It will be crucial to take into account any potential effects on physical, chemical (including allergies), and microbiological cross contamination when making these judgements. (Nakat and Bou 2021)

About 2.4 Litre of icecream were consumed globally per person in 2010. Therefore, the icecream business has the potential to make a significant contribution to global economic growth and development. The crucial step in the production of icecream is pasteurising and freezing the raw material, which consumes a significant amount of energy in the form of steam and electricity. The creation of plastic and icecream are the "hotspots" for energy consumption in vanilla icecream manufacturing, according to Konstantas *et al*, "cradle to grave" 's analysis. Therefore, one of this industry's greatest difficulties is to reduce the cost of manufacturing energy. (Soufiyan *et al*., 2017)

The following are the fundamental procedures in making icecream: mixing the components, pasteurising, homogenising, maturing, flavouring, and colouring, freezing, adding fruits and nuts, packing, and hardening. Fossil fuels, either directly or indirectly through electrical power, currently provide the majority of the energy needs of the icecream business. However, in order to stop or at least slow down this unfortunate trend, research into the effective use of fossil fuel resources and the creation of environmentally friendly alternative energies has been stimulated by the energy crisis and, more crucially, environmental issues. On the other hand, the cost of energy significantly affects the price per unit of processed food products. These are the reasons why food makers are more interested in energy saving techniques. Modern engineering techniques such as thermodynamic methods offer hope for solving issues with energy production, transmission, storage, and use as well as end of life waste management. (Dowlati *et al*., 2017)

The present Indian icecream market, including the unorganised sector, is worth Rupees. 3,000 crore. Numerous domestic and foreign companies compete in the branded market; among the well known ones are Amul, Kwality Walls, Mother Dairy, Vadilal, Cream Bell, and Baskin Robbins. One of the culinary categories with the fastest growth in India is icecream. Notably, the business is seasonal, with the peak season occurring from April to June and the off season occurring from November to January. During the monsoon, sales also decline. Icecream and other frozen treats have become more popular in recent years, especially during the winter. A variety of factors, including shifting consumer perception, capturing regional variations, diverse consumer segments, favourable retail location, product range and innovation, celebrations, marketing and promotions, are to blame for lessening the seasonal impact and fostering overall growth of the nation's icecream industry. (Biswari 2016)

The global icecream market is expanding, not only in India. Global population growth, economic stability and income growth, innovations enhancing higher sensory appeal and nutritional qualities both in terms of macro and micro nutrients, have all been cited as reasons for this growth. According to several reports, Asia is the world's biggest market for icecream, followed by North America, Europe, and other regions. As icecream consumption in India is significantly lower than the global average of 2,300 millilitre per person per year, companies are working hard to maintain the category's importance in the food sector segment through innovative programmes on flavours, formats, availability, etc. to provide some market cushioning against seasonality. (Patil and Banerjee 2017)

A considerable drive for better food options has resulted from consumers' greater attention to their health over the past two decades. Consumers generally have a basic awareness of nutrition in relation to sugar, but how they apply this information to their food choices separates healthy consumers from unhealthy consumers. Current studies emphasise the significance of instilling healthy eating habits in children at a young age, and many parents want to give their kids items with decreased sugar. (McCain *et al*., 2018)

People are now more aware of their health state and consequently cautious of their food due to the increased prevalence of obesity and Type 2 diabetes among children and adolescents.

The icecream industry faces a significant threat as a result of this health conscious choice. In order to satisfy consumers, the icecream market is evolving toward icecream formulations with reduced calories, low sugar, and outstanding texture and sensory qualities. As a result, numerous studies have been done to create new functional icecreams that contain probiotics, low glycemic index sweeteners, nutritional fibre, and alternative sweeteners including xylitol, sorbitol, and maltitol. These inventive icecreams are primarily made with artificial sweeteners. There aren't many research that use natural sweeteners in the making of icecream. (Pon *et al*., 2015)

According to WHO guidelines, sugar shouldn't make up more than 10 percent of daily calories consumed, and by 2020, EFSA will set a science based upper limit for daily exposure to added sugars from all sources. Sugar replacements appear to decrease both short term and long term energy consumption, which affects body weight gain or loss. Even while the majority of the research on icecream and desserts that is now accessible focuses on fat reduction, it might be difficult to make low sugar products, especially when using sweeteners with a low glycemic index. A clear confirmation of the role of sugar on controlling the ice content, in addition to its role on sweetness and texture properties, was obtained when sugar was reduced in vanilla icecream formulations from 0 to 50 percentage. This resulted in an increase in ice content, a harder texture, and a slower melting rate. (Di *et al*., 2018)

The non artificial sweetener stevia, a short and shrubby plant that grows in the Amambi mountainous region of Brazil and Paraguay, has a relative sweetness of 250 to 300 when compared to sucrose. It has a relatively low calorie content, making it a viable sugar substitute for people with diabetes and other disorders linked to sedentary lifestyles. Numerous meals without sugar have been made with this plant, including custard, kulfi, biscuits, and Sandesh. Despite the prevalence of artificial sweeteners, JECFA, WHO, and the Food and Drug Administration (FDA) all acknowledge stevioside as safe supplements with comparatively high upper limits. The creation of icecream with a low calorie content and GI will contribute to better managing the epidemic of obesity and delaying the onset of death. (Alizadeh *et al*., 2014).

The best probiotic carriers are icecream and frozen treats. The impact of freezing during production and prolonged storage on the viability of probiotic organisms is still something to think about. Icecream with probiotic cultures is more valuable and serves as a better example of a food with nutritional value. Every step of the process needs to be optimised to ensure functional qualities. Milk serves as a substrate for fermentation. The ideal temperature and pH levels are maintained to prevent undesired changes during fermentation and storage of food products. Probiotic strains are extremely sensitive to lower pH levels (4.0 to 4.5), which has an adverse effect on the product's sensory appeal. Probiotic cultures can now be added to icecream and other sweets thanks to the widespread adoption of frozen yoghurt technology. Bifidobacterium and Lactobacilli have been utilised in a number of different combinations. It can be added directly (by blending probiotic cultures with the icecream mix before the freezing process) or by fermenting milk to promote the growth of probiotic cells. In both situations, it's crucial to shield cells from shock or damage caused by cryogenics. (Homayouni *et al*., 2012)

The manufacturing of fermented icecream is seen as a positive challenge for the icecream industry, which focuses on finding ways to avoid giving icecreams an overpowering yoghurt flavour. The production of healthful icecream products is made possible by the use of cultured milk and its by products. Probiotic strains are widely used as functional foods or functional food ingredients and are thought to be safe and helpful in these applications. (Patil and Banerjee 2017)

Dietary fibre is made up of a variety of different food components, such as cellulose, hemicelluloses, lignin, pectin, seaweed. Oats, wheat, fruits, vegetables, and other food sources all contain dietary fibres in varying amounts. Numerous studies have attempted to increase the health benefits of various food products by including dietary fibre. When dietary fibre is included, physical attributes including icecream's ability to melt are greatly improved while viscosity, overrun, and texture are barely affected. Oat and wheat fibre were used in a study that demonstrated improved viscosity development as a result of their capacity to bind water. (Babu *et al*, 2018)

For many years, whey and whey products have been utilised successfully in the production of icecream and other frozen dairy sweets. Whey proteins are a great source of physiologically active peptides and necessary amino acids. Whey protein has been added to icecream, which has improved its flavour, smoothness, creaminess, and overrun. Recent research has demonstrated that whey protein can enhance sensory qualities in addition to enhancing the protein content of reduced fat icecream. (Pandiyan *et al*., 2010)

consuming soy icecream Consumption of saturated fat may be reduced by substituting ordinary icecream. 39,40 Soy icecream is lactose free and more digestible, according to experimental findings. It can be a suitable substitute for cow's milk, especially for those who are lactose intolerant and allergic to cow's milk. Diabetics are said to benefit from it and are advised to do so. Sesame oil can be advantageously included when making soy icecream. Sesame oil includes a substance called Sesamol that makes it resistant to oxidation, as well as lignin, which has antioxidant properties, and vitamin levels. Additionally, sesame oil contains dietary and health important unsaturated fatty acids including oleic acid and linoleic acid. The removal of beany flavour from soymilk and enhancement of its organoleptic quality make the inclusion of cocoa powder in the creation of soymilk based icecream appropriate. (Tiwari *et al*., 2015)

New icecream formulations have recently been created with enhanced nutritive, sensory, and textural qualities. Depending on their capacity to bind water and produce gels, as well as their texturizing and thickening effects, dietary fibres can enhance the textural qualities of food. The average daily intake of dietary fibre is much lower than the recommended intakes of 38 and 25 grams for men and women, respectively, according to the National Academies of Science (Washington, DC). In order to promote health impacts, dietary fibre has been added to a variety of food compositions. It does so via lowering cholesterol, reducing blood glucose reactions, acting as a laxative, and acting as a prebiotic ingredient for probiotic bacteria. (Akalın *et al*., 2018)

The Study entitled, **"Standardisation of Millets and Greens Based Icecream"** Was undertaken with the Following Objectives.

- To develop and standerdisation of Icecream enriched with Millets and Greens.
- To assess the sensory attributes and analyse the nutrient composition of the developed Icecream and
- To study the acceptability of the developed enriched Icecream.

Review of literature

2. Review of literature

The review of literature relevant to the study titled **"Standardisation of Millets and Greens Based Icecream"** is disclosed in the following subheadings.

A. **Millets and Greens – The Essential Ingredients for Good Health**
B. **Nutritional contribution of the millets and greens**
C. **Millets and greens – It's role in prevention of Diet related disorders**

A. Millets and Greens – The Essential Ingredients for Good Health

The French word "mille," which meaning thousand, is where the term "millet" comes from. A handful of millet can contain up to 1000 grains. The group of small seeded species of annual plants known as cereal crops or grains includes millet. The grain is a member of the Chloridodeae subfamily of the Ethiopian originating Poaceae family. (Abah *et al*., 2020)

Due to their superior nutritional contents, millets are one of the main crops that have been farmed for human consumption in India, China, and Africa for thousands of years. Proso, pearl, finger, kodo, and foxtail millet species are those that are most often grown around the world. Millet crops have a strong root system, may grow to a height of 30 to 100 centimetres, and typically don't need fertiliser. Since millet may be produced in a variety of soil types sandy, salty, alkaline, and acidic its ideal pH fluctuates considerably from 4.5 to 8.0. Additionally, millets have modest nutrient needs, and a few cultivars can thrive on low fertility soils (sandy loam, slightly acidic soils). Due to their strong disease resistance traits, millets are also typically pest free, which may be a key to lowering the use of pesticides and the resulting pollution. (Wang *et al*., 2018)

Humans have been eating cereal for thousands of years, and it is a crucial part of our diet because it is our major source of energy. Over the past 50 years, the amount of cereal produced worldwide has increased by nearly 1 billion tonnes; in 2016, production was 29 percentage higher than in 2013. (Martins *et al*., 2018)

More than 32 million hectares of pearl millet are grown largely in Africa and Asia, where it has a limited geographic distribution. The world's largest pearl millet farming area is in India (8.8 million ha). (FAO 2016).

Small millets made up more than 40 percentage of all grains that were grown in India before the Green Revolution began there in the middle of the 1960s. At the time, the country's agriculture sector was responsible for more than 50 percentage of its GDP. Small millets are high in polyphenols, antioxidants, and fibre, all of which are crucial for a healthy body. (Adekunle *et al*., 2018)

In addition to being a nutritious food for babies, the grain is used as flour to make cakes, bread, and other pastries. The southern states of India are where finger millet is primarily grown in Asia, and these regions have ideal growing conditions. Finger millet is the fourth most produced millet in the world after sorghum, pearl millet (*Cenchrus americanus*), and foxtail millet (*Setaria italica*). According to a recent report, finger millet is grown on 1.19 million hectares in India and makes up nearly 85 percentage of all millets produced there. (Antony *et al*., 2018).

The ancient millet crop known as barnyard millet (*Echinochloa species*) is farmed around the world in warm, temperate climates. It is very popular in Asia, particularly in India, China, Japan, and Korea. It is the fourth most produced minor millet and provides many hungry people with food security all around the world. In terms of area (0.146 m ha 1) and production (0.147 mt), India is the world's largest producer of barnyard millet, with an average productivity of 1034 kg/ha during the previous three years. The National Center for Biotechnology Information's (NCBI) PubMed database has more than 350 publications on barnyard millet since 2010, which implies that interest in the field has grown significantly in recent years. (Renganathan *et al*., 2020)

Millions of people in developing nations still rely on pearl millet as their primary source of income. Large balls of flour, parboiled grains, or fermented beverages made from pearl millet are all common forms in which it is eaten. This drink is a favourite in northern Nigeria and southern Niger, where it is known as "fura." (Kaur *et al*., 2014)

The most widely cultivated millet species worldwide is pearl millet (*Pennisetum glaucum (L.) R. Br.*), which is followed in popularity by finger millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), and proso millet (*Panicum miliaceum*). Pearl millet is the sixth most significant cereal in the world (*Eleusine coracana*). In dry and semi arid areas of India and sub Saharan Africa, pearl millet is a significant cereal that helps to provide food security. It also has additional uses, including as a source of fuel and building materials. (Boncompagni *et al*., 2018)

Pearl millet (*P. glaucum (L.) R. Br.*) is a member of the Paniceae section of the Poaceae family. In Africa, Asia, and the Americas, it is a significant food and fodder crop. It has enormous potential because it can withstand agriculture's most harsh conditions. The International Crops Research Institute for the Semi Arid Tropics (ICRISAT) gene bank has a total of 21,392 germplasm accessions, including 750 accessions of wild species of the genera Pennisetum and Cenchrus from 50 different countries. (Malik 2015)

With the price of animal based protein ingredients rising, consumers' preferences for lean protein, as well as their desire for healthy, natural, and sustainable plant based foods, there is an increasing interest in plant based protein on a global scale. To fulfil the huge need for protein foods, which is anticipated to exceed one third of the current demand by the year 2050, the hunt for non traditional plant based protein sources, such as millet, sorghum, quinoa, hemp, and water lentil, is gaining a lot of scientific interest. (Akharume *et al*., 2020).

Traditional green leafy vegetables are frequently affordable and easily accessible, and they help to diversify and improve the micronutrient quality of local diets. They may also alleviate the burden of "hidden hunger," boosting health. The majority of traditional green leafy vegetables are boiled before being eaten, but others require additional processing to lessen bitterness, enable integration into conventional sauces, and enhance flavour. Many rural and resource poor households rely on their own consumption to provide them with the micronutrients they need. However, seasonal availability and inadequate attention given by agricultural food systems to traditional foods like wild green leafy vegetables also contribute to a decline in their use. (Ejoh *et al*., 2021)

Many leafy vegetables are mostly seasonal, however some are naturally grown all year round, notably in Bangladesh's coastal belt regions. The residents of the area depend on these lush vegetables for their daily needs. These green vegetables are one of the main cooked food items that coastal residents consume on a regular basis. Although leafy vegetables make up a sizable component of the diet of the country's coastal residents on a daily basis, there has been no scientific investigation of these resources to raise awareness of their beneficial impacts in terms of nutrition and medical value. (Zihad *et al*., 2019)

Due to their widespread cultivation and consumption across practically every continent, leafy vegetables come in a wide range of forms and variants. There are five distinct types of lettuce, each with its own variety and unique growing and harvesting requirements. Some leafy cultivars are incredibly adaptable and may be cultivated in a wide range of climates and environments. Over the past five decades, the harvested area for the major leafy vegetables (cabbages and other brassicas, cauliflowers and broccoli, spinach, lettuce and chicory, and lettuce) has steadily increased, from 83 percentage (cabbages and other brassicas) to 488 percentage (cauliflowers and broccoli), or by an average of 230 percentage overall. Meanwhile, the growth in agricultural output in terms of quantity outpaced the growth in harvested area. (Aramrueang *et al*., 2019)

In the winter months (November to March), leafy greens are primarily grown in the desert parts of California, Arizona, and Mexico, whereas in the spring, summer, and fall (April to October), they are primarily grown in the central coastal districts of California. The majority of leafy greens eaten in Canada are imported from the United States. (Marshall *et al*., 2020)

Recent research has demonstrated that under particular light spectra and intensities, many green vegetables grow differently and accumulate distinct metabolites. The energy input for light per mass is notably higher while producing leafy vegetables since their growing cycle is significantly longer than that of microgreens. But because there have been so many research done with diverse criteria, it is really difficult to pinpoint the ideal light conditions for growing various kinds of leafy vegetables well. (Wong *et al*., 2020).

Numerous researchers have also suggested the use of mint leaves in a variety of foods, including dressings, soups, sweets, sherbets, vegetable and fruit salads, and desserts. (Eltawil *et al*., 2018).

B. Nutritional contribution of the millets and greens

According to the Nutritive Value of Indian Foods, pearl millet has a high energy content (361 Kilocalorie/100grams), making it comparable to other regularly eaten grains like wheat (346 Kilocalorie/100 grams), rice (345 Kilocalorie /100 grams), maize (125 Kilocalorie /100 grams), and sorghum (349 Kilocalorie /100 grams) (NIN, 2003). (Malik Shweta, 2015) Pearl millet, sometimes referred to as "Bajra" in India, is a high energy cereal renowned for its superior nutritional content. It contains carotenoids (293 grams), carbs (0.81 grams), protein (12 to 16 percentage), lipids (4 to 6 percentage), vitamins B1 (0.25 milli grams), B2 (0.20 milli grams), B3 (0.86 milli grams), and B6 (0.50 milli grams), as well as minerals, dietary fibre, and polyphenols (0.2 to 0.3percentage). 11. Millets also improve antioxidant activity, which aids in the treatment of metabolic diseases, cardiovascular ailments, and diabetes in addition to their rich nutritional qualities. (Anand *et al*., 2020)

Starch, dietary fibre, and soluble sugars are all components of the carbohydrates found in pearl millet grains. The endosperm of pearl millet, which contains glucose in the form of amylase and amylopectin, is thought to be predominately made up of starch. According to, the starch content of different pearl millet grain genotypes ranges from 62.8 to 70.5 percentage and between 71.82 and 81.02 percentage. Soluble sugars range from 1.2 to 2.6 percentage, and amylose from 21.9 to 28.8 percentage. Protein is the second important ingredient in millet. According to estimates, pear millet has a protein content of roughly 11.6 percentage, which is higher than the 7.2 percentage found in rice, 11.5 percentage in barley, 11.1 percentage in maize, and 10.4 percentage in sorghum.

Additionally, pearl millet was discovered to have a 9.79 percentage protein content. Compared to 3.21 to7.71 percentage in maize, the estimated fat content of pearl millet is between 5 to 7 percentage. The percentage of lipid in finger and pearl millet was also reported to be 1 percentage and 5 percentage, respectively. While oleic acid is reported to be present in lower amounts than in maize, fatty acids including palmitic, stearic, and linoleic acids are present in higher amounts in pearl millet. Pearl millet has a greater total lipid content than other millet kinds, ranging from 1.5 to 6.8 percentage. Pearl millet contains 5.6 to 6.1 and 0.6 to 0.9 percentage, respectively, of free and bound lipids. As free and bound non polar lipid components in pearl millet, triglycerides, diglycerides, and monoglycerides have been found. (Hassan *et al*., 2021)

One of the major issues facing the world today has been food security. Depletion of the corresponding antioxidant enzyme levels can result from a lack of minerals, vitamins, and other nutritional components, which causes oxidative stress. (Zihad *et al*., 2019)

India is one of the world's top producers of the nutritious cereal pearl millet, which is farmed on roughly 10 million hectares there. In addition to serving as a source of food, millet stems are also employed for a variety of other tasks, such as the creation of hut walls, fences, and thatches as well as brooms, mats, baskets, and sunshades. Because nutritional well being is a sustained force for health and development and the maximisation of human genetic potential, it is essential for preserving human total physical well being. Therefore, dietary quality should be taken into account to address the issues of widespread food insecurity and malnutrition. Pearl millet is regarded as a significant crop in emerging nations since it aids in reducing food shortages and providing for the growing population's nutritional needs. It is a significant source of protein and calories in the daily diet of a sizable portion of the underprivileged people. Resistant starch, soluble and insoluble dietary fibres, minerals, and antioxidants were all shown to be significantly abundant in pearl millet. There are roughly 63.2 percentage starch, 7.8 percentage crude fibre, 7.8 percentage crude fat, 13.6 percentage crude protein, and 92.5 percentage dry matter in it.

Diets high in plant foods are protective against a number of degenerative diseases, including cancer, cardiovascular disease, diabetes, metabolic syndrome, and Parkinson's disease, according to epidemiological evidence from research studies. Due to the fact that millets include dietary fibres, proteins, energy, minerals, vitamins, and antioxidants necessary for human health, millets must also be recognised as functional foods and nutraceuticals. Millets have been linked to a number of potential health advantages, including the potential to lower blood pressure, risk of heart disease, cholesterol, and rate of fat absorption, delay gastric emptying, and provide gastrointestinal bulk. Consuming whole grains is thought to help prevent and control diabetes mellitus, and epidemiological studies have shown that cultures who consume millet have a lower incidence of the disease. Has a low glycemic index and aids in managing diabetes Nutritionally significant starch fractions include SDS and or RS because of their effects on human health, particularly glucose metabolism and the control of diabetes.

Compared to other cereals, pearl millet shows a better apparent small intestine digestibility of critical amino acids. Given its high concentration of essential amino acids and good in vitro pepsin digestibility characteristics, pearl millet may be a wholesome and easily absorbed source of calories and protein for people. There are a wealth of health benefits associated with pearl millet. The grain itself has a very minimal likelihood of producing allergy responses and is very digestible. Because of its hypoallergenic qualities, it can be safely consumed by infants, breastfeeding women, the elderly, and convalescents. One of the main causes of diabetes problems and ageing is non enzymatic glycosylation, a chemical interaction between the amino group of proteins and the aldehyde group of reducing sugars. Although it has been proven that phytates, phenols, and tannins can contribute to antioxidant activity that is vital for health, ageing, and metabolic syndrome, millet grains are also high in antioxidants and phenolics. (Patni and Agrawal 2017)

Millets are a type of nutri cereal that has become more popular due to its health advantages. One of the minor millet cereals, finger millet [*Eleusine coracona (L. Gaertner*), popularly known as "Ragi," is only grown for human use in the semi arid tropical regions of Asia and Africa. Due to its high content in dietary fibre (18 percentage), phenolic compounds (0.3 to 3 percentage), and calcium (0.38 percentage), this "nutritious millet" has a number of health advantages. Additionally, it is acknowledged for its anti diabetic, anti tumorigenic, and anti atherogenic actions as well as antioxidant and antibacterial characteristics. (Sekar *et al*., 2018)

The main uses of pearl millet are as dry fodder and food. Its grains are more balanced in their amino acid composition than those of maize or sorghum, and they have higher quantities of metabolizable energy and protein, as well as higher concentrations of iron and zinc. A superior feed crop, pearl millet has a lower hydrocyanic acid concentration than sorghum. Its green feed is oxalic acid free and high in protein, calcium, phosphorus, and other nutrients. In addition to being used for food, a sizable amount of pearl millet grain is also utilised for non food applications such the production of animal feed and ethanol. Research on the diversification of the genetic base of male sterile lines (seed parents) of hybrids has intensified as a result of the recurrent issue of Diabetes Mellitus epidemics in pearl millet hybrids up until 1980. As a result, between 1981 and 1995, a significant number of genetically varied male sterile lines were created and applied to hybrid breeding. As a result, Diabetes Mellitus was substantially controlled, and productivity climbed during this phase at a rate that was twice as fast as it did during the phase before it. (Yadav *et al*., 2013)

Another significant leafy vegetable with excellent nutritional value is spinach (*Spinacia oleracea L*.), which ranks third among vegetables in terms of antioxidant capacity. Due to its abundance in polyunsaturated fatty acids, vitamins A, B, and C, iron, magnesium, and iron, the crop is widely grown and consumed. (Bantis *et al*., 2021)

Vegetables with leaves are high in vitamin B. Spinach, broccoli, lettuce, and cabbage contain thiamin (B1). Among the chosen green vegetables, spinach and broccoli have the highest concentrations of riboflavin (B2). In higher concentrations, spinach, broccoli, and cauliflower contain niacin (B3). Additionally good sources of pantothenic acid are broccoli and cauliflower (B5). The amounts of pyridoxine (B6) in spinach, broccoli, and cabbage are higher. In higher concentrations, spinach and romaine lettuce contain folate (B9). Leafy greens frequently include carotene, vitamin A (retinol activity equivalents), lutein and zeaxanthin, and vitamin K, with spinach and lettuce having the highest concentrations. Since plant photosynthesis occurs predominantly in leaves, dark green leafy foods have the highest concentration of chlorophyll. (Aramrueang *et al*., 2019)

One of the vegetables used in the Mediterranean diet is spinach (*Spinacia oleracea L*.), which stands out for its high nutritional value due to its vitamin, amino acid, and mineral content. With more than 23 million tonnes produced globally in 2013, it is one of the vegetables that is currently most extensively farmed. (Jiménez *et al*., 2018) The textures of spinach leaves are sensitive and soft, and they are rich in vitamin A and C, carotenoids, and antioxidant compounds. (Imperio *et al*., 2019)

C. Millets and greens – It's role in prevention of Diet related disorders

The desire for wholesome and secure food never goes away because of the world's expanding population. Millets, a diverse category of small seeded cereal crops distinguished by their small coarse grains, contributed to improving food security. (Samuel and Peerkhan 2020)

Gluten free, non acid producing, simple to digest, and low glycemic index are all qualities of millet grains. Due to the grain's low glycemic index, it is said to be a suitable alternative for those with diabetes and celiac disease, a condition brought on by consuming gluten containing cereal proteins, as it helps to control blood sugar levels. In addition to their nutritional value, millet has been linked to a number of potential health advantages, including the ability to delay gastric emptying and provide gastrointestinal bulk. Other potential advantages include the ability to prevent cancer and cardiovascular diseases, decrease the incidence of tumours, and lower blood pressure, risk of heart disease, cholesterol, and rate of fat absorption. (Abah *et al*., 2020)

Depending on the species under study, different treatments had different effects on plant growth and colour indices. In contrast to Swiss chard, where K50 and K50 to 7d lowered FW by 23 percentage and 15 percentage, respectively, and leaf area by 15.4 percentage, on average, compared to K200 control, the reduction of K in the NS had no effect on FW or leaf area in spinach. (Imperio *et al*., 2019)

The high levels of protein, fibre, minerals, and fatty acids in pearl millet, as well as its antioxidant characteristics, are what give them the nickname "nutri cereals." They also provide a gluten free and gluten sensitive person with a food option. The most popular variety of millet in China is foxtail millet (*Setaria italica*), which is frequently consumed by pregnant and nursing women as a nourishing gruel or soup. Additionally, the well known Chinese pharmacopoeia Compendium of Materia Medica states that foxtail millet can be used as a Chinese traditional medicine to restore kidney vitality, control the damp heat of the spleen and stomach, treat excessive thirst, and facilitate urination. A sizable number of essential nutrients, particularly protein, dietary fibre, phytochemicals, and minerals, are present in foxtail millet. (Hou *et al*., 2018)

The majority of grains, including pearl millet, can be ground, decorated, germinated, fermented, boiled, and extruded to produce goods including flours, biscuits, snacks, pasta, and non dairy probiotic drinks. The low glycemic index of pearl millet makes it a useful alternative meal for managing weight and lowering the risk of chronic illnesses like diabetes. Pearl millet also has other useful characteristics. (Martins *et al*., 2018)

Being gluten free, pearl millet has a lot of promise in meals and beverages that can be suitable for those with celiac disease. Peral millet contains flavonoids, phenolics, omega 3 fatty acids, and inhibits the growth of HT-29 adenocarcinoma cells and the scission of DNA. So full of help in NCD (Non-communicable diseases). In addition to being a rich source of calcium, pearl millet has a lot of phosphorus. Both are crucial for the development and growth of bones. Excessive stomach acid after eating is the most typical cause of stomach ulcers. One of the few meals, pearl millet, retains its alkaline properties and prevents or lessens the effects of stomach ulcers. Because millet contains powerful antioxidants including lignin and phytonutrients, heart related disorders are prevented. Therefore, pearl millet is thought to be beneficial for heart health. It has been demonstrated that the high magnesium content of pearl millet lowers blood pressure and eases heart strain. Because of its high magnesium content, pearl millet is beneficial at reducing migraine attacks as well as the severity of asthmatic patients' respiratory issues. Due to its high fibre content, pearl millet can aid in the weight loss process. Gall stone formation is also known to be decreased by pearl millet's high fibre content. The amount of insoluble fibre in pearl millet lowers our body's excessive bile production. The grain takes longer to transit from the stomach to the intestines due to its high fibre content. In this manner, pearl millet helps to reduce overall food consumption by providing long lasting satiation of appetite. (Patni and Agrawal 2017)

A sufficient number of nutrients, including carbohydrates, protein, vitamins, and minerals, are present in foxtail millet. Due to the coarse texture of foxtail millet grains, only about 79 percentage of them are digestive. The remaining half of the grain, which cannot be digested, contains a significant amount of fibre as well as several anti nutrients. Like most millets, foxtail millet is an excellent source of crude fibre, aids in digestion, and encourages bowl movement. As a result, it has a laxative effect that is good for a healthy digestive system. (Sharma and Niranjan 2018).

Indian names for finger millet (*Eleusine coracana L.*) include ragi and mandua. It is a good source of nutrients, including fibre, calcium, iron, phosphorus, zinc, and potassium. It is an excellent source of several phenolic chemicals, which may be good for your health. While flavonoids are present in trace amounts, phenolic acid and tannins constitute the primary polyphenols. It has been established that polyphenols have antibacterial, anti diabetic, and antimutagenic activities. Additionally to this, finger millet also possesses the functional feature of gelatinization. Compared to other millets, finger millet contains a significant quantity of tannin concentration, ranging from 0.04 to 3.47 percentage. The poor ionizable iron and low iron availability in brown finger millet variants are caused by the high tannin content, which has a negative impact on the nutritional value. Finger millet contains between 240 and 300 milligrams of phytate per 100grams, which serves as an anti nutrient. (Chauhan 2018)

The value of African leafy vegetables (ALVs) as sources of micronutrients and bioactive substances like phenolic acids and flavonoids is being recognised by African communities more and more. Phenolic acids and flavonoids are formed from the aromatic amino acid phenylalanine in plants as secondary metabolites through the shikimic acid pathway, and they have been associated with a lower risk of developing chronic diseases like Alzheimer's disease, cancer, inflammatory bowel syndrome, and cardiovascular diseases in humans. (Moyo *et al.*, 2018)

Spinach is very nutrient dense. Magnesium, manganese, folate, iron, vitamins A, C, and K, as well as magnesium are all abundant in it. Green leafy vegetables include biological elements that have significant pharmacological or therapeutic value. Green leafy vegetables include phytonutrients that provide numerous general health advantages, including defence against oxidative stress, iron deficiency, and eye diseases. Green leafy foods are beneficial for human health since they increase nutritional status and lower the chance of developing certain diseases like diabetes, cancer, and hepatotoxicity. In the current investigation, the antibacterial activity of this extract was analysed in order to assess the bactericidal activities of the crude aqueous, ethanol, and ethyl acetate extracts of the leaves (*Spinach oleracea*). These bioactive components are present, and their existence is linked to the plant's antibacterial action. (Olagoke 2018)

Methodology

3. Methodology

The methodology for the study titled **"Standardisation of Millets and Greens Based Icecream"** is discussed under the following headings.

A. **Selection of ingredients and formulation for variations of Millets and Greens Based Icecream**
B. **Standardisation process for the Millets and Greens Based Icecream**
C. **Sensory evaluation of the developed Millets and Greens Based Icecream**
D. **Nutritional analysis, shelf life analysis and food cost analysis of the developed Millets and Greens Based Icecream**
E. **Acceptability of the developed Millets and Greens Based Icecream among the selected young adult women**

A. Selection of ingredients and formulation for variations of Millets and Greens Based Icecream

The raw materials for making millets and greens based icecream have been purchased from the local market in coimbatore. The ingredients such as pearl millet, soya bean, coconut, spinach, sugar and soya lecithin (emulsifier) was procured for preparing spinach icecream. For mint icecream, pearl millet, soya bean, coconut, mint, sugar and soya lecithin (emulsifier) was procured.

The study was approved by the Institutional Human Ethics Committee (IHEC) of Avinashilingam Institute for Home Science and Higher Education for Women, and it was attached in the Appendix I.

Table I

Ingredients for the Formulation of Millets and Greens Based Icecream

Ingredients					
Botanical Name	*Pennisetum glaucum*	*Spinacia oleracea L*	*Glycine max*	*Cocos nucifera*	*Mentha*
Common name in Tamil	Kambu	Palak keerai	Soya bean	Thenga	Pudina
Hindi	Bajra	Palak	Soya bean	Nariyal	Pudeena
Malayalam	Kambam	Palak cheera	Seeya bin	Thengu	Puthina
Telugu	Sajjalu	Palak akulu	Soya bin	Kobbari chettu	Mentha
Health benefits	Gluten free, rich in magnesium calcium, phosphorus, antioxidants, omega 3 fatty acid.	High in carotenoids, B vitamins, folic acid, iron, calcium, potassium and magnesium.	Low in saturated fat high in protein, vitamin C, folate and antioxidants.	Low in carbs, both coconut flesh and oil have high levels of good (HDL) cholesterol.	High in antioxidant, anti inflammatory agent called rosmarinic acid.
Therapeutic uses	Good gut health, lowers blood pressure, alleviating stomach ulcer, maintain blood glucose levels.	Anaemia, hypertension, natural anti ageing properties and intestinal disorders.	Improves blood circulation, healthy digestion, weight management.	Coconut is excellent for the immunity system, antiviral, antifungal and anti bacterial.	Easing queasy stomachs, calming stress anxiety and improves cold symptoms.
Culinary form of use	Used as flour, porridge, poha and upma.	Spinach poriyal, kootu, sambar and thuvaiyal.	Soybean masala, sundal and soya milk.	Coconut is shredded for use in baked goods, candies, coconut milk and cream.	Lemon mint sorbet, mint chocolate, fruit salad with mint and garnishes.

Method of processing

The process like soaking, extraction of milk, preparation of coconut cream, spinach paste, mint paste were done to enhance the nutrients of icecream.

Soaking

Millets and soyabeans have been soaked for seven hours in order to breakdown the phytic acid in it which has an impact on the absorption of iron, zinc, and calcium and makes the digestion of millets much easier for the gut.

Extraction of milk

Pearl millet

In the soaked millet, the water was added and blended on high speed in a mixer, and the milk was strained using a muslin cloth to obtain the millet milk.

Soya milk

Soya milk is an extract of soya beans. Soya bean were soaked in hot water for seven hours to reduce the beany flavour by inactivating oxidase activity. It was then blended on high speed in a mixer. The obtained extract was strained using muslin cloth to get the soya milk.

Preparation of Coconut Cream

Coconut milk is obtained by a grinding shreded coconut with water and high speed in a mixture. It was strained using muslin cloth. The extracted milk was then heated. The heated milk was refrigerated for five hours for the fat to be separated. The separated fat was then beaten by an electric beater until it reached creamy consistency.

Spinach paste

The spinach was washed and steamed for three minutes. The steamed leaves were blended to a smooth paste.

Mint paste

Wash the mint and blend it in a mixer to a smooth paste.

Product variations

The table II depicts the variations of the spinach icecream.

Table II

Variations of the spinach icecream

Variations	Pearl millet milk (%)	Spinach paste (%)	Soy bean milk (%)	Coconut cream (%)	Sugar (%)	Soy lecithin (%)
Variation 1	26	13	17	17	26	1
Variation 2	25	15	17	17	25	1
Variation 3	24	17	17	17	24	1

Table II shows the variations of the spinach icecream. 17 percent of soya bean milk, coconut cream and one percent of soya lecithin was used in the variation I, II and III. whereas, 26 percent of pearl millet milk, 13 percent of spinach paste and 26 percent of sugar was used in the variation I. In variation II, 25 percent of pearl millet milk, 15 percent of spinach paste and 25 percent of sugar was used. In variation III, 24 percent of pearl millet milk, 17 percent of spinach paste and 24 percent of sugar was used.

The table III depicts the variations of the mint icecream.

Table III

Variations of the mint icecream

Variations	Pearl millet milk (%)	Mint paste (%)	Soya bean milk (%)	Coconut cream (%)	Sugar (%)	Soya lecithin (%)
Variation 1	28	7	18	18	28	1
Variation 2	27	9	18	18	27	1
Variation 3	26	11	18	18	26	1

Table III shows the variations of the mint icecream. 18 percent of soya bean milk, coconut cream and one percent of soya lecithin was used in the variation I, II and III. whereas, 28 percent of pearl millet milk, seven percent of mint paste and 28 percent of sugar was used in the variation I. In variation II, 27 percent of pearl millet milk, nine percent of mint paste and 27 percent of sugar was used. In variation III, 26 percent of pearl millet milk, 11 percent of mint paste and 26 percent of sugar was used.

B. Standardisation process for the Millets and Greens Based Icecream

Standardisation is the act of creating a set of guidelines, specifications, or protocols that specify how a specific task or product should be carried out or created. These guidelines guarantee that the finished product satisfies a set of quality criteria and can be evaluated against other items of a like kind.

Overall, standardisation is an important tool for ensuring quality, consistency, and comparability in a wide range of industries.

Standardisation of the Millets and Greens Based Icecream

Preparation of Coconut Cream




Shreding of coconut → **Extraction** → **Refrigeration** → **beating**

Millet Extraction




Soaking → **Grinding** → **Double boiling** → **Double boiled milk**

Soyabean Extraction




Soaking → **Grinding** → **Double boiling** → **Double boiled milk**

Spinach and Mint Paste





Weighing **Steaming** **Spinach Paste** **Weighing** **Mint paste**

Spinach Icecream




Weighing **Weighing** **Grinding** **Refrigeration**

Mint Icecream




Weighing **Weighing** **Grinding** **Refrigeration**

Plate 1 - Standardisation of the Millets and Greens Based Icecream

I. Spinach Icecream

Category: Dessert Yield: 175 grams

Preparation time: 40 minutes Portion size: 3 Nos

Freezing time: 7 hours

Ingredients:

- Pearl millet milk – 60 millilitres
- Soya bean milk – 40 millilitres
- Coconut cream – 40 grams
- Spinach paste – 35 grams
- Sugar – 60 grams
- Soya lecithin (emulsifier) – 2grams

Method of preparation:

- Pearl millet and soya beans were washed thoroughly and soaked in water for seven hours. Pearl millet and soya beans were ground together to extract the milk. The extracted liquid was poured into the pan, and it was double boiled.
- To the shredded coconut, water was added and blended on a high speed in a mixer, and the milk was strained using a muslin cloth to get the coconut milk.
- The extracted milk was then heated. It was refrigerated for five hours and the fat was separated in this process. The separated fat was beaten by an electric beater until it reached creamy consistency.
- The spinach was washed, steamed and blended in a mixer to a smooth paste.
- In a bowl, all the ingredients, such as millet milk, soya milk, coconut cream, spinach paste, sugar, and soya lecithin were gently whisked together.
- The mixture was poured into a freezer proof container and frozen for two hours. The mixture was then removed from the freezer and whisked with a fork to break up the ice crystals. Again, the mixture was frozen for five hours, and the mixture was taken out and whisked at an interval of 30 minutes. Then the icecream was stored in refrigeration temperature.
- Scoop and serve cool.

The tables IV, V and VI depicts the measurements and quantities of the ingredients used for spinach icecream.

Spinach Icecream

Table IV

Proportion and formulation of variation I

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	10	30
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

Table V

Proportion and formulation of variation II

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	12	35
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

Table VI

Proportion and formulation of variation III

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	16	40
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

As depicted in tables IV, V and VI all the required ingredients were weighed for preparation of millets and greens based icecream. The millets and soya beans were soaked for seven hours. Soaked millets and soya beans were blended and from the coconut milk coconut cream was prepared. Spinach was steamed to make a smooth paste. Then all the ingredients were added together and blended in a mixer. The blended mix was cooled and frozen for seven hours.

II. Mint icecream

Category: Dessert | Yield: 150 grams

Preparation time: 40 minutes | Portion size: 3 Nos

Freezing time: 7 hours

Ingredients:

- Pearl millet milk – 60 millilitres
- Soya bean milk – 40 millilitres
- Coconut cream – 40 grams
- Mint paste – 20 grams
- Sugar – 60 grams
- Soya lecithin (emulsifier) – 2 grams

Method of preparation:

- Pearl millet and soya beans were washed thoroughly and soaked in water for seven hours. Pearl millet and soya beans were ground together to extract the milk. The extracted liquid was poured into the pan, and it was double boiled.
- To the shredded coconut, water was added and blended on a high speed in a mixer, and the milk was strained using a muslin cloth to get the coconut milk.
- The extracted milk was then heated. It was refrigerated for five hours and the fat was separated in this process. The separated fat was beaten by an electric beater until it reached creamy consistency.
- The mint was washed and blended in a mixer to a smooth paste.
- In a bowl, all the ingredients, such as millet milk, soya milk, coconut cream, mint paste, sugar, and soya lecithin were gently whisked together.
- The mixture was poured into a freezer proof container and frozen for two hours. The mixture was then removed from the freezer and whisked with a fork to break up the ice crystals. Again, the mixture was frozen for five hours, and the mixture was taken out and whisked at an interval of 30 minutes. Then the icecream was stored in refrigeration temperature.
- Scoop and serve cool.

The tables VII, VIII and IX depicts the measurements and quantities of the ingredients used for mint icecream.

Mint Icecream

Table VII

Proportion and formulation of variation 1

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	10	15
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

Table VIII

Proportion and formulation of variation 2

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	15	20
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

Table IX

Proportion and formulation of variation 3

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	20	25
Sugar (tbsp)	6	60
Soya lecithin (tbsp)	1	2

As presented in tables VII, VIII, IX, all the required ingredients were weighed for preparation of millets and greens based icecream. The millets and soya beans were soaked for seven hours. Soaked millets and soya beans were blended, and from the coconut milk coconut cream was prepared. Mint was washed and blended in a mixer to get a smooth paste. Then all the ingredients were added together and blended in a mixer. The blended mixer was cooled and frozen for seven hours.

C. Sensory evaluation of the developed Millets and Greens Based Icecream

Sensory analysis

The sensory characteristics of the product, such as appearance, colour, flavour, consistency, and taste have been evaluated by human senses.

The millets and greens based icecream was evaluated using a five point hedonic scale, which includes 1 is poor (extreme hardness and crystallisation), 2 is fair (slightly hardness and semi crystallisation), 3 is good (slightly creamy, easily melting), 4 is very good (melts right away in the mouth, soft and creamy), and 5 is excellent (melts slowly in the mouth, soft and creamy). Twenty semi trained panelists were selected to participate in the sensory evaluation. Before and after tasting the product, water was given to panel members to rinse their mouths.

The panelists received the score card as given in appendix 2 to assess the developed products. The average of the sensory scores was calculated.

D. Nutritional analysis, shelf life analysis and food cost analysis of the developed Millets and Greens Based Icecream

Nutrient analysis

Energy, carbohydrate, protein, fat, iron, calcium, vitamin C, vitamin A, potassium, magnesium and phosphorus were analysed for the millets and greens based icecream. The protein was analysed by Lowry's method, carbohydrate was analysed by Anthrone procedure, potassium was analysed by Flame Photometry. The procedure of nutrient analysis for the above nutrients are attached in the Appendix III, IV, V, VI, VII, VIII, IX, X, XI, XII and XIII.

Shelf life analysis

The shelf life test is a method used to evaluate the quality of a product over time. It was used to determine how long the two variations of millets and greens based icecream had an acceptable quality level.

To conduct the test, the icecream was evaluated based on several sensory parameters including appearance, colour, consistency, flavour and taste. The shelf life was carried out for a period of seven days at refrigeration temperature (four degree Celsius) by preparing it in air tight container.

Food cost analysis

Food cost analysis is a way of determining the cost of a product by analysing the costs of its ingredients and other expenses associated with its production. This can help businesses to understand their costs and pricing strategies.

The standard method of calculating food costs involves dividing the price of each ingredient by the total cost of all the ingredients and their quantities. This gives the proportion of the total cost that each ingredient contributes. Then, this proportion is multiplied by the quantity of the ingredient used in the product to get the cost of that ingredient in the dish.

E. Acceptability of the developed Millets and Greens Based Icecream among the selected young adult women

The overall acceptability of the developed millets and greens based icecream was tasted by young adult women with age of 20 to 25 years. A five point hedonic scale, which includes 1- poor (extreme hardness and crystallisation), 2- fair (slightly hardness and semi-crystallisation), 3- good (slightly creamy, easily melting), 4- very good (melt right away in mouth, soft and creamy), and 5- excellent (melt slowly in mouth, soft and creamy), was used to evaluate the developed millets and greens based icecream. Twenty young adult women were selected to evaluate the appearance, colour, consistency, taste and flavour of the millets and greens based icecream.

Flow diagram depicting the methodology of the study

Selection of ingredients and product formulation

- Ingredients – pearl millet, soya bean, coconut, spinach, mint, sugar, soya lecithin.

↓

Standardisation process of developed products

- The product was formulated and standardised.

↓

Sensory evaluation of developed products

- Twenty semi trained panelists.
- Five point hedonic scale.

↓

Nutrient analysis and shelf life of the developed products

- The macro and micro nutrients present in the Millets and Greens Based Icecream were analysed.

↓

Food cost analysis of developed products

- Food cost of millets and greens based icecream was calculated by multiplying actual cost with overhead cost.

↓

Acceptability among young adult women for the developed icecream

- Twenty young adult women (20 to 25 years)
- Five point hedonic scale

Results and Discussion

4. Results and Discussion

The result of the study entitled **"Standardisation of Millets and Greens Based Icecream"** is discussed under the following headings.

A. **Selection of ingredients and formulation for variations of Millets and Greens Based Icecream**
B. **Standardisation process for the Millets and Greens Based Icecream**
C. **Sensory evaluation of the developed Millets and Greens Based Icecream**
D. **Nutritional analysis, shelf life analysis and food cost analysis of the developed Millets and Greens Based Icecream**
E. **Acceptability of the developed Millets and Greens Based Icecream among the selected young adult women**

A. Selection of ingredients and formulation for variations of Millets and Greens Based Icecream

The Production Process of Millets and Greens Based Icecream

The process like soaking, extraction of milk, preparation of coconut cream, spinach paste and mint paste were done to enhance the nutrients of icecream.

Soaking

Soaking millets and soyabeans for seven hours before cooking can help to reduce the phytic acid content in these foods. Phytic acid is a natural compound found in many plant based foods, including grains, legumes, and nuts. While phytic acid has some health benefits, it can also bind to minerals such as iron, zinc, and calcium in the digestive tract, reducing their absorption.

Extraction of milk

Pearl millet

Pearl millet is a nutritious grain that can be used as an alternative for dairy milk. To make this milk, the pearl millet was soaked in water. Then, the soaked millet was blended in a high speed mixer. This creates a milky liquid that contains all of the nutrients from the millet. To remove the solid contents of the millet milk, it was strained through a muslin cloth. The final step ensures that the milk was smooth and free of any grit or large particles.

Soya milk

Soya milk is a plant based milk made from soyabeans. To make soya milk, the first step was to soak the soyabeans in water. This helps to soften the beans and remove impurities. The soaked soyabeans was blended with water at high speed in a mixer. This created a smooth, creamy liquid that resembled milk. However, it still contained some solid particles from the beans.

To remove these particles and get a smoother texture, the soya milk was then strained through muslin cloth. This helped to filter out any remaining solids. During the processing of soya milk, it was observed to have a strong bean flavour. To avoid this, hot water was used to soak the soya beans, and this helped to inactivate the enzyme that caused the beany flavour.

Preparation of Coconut Cream

Coconut milk was obtained by grinding shreded coconut with water and high speed in a mixture. It was strained using muslin cloth. The extracted milk was then slightly heated. The heated milk was stored in the refrigerator for five hours to make it cool, and for fat separation. The separated fat was beaten by an electric beater until it reached creamy consistency.

Spinach paste

For the spinach paste, fresh spinach leaves were first washed to remove any dirt or debris, then steamed for three minutes. Steaming is a gentle cooking method that helps to preserve the nutrients in the spinach, including folate, B vitamins. Steaming also reduces the amount of oxalic acid in the spinach, which can interfere with the absorption of certain minerals like calcium and iron. Once the spinach was steamed, it was blended in a food processor or blender until it becomes a smooth paste with a thick consistency.

Mint paste

Fresh mint leaves were washed and blended in a mixer or food processor to obtain a smooth paste. Mint is also known for its medicinal properties, and the paste can be used topically as a natural remedy for headaches, insect bites, and other minor ailments. Mint is a herb that is often used to add flavour to various products. It can also be added to marinades, salad dressings, or used as a garnish for soups and stews.

B. Standardisation process for the Millets and Greens Based Icecream

I. Standardisation of the Spinach Icecream

Table X depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, spinach paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of spinach icecream.

Table – X

Standardisation of the Spinach Icecream – Variation I

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	10	30
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The spinach paste was prepared with 30 grams of spinach. It was steamed and then grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream.

Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

Table XI depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, spinach paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of spinach icecream.

Table – XI

Standardisation of the Spinach Icecream – Variation II

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	12	35
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The spinach paste was prepared with 35 grams of spinach. It was steamed and then grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream.

Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

Table XII depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, spinach paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of spinach icecream.

Table – XII

Standardisation of the Spinach Icecream – Variation III

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
Spinach paste (tbsp)	16	40
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The spinach paste was prepared with 40 grams of spinach. It was steamed and then grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream.

Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

II. Standardisation of the Mint Icecream – Variation I

Table XIII depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, mint paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of mint icecream.

Table – XIII

Standardisation of the Mint Icecream – Variation I

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	10	15
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The mint paste was prepared with 15 grams of mint. It was grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream.

Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

Table XIV depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, mint paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of mint icecream.

Table – XIV

Standardisation of the Mint Icecream – Variation II

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	15	20
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The mint paste was prepared with 20 grams of mint. It was grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream. Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

Table XV depicts the list of ingredients such as pearl millet milk, soybean milk, coconut cream, mint paste, sugar, and soya lecithin, along with their corresponding measurements for the standardisation of mint icecream.

Table – XV

Standardisation of the Mint Icecream – Variation III

Ingredients	Measurement	Quantity (g)
Pearl millet milk (tbsp)	6	60
Soya bean milk (tbsp)	4	40
Coconut cream (tbsp)	4	40
mint paste (tbsp)	20	25
Sugar (tbsp)	6	60
Soya lecithin (tsp)	1	2

All the required ingredients were weighed for making Millets and Greens Based Icecream. The millets and soya beans were soaked for seven hours. After soaking, it was blended together to a smooth paste. Millet milk 60 millilitres and soyabean milk 40 millilitres were added to the blender. meanwhile, 40 millilitres of coconut cream was prepared from the coconut milk. The mint paste was prepared with 25 grams of mint. It was grind to a smooth paste.

Sixty grams of sugar and two grams of soya lecithin emulsifier were added to the mixer and blended well. The mixture was then cooled and frozen for seven hours until it turned into icecream. Overall, the processes like soaking, blending, adding ingredients and freezing were done to make a delicious millet and green based icecream.

C. Sensory evaluation of developed Millets and Greens Based Icecream

Sensory Analysis

The sensory evaluation of "Millets and Greens Based Icecream" was carried out using a five point hedonic rating scale. Sensory evaluation is a scientific method used to measure, analyze, and interpret how humans perceive different sensory attributes of food, such as appearance, colour, flavour, consistency and taste.

A hedonic scale is a type of rating scale used to evaluate the overall acceptability of a product. The five point hedonic scale ranges from 1 to 5, with 1 being the poorest quality (extremely hard and crystallized) and 5 being the highest quality (soft and creamy, with slow melting). For sensory evaluation, twenty semi trained panelists were selected to taste the product.

I. Sensory Analysis for Spinach Icecream

Table XVI shows the results of a sensory evaluation of spinach icecream.

Table – XVI

Sensory Analysis for Spinach Icecream Variation I

Attributes	Variation – I
Appearance	4.3 ± 0.66
Colour	4.3 ± 0.66
Consistency	3.7 ± 0.57
Taste	3.8 ± 0.72
Flavour	3.5 ± 0.60

The sensory attributes were evaluated and the mean scores for appearance, colour, consistency, taste and flavour were 4.3, 4.3, 3.7, 3.8, and 3.5 respectively. The results of the sensory analysis indicates that variation I of spinach icecream, containing 30 grams of spinach, received good scores for appearance and colour, but the scores for flavour, consistency, and taste were moderately acceptable. The sensory evaluators reported that the flavour was insufficient, due to the small amount of spinach used, and the taste was excessively sweet due to high sugar content. Moreover, the addition of 30 grams of spinach resulted in a moderately green colour of the icecream.

Sensory analysis for spinach icecream

Plate 2 – Sensory analysis for spinach icecream

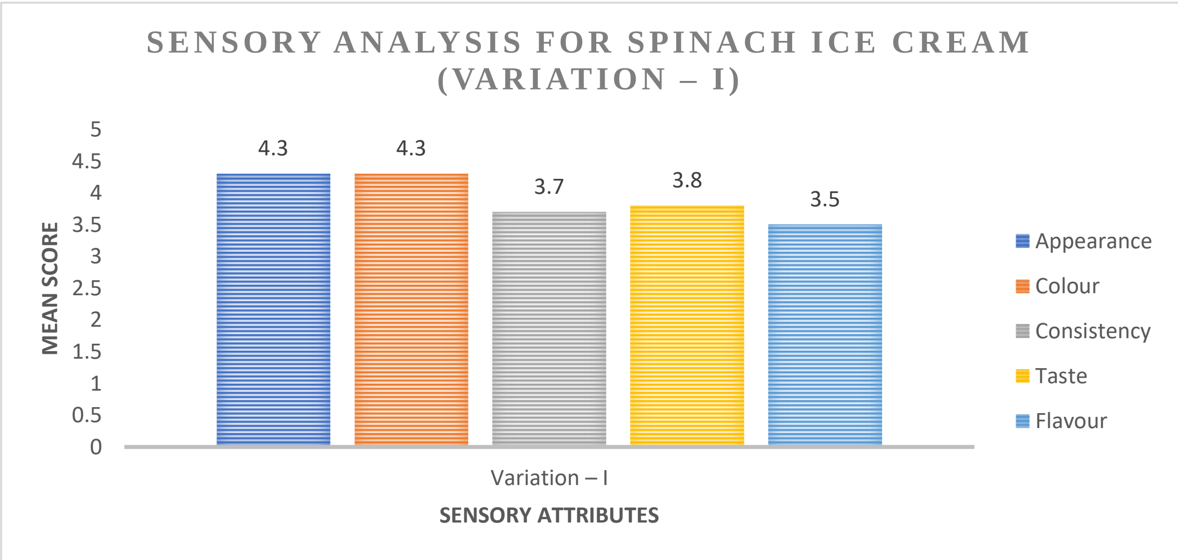

Chart 1 – Sensory analysis for spinach icecream

Table XVII shows the results of a sensory evaluation of spinach icecream.

Table – XVII

Sensory Analysis for Spinach Icecream Variation II

Attributes	Variation – II
Appearance	4.6 ± 0.49
Colour	4.6 ± 0.50
Consistency	4.3 ± 0.64
Taste	4.5 ± 0.58
Flavour	4.5 ± 0.61

The sensory attributes were evaluated and the mean scores for appearance, colour, consistency, taste and flavour were 4.6, 4.6, 4.3, 4.5, and 4.5 respectively. The sensory analysis results indicates that Variation II of the spinach icecream with 35 grams of spinach was highly preferred by most of the sensory panel members, with the flavour, colour, and taste being particularly appreciated. Overall, the panelists found this variation to be enjoyable and satisfying. The taste was sweet and there were no noticeable raw or unpleasant flavour in this variation. Additionally, the colour of the icecream was green, which was likely due to the reduction in the amount of spinach paste used.

Sensory analysis for spinach icecream

Plate 3 - Sensory analysis for spinach icecream

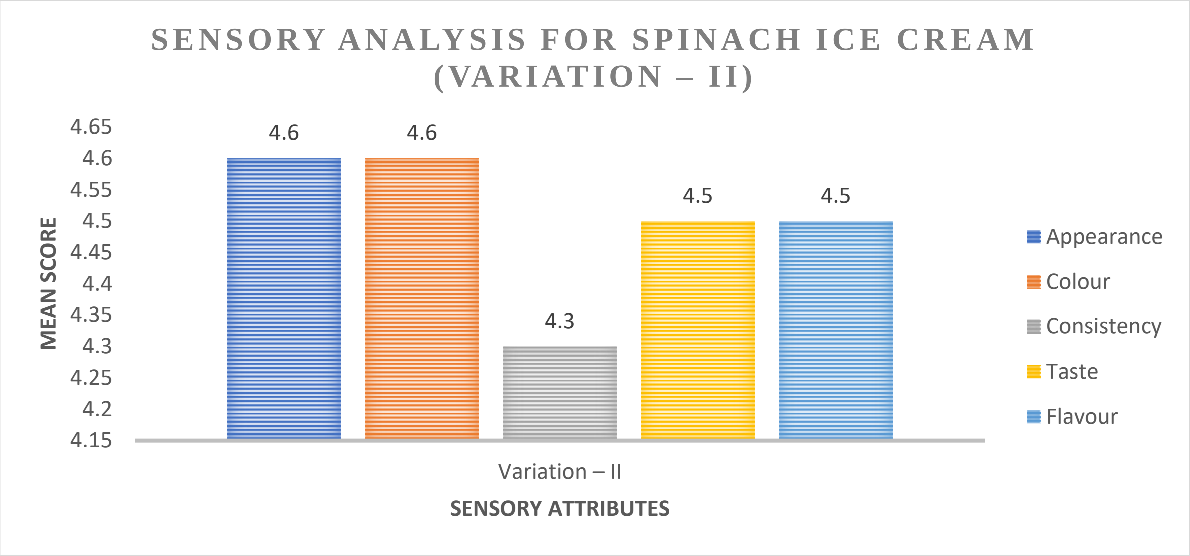

Chart 2 - Sensory analysis for spinach icecream

Table XVIII shows the results of a sensory evaluation of spinach icecream.

Table – XVIII

Sensory Analysis for Spinach Icecream Variation III

Attributes	Variation – III
Appearance	4.5 ± 0.61
Colour	4.3 ± 0.72
Consistency	3.6 ± 0.75
Taste	3.9 ± 0.67
Flavour	3.7 ± 0.69

The flavour of variation III, which contained 40 grams of spinach was quite strong and had a prominent spinach taste. Moreover, the sweetness in the icecream was slightly lower than optimal.

The sensory analysis indicates that the spinach flavour in variation III was intense and apparent. This duo to attributed by the high quantity of spinach used in the product. Also, the sweetness level was slightly lower than what is typically expected in icecream, which have resulted in a less enjoyable taste experience for the panelists.

Sensory analysis for spinach icecream

Plate 4 -Sensory analysis for spinach icecream

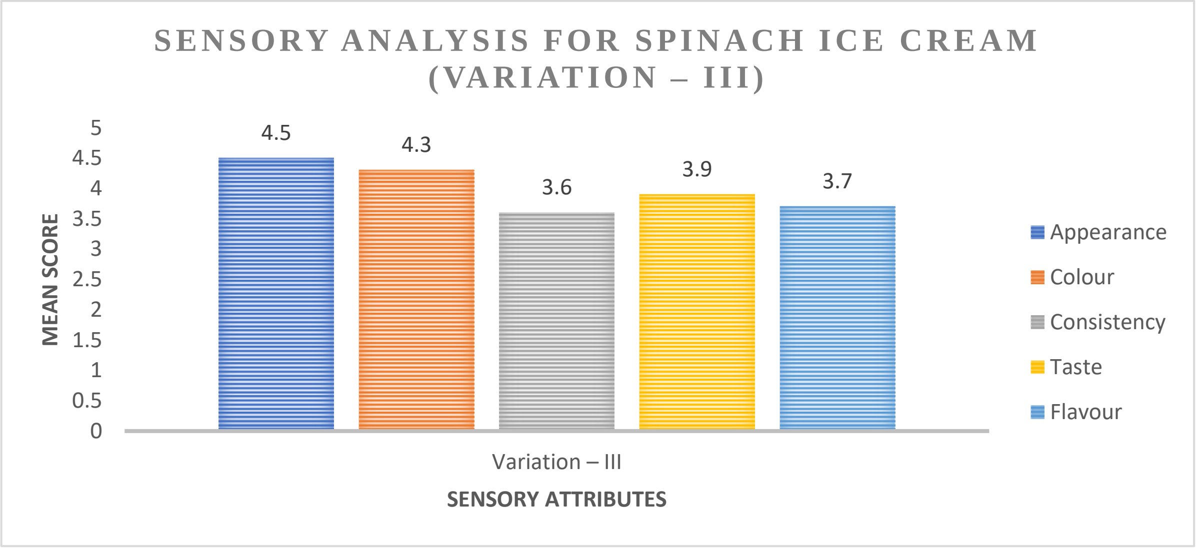

Chart 3 - Sensory analysis for spinach icecream

II. Sensory Analysis for Mint Icecream

Table XIX shows the results of a sensory evaluation of mint icecream.

Table – XIX

Sensory Analysis for Mint Icecream variation I

Attributes	Variation – I
Appearance	4.7 ± 0.47
Colour	4.1 ± 0.45
Consistency	4.2 ± 0.75
Taste	3.8 ± 0.41
Flavour	3.8 ± 0.62

The sensory attributes were evaluated and the mean scores for appearance, colour, consistency, taste and flavour were 4.7, 4.1, 4.2, 3.8, and 3.8 respectively. Based on the sensory analysis results, Variation I of mint icecream containing 15 grams of mint received favourable scores for appearance and colour, but the scores for taste, consistency, and flavour were moderately acceptable. The sensory evaluators observed that the flavour was insufficient, possibly due to the small amount of mint used, and the taste was over sweet due to the high sugar content. The icecream had a moderate green colour attributed to the addition of 15 grams of mint.

Sensory analysis for mint icecream

Plate 5 - Sensory analysis for mint icecream

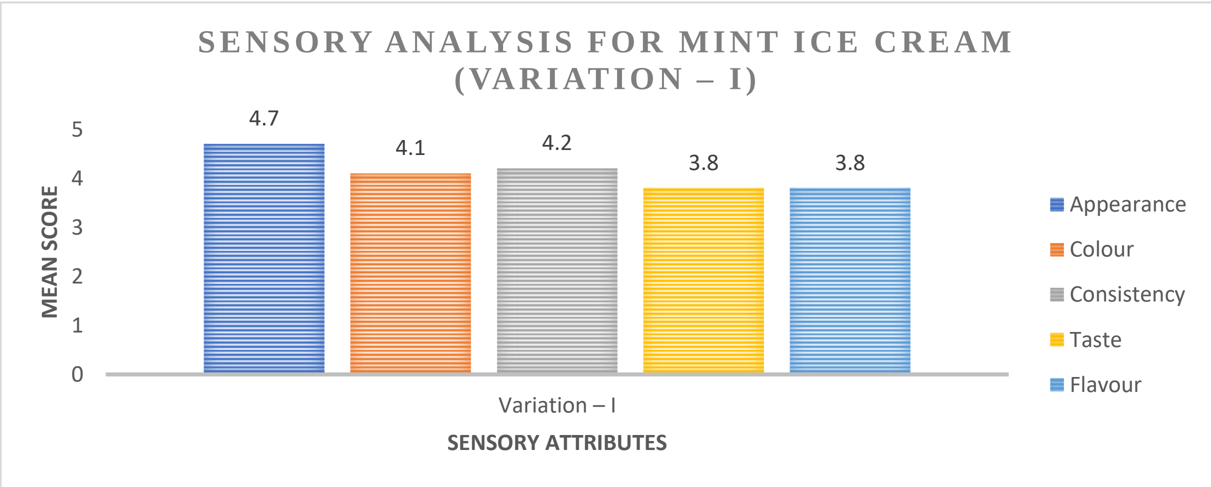

Chart 4 - Sensory analysis for mint icecream

Table XX shows the results of a sensory evaluation of mint icecream.

Table – XX

Sensory Analysis for Mint Icecream variation II

Attributes	Variation – II
Appearance	4.8 ± 0.37
Colour	4.6 ± 0.49
Consistency	4.5 ± 0.51
Taste	4.7 ± 0.55
Flavour	4.7 ± 0.57

The sensory attributes were evaluated and the mean scores for appearance, colour, consistency, taste and flavour were 4.8, 4.6, 4.5, 4.7, and 4.7 respectively. The results of the sensory analysis indicates that the mint icecream variation II, containing 20 grams of mint, received positive feedback from the majority of the panelists, who particularly appreciated its flavour, colour, and taste. Overall, the evaluators found this variation to be enjoyable and satisfying, with a pleasant sweetness and no detectable unpleasant aromas. The green colour of the icecream was due to the approximate amount of mint used in the product.

Sensory analysis for mint icecream

Plate 6 - Sensory analysis for mint icecream

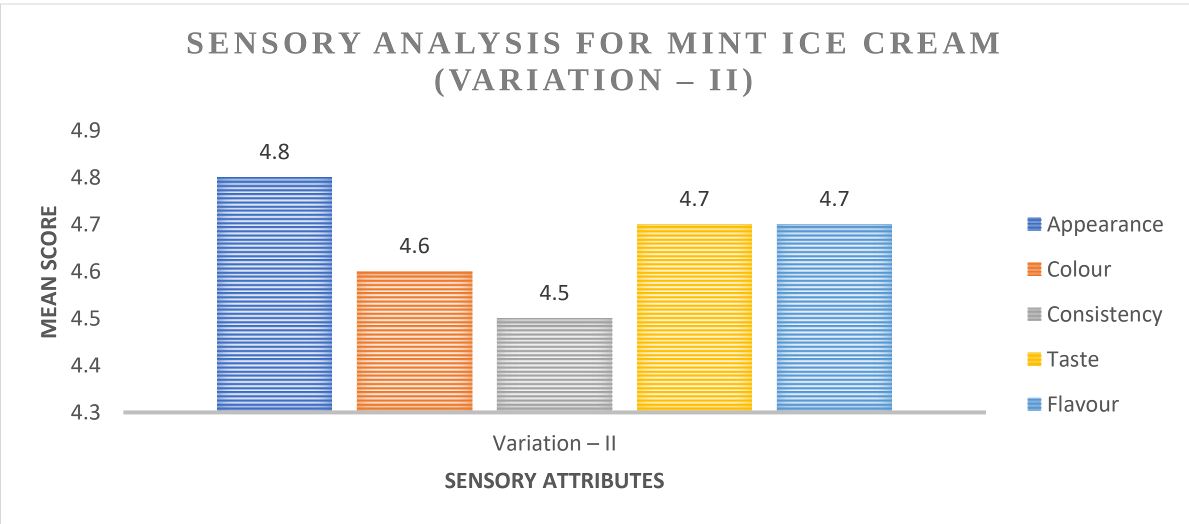

Chart 5 - Sensory analysis for mint icecream

Table XXI shows the results of a sensory evaluation of mint icecream.

Table – XXI

Sensory Analysis for Mint Icecream variation III

Attributes	**Variation – III**
Appearance	4.5 ± 0.76
Colour	4.2 ± 0.67
Consistency	4.3 ± 0.64
Taste	3.3 ± 0.47
Flavour	3.7 ± 0.44

The flavour of Variation III, which contained 25 grams of mint, was quite strong and had a prominent mint taste. Moreover, the sweetness in the icecream was slightly lower than optimal. The sensory analysis indicates that the mint flavour in Variation III was intense and apparent. This could be attributed by the high quantity of mint used in the product. Also, the sweetness level was slightly lower than what is typically expected in icecream, which have resulted in a less enjoyable taste experience for the panelists.

Sensory analysis for mint icecream

Plate 7 – sensory analysis for mint icecream

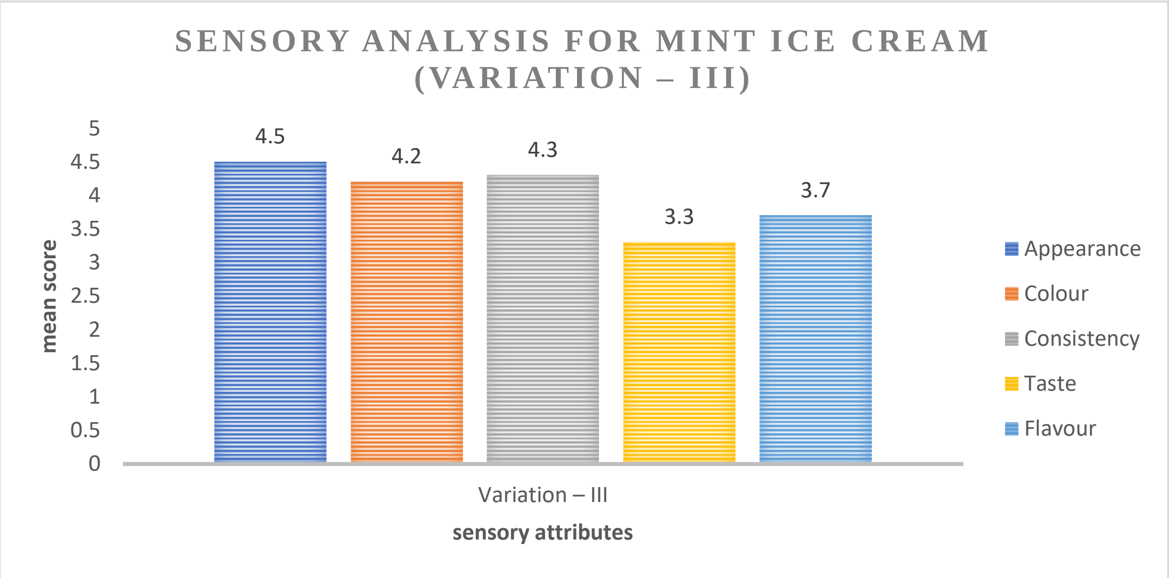

Chart 6 - Sensory analysis for mint icecream

D. Nutritional analysis shelf life analysis and food cost analysis of the developed Millets and Greens Based Icecream

Nutritional analysis

The nutritional content of the two variations, spinach icecream and mint icecream were analysed. After conducting sensory evaluations with panel members, the investigators found that the spinach and mint icecream with "variation II" had the highest acceptability rating among the other variations. Based on these results, it was decided to analyse the nutritional content of the icecream with variation II (spinach and mint).

I. Nutrient analysis for Spinach Icecream

Table XXII, XXIII displays the macronutrient and micronutrient composition of Spinach icecream variation II.

Table – XXII

Macronutrient content of the variation II in 100 gm Spinach Icecream

Macro nutrients	Units	Variation II
Energy	kcal	166
Protein	gm	5
Carbohydrate	gm	29
Total Fat	gm	3

Table – XXIII

Micronutrient content of the variation II in 100 gm Spinach Icecream

Micro nutrients	Units	Variation II
Vitamin A	mcg	243
Vitamin C	mg	27.0
Iron	mg	2.2
Calcium	mg	147.3
Magnesium	mg	38.7
Phosphorous	mg	39.6
Potassium	mg	280.4

The 100 grams of spinach icecream Variation II, provides 166 kilocalories of energy, 5 grams of protein, 29 grams of carbohydrates, and 3 grams of total fat. In terms of micronutrients, Variation II contains 243 milligrams of Vitamin A, 27.0 milligrams of Vitamin C, 2.2milligrams of iron, 147.3 milligrams of calcium, 38.7 milligrams of magnesium, 39.6 milligrams of phosphorus, and 280.4 milligrams of potassium.

II. Nutrient analysis for Mint Icecream

Table XXIV, XXV displays the macronutrient and micronutrient composition of Mint icecream variation II.

Table – XXIV

Macronutrient content of the variation II in 100 gm Mint Icecream

Macro nutrients	**Units**	**Variation II**
Energy	kcal	173
Protein	gm	3
Carbohydrate	gm	31
Total Fat	gm	4

Table – XXV

Micronutrient content of the variation II in 100 gm Mint Icecream

Micro nutrients	Units	Variation II
Vitamin A	mcg	52.1
Vitamin C	mg	6.9
Iron	mg	1.1
Calcium	mg	132
Magnesium	mg	61.2
Phosphorous	mg	122.1
Potassium	mg	242

Table XXIV displays the macronutrient content of Variation II in 100 grams of Mint Icecream, contains 173 kilocalories of energy, 3 grams of protein, 31 grams of carbohydrate, 4 grams of total fat.

Table XXV displays the micronutrient content of Variation II in 100 grams of Mint Icecream, contains 52.1 milligrams of vitamin A, 6.93 milligrams of vitamin C, 1.1 milligrams of iron, 132 milligrams of calcium, 61.2 milligrams of magnesium, 122.1 milligrams of phosphorus, 242 milligrams of potassium.

II. Food cost of the and shelf life analysis

Food Cost Analysis

The overhead method is used to determine the cost of a product. It involves figuring out the price of each ingredient that goes into making the product and then multiplying the result by the overhead cost.

Table XXVI displays the costs of spinach icecream.

Table – XXVI

Food cost of the Spinach Icecream (variation II) for 3 portions

Ingredients	Quantity (gm)	Cost (in Rupees)
Pearl millet	60	60
Soya bean	40	5
Spinach	35	2
Coconut milk	40	8
Sugar	60	9
Soya lecithin (emulsifier)	2	0.5
Total	237	140

Total Yield: 175 grams

Portion size: 3 Nos

Cost per portion: Rupees. 46/-

The table XXVI shows the ingredients used, the quantity of each ingredient used, the cost of each ingredient, and the total cost of all ingredients. The ingredients used in this products were pearl millet, soyabean, spinach, coconut milk, sugar, and soya lecithin.

The total cost of all ingredients used in making the spinach icecream variation II is Rupees 140. The total yield of the product was 175 grams, and the portion size was three servings. The cost per portion was Rupees. 46.

The table XXVII provides the food cost of making a mint icecream of variation II.

Table – XXVII

Food cost of the Mint Icecream (variation II) for 3 portions

Ingredients	Quantity (gm)	Cost (in Rupees)
Pearl millet	60	60
Soya bean	40	5
Mint	20	3
Coconut milk	40	8
Sugar	60	9
Soya lecithin (emulsifier)	2	0.5
Total	222	142

Total Yield: 150 grams

Portion size: 3 Nos

Cost per portion: Rupees. 47/-

The table XXVII provides the food cost of Mint Icecream (variation II) and total cost of each ingredient. The ingredients used in the product were pearl millet, soyabean, mint, coconut milk, sugar, and soya lecithin (an emulsifier). The Table XXVII shows the quantity of each ingredient used in grams or millilitres, as well as the total cost of each ingredient needed to make the icecream. The total cost of all the ingredients was Rupees 142.

The total yield of mint icecream was 150 grams, and the portion size was three servings. The cost per portion was Rupees 47.

III. Shelf Life Analysis

The shelf life analysis is a method used to evaluate the quality of a product over time. Sensory characteristics it was used to determine how long the two variations of Millets and Greens Based Icecream, maintains an acceptable quality level of icecream. The developed products were stored in airtight containers and kept at a refrigerated temperature (four degrees Celsius) for the duration of their shelf lives. The icecream was made with millets and greens. The shelf life was tested for the two variations of developed products, spinach icecream and mint icecream. The appearance, colour, flavour, consistency and taste were not changed for the first four days. The flavour, consistency and taste were changed on the next day. The appearance and colour remains unchanged for seven days.

Table XXVIII shows the Shelf life of the developed Millets and Greens Based Icecream at refrigerated temperature.

Table – XXVIII

Shelf life of the developed Millets and Greens Based Icecream

Period	**Appearance**		**Colour**		**Flavour**		**Taste**		**Consistency**	
	Spinach ice cream	Mint ice cream	Spinach ice cream	Mint ice cream	Spinach ice cream	Mint ice cream	Spinach ice cream	Mint ice cream	Spinach ice cream	Mint ice cream
Day 1	×	×	×	×	×	×	×	×	×	×
Day 2	×	×	×	×	×	×	×	×	×	×
Day 3	×	×	×	×	×	×	×	×	×	×
Day 4	×	×	×	×	×	×	×	×	×	×
Day 5	×	×	×	×	×	×	×	×	×	×
Day 6	×	×	×	×	✓	✓	✓	✓	✓	✓
Day 7	×	×	×	×	✓	✓	✓	✓	✓	✓

Note: ×- no change, ✓-changed.

Shelf life of the developed Millets and Greens Based Icecream

Plate 8 - Shelf life of the developed Millets and Greens Based Icecream

E. Acceptability of the developed Millets and Greens Based Icecream among selected young adult women

To determine the developed millets and greens based icecream was enjoyable to eat, recruited a group of 20 young adult women between the ages of 20 to25. The young adult women were asked to evaluate the appearance, colour, consistency, taste and flavour of the icecream using five point hedonic scale.

I. Acceptability of spinach icecream among young adult women

Table XXIX shows the results of acceptability among young adult women conducted on all three variations of spinach icecream.

Table – XXIX

Acceptability of spinach icecream among young adult women

Variations	Overall Acceptability
Variation I	3.9 ± 0.39
Variation II	4.5 ± 0.37
Variation III	3.9 ± 0.67

The acceptability of spinach icecream among young adult women, with three different variations were tasted. Variation I contained 30 grams of spinach, variation II contained 35 grams, and variation III contained 40 grams. The overall acceptance of the icecream was measured on a scale from 1 to 5, with 5 being the most acceptable.

The results indicates that variation II, was seemed to be enjoyable and satisfied by the evaluators. Variation I was moderately acceptable, and the evaluators reported that the flavour was insufficient. Variation III was strong spinach taste and slightly acceptable. The young adult women prefer variation II of spinach icecream with a moderate amount of spinach, as it provides a good balance between taste and acceptability.

Acceptability of spinach icecream among young adult women

Plate 9 - Acceptability of spinach icecream among young adult women

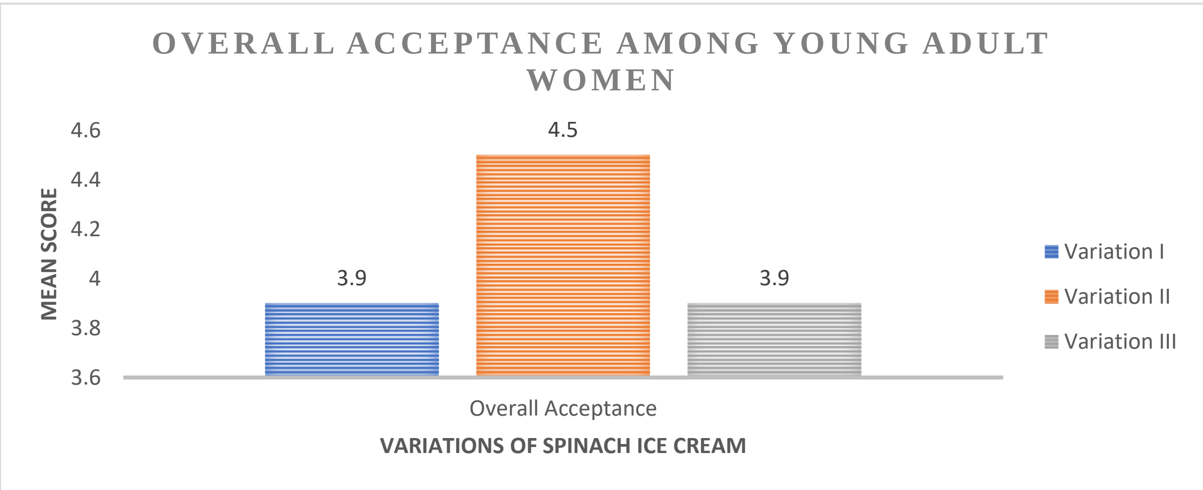

Chart 7 - Acceptability of spinach icecream among young adult women

II. Acceptability of mint icecream among young adult women

Table XXX shows the results of acceptability among young adult women conducted on the variations of mint icecream.

Table – XXX

Acceptability of mint icecream among young adult women

Variations	Overall Acceptance
Variation I	4.1 ± 0.35
Variation II	4.6 ± 0.30
Variation III	3.9 ± 0.25

The acceptability of mint icecream among young adult women, with three different variations were tasted. The study had three variations of the icecream, each containing different quantity of mint. Variation I had 15 grams of mint, Variation II had 20 grams, and Variation III had 25 grams. The overall acceptability of the icecream was rated on a scale of 1 to 5, with 5 being the highest rating.

The results indicates that variation II, was found to be enjoyable and satisfied by the evaluators. Variation I was moderately acceptable, and the evaluators reported that the flavour was insufficient. Variation III was strong mint taste and slightly acceptable. The young adult women preferred variation II of mint icecream as it provided a good taste and acceptability.

Acceptability of mint icecream among young adult women

Plate 10 - Acceptability of spinach icecream among young adult women

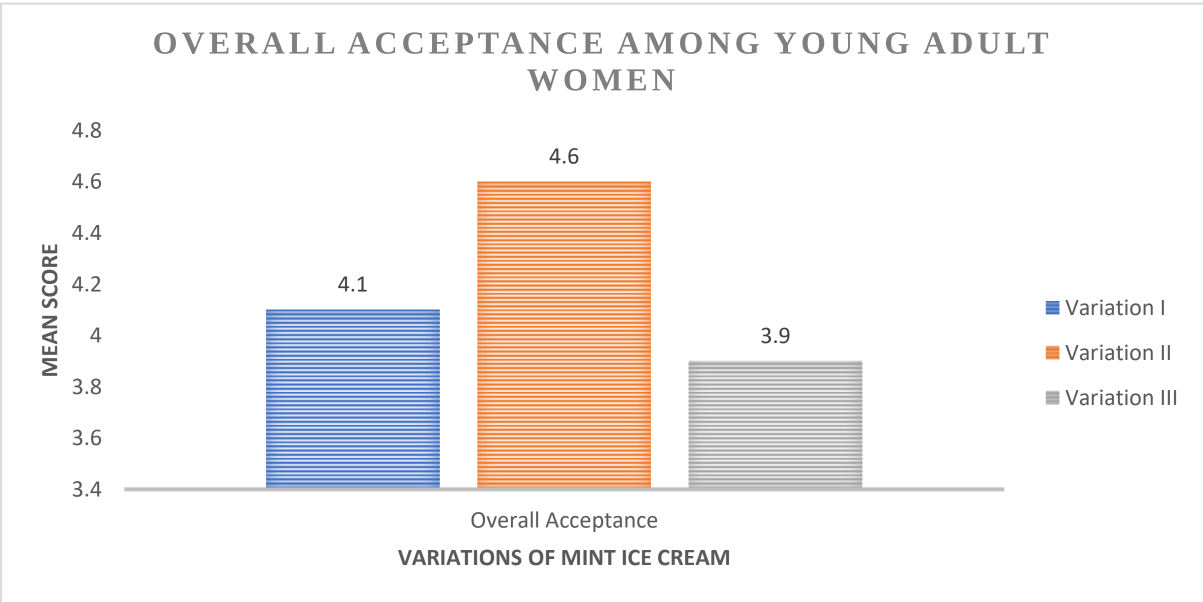

Chart 8 - Acceptability of spinach icecream among young adult women

Summary and Conclusion

5. Summary and Conclusion

Indian food processing industry is one of the largest in the world in terms of growth, production, consumption, and exports. Food processing involves transforming agricultural products into food or transforming one form of food into other forms.

The global icecream industry has been steadily rising since its commercialization, and recently, it has seen a significant increase in consumption, which is due to the huge young population, increasing urban numbers, and steadily increasing income. Icecream is a frozen mixture of a combination of components, including milk, sweeteners, stabilizers, emulsifiers, and flavoring. To replace dairy milk with millet milk, a study titled "Standardization of Millets and Greens Based Icecream" was under taken with the following objectives, to Standardise the millets and greens based icecream, to analyse the sensory attributes and nutrients of the developed icecream and to examine the accessibility of the standardised millets and greens based icecream.

The methodology includes, the raw materials for making millets and greens based icecream were purchased from the local market. The ingredients include pearl millet, soya been, coconut, spinach, mint, sugar and soya lecithin (emulsifier). The product formulation of the millets and greens based icecream was done, and the product quantity was modified as part of the standardisation procedure to obtain the desired results. Sensory evaluation was undertaken to evaluate the quality attributes such as appearance, colour, texture or consistency, flavour and taste of the two products with variations using five point hedonic scale. As the result of sensory analysis the variation II was selected from both products to analyse the nutrient content present in the spinach and mint icecream. Nutrient analysis such as energy, carbohydrate, protein, fat, iron, calcium, vitamin C, vitamin A, potassium, magnesium, phosphorus, antioxidants were analysed. The shelf life was carried out for a period of seven days at refrigeration temperature (4ºC) by preparing it in air tight container. Food costing was done for each product. The acceptability was carried out among young adult women to find the extent of acceptance for the developed icecream.

The salient findings of the study are:

- To standardise the Millets and Greens Based Icecream, the pearl millet, soya bean, spinach and mint were selected for the study.
- The spinach icecream was standardised with three variations by using various proportions of the selected ingredients. By using five point hedonic scale sensory analysis was done by the semi trained panel members comprising post graduate students of Avinashilingam University, Coimbatore for those three variations. The result of the sensory analysis states that the appearance, colour and consistency was highly acceptable and taste, flavour was moderately acceptable for variation I where as for variation II appearance, colour, flavour, consistency and taste was highly acceptable and in variation III appearance, colour was highly acceptable, consistency was acceptable and taste, flavour was moderately acceptable for spinach icecream.
- The mint icecream was standardised with three variations by using various proportions of the selected ingredients. By using five point hedonic scale sensory analysis was done by the semi trained panel members comprising post graduate students of Avinashilingam University, Coimbatore for those three variations. The result of the sensory analysis states that the variation I appearance, colour and consistency was highly acceptable and taste, flavour was moderately acceptable for variation I where as for variation II appearance, colour, flavour, consistency and taste was highly acceptable and in variation III appearance, colour was highly acceptable, consistency was acceptable and taste, flavour was moderately acceptable for mint icecream.
- The macro nutrients present in the 100 grams spinach icecream of variation II is 167 kilocalories of energy, 5 grams of protein, 29 grams of carbohydrate, 3 grams of total fat. The micro nutrients present in the 100 grams spinach icecream of variation II is 243 milligrams of vitamin A, 27 milligrams of vitamin C, 2.2 milligrams of iron, 147.3 milligrams of calcium, 38.7 milligrams of magnesium, 39.6 milligrams of phosphorus, 280.4 milligrams of potassium.
- The macro nutrients present in the 100 grams mint icecream of variation II is 173 kilocalories of energy, 3 grams of protein, 30 grams of carbohydrate, 4 grams of total fat. The micro nutrients present in the 100 grams mint icecream of variation II is 52.1

milligrams of vitamin A, 6.9 milligrams of vitamin C, 1.1 milligrams of iron, 132 milligrams of calcium, 61.2 milligrams of magnesium, 122.1 milligrams of phosphorus, 242 milligrams of potassium.

- The shelf life for the developed products were observed at the refrigeration (4ºC). The icecreams appearance, colour, flavour, taste and consistency remained unchanged for four days. The flavour, consistency and taste were changed in the fifth day.
- The cost of developed products were calculated. The cost of the per portion of spinach icecream was rupees 46. The cost of the per portion of mint icecream was rupees 47.
- The overall acceptability of the millets and greens based icecream were done using five point hedonic scale among the young adult women from Avinashilingam University, Coimbatore. The results of spinach icecream variation I was moderately acceptable, variation II was highly acceptable and variation III was fairly acceptable. The results of mint icecream variation I was moderately acceptable, variation II was highly acceptable and variation III was fairly acceptable.

Conclusion:

Today's food industry is focused by delivering foods processed and preserved with additives and colouring agents. While also being over corporate and poorly regulated, leading to a number of immoral, harmful, and illegal practises that have a significant negative impact on the environment, animals, and public health. To address this, there is a need to focus on sustainable agriculture and the development of healthier food options.

Millets and green leafy vegetables are nutrient rich foods that offer numerous health benefits, including the prevention of non communicable diseases. By incorporating the millets and greens into an icecream, shall create a ready to eat, nutritious, and delicious product, suitable for vegans and those with lactose intolerance. Overall, this study highlights the potential for innovative approaches to address the challenges by food industry and promote healthier eating choices.

Scope for future research work:

- Promotion of millets usage in the production process of icecream.
- Use of natural food colours in food industries.
- Incorporation and acceptability of green leafy vegetables in icecream production.

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Appendices

APPENDIX I

Approval from Institutional Human Ethics Committee

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be university under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore- 641043, Tamil Nadu, India

Chairman
Dr. Sudha Ramalingam
Director – Research and Innovation
Professor- Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore.

Member Secretary
Dr A Thirumani Devi
Professor
Department of Food Science and Nutrition

Members
Mr. K Arulmoli (Legal Expert)
Dr. Subashini K.Sripathi
Dr. A Saraswathy(Medical Officer)
Ms. D. Kavitha
Dr. A R Sudamani Ramasamy
Dr. G. Victoria Naomi
Dr. Judith Justin
Dr. Anitha Subash
Dr. K Sampath Rani

05.01.2023

To
MS. Shalini, K.
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore- 641043

Dear Shalini,

Ref: Your proposal No. IHEC/22-23/FSMD-21 entitled "Standardisation of Millets and Greens Based Icecream" submitted for approval of IHEC 21.11.2022

The Institutional Human ethics Committee of our University hereby grants approval to your research proposal No. IHEC/22-23/FSMD-21 entitled "Standardisation of Millets and Greens Based Icecream" submitted by you. The Approval number for the same is AUW/IHEC/FSMD- 22-23/XPD-21.

We wish you all the best in your research endeavours.

Regards

5.1.23

Dr. A Thirumani Devi
Member Secretary

Institutional Human Ethics Committee

APENDIX II

Score card for the Millets and Greens Based Icecream

Name: date:

Product Name:

Attributes	Variation – I	Variation – II	Variation – III
Appearance			
Colour			
Consistency			
Taste			
Flavour			
Overall Acceptability			

Score	Appearance	Colour	Consistency	Taste	Flavour
5	Creamy	Presence of Bright Green Colour	Smooth and Creamy	Sweet	Subtle
4	Slightly creamy	Presence of pale Green Colour	Slightly Smooth	Moderately Sweet	Mild
3	No Creamy	Presence of greyish Green Colour	Semi Crystalized	Slightly Sweet	Moderate
2	Semi Crystalized	Presence of Half White Colour	Crystalized	Slightly Sour	Strong
1	Crystalized	Absence of Green Colour	Watery/Solid	Bland	Flavorless

Signature: Date:

APPENDIX III

Determination of Energy

Lists the following energy conversion

Carbohydrates	17KJ/g, 4kcal/g
Fat	38 KJ/g, 9kcal/g
Protein	17 KJ/g, 4kcal/g

Energy (kcal/g) = (Carbohydrate X 4) + (Fat X 9) + (Protein X 4)

APPENDIX IV

Determination of Total Protein

Method: Lowry's Method

Reagents:

- 2% Sodium carbonate in 0.1 N Sodium hydroxide (Reagent A)
- 0.5% Copper sulphate ($CuSO_4.5H_2O$) and 1% Potassium sodium tartarate in 100 ml distilled water (Reagent B)
- Alkaline copper solution: Mix 50 ml of A and 1 ml of B prior to use (Reagent C)
- Folin-Ciocalteau Reagent
- Protein Solution (Stock Standard) - Weigh accurately 50 mg of bovine serum albumin and dissolve in distilled water and make up to 50 ml in a standard flask
- Working Standard- Dilute 10 ml of the stock solution to 50 ml with distilled water in a standard flask. 1 ml of this solution contains 200 µg protein

Procedure

- Extraction of Protein from sample: Extraction is usually carried out with buffers used for the enzyme assay. Weigh 500 mg of the sample and grinded well with a pestle and mortar in 5-10 ml of the buffer. Centrifuged and used the supernatant for protein estimation
- Pipette 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard into a series of test tubes

- Pipette 0.1 ml and 0.2 ml of the sample extract in two other test tubes
- Make up the volume to 1 ml in all the test tubes. A tube with 1 ml of water serves as the blank
- Add 5 ml of reagent C to each tube including the blank. Mix well and allow standing for 10 minutes
- Then add 0.5 ml of reagent D, mix well and incubated at room temperature in the dark for 30 minutes. Blue colour is developed
- Take the readings at 660 nm
- Draw a standard graph and calculate the amount of protein in the sample and express the amount of protein in mg/g or 100 g sample

Calculation

$$\text{Concentration of the Protein (\%)} = \frac{\text{OD (test)}}{\text{OD (std)}} \times \frac{\text{Conc (std)}}{\text{Aliquot (test)}} \times 100$$

APPENDIX V

Determination of Total Carbohydrate

Methods: Anthrone method

Reagents

- 2.5N HCl
- Anthrone reagent: Dissolve 200 mg anthrone in 100 ml of ice-cold 95% Sulphuric acid. Prepare fresh before use
- Standard Glucose (stock): Dissolve 100 mg in 100 ml distilled water

Working standard: 10 ml of stock diluted to 100 ml with distilled water. Store refrigerated after adding a few drops of Toluene

Procedure

- Weigh 10-100 mg of the sample in to a boiling tube
- Hydrolyze by keeping it in a boiling water bath for 3 hours with 5 ml of 2.5 N HCl and cool to room temperature
- Neutralize with solid Sodium carbonate until the effervescence ceases
- Make up the volume to 100 ml and centrifuge
- Collect the supernatant and take 0.5 and 1 ml aliquots for analysis
- Prepare the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard, '0' serves as blank
- Make up the volume to 1 ml in all the tubes including the sample tubes by adding distilled water
- Then add 4 ml of Anthrone reagent
- Heat for 8 minutes in a boiling water bath
- Cool rapidly and read the green to dark green colour at 630 nm
- Draw a standard graph by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis
- From the graph calculate the amount of carbohydrate present in the sample tube

Calculation

Concentration of the Carbohydrate (%) = OD (test) x Conc (std) x 100

OD (std) Aliquot (test)

APPENDIX VI

Determination of Total Fat

Method : Soxhlet method

Reagent: Ether

Procedure

- Weigh, accurately 5-10 g (W1) of dry sample into a thimble and keep a cotton plug on top of it
- Place the thimble in a Soxhlet apparatus and add ½ volumes of Ether into a pre-weighed flat- bottom flask (W2) and distilled for 16 hours (Cool the apparatus and filter the solvent into a pre- weighed conical flask (W2)
- Rinse the flask of the apparatus with small quantities of Ether and then added washings to the above flask)
- Remove Ether by evapouration and dried the flask with fat at 80-100□C, cool in a desiccator and weigh (W3)

Calculation

Fat content (g/ 100%)=

(W3-W2) × 100

= X ————————

W1

Where, W1- Weight of dry matter taken for extraction

W2- Weight of flat bottom flask, W3- Weight of flask with fat

APPENDIX VII

Estimation of Iron

Method : Atomic absorption method

Apparatus:

- 3.1 Atomic absorption spectrophotometer with air acetylene flame
- 3.2 Cathode Lamp-Fe – 248.3 nm.

Reagent:

- 4.1 Fe (NIST traceable)
- 4.2 Nitric acid (1:499).
- 4.3 CaCl2 solution:
- Dissolved 630 mg CaCO3, 50 ml of 20% v/v HCL, if required boil gently to obtained complete solution. Cool and dilute to 1000 ml with distilled water.

Procedure:

- Take 100 ml standard flask
- Prepare Iron standards (Nist traceable) to 0.05,0.1, 0.125,0.15,0.20 and 0.25 mg/l in nitric acid (1:499) from 1000 ppm solution.
- Prepare a blank solution in 100ml distilled water.
- Pipette out 100 ml of sample in a beaker and digest with 0.5 ml. of conc. Nitric acid and add 25 ml CaCl2 till the volume reduced to three fourth.
- Make up to 100 ml. with distilled water.
- Process the blank also in the above manner.
- Set the AAS as per the specific work instruction.
- Aspirate the blank, standards and DIGESTED FOOD SAMPLE solutions.
- Measure the absorbance of the iron at 248.3nm

Calculation:

- Draw the standard calibration graph by plotting the absorbance Vs standard conc. for each standard
- Process one quality check standard at 0.05 mg/l along with each batch of samples.

APPENDIX VIII

Determination of Calcium

Method: Complexometric titration

Reagents: HCl, HNO 3, methyl red., NH 4 OH, ammonium oxalate, H2S04,0.02M

PROCEDURE:

- Weigh accurately about 2g of sample in a porcelain dish.
- Ignite in furnace to carbon free ash, but avoid fusing.
- Boil the residue in 40ml HCl (1+3) and few drops of HNO3.
- Cool and transfer to a 250ml standard flask, dilute to volume and mix.
- Pipette 25ml clear liquid into a beaker, dilute to 100ml and add 2drops of methyl red.
- Add NH4OH (1+1) drop wise to pH 5.6 (brownish orange colour).
- If overstepped add HCl (1+3) with dropper to orange.
- Add two more drops of HCl to pink and pH 2.5-3.0
- Dilute to 150ml and boil.
- Add slowly with constant stirring 10ml of hot saturated (4.2%) solution of ammonium oxalate.
- If red changes to orange or yellow, add HCl drop wise until pink
- Let stand overnight for precipitate to settle.
- Filter the supernatant through Whatman no.40 and wash the precipitate thoroughly with NH4OH (1+50).
- Place the paper in original beaker and add a mixture of 125ml water
  And 5ml H2SO4.
- Heat to 70˚C and titrate against 0.02M KMnO4(0.1N) to slight pink Color.

Calculation:

$$\text{Calcium (as Ca)} = \frac{\text{Titre volume} \times \text{normality of } KMnO_4 \times 100 \times 28 \times 40}{\text{Sample weight} \times 1000 \times 56}$$

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

Where,

M1 = mass in g of dish with material before drying.

M2 = mass in g of dish with material after drying, and

M = mass in g of the empty dish.

APPENDIX IX

Estimation of Vitamin C

Methods: Titration method

Reagents: starch indicator solution, iodine solution

Procedure:

- Take 1gm sample and dissolved with 50ml of water into a 250 mL conical flask and add about 100 mL of distilled water and 1 mL of starch indicator solution.
- Titrate the sample with 0.005 mol L^{-1} iodine solution. The endpoint of the titration is identified as the first permanent trace of a dark blue-black colour due to the starch-iodine complex.
- Repeat the titration with further aliquots of sample solution until you obtain concordant results (titres agreeing within 0.1 mL)

Calculation

Calculate the average volume of iodine solution used from your concordant titres.

Calculate the moles of iodine reacting.

Using the equation of the titration (below) determine the number of moles of ascorbic acid reacting.

4. Calculate the concentration in mol L^{-1} of ascorbic acid in the solution obtained from the Sample.

1ml of Iodine mol/L equivalent to 0.88 mg ascorbic acid or vitamin C

At the end point of titrationC1 V1 of iodine =C2V2 of ascorbic acid

Weight of ascorbic acid (mg/100g)= Volume(ml) X Concentration X Molecular weight of ascorbic acid x 100

Weight of the sample in mg

APPENDIX X

Estimation of β-carotene: Vitamin A

Method: spectrophotometer.

Reagent: saturated butanol (WSB)

Procedure:

β-carotene was estimated following approved method as described below.

sample was taken in 150 ml glass stoppered Erlenmeyer flask and 40 ml water saturated butanol (WSB) was added. The contents of the flasks were mixed vigorously for 1 minute and kept overnight (16-18 hrs) at room temperature under dark for complete extraction of β-carotene. Next day, the contents were shaken again and filtered completely through the Whatman no.1 filter paper into a 100 ml volumetric flask. The optical density of the clear filtrate was measured at 440 nm using spectrophotometer.

Pure WSB was used as blank. The β-carotene content was calculated from calibration curve from known amount of β-carotene as discussed below and expressed as parts per million (ppm). Standard solution of β-carotene (Sigma) was prepared in water saturated butanol (WSB) at the concentration of 5 µg/ml. WSB is prepared by mixing n-butanol with distilled water in 8:2 ratios.

Calibration curve is made from known amounts of pure β-carotene from 0.25 µg/ml to 1.5 µg/ml which are prepared after suitable dilutions of original stock with WSB in calibrated 10 ml volumetric flasks (from 0.5 ml to 3 ml of standard solution in 10 ml). Absorbance of each dilution is measured and a calibration curve is established. β-carotene content of unknown samples is calculated from standard curve

APPENDIX XI

Determination of Potassium

Method: flame photometry

Reagents: minced sample, dilute HCl

Procedure:

Sample preparation

- Prepare a homogeneous, finely divided sample of 500g or more using the mixer-grinder.
- Transfer the ground sample to a straight side, wide mouth jar and refrigerate until analysed.
- Allow the refrigerated samples to come to room temperature (about 30 minutes).
- Weigh about 10g of the minced sample into a suitable Pyrex beaker. Record sample weight (A). Add sufficient deionised water (usually 100ml) to cover the cutters of the blender and homogenize at maximum speed for about 90 seconds.
- Rinse the shaft and cutters of the blender with deionised water, allowing the rinse water to flow into the mixture.
- Quantitatively transfer the solution to a previously tarred centrifuge bottle (250ml) with deionised water. Make up to about 200g. Record the solution weight(B).
- Cap the centrifuge bottle and shake vigorously to disperse the homogenate.
- After every sample, rinse the shaft and cutters of the blender with acetone. Immerse the cutters in a beaker of acetone and run at half speed. Repeat the rinse with deionised water.
- Centrifuge the bottles for 20 minutes at 1000rpm to settle fibrous material.
- Filter a portion of the supernatant (about 50ml) into a PP bottle, discarding the first 5 to 10ml.
- Perform serial dilution/s of the samples, until the reading from the flame photometer is within the calibration range of the instrument (see below), using dilute HCl and volumetric glassware of the appropriate size. Determine K in the filtrate within 24 hours.

Preparation of standard solutions for calibration curve

1. Dissolve exactly 2.542gm of sodium chloride in water and make up to 1 liter. This contains 0.1mg per ml (1000) ppm. Dilute this to 10, 5, 2.5, and 1 ppm sodium ion solutions.

2. Estimation of sodium by flame photometer:

3. First, switch on the digital flame photometer followed by the air compressor with the required value (10 bar)

4. Open the gas from the gas cylinder (after the instrument is warmed up for 10 minutes). Initially allow the ion-free water (distilled water) to aspirate in to the flame and set the digital value as 100. Now the instrument is said to be calibrated. After this calibration of the instrument, no adjustment should be made .Introduce the solutions containing different concentrations of sodium chloride (2, 4, 6, 8, 10μg) to the flame and find out the intensity of emitted light of each solution.

5. Plot a calibration graph between concentration and intensity of NaCl solution which passes through the origin. Finally, introduce the sample of unknown solution containing sodium into the flame and find out the intensity of emitted radiation. From the intensity, the concentration of unknown solution can be determined.

Flow chart for flame photometry

Sample Oxidant (Compressor)

↓ Sent to

Neutralizer (Sample atomized)

↓

Electrons get excited on heating and on cooling returns to ground state

↓

Raditions emitted

↓

The detector present will detect the radiation by the corresponding wavelength

↓

Emitted radiations are converted to electric impulse.

↓

Electrical impulses are converted to numerical values by microprocessor.

↓

Reading are noted for the corresponding element. (E.g. K)

Calculation

Potassium

Potassium content of sample (ppm) = (A = instrument reading)

PPM = mg/L (for liquid matrices) and mg/kg (for solid matrices)

Dilution factor (B) =

Weight of homogenized sample = C to calculate for per packet or use 100 to calculate for percentage.

Weight of sample used for extraction (D)=

A (ppm) x B x C or 100

Potassium content of sample = ______________________

Extracted sample weight (A)

Result

Potassium content of ______________________ is ____________________

APPENDIX XII

Determination of Magnesium

Method: Complexometric titration

Reagents: HCl, HNO 3, methyl red.,NH 4 OH, ammonium oxalate, H2So4,0.02M KMnO4

Procedure:

- Weigh accurately about 2g of sample in a porcelain dish.
- Ignite in furnace to carbon free ash, but avoid fusing.
- Boil the residue in 40ml HCl (1+3) and few drops of HNO 3.
- Cool and transfer to a 250ml standard flask, dilute to volume and mix.
- Pipette 25ml clear liquid into a beaker, dilute to 100ml and add 2drops of methyl red.
- Add NH 4 OH (1+1) drop wise to pH 5.6 (brownish orange color).
- If overstepped add HCl (1+3) with dropper to orange.
- Add two more drops of HCl to pink and pH 2.5-3.0
- Dilute to 150ml and boil. • Add slowly with constant stirring 10ml of hot saturated (4.2%) solution of ammonium oxalate.
- If red changes to orange or yellow, add HCl drop wise until pink
- Let stand overnight for precipitate to settle.
- Filter the supernatant through Whatman no.40 and wash the precipitate thoroughly with NH 4 OH (1+50).
- Place the paper in original beaker and add a mixture of 125ml water
- And 5ml H 2 SO 4 .
- Heat to 70˚C and titrate against 0.02M KMnO 4 (0.1N) to slight pink Color.

  Calculation:

  Magnesium = Titre volume× normality of KMnO 4 ×100×28×40 / Sample weight×1000×56

APPENDIX XIII

Estimation of Phosphorus

Method: Carius method

Reagent: working standard, ammonium molybdate I, ammonium molybdate II, ANSA.

Procedure

- Took 1,2,3,4, and 5mL aliquots of working standard solution corresponding to 10, 20, 30, 40 and 50 γ of phosphorus in a series of test tubes.
- 1mL of ash solution of the unprocessed and processed sample each was taken in duplicates.
- To all the test tubes that contain standard solutions added 1mL of ammonium molybdate I. To each to the sample tubes added 1mL of ammonium molybdate II
- Made up the volume in each test tube to 9.6mL with distilled water and then added 0.4mL of ANSA to all tubes.
- Prepared a reagent blank simultaneously by taking 1mL of ammonium molybdate I, 8.6mL of distilled water, and 0.4mL of ANSA.
- Mixed the solutions in all the tubes thoroughly, and allowed to stand for 20mins for colour development.
- Read the intensity of colour developed in a photoelectric-colorimeter against the reagent blank at 660nm.

Estimation of phosphorus – colorimetric solutions

Vol.of solution in (ml)	Conc. In (γ)	Vol. of Molybdate I (ml)	Vol. of Molybdate II (ml)	Vol. of distilled water (ml)	Vol. of ANSA (ml)	OD value
Blank	-	1	-	8.6	0.4	
Standard 1 2 3 4 5	 10 20 30 40 50	 1 1 1 1 1	 - - - - -	 7.6 6.6 5.6 4.6 3.6	 0.4 0.4 0.4 0.4 0.4	
Up sample 1.0 1.0	 - -	 - -	 1 1	 7.6 7.6	 0.4 0.4	
P Sample 1.0 1.0	 - -	 - -	 1 1	 7.6 7.6	 0.4 0.4	

*P=Processed UP= Unprocessed

Calculation

A. Unprocessed sample

As per the graph the OD value of processed sample corresponds to _____γ of phosphorus.

i.e, 1.0ml of ash solution corresponds to _______γ of phosphorus.

Amount of phosphorus in 100ml of ash solution = _______x100 γ of phosphorus

100ml of ash solution was made from 2g of sample

i.e., 2g of sample contains =_______x100 γ of phosphorus

Therefore, 100g of unprocessed sample contains = ___________x100x100

2x1000

=________ mg of phosphorus.

B. Processed sample

As per the graph the OD value of processed sample corresponds to _____γ of phosphorus.

i.e, 1.0ml of ash solution corresponds to _______γ of phosphorus.

Amount of phosphorus in 100ml of ash solution = _______x100 γ of phosphorus

100ml of ash solution was made from 2g of sample

i.e., 2g of sample contains =_______x100 γ of phosphorus

Therefore, 100g of processed sample contains =_______x100x100

2x1000

=________ mg of phosphorus.

C. Percentage difference

Phosphorus content of (unprocessed – processed)

Percentage difference = ________________________________ x 100

Unprocessed

=

Results

1. 100g of unprocessed sample contains =
2. 100g of processed sample contains =
3. Percentage gain/loss =

APPENDIX XIX

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NABL ISO / IEC 17025:2017 | ISO 9001:2015

TEST REPORT

Report No.	GLARL/TRE/1614	Date	13.04.2023

Details of Customer	
Customer Name and Address	Ms. K. Shalini Avinashilingam University Coimbatore- 641 043.
Customer Reference	-

Details of Sample			
Sample Received Date	30.03.2023	Sample-By	Customer
Nature of the sample	Food Product	Description	Spinach Ice Cream
Sample Code	GLARL/F/03/23/1614	Received condition	Packed in a PET Jar
Analysis Started on	31.03.2023	Analysis Completed on	12.04.2023

Result of Analysis

S.No	Characteristic	Test Method	Unit	Results
1.	Energy	FSSAI/IS	Kcal	166.6
2.	Protein		g/100g	5.12
3.	Carbohydrate		g/100g	29.49
4.	Iron		mg/100g	2.238
5.	Total Fat		g/100g	3.04
6.	Potassium		g/100g	280.4
7.	Magnesium		mg/100g	38.7
8.	Vitamin A		mcg/100g	243
9.	Vitamin C		mg/100g	27.0
10.	Phosphorous		mg/100g	39.6
11.	Calcium		mg/100g	147.3

****End of Report****

Green Link Analytical And Research Laboratory (India) Pvt Ltd CBE - 14

Authorized Signatory
(M.Amsaveni)
Technical Manager

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GREENLINK

APPENDIX XX

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NABL ISO / IEC 17025:2017 | ISO 9001:2015

TEST REPORT

Report No.	GLARL/TRE/1615	Date	13.04.2023

Details of Customer	
Customer Name and Address	Ms. K. Shalini Avinashilingam University Coimbatore- 641 043.
Customer Reference	-

Details of Sample			
Sample Received Date	30.03.2023	Sample-By	Customer
Nature of the sample	Food Product	Description	Mint Ice Cream
Sample Code	GLARL/F/03/23/1615	Received condition	Packed in a PET Jar
Analysis Started on	31.03.2023	Analysis Completed on	13.04.2023

Result of Analysis

S.No	Characteristic	Test Method	Unit	Results
1.	Energy	FSSAI/IS	Kcal	173.5
2.	Protein		g/100g	3.29
3.	Carbohydrate		g/100g	30.93
4.	Iron		mg/100g	1.112
5.	Total Fat		g/100g	4.07
6.	Potassium		g/100g	242
7.	Magnesium		mg/100g	61.2
8.	Vitamin A		mcg/100g	52.1
9.	Vitamin C		mg/100g	6.93
10.	Phosphorous		mg/100g	122.1
11.	Calcium		mg/100g	132

****End of Report****

CBE - 14

Authorized Signatory
(M.Amsaveni)
Technical Manager

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