DEVELOPMENT AND QUALITY EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

DISSERTATION SUBMITTED

In partial fulfillment of requirement for the award of the degree of

MASTER'S PROGRAMME IN

CLINICAL NUTRITION AND DIETETICS

By

Zakiah.K

(Register No: SM21MCN013)

DEPARTMENT OF CLINICAL NUTRITION AND DIETETICS

ST. TERESA'S COLLEGE (AUTONOMOUS)

ERNAKULAM

MAY 2023

CERTIFIED AS BONAFIDE RESEARCH WORK

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

DECLARATION

I hereby declare that the project entitled **"DEVELOPMENT AND QUALITY EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT"** submitted in partial fulfilment of the requirement for the award of the degree of Master's Programme in Clinical Nutrition and Dietetics is a record of original research work done by me under the supervision and guidance of **Ms. Dr.Soumya.P.S** , Assistant Professor, Department of Clinical Nutrition and Dietetics, Women's Study Centre, St. Teresa's College (Autonomous), Ernakulam and has not been submitted in part or full of any other degree/diploma/fellowship or the similar titles to any candidate of any other university.

Place: (Zakiah.K)

Date:

CERTIFICATE

I here certify that the dissertation entitled **"DEVELOPMENT AND QUALITY EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT"** submitted in partial fulfilment of the requirement for the award of the degree of Master's Programme in Clinical Nutrition and Dietetics is a record of original work done by Ms. **Zakiah.K** during the period of the study under my guidance and supervision.

Signature of the HOD

Signature of the Research Guide with designation

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ABSTRACT

DEVELOPMENT AND QUALITY EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

Yogurt as a coagulated milk product obtained by lactic acid fermentation .Adding rice flour to milk while preparing yogurt will also enhance the nutritional qualities, also it is a good alternative for the conventional yogurt. Rice based yogurt has more health benefits. The aim of the study was to develop a product based on pokkali rice,with yogurt and fruit pulp which enhance the flavour.

According to findings of nutritional components of pokkali rice it is rich in phosphorus and carbohydrates, protein, dietary fibre, sodium and lack of iron, zinc, and manganese. Pokkali rice has good water absorption capacity, bulk density, and swelling property. It is well soluble in water.

Yogurt products are made incorporation with pokkali rice slurry and fruit. The products are made with different proportion T1, T2, T3 of each flavour. The selection of best flavour and most acceptable proportion among six flavour (apple, banana, papaya, pineapple, mango and passion fruit) is analyzed by organoleptic evaluation, according to the report highest acceptable flavour is pineapple on par with apple and mango, the least acceptable flavour is papaya. The selected flavour of best proportion is identified and tested.

According to nutritional analysis of selected product are rich in energy, carbohydrates on par with potassium and then protein, lack in iron. Vitamin C is present only in pineapple flavour. Comparing dietary fibre of pokkali rice-based fruit blended yogurt and plain yogurt, fruits and brown rice has fibre in it,so including pokkali rice based fruit blended yogurt into daily diet helps improve satiety.

Storage of the developed product is about 5 days because of adding fruit puree and pokkali rice slurry. Yeast and mould growth is observed from 6^{th} day. Preservatives are not added to the product.

Pokkali rice-based fruit blended yogurt is bit higher cost than control (plain yogurt). Among the fruit flavour pokkali rice-based passion fruit blended yogurt was costly on par with pokkali rice-based pineapple blended yogurt, and the least cost was pokkali rice based banana (robusta) blended yogurt. When compared with commercial fruit yogurt, pokkali rice-based fruit blended yogurt is bit high cost. It is well known that the raw materials used to have direct impact on product cost.

Further studies on theraputic qualities about pokkali rice based fruit blended yogurt can be performed and create awareness. As pokkali rice-based fruit blended yogurt has dietary fibre than plain yogurt, this product can be included in weight loss diet plan.

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1.INTRODUCTION

The majority of diseases begin in the digestive tract when "good" bacteria are no more to control "bad" bacteria.

- Elie Metchnikoff

The Father of Probiotics and Nobel Laureate

FAO/ WHO (1977) describes yogurt as a coagulated milk product obtained by lactic acid fermentation through the action of started organisms *i.e.,* Lactobacillus bulgaricus and Streptococcus thermophilus from milk and milk products.

Incorporating of fruits to yogurt enhance nutrition qualities, organoleptic qualities. These types of probiotic products in market shows greater increase in yogurt consumption by consumers.

Adding rice flour to milk while preparation of yogurt will also enhance the nutritional qualities, also it is a good alternative for the conventional yogurt, as it can be made in low cost. Rice based yogurt has more health benefits.

For a substantial portion of the world's population, rice (*Oryza sativa*) is the main food staple, especially in Asia. Only two of the 23 species of Oryza that are known to science—Oryza sativa and Oryza glaberrima—are used for commercial production. A specific species of rice known as Pokkali is grown organically over a total of 5,500 acres in Kerala's inundated coastal districts of Ernakulam, Alappuzha, and Thrissur. The cultivation of pokkali rice dates back three thousand years. It is also one of the world's oldest crops to have been grown organically. At Pokkali, rice is raised in a conventional and organic way. It is considered to have several medical advantages and a high market worth.

The world's most popular tropical fruit is the banana (*Musa acuminata Cavendis*h), papaya (*Carica papaya)* and pineapple (*Ananas comosus*). Popular and significant fruit trees in tropical and subtropical regions of the world include the papaya (*Carica papaya L.*). It is rich vitamin A, B, and C content as well as

proteolytic enzymes like papain and chymopapain. *Mangifera* is a powerful antioxidant, anti-lipid peroxidation, immunomodulator, cardiotonic, hypotensive, wound healing, antidegenerative, antioxidant and antidiabetic compound. Pineapple is nutrient rice and contains a variety of volatile substances in trace amounts and complicated mixes, it is recognized as a flavorful fruit. The pulps of passion fruit *(Passiflora)* are abundant in polyphenols and phenolic acids. Amylase and glucosidase have been found to have antioxidant capability and in vitro inhibitory activity. *Malus domestica,* Apples have a significant role in the consumption of nutrients connected to the prevention of cardiovascular disease (CVD). Apples have been demonstrated to have positive effects to vascular function. In a whole apple, there is evidence of a synergistic in between the fibre and flavonoids, which is probably partially mediated by the gut flora.

Combination of probiotic product (yogurt) with pokkali rice which is a good alternative choice with fruits pulps of banana (robusta), papaya, pineapple, mango, apple, passion fruit, helps to enhance the organoleptic qualities and nutritional qualities of the product. The aim of the present work is to bring pokkali rice to all the consumers, incorporation with yogurt helps consumers to purchase and it helps the farmers utility. This can replace the plain yogurts, enriched with pokkali rice and locally available fruits, which is a probiotic food.

Hence, the present study entitled “Development and Quality Evaluation of Pokkali Rice Based Fruit Blended Yogurt” was undertaken with the following objectives.

1.To determine the nutritional and functional analysis of the pokkali rice powder.

2. The study aims to develop pokkali rice-based fruit blended yogurt

3. To determine the quality parameters of the developed product

4. To determine the shelf life

5. To find out cost analysis

2.REVIEW OF LITERATURE

The literature pertaining to the study "Development and Quality Evaluation of Pokkali Rice Based Fruit Blended Yogurt" is presented under the following heads

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2.1 FERMENTED FOOD FOR GUT HEALTH - YOGURT

Yogurt gels are a type of soft solid with dynamic structures that can change. The physical properties of yogurt can be explained by a model that considers the balance between attractive and repulsive forces, such as hydrophobic attractions, calcium phosphate nanoclusters, and charge repulsions. Different methods are available to study the physical and structural characteristics of yogurt. Processing variables like total solids content, heat treatment, and incubation temperatures affect the texture of yogurt. Improved knowledge of these factors may help manufacturers enhance yogurt quality. (Lee and leucy *et al*., 2010)

Fisberg and Machado (2015) explain the history of Yogurt, it is a staple food of the human diet for many centuries and is known by many different names around the globe. It is thought that the Turkish term "yourmak," which meaning to thicken, coagulate, or curdle, is where the name "yoghurt" originated.

Although Indian Ayurvedic texts from 6000 BC make mention of yogurt's health advantages, it wasn't until the 20th century that a Bulgarian medical student named Stamen Grigorov connected the benefits to lactic acid bacteria. Today, most of the yoghurt is made by fermenting acidified milk with live, distinct microorganisms (*Lactobacillus bulgaricus* and *Streptococcus thermophiles*). Yogurt is a good to outstanding source of highly bioavailable protein, an excellent source of calcium, and a source of probiotics that may have a variety of health advantages. Low yoghurt consumption indicates a missed opportunity to support a healthy lifestyle.

Patel and Roy *et al.* (2016) conducted experiment on texture analysis on goat milk and cow milk to compare the quality of yogurt and the result are,

yogurt made from cow milk has high firmness, consistency, cohesiveness, and index of viscosity than goat milk.

The main objective of this review is to assess the plausibility of potential mechanisms frequently mentioned in the literature to understand the inverse relationships between yoghurt consumption and various cardiometabolic health parameters that are related to its nutrient profile, bacterial constituents, and food matrix. In this article, the research agenda to back up yogurt's purported role in avoiding cardio metabolic illnesses is discussed. (Fernandez *et al.,* 2017)

Yogurt is a food that is rich in nutrients such as calcium and protein, making it an important part of a healthy diet. People who consume yogurt tend to have a better diet and healthier habits than those who do not. They are less likely to be overweight or obese and may have other positive behaviors such as not smoking and being physically active. In addition, yogurt production has a low to moderate carbon footprint, making it an environmentally friendly food option. Therefore, incorporating yogurt into the diet can contribute to a healthy and sustainable lifestyle. (Tremblay and Panahi e*t al .,* 2017)

This article discusses the quality of milk needed for making yogurt and explains the steps involved in formulating and processing different types of yogurts, including plain, stirred, light, custard, and more. It also provides a brief overview of various yogurt styles, such as yogurt drinks, smoothies, mousses, and frozen yogurt, as well as the fruit preparations used for flavouring them. Chandan (2017)

Kaskens *et al. (*2022) introduced pulse-based yogurt for people with lactose intolerance. Yogurt was developed as a vegan option because of the current paradigm shift toward plant-based diets. Pulses are produced all over the world and are high in protein. Consuming yoghurt made from pulses is a creative approach to reap the health advantages of yoghurt. Currently, heat treated fermented pulse yogurts have been shown to produce acceptable sensory profiles but lack the stability of dairy yogurt.

Lactose digestion in yogurt and how it can be consumed by lactose-intolerant people. Yogurt is easier to digest than other dairy sources because the bacteria in it assist with lactose digestion. The bacteria survive stomach acid and are active in the small intestine, allowing them to break down lactose sufficiently to prevent symptoms in lactose-intolerant people. The lactase capability of different yogurts is similar because they contain enough bacteria. Flavored yogurts have slightly reduced lactase activity but are still well tolerated. The article also discusses the growing interest in functional foods, including yogurt, due to their beneficial effects on health. Research is being done to find natural sources of functional compounds, such as plant extracts, to add to yogurt and other dairy products. Yogurt is a popular choice for functional food because of its desirable taste and texture. Jalali and Nickfar (2022)

2.2 RELATIONSHIP BETWEEN YOGURT AND DISEASE

The potential benefits of yogurt consumption on cardiometabolic health, particularly in children and adolescents. It highlights the nutrient density, satiety, and high-quality protein found in yogurt. Additionally, the passage explores the role of yogurt in modulating gut microbiota in infants and proposes that the unique properties of yogurt could be used to increase its functionality. Another study mentioned in the passage examines the effect of long-term yogurt consumption on immunity in young and senior adults. The study found that regular consumption of yogurt, especially live-culture yogurt, was associated with a decrease in allergic symptoms and stable cholesterol levels but had little effect on interferon-γ and immunoglobulin E production. (Van de Water and Keen *et al.,* 1999)

Yogurt is a popular food consumed globally. Its fermentation with a starter culture result in partially digested milk, making it easy to digest even for those who are lactose intolerant. Yogurt can also be used in baking to create tender products. It is a good source of protein and calcium, with the fermentation process increasing their absorption. Yogurt has several health benefits, such as

boosting immunity and reducing the risk of yeast infections and colon cancer. (Cascio and Dinstel *et al.,* 2011)

According to, Kok and Hutkins (2018) Yogurt, kefir, and other fermented foods are becoming more commonly consumed because of their potential health benefits. According to epidemiological study, eating fermented foods has been associated with better weight control, decreased risks of type 2 diabetes, metabolic syndrome, and heart disease. These health benefits are assumed to be influenced by the microbial concentration of LAB. According to several studies, yoghurt and other fermented foods may help to enhance intestinal and extraintestinal health, treat infectious diarrhoea, reduce the length and frequency of respiratory infections, and enhance immunological and anti-inflammatory responses.

According to the cohort study of (Buendia *et al.,* 2018), The study investigated the relationship between yogurt consumption and cardiovascular disease (CVD) risk in hypertensive individuals. It was found that regular yogurt consumption, particularly when combined with a healthy diet, can reduce the risk of CVDs such as myocardial infarction and stroke in hypertensive men and women.

Ramachandran and Vargees (2020) discuss about the health benefits of yogurt and provides instructions for making it at home. It highlights the fact that despite being used for thousands of years in many cultures, yogurt is still not well-known by many people. Additionally, a research study is referenced that explores the potential use of homemade yogurt as a dietary supplement for the treatment of irritable bowel syndrome (IBS). The study found that homemade yogurt containing lactic acid bacteria (LAB) can lead to remission and complete cure for IBS without any negative side effects if consumed regularly. The study included sample populations from India and the United States and found high success rates in achieving remission and cure for IBS with the use of homemade yogurt.

Yogurt has live bacteria and unique nutrition. It's beneficial for children's health as it provides necessary nutrients and promotes healthier eating habits. Specific probiotic strains in yogurt can aid in pediatric infectious and gastrointestinal diseases and atopic-related disorders. The benefits of yogurt are due to the enhancement of the immune system through the gut microbiota. Adding probiotic strains to standard yogurt cultures could promote health in children of different ages. (Fiore and Profio *et al.,* 2022)

The yogurt matrix is a complex mixture of bioactive components that come from dairy, fermentation, or fortification. Recent studies have shown that consuming yogurt can improve the immune system through various mechanisms that involve the gut microbiota, the intestinal barrier, and immunocytes. The bioactive components in yogurt work together to enhance the immune system by improving gut health, strengthening the intestinal barrier, and modulating immune cells. Epidemiological and human intervention studies have also indicated that regular consumption of yogurt can reduce chronic inflammation and enhance immune function. In summary, yogurt is a simple and effective way to support overall health and reduce the risk of chronic diseases. (Hasegawa and Bolling *et al.,* 2023)

2.3 YOGURT BLENDED WITH FRUIT FLAVOUR

Addition of fruit pulp such as (banana, papaya and watermelon) with 5%, 10% and 15% of concentration and stored in refrigeration over set period, according to organoleptic test maximum people choose 15% of fruit pulp is the best for adding fruit into yogurt (Roy *et al.,* 2015).

Reeta *et al.* (2016) experimented about the higher acceptability between traditional Greek dahi and Greek dahi incorporated with pomegranate pulp. And the result showed that 20% of pomegranate fruit pulp has highest quality acceptance by consumers.

A study compared the antioxidant potential and total phenolic content of 12 commercially available fruit-flavored yogurts from three different producers in Romania. The results showed a positive linear correlation between antioxidant

activity and total phenolic content for all yogurt samples. Moldovan, Iasko *et al.,* (2016)

Fernandez and Marette (2017) develop new product based on Fruit and yoghurt have both been identified as indicators of healthy eating practises. Yogurt and fruits may have combined health benefits when ingested together because of their possible prebiotic and probiotic effects. Additionally, substituting fruit and yoghurt for high-energy, nutrient-poor snacks may reduce consumption of foods that are high in calories and encourage obesity.

Cardinali *et al.* (2021) develop a new product based on the variety of probiotic yoghurts available. Six probiotic yoghurts or fermented milks were created, along with one control yoghurt, and their physical and chemical properties. The evaluated fermented milk products did not differ in colour or change colour over time. S. thermophilus counts decreased from 1.8 to 3.5 log during storage. A decrease in *L.bulgaricus* counts (between 30 and 50% of the initial population in probiotic yoghurts; 17 to 0.50 units) and an increase in titratable acidity (0.09 to 0.29%) during storage were also observed.

Chadha *et al.* (2022) adding sweeteners to yogurt can increase its sugar content by up to 13%, but reducing or replacing sugar can affect its quality. This study aimed to investigate the sensory profile, liking, satiety, and post-consumption measurements of yogurt with natural sweeteners. Plain yogurt samples were made with equal amounts of sucrose, xylitol, stevia, and monk fruit. Xylitol-sweetened yogurt received the highest taste rating, followed by stevia and monk fruit. Sucrose-sweetened yogurt was rated the healthiest, most satisfying, and most likely to be purchased, followed by xylitol. Consumption

of xylitol, stevia, or monk fruit-sweetened yogurt significantly reduced appetite compared to sucrose-sweetened yogurt.

Two recent articles discuss yogurt production and its popularity as a fermented dairy product with health benefits. The first article explores the factors influencing the quality and sensory properties of Greek yogurt. The second article provides insight into the production of yogurt and serves as a guide for entrepreneurs looking to start a new project in the industry. A third article reports on a study that aimed to determine the optimum formulation of fruitghurt using watermelon skin and dragon fruit extract as a natural colorant. Hamsina and Sonia (2023).

This study investigates the impact of the quantity of yogurt starter on the sensory properties of yogurt with watermelon, melon, and golden melon. The yogurt starter used was composed of Streptococcus thermophilus, Lactobacillus bulgaricus, L. acidophilus, and Bifidobacterium. The results demonstrated that the amount of starter had an impact on the sensory properties of the yogurt. Watermelon yogurt made with 4% starter had the highest color score, while watermelon yogurt made with 6% starter had the highest aroma score. Golden melon yogurt made with 4% starter and watermelon yogurt made with 6% starter had the highest texture score. Plain yogurt made with 4% starter had the highest score for taste. (Puspaningrum, Chusnah *et al.,* 2023)

2.4 BLENDED YOGURT

The first study investigates the use of modified wheat starch as a fat replacer in low-fat yogurt production. The results show that modified starch can provide a firm body and minimal whey separation, resulting in good quality non-fat and low-fat yogurts without the use of any other stabilizer. The second study looks at the effect of apple and wheat fibers on the viability of Lactobacillus acidophilus in symbiotic yogurt and its physicochemical, sensory, and rheological properties during storage. The results show that the addition of fiber can improve the viscosity and reduce syneresis in yogurt but may also

affect color and taste. The study suggests that using wheat fiber at a rate of 0.5% can improve the texture and chemical properties of yogurt while also providing consumer satisfaction. Zomorodi and Aberun (2015).

Hasani *et al.* (2017) prepared yogurt from milk having pH 6.7 and terrible acidity 0.15. so, for dietary fibre they have added barley bran into yogurt.

Dabija *et al.* (2018) experiment by preparing yogurt using cow milk, they have added 4 different types of fibres like inulin, pea, oat and wheat in to the formulation with different proportion 1% - 2.5%. Study revealed that addition of fibre in yogurt could be best option to add fibre into daily diet routine.

Cichońska *et al.* (2021) The purpose of the current study was to examine how adding whole and ground flaxseed to yoghurt affected its quality attributes. The purpose of the current study was to examine how adding whole and ground flaxseed to yoghurt affected its quality attributes. The findings suggest that milled flaxseed is preferable to whole flaxseed for increasing perceived viscosity and decreasing syneresis.

According to research, rice-based yoghurt with fruit additions is a great swap for traditional yoghurt. Thus, four different types of rice-based yoghurt were made using rice slurry. The rice-based yoghurt that contained 75% rice slurry and 25% milk scored highest in the microbiological study. Therefore, rice-based probiotic yoghurt made with 75% milk, 25% rice slurry, 20% anona fruit pulp, and 5% papaya fruit pulp was used to create the best combinations (Nandakumar *et al.,* 2022).

Cichońska *et al.* (2022), This study sought to learn more about the characteristics of rice-based yogurt-like beverages that have been fermented with Propionibacterium and lactic acid bacteria. Depending on the starter culture that was utilised for the fermentation, the samples' individual sugar

content also differed. The findings imply that the synthesis of rice-based yogurt-like milk substitutes is aided by the combination of lactic and propionic fermentation.

Oroian *et al.* (2022) This study's objective was to assess the impact of cranberry powder with varying particle sizes (300 m and 300-500 m) on the yogurt's physicochemical, rheological, textural, and sensory properties. The results showed that adding cranberries raised all of the rheological parameters (G', G"). According to the findings, cranberry powder with a particle size of 300–500 m can successfully be used to replace synthetic colours and may also be utilised the enhance the rheological qualities of yoghurt.

2.5 NUTRITIONAL VALUE OF FRUITS

2.5.1 Banana

Pereira and Maraschin (2015), *Journal of ethnopharmacology*, People in the tropics produce a lot of the fruit known as the banana as a source of food and income. Both its nutritional benefits and its widely acknowledged medicinal advantages are present.

Banana peel is well known for its local and traditional usage to treat or prevent a wide range of illnesses, including depression, as well as to expedite wound healing, particularly after burns. Since banana peel and pulp include substances including carotenoids, phenolics, and amines, they can be used as a natural source of antioxidants and pro-vitamin A. Banana fruit peel and pulp could be valuable raw materials for making phytomedicines or even allopathic medicines because they are full of beneficial bioactive components.

Bananas are a highly popular fruit in the global market, and are widely consumed as a staple food in many countries. They are grown worldwide and are the fifth most important agricultural food crop in terms of international trade. Bananas can be classified into two types, sweet dessert bananas and cooking bananas or plantains. They can be eaten raw or processed, and are often used as

a functional ingredient in various food products. Bananas contain numerous beneficial compounds, such as phenolics, carotenoids, biogenic amines, and phytosterols, which are highly desirable in the diet due to their positive effects on human health and well-being. Many of these compounds have antioxidant properties, which can help protect the body against oxidative stress. Bananas have traditionally been used to treat various diseases and can reduce the risk of chronic degenerative disorders. (Singh and Kaur *et al.,* 2016).

2.5.2 Papaya

Nutraceutical Potential of *Carica papaya* in Metabolic Syndrome, explain about the Carica papaya L. plant is well known around the world and is particularly prevalent in tropical and subtropical regions. The pulp contains dietary fibres, folic acid, minerals like magnesium and potassium, vitamins A, C, and E, B complex vitamins like pantothenic acid, and folate. The seeds include phenolic substances such benzyl isothiocyanate, glucosinolates, tocopherols (and), cryptoxanthin, carotene, and carotenoids (Santana *et al.,* 2019).

The leaves of this plant contain dietary fibers and polyphenolic chemicals such as flavonoids, saponins, pro-anthocyanins, tocopherol, and benzyl isothiocyanate. On the other hand, the oil obtained from its seeds is primarily made up of oleic fatty acid, followed by palmitic, linoleic, and stearic acids. According to studies, these nutrients are beneficial for the cardiovascular system and help prevent cardiovascular diseases and damage caused by free radicals. They also aid in managing diabetes mellitus and lowering cholesterol levels. Hence, the plant's pulp, leaves, and seeds all have properties that are antioxidant, anti-hypertensive, hypoglycemic, and hypolipidemic, which can help in preventing and treating obesity and other metabolic problems associated with it. (Santana *et al.,* 2019)

The non- dairy fermented foods are useful for the people with lactose intolerance and increase popularity of food based on veganism. The aim of this

study is to develop a product based on fermented food to help improve the guy microbiota. Some communities are pure vegetarian, so they need to build the gut microbiota. Fermentation of fruits and vegetables will help them. In which fermentation is performed using LAB. This also increases nutrition qualities, antioxidants property, anticancer property of the fruit and vegetable juices. Szutowska (2020).

2.5.3 Mango

Basu and Athmaselvi (2018), the research communication explains how to make mango-flavoured curd powder. High-quality finished powder that can be utilised either directly or as an ingredient was obtained. The number of probiotics in the produced powder was indicated by the proportion of lactic acid in it.

Mangoes are used in many bland food products to enhance the taste, increases the acceptability of the product and it dense with nutrition qualities. Currently chemically preserved, canned, dried, and frozen forms like jam, jellies, canned slice, dehydrated pulp, frozen chunks, traditional pickle, chutney are processed from mango. Pulp and puree are the base product for variety of mango-based product. The waste from mango like seed, peel is used as value added utilization in functional food. Siddiq and Roidoung *et al.* (2017)

The study aimed to test the antioxidant content, particularly vitamin C, in snack cookies made from fermented mango and pineapple fruits. Three formulations of the cookies were prepared, and all were inoculated with Lactobacillus paracasei to obtain simpler food fiber. The fermented products were made into flour, and vitamin C analysis was conducted using the Titration Iodometric Method. The cookies' antioxidant activity was also determined using the DPPH method. Results showed that sample 3 had the highest vitamin C content and antioxidant activity. The study suggests that cookies made from fermented mango and pineapple have the potential to be a healthy snack

alternative due to their high antioxidant and prebiotic content, which can improve immunity and the gut microbiome. (Rompies and Mayulu *et al.,* 2021)

The mango fruit generates by-products such as peel and kernel during processing. Mango seed kernels, which make up about 17-22% of the fruit, contain starch, fat, and protein. They are a good source of polyphenols, phytosterols, and natural antioxidants, making them suitable for use in functional food ingredients, antimicrobial compounds, and cosmetics. The mango stone obtained after decortication of the mango seed can also be used as an adsorbent. Mango seed kernels have high potential for nutritional and environmental purposes, and further research is needed to identify their bioavailability and health effects. Strategies should be implemented to monetize the nutritional and functional potential of mango seed kernels. Torres-León, (Aguilar *et al.,* 2016).

Mango juice was fermented with lactic acid bacteria at 30°C for 72 hours under micro-aerophilic conditions. Lactobacillus plantarum showed the fastest utilization of sugar and reduction of PH. The viability of cells was maintained throughout storage, and it was concluded that mango juice is suitable for probiotic beverage production. (Reddy and Wee *et al.,* 2015).

2.5.4 Apple

A probiotic yogurt fortified with apple pomace flour (APF) was developed to create functional food in line with sustainable development. The addition of 1%, 3%, and 5% APF during fermentation resulted in enhanced yogurt with decreased syneresis and increased phenolic content, DPPH, and reducing activity. The yogurt with 3% APF had the best texture, taste, and color, and the supernatants from 3% and 5% APF yogurt decreased colon cancer cell viability (Jovanović *et al.,* 2020).

Apple and their by-product are used in pharmaceutical industry eg. ORS of apple flavour, canning, beverage industry, alcoholic and non-alcoholic form.

Fermentation is used to increase the bioavailability of bioactive compund present in apple. There is also vast changes in their nutritional profile, product properties and their sensory profile. Probiotic apple beverage and apple vinegar are considered to consume and have health benefits. (Guine and Barraco *et al.,* 2021).

A new probiotic dairy product was developed by incorporating Lactobacillus casei enriched apple pieces, dried raisins, and wheat grains in fresh and freeze-dried form into yogurt. The viability of L. casei cells in the yogurts was analyzed during 60 days of storage at 4°C, and the impact of enriched materials on physicochemical parameters, microbiological properties, and sensory acceptance of the yogurt was evaluated. The addition of apples, raisins, and wheat grains resulted in improved viability of L. casei cells, with counts around 7 log cfu. (Bosnea and Kopsahelis, *et al.* (2017)

The study evaluated the use of tibicos as an initiator inoculum in the fermentation of traditional apple nectar beverage, Tepache. The addition of tibicos increased the levels of phenolic compounds with high reducing power and free radical scavenging activity. Another study produced a fermented functional beverage using a mixture of carrot, beet, and apple juices with Lactobacillus casei, which showed an increase in probiotic bacteria and a decrease in sugar and brix levels during the fermentation process. The A3B1 treatment with a concentration of 40% and 1.5 x10^6 cfu/ml of Lactobacillus casei was considered the best treatment with maximum cell viability during 4 weeks of storage at 4°C. (Zandi and Berenjy *et al.,* 2016).

2.5.5 Pineapple

Bromelain is a compound extracted from pineapple plants that has been used in traditional folk medicine for various illnesses. It has been found to have medicinal value in several surgical sub-specialties due to its anti-inflammatory, anti-oedematous, analgesic, anti-thrombotic, and exfoliating effects. Bromelain is comparable to non-steroidal anti-inflammatory drugs but has fewer negative

side effects. It is primarily used for surgical wounds, inflammation caused by trauma and surgery, and debridement of deep burns in Europe, where it is approved for oral and topical use. However, more clinical trials are needed to confirm its effectiveness as an anti-inflammatory medication in surgical care Muhammad and Ahmad (2017).

Pineapple, a tropical fruit known for its sweet taste and pleasant aroma, is highly appreciated for its diverse mix of volatile substances in trace amounts. It is not only a tasty fruit but also a rich source of vitamins and minerals that are beneficial for health. The pineapple industry has grown rapidly worldwide, utilizing both the fruit and its waste for food-based processing. Pineapple is abundant in bioactive compounds, dietary fiber, minerals, and nutrients. Moreover, pineapple is known to have numerous health benefits such as reducing inflammation, providing antioxidant activity, aiding in nervous system function, and promoting healthy bowel movement. (Mohd Ali *et al.,* 2020)

Pineapple is considered has functional drink due to health promoting properties such as anti-inflammatory, anti-atherosclerotic, anti-aging and many other health properties. (Khalid and Suleria *et al.,* 2016).

The global market for pineapples is seeing an increasing demand. Typically, ripe pineapples are consumed fresh or in juice form, as they are a source of essential minerals and vitamins with some medicinal benefits. Pineapple is rich in calcium, potassium, fiber, and vitamin C. Pineapple can also be used to produce a variety of food items such as jam, jelly, and pickles. The quality of pineapple can vary depending on the growing environment and the variety. While ripening agents can speed up the ripening process, they can also have a negative impact on the nutritional value of the fruit. (Hussain and Anwar *et al.,* 2015).

Pineapple is a rich source of vitamins and minerals, as well as phytochemicals like phenols, flavonoids, and β-carotenes, which possess potent antioxidant properties. The primary proteolytic enzyme found in pineapple is

bromelain, which has significant health benefits. It is often sold as a digestive aid and anti-inflammatory agent, and is used to treat a range of conditions, including skin burns, sinus inflammation, osteoarthritis, hay fever, upper respiratory tract infections, and cardiovascular diseases. Additionally, bromelain has been shown to inhibit tumor cell growth and slow the progression of cancer. (Zaman, 2019).

The study found that information about the high-pressure technology used in the production of pineapple juice positively influenced consumer intention to purchase, and when adequately communicated, it could be an essential factor. Another study conducted in 2021 featured the effect of different proportions of pineapple, cucumber, and Jatropha leaf on the functional and sensory properties of composite jam. The study found that the experimental jam samples with different proportions showed significant differences in vitamins, minerals, total titratable acidity, pH, Brix, and total soluble solids, and sensory properties differed significantly by appearance, aroma, and spreadability but were of similar taste and overall liking. The study suggests that the new pineapple jam with cucumber and Jatropha leaf is a promising functional product. (Friday and Julius 2021).

Pineapple is a popular tropical fruit known for its sweet taste, juiciness, and nutritional benefits. It is rich in sugars, organic acids (such as citric acid), essential minerals (like Cu, Mg, Mn, K), fiber, and vitamins (including A, C, and B-group). The composition of pineapples varies depending on the variety and growing conditions. The 'Smooth Cayenne' is the most widely grown cultivar, but the 'MD2' sweet hybrid variety is becoming more popular. Probiotication is an important method in the food industry, and incorporating probiotics in fruit juice without lactose is desirable. The viability, physicochemical, and sensory properties of probioticated pineapple juice using lactic acid bacteria were studied, and the results showed that the pineapple juice supported the viability and antagonistic potential of the probiotic candidate. The

study suggests that probiotic fruit juice can be developed as functional foods and nutraceuticals with health benefits. (Tayo and Akpeji *et al.,* 2016)

Pineapple is a significant tropical fruit, commercially available in two main varieties. Pineapple is a good source of phytochemicals, dietary fiber, and vitamin C, as well as other bioactive compounds like polyphenols and carotenoids. These bioactive compounds have potential health benefits, including antioxidant, antiviral, anti-inflammatory, and anti-cancer activities. However, the functional properties and health benefits of each compound depend on its bioavailability and bioaccessibility in the gastrointestinal tract. (Rodríguez and Ancos 2017).

2.5.6 Passion fruit

Rebouças, *et al.* (2014) developed a prebiotic beverage using crushed cashew nut kernels and passion fruit juice to enhance its sensory qualities and increase its consumer acceptability through response surface methods. The formulation consisted of passion fruit juice, oligofructose, hydro soluble cashew nut kernels, and 3% sugar. Through response surface technology, a combination of 14% oligofructose and 33% passion fruit juice was found to produce a highly accepted formulation that meets bifidogenic action requirements and uses hydro soluble cashew nut kernels. The outcome of this study is a new functional prebiotic product that combines the sensory qualities of passion fruit juice with the functional and nutritional benefits of cashew nuts and oligofructose. The new product also allows the industry to increase its revenue by substituting broken cashew nut kernels, which have a lower market value, with this innovative product during industrial processing.

Propagation of various species of passion fruit (Passiflora spp.) can be achieved either sexually by using seeds, or asexually through stem cuttings, grafting or tissue culture. Both methods have been studied, and their scientific and technological advancements have been presented in this study, along with their various applications. Additionally, the study highlights the need for further

research and development activities due to the vast range of passion fruit species and their potential for use in food and medical uses. (Faleiro and Junqueira, 2019)

Passion fruit (*Passiflora edulis*) is a major species widely cultivated in tropical and subtropical regions. Its seeds, often discarded in processed foods, contain valuable nutrients and functional components. Studies have shown that passion fruit seeds are rich in polyphenols, particularly stilbenes like piceatannol, which exhibit various physiological functions such as antioxidant effects, improvement of skin condition, fat-burning promotion effects, and hypoglycemic effects. Industrial use of these seeds is desirable to reduce waste. (Kawakami and Morinaga, 2021)

This study sought to determine the impact of *Lactiplantibacillus plantarum* CCMA 0743 on the sensory profiles and volatile components of fermented passion fruit juice in both single and co-culture. (Fonseca *et al.,* 2022)

Passion fruit juice was found to be a suitable matrix for delivering probiotic strains, with both single-culture and co-culture fermentations altering its sensory character. The juice also retained significant probiotic levels after 28 days of refrigeration. Additionally, passion fruit has bioactive properties such as antioxidants and enzyme inhibition, making it a potential ingredient for various products, including non-fermented and fermented beverages. The inclusion of passion fruit in pharmaceuticals could also be explored through in vivo testing. Overall, understanding the interaction between strains and matrices is crucial for creating unique fermented products with desirable properties. (Pereira and Corrêa *et al*., 2023)

2.6 Sensory evaluation

This study investigated the effect of fructooligosaccharide plus Lactobacillus acidophilus (symbiotic) on the sensory qualities and consumer acceptability of peach-flavored drinkable yoghurts. Both descriptive analysis

and consumer testing were conducted on six yoghurt drinks, revealing significant differences in 8 out of 12 sensory qualities. The addition of prebiotics did not have an adverse effect on acceptability, while the addition of symbiotic had a detrimental effect on the samples' acceptability. The discrepancies between samples could be attributed to the fat level or the presence of prebiotics and symbiotics. Overall, understanding the impact of prebiotics and symbiotics on the sensory qualities and acceptability of yoghurts can aid in creating products with desirable properties (Adhikari *et al.,* 2011).

Sensory evaluation practices help to assess the innovation, consumer preferences and acceptability, multivariate statistical analysis. The importance of scientific sensory evaluation is to understand the consumer preferences in food, beverage, cosmetic industry. Sensory evaluation technique is demonstrated by test selection, application, and measurement, testing the right consumer. (Stone, Bleibaum *et al.,* 2020)

Greek yogurt is a popular dairy product due to its high total solids and lower lactose content. However, there is limited information on the factors that affect its quality and sensory properties. This review discusses the impact of ingredients, starter cultures, processing techniques, and other parameters on Greek yogurt. It also explores new sensory evaluation techniques that can aid in the development of innovative products. The review aims to provide the Greek yogurt industry with valuable information to improve current products and develop new ones. (Gyawali and Feng, 2022)

2.7 Bacteria for yogurt

The LAB plays a crucial role in producing flavor compounds during yogurt fermentation through various biochemical processes such as glycolysis, proteolysis, and lipolysis. Specific flavor compounds are produced through these processes. However, the flavor generated largely depends on the LAB species utilized. Several techniques have been developed to regulate the flavor formation process. Genetic tools can be employed to enhance the production of

desired flavor compounds by redirecting metabolic flux. Advanced techniques such as omics-based techniques and systems biology approaches are essential to gain better insight, control and manipulate flavor formation in yogurt fermentation process. (Chen and Zhao, 2017)

According to (Ali *et al.,* 2019) study focused on isolating exopolysaccharide (EPS)-producing strains of *Lactobacillus delbrueckii subsp*. bulgaricus from curd samples to improve yogurt's rheological characteristics. Different techniques were used to isolate strains, and various tests were conducted to determine their technological characteristics. Strains optimal in terms of technological characteristics were combined with Streptococcus thermophilus strains to manufacture yogurt with EPS concentrations ranging from 41 to 268 mg/L. The maximum value of EPS concentration was found in S. thermophilus and Lb. bulgaricus, which does not produce EPS, after 14 days of storage.

Yang and Yoon, (2022) Greek yogurt, a strained yogurt with high protein content, was produced using different combinations of probiotic lactic acid bacteria. Samples fermented by S. thermophilus, L. bulgaricus, L. gasseri BNR17, and L. plantarum HY7714 demonstrated superior characteristics and scored highest in sensory evaluation. Probiotic LAB-fermented Greek yogurt showed more efficient reduction of EHEC populations than commercial Greek yogurt, indicating enhanced microbial safety.

The lactic acid bacteria *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp*. *bulgaricus* generate yoghurt, a popular fermented dairy product. These bacteria create lactic acid during the making of yoghurt, which lowers pH and causes milk protein to coagulate. The quality of yoghurt is significantly impacted by their metabolites, including carbonyl compounds, non-volatile or volatile acids, and exopolysaccharides. (Nagoka, 2019)

This study explores the nutritional value of yogurt and its effect on gastrointestinal health and function. The Lactic Acid-producing Bacteria (LAB)

found in yogurt, including Lactobacillus bulgaricus and Streptococcus thermophilus, are known to have beneficial effects on gut health. Yogurt is considered a main source of dairy in the Mediterranean diet, which is associated with high life expectancy and low rates of chronic diseases. The study suggests that consuming yogurt can protect against enteric infection, inhibit the development of gastrointestinal tumors, and improve gut microflora, bowel transit, and immune responses. The combination of probiotics and prebiotics in yogurt can further enhance its beneficial effects on gut health. (Aymen and omer *et al.,* 2009)

The study evaluated two strains of *Lactobacillus delbrueckii subsp.* bulgaricus LJJ, isolated from traditional yogurt, for their antioxidant properties. The results showed that these strains exhibited strong antioxidant capacity, which could potentially be useful in the dairy manufacturing industry as a dietary source of antioxidants for consumers. (Zhang and Liu 2011)

The study examined the best conditions for the growth and preservation of lactic acid bacteria. The addition of up to 3% sucrose and 12% skim milk increased the number of bacteria, but the combination of sucrose and skim milk did not have a greater effect than skim milk alone. The highest number of cells was observed at pH levels between 5.0-5.5 during the growth phase and pH 4.63 during yogurt storage. After being stored for 150 days at temperatures between -18°C and -12°C, the final cell count of the yogurt was only one-third of the initial count. (Kim and lim *et al.,* 2019)

2.8. OUR STAPLE FOOD – ORYZA SATIVA

2.8.1 Rice

The by-product of the rice milling procedure, which entails turning brown rice into polished rice, is rice bran. It has a sizable number of useful bioactive substances. Unfortunately, the use of these substances is restricted, necessitating an attempt to ferment rice bran. The solid-state fermentation is one

technique that can considerably boost the added value and bioactivity of rice bran. It may also be one of the methods used to produce rice bran, a functional substance with high bioactivity for the improvement of health. (Ardiansyah, 2021)

Rice has been cultivated in Kerala for a very long time, and there are records describing various cultivation systems and rice varieties adapted to different ecological and geographic regions of the state dating back to the 15th century. Despite being a principal crop, the area of rice cultivation has significantly decreased since the mid-1970s, with a corresponding decline in production. This decline is due to low per capita land availability, which has led to increased land use intensification and conversion of paddy fields to cash crops. The loss of rice cultivation has resulted in a reduction of food production capacity and a negative impact on ecosystem services. Rice cultivation in Kerala is diverse and influenced by local climate and land forms, with cultivation ranging from below sea-level to high altitude areas. The environmental implications of rice cultivation in the state, including its impact on climate change, are significant. This article reviews the historical and ecological aspects of rice production in Kerala. (Kumar and kunhamu *et al.,* 2021)

India stands second in the production of rice next to china. It is a major cereal crops and staple food in india. 40,000 varities of rice exist but only few are extensively milled and polished. White rice is commanly used in many countries, some special rice is also cultivated and used in daily diet routine. Each type of rice varieties has different aroma, colour in each rice varieties. Nutritional profile of rice varieties is higher than white rice. The colour in different rice varieties is due to the deposition of anthocyanin pigments in bran which is rice in phytochemical and antioxidants. The rice bran is removed during milling, which is rich in dietary fibre, the removed bran is incorporated for the development of functional food and other added products. The more

focus on developing product using special rice varieties helps to improve our nutritional status. (Ratna and Ann *et al.,* 2019)

This study explores the origin and evolution of the gene underlying fragrance in rice, finding that a single allele, badh2.1, is the predominant allele in most fragrant rice varieties today. Despite multiple origins of the fragrance trait, the badh2.1 allele originated in the Japonica varietal group and was introgressed into Indica. These findings challenge the traditional assumption that the fragrance trait arose in the Indica varietal group. (Kovach and Calingacion *et al.,* 2009)

Adequate nutrient levels in plants enhance their ability to resist diseases. In contrast, nutrient deficiency or toxicity can adversely affect plant growth and exhibit characteristic symptoms. To achieve optimal rice production, all nutrients must be maintained in balanced proportions. Integrated nutrient management can help increase soil fertility and sustainable crop productivity. This information can be useful for rice growers and researchers seeking to enhance rice production sustainably. (Shrestha and Kandel, 2020)

2.8.2 Pokkali rice

The article discusses the unique ecosystem of Kaipad, a saline-prone rice production tract in North Kerala, India. The rice produce from this ecosystem is purely organic and is cultivated naturally using the monsoon and sea tides. The article highlights the need for comprehensive multi-faced development to preserve, protect and develop this unique organic rice bowl of Kerala, governed by small and marginal farmers. Another related article discusses the farming practices in the water-logged areas of Kerala, including the integrated rice-shrimp/prawn farming practiced in Kuttanad, Pokkali, Kole, and Kaipad areas. The article also emphasizes the need for sustainable farming and resource-based planning based on public participation to conserve these areas. (Jayan and Sathyanathan *et al .,* 2010)

The study reported by (Roshini, 2016) explores the traditional Pokkali rice cultivation system in Kerala, India, which has been in existence for centuries and relies on a natural relationship between rice and prawns. The system is organic and utilizes the monsoons and sea tides. Prawns feed on rice and their excrement fertilizes the rice fields, reducing the need for external inputs. The Pokkali system has evolved naturally in the central strip of Kerala, which has unique ecological features that make it highly suitable for rice cultivation. However, the current social and economic system is posing challenges to maintaining the system in its original form, despite government efforts to promote it. The article stresses the importance of preserving the Pokkali system as an agricultural heritage of Kerala.

The waste from Pokkali rice provides food for the fish/prawn, and no selective stocking or supplementary feedings are required. This practice has been effectively used for centuries, maintaining ecological balance and ensuring a reasonable profit for the farmers. The study also mentions scientific interventions, such as breeding rice varieties to manage acid saline soils. The traditional technique of prawn infiltration has been developed by the innovative Pokkali farmers. (Sreelatha *et al.,* 2017)

Sasidevan and Santha *et al.* (2020), explain about the mechanisms causing significant changes in pokkali farming in Ernakulam, Kerala, as well as the social-ecological surroundings of pokkali wetlands. This study has attempted to comprehend the numerous social and ecological contexts of pokkali cultivation in this context. It has gone through a variety of transformations. The nature of local knowledge systems that exist among various intersectional actors engaged in pokkali farming has been investigated in this study. In the context of the prevalent discourses surrounding pokkali farming, it also looked at the social interfaces there. This thesis' main premise is that social actors' historical and structural situations continually impact local knowledge. Local knowledge is therefore located within the social hierarchies

and power dynamics among a variety of players, actively engaged in maintaining the pokkali wetlands daily.

2.9 INCUBATION OF YOGURT

2.9.1 Incubation of yogurt in industry

A study was conducted to analyze the impact of incubation temperature (between 35-45°C), starter culture level (between 0.003-0.006%, w/v), and milk total solids content (between 12.32-15.68%, w/v) on the rheological properties of yogurt. This was done using central composite rotatable design (CCRD) and response surface methodology (RSM) to investigate the gelation time during milk fermentation and the apparent viscosity of yogurt stored for 3 days. The findings showed that the gelation time and apparent viscosity of yogurt were significantly influenced by the incubation temperature, starter culture level, and total solids. (Bandhari and Mao *et al.,* 2009).

The effects of inoculation rate and incubation temperature on the physical properties and microstructure of yogurt gels were studied. Higher inoculation rates and lower incubation temperatures resulted in higher storage modulus values. Permeability, pore size, and whey separation increased with decreased inoculation rate and increased incubation temperature. Whey separation was negatively correlated with storage modulus and positively correlated with maximum loss tangent and permeability. Weak yogurt gels with high loss tangent values favored rearrangements in the network, resulting in larger pores and greater whey separation. (Lee and Leusy *et al.,* 2003).

A study examined the impact of starter cultures (at 2%, 3%, and 5% levels) on the rheological properties of set yogurt during gelation. The viscosity remained constant at the beginning of gelation, then increased quickly to a peak before gradually decreasing. The type and level of starter had a clear impact on yogurt viscosity during this process. The curd's flow behavior was characterized using the Ostwald-de Waele power-law model. (Jumma and shakir, *et al.,*2001)

The study investigated the firmness of set yogurt and Greek-style yogurt across seasons and found that those made from early-season milk had the highest firmness. Gel strength of glucono-δ-lactone-induced acid gels correlated with yogurt firmness, suggesting its potential as a predictor. The study also highlighted the role of κ-casein glycosylation in seasonal variations in yogurt structures. Mid-season yogurt had the lowest water-holding capacity, while late-season stirred yogurt displayed strong resistance to shear-induced thinning due to unique viscoelastic properties of its gels. (Li and Singh *et al.,* 2021)

The study investigated the impact of incubation temperature on the rheological properties of set yogurt using a cylindrical rotational viscometer. Fresh raw milk with standardized fat content was heated, homogenized, inoculated with 3% yogurt starter culture, and incubated at different temperatures (40, 45, and 48°C). The results indicated that the optimum incubation temperature for acid development was 45°C. Increasing the incubation temperature resulted in decreased flow behaviour index and increased consistency coefficient, with the minimum viscosity at 40°C and maximum viscosity at 48°C. These findings suggested that the incubation temperature influenced yogurt viscosity during the gelation process. (Jumma and Shakir *et al.,* 2001).

The process of manufacturing yogurt involves heating milk to 80-85 °C and cooling it to 45 °C, followed by bacterial fermentation to give it the desired texture and flavor. The fermentation requires a controlled temperature between 42-45 °C, with 43 °C being the optimal temperature. After fermentation, the yogurt is cooled to 5-10 °C for storage. (Pacc and H.H.C 2023).

2.9.2 Incubation of yogurt at home

The critical factors that affect the pH values of homemade yogurt and determine the optimal settings for these factors. The results showed that the incubation time and fat percentage had the greatest impact on pH development,

with optimal settings of 11.31 hours for incubation time and 1.5% for fat percentage. (Hakimi, Rohini, *et al.,* 2013).

Yogurt is a dairy product made with fermented milk and flavorings. Concentrated yogurt is made by filtering out most of the whey, resulting in a thicker texture and sour taste. A new device has been developed to make concentrated yogurt at home. It is affordable and allows users to make concentrated yogurt quickly in their home kitchen using only milk. (Farzpourmachiani, 2021).

Adding pepper juice to yogurt changes its antimicrobial activity slightly but increases its polyphenol content and antioxidant activity. Stirred yogurt with 3% fermented red pepper juice or 1% green pepper juice received high scores in flavor, appearance, texture, and overall acceptance during sensory testing. Yogurt with reduced pungency from fermented pepper juice remained palatable during storage at 4 C. Yogurt with added hot pepper juice may be useful as a functional food for anti-obesity purposes. (Kang and Kim *et al.,* 2018).

3. MATERIALS AND METHODS

The present study entitled "Development and Quality Evaluation of Pokkali Rice Based Fruit Blended Yogurt" was conducted and the methodology adopted is discussed under following headings.

3.1 Selection and Collection of raw material

3.2 Nutritional analysis of pokkali rice

3.3. Analysis of functional properties of pokkali rice

3.4. Development of Yogurts

3.4.1 Standardization formulation of plain yogurt

3.4.2 Standardization formulation of pokkali rice-based fruit blended Yogurt

3.5 Organoleptic evaluation

3.6 Analysis of nutritional and chemical constituents of "Pokkali Rice-Based Fruit Blended Yogurt"

3.7 Microbial enumeration of pokkali rice-based fruit blended yogurt

3.8 Cost analysis

3.9 Statistical analysis

3.1 SELECTION AND COLLECTION OF RAW MATERIAL

Yogurt is a worldwide acceptable product which maintain the microbial balance in our body and improves our digestive system. Yogurt, fruit pulp and rice combination are nutrient dense.

Collection of yogurt culture

The yogurt culture (*Lactobacillus bulgaricus* & *Streptococcus thermophilus)* was purchased from KVASU college of dairy science and technology, Manurthy, Thrissur. (Plate-1)

Collection of raw materials

Pokkali rice is collected from the local farmers from Ezhikara, Ernakulam. (Plate 2)

Fresh and ripened fruits such as (apple, banana, papaya, mango, pineapple, passion fruit) was selected and collected from local market, Ernakulam. Sugar and skimmed milk powder is collected from local supermarket.

3.2 NUTRITIONAL ANALYSIS OF POKKALI RICE

TABLE 1: METHODS ADOPTED FOR ANALYSIS

PARAMETERS	UNIT	METHOD ADOPTED
Carbohydrate	%	AOAC 20th edition 2016:986.25
Protein	g/100g	AOAC 20th edition 2016 920.87
Dietary Fibre	g/100g	IS 11062 – 1984, R-2015
Iron	mg/100g	AOAC 20th edition 2016,944.02
Calcium	mg/100g	AOAC 20th edition 2016.927.02
Sodium	mg/100g	IS 9497- 1980;R-2015
Manganese	mg/kg	AOAC 21st edition, 2019;999.11
Phosphorus	mg/100g	AOAC 21st edition.2019: Ch.37:942.14
Zinc	mg/kg	AOAC 21st edition.2019;999.11

3.3 ANALYSIS OF FUNCTIONAL PROPERTIES OF POKKALI RICE

Functional properties are the fundamental physio- chemical properties that reflect the complex interaction between the composition, structure, molecular conformation, and physio-chemical properties of food components, together with the nature of environment, in which these are associated and measured (Kinsella, 1976). Functional properties such as swelling power, solubility, water absorption capacity and bulk density were estimated.

3.3.1 Swelling power

Swelling power and solubility were carried out in the temperature range of 55-95^{0}C using the method of Leach *et al.* (1959). 0.1 g of samples were accurately weighed and quantitatively transferred into a clear dried test tube and weighed (W1); 10 cm^3 of distilled water was added to the test tube and the mixture was mixed thoroughly with a vari whirl mixer for 30 seconds. The resultant slurries were heated at a temperature that varied between 55^{0}C and 95^{0}C for 30 minutes in a water bath (using temperature regulated water bath). The mixture was cooled to room temperature and centrifuged (5000 rpm, for15min). The residue obtained (after centrifuge) with water was retained and test tube was weighed (W2).

$$\text{Swelling power (g)} = \frac{W_2 - W_1}{\text{Weight of sample}}$$

3.3.2 Solubility

A known volume of nutri flour (1gm) and distilled water (10ml) was heated at 80^{0}C.The resulting product mixture was centrifuged, and the supernatant was taken into a pre- weighed petri dish and evaporated for 2h at 130^0 C and then weighed. The residue obtained after drying of supernatant

represented the amount of flour solubilized in water (Oladele and Aina, 2011). Formula used for calculating solubility was.

$$\text{Solubility (\%)} = \frac{\text{Weight of the dried sample in supernatant}}{\text{Weight of original sample}} \times 100$$

3.3.3 Water absorption capacity

One gram sample was mixed with 10ml of distilled water for 30 minutes. The contents were allowed to stand at 30^0C in a water bath for 30 minutes and then centrifuged at 3000-5000rpm for 20-30 minutes. After centrifuging, the volume of the supernatant was recorded, which was used for determination of water absorption and the result was expressed as g/g sample (Rosario and Flores,1981). Formula used for calculating water absorption capacity was.

$$\text{Water absorption capacity (\%)} = \frac{\text{Weight of water absorbed (g)}}{\text{Weight of dry sample}} \times 100$$

3.3.4 Bulk density:

A ten ml capacity graduated cylinder was filled with the sample. This was done by gently tapping the bottom of the cylinder on the laboratory bench several times until there was no further diminution of the sample level after filling to the 10 ml mark. Formula used for calculating bulk density was.

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}}$$

3.4. DEVELOPMENT OF YOGURTS

3.4.1 Standardization formulation of plain yogurt

PREPERATION OF SUBCULTURE

Materials:

- Beaker of 500 ml – 5
- Glass rod – 1
- Pipette – 1
- Milk – 2.5litre

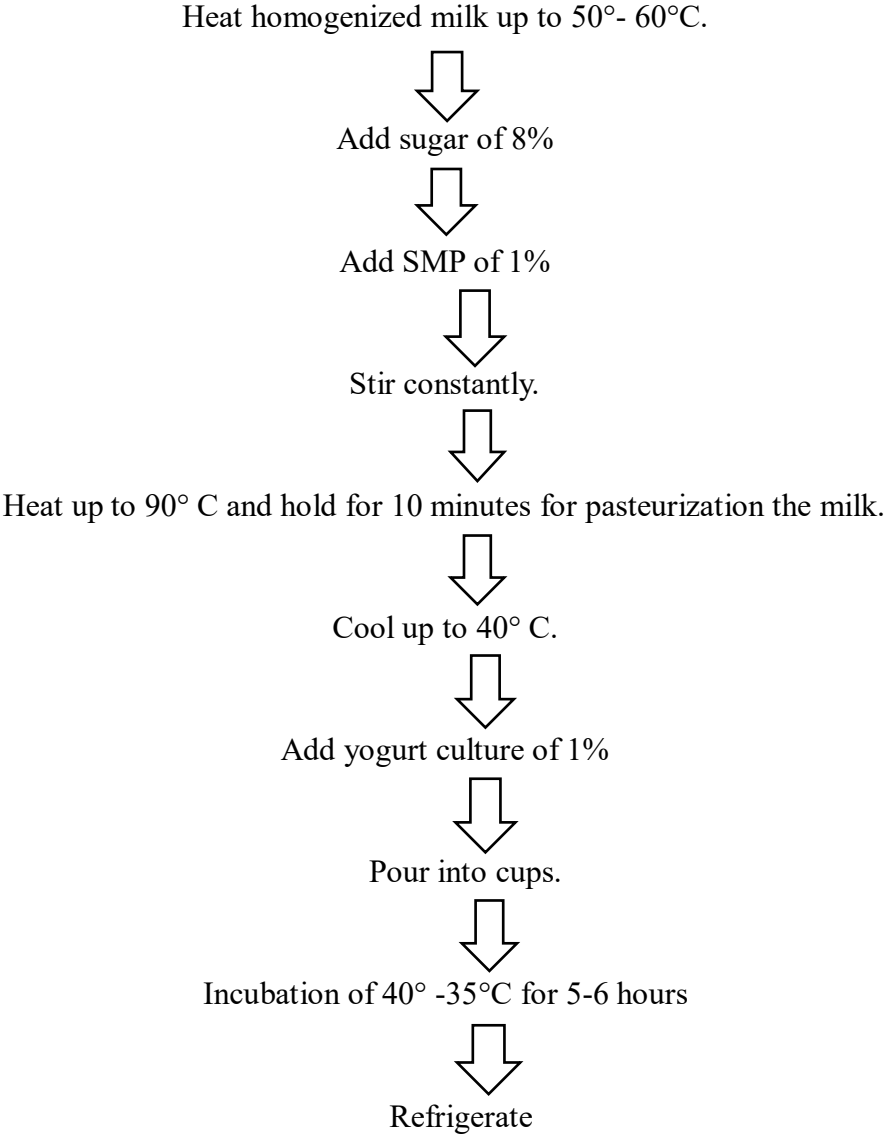
Procedure:

- Add milk to beaker.
- Close it with foil paper.
- Keep the milk for sterilization.
- After sterilization, keep it for 24hrs without disturbing.
- Then check if the milk is spoiled.
- If the milk is not spoiled, then we can make the subculture for stock.
- Pipette out 1% of culture (*lactobacillus bulgaricus* and *streptococcus thermophilus*) to each beaker.
- Allow in room temperature for 24hrs to set.
- Stocking of sub-culture helps to use in future purpose.

Sterilization:

- Set the pressure cooker with water in which half of the beaker is immersed
- Place steaming rack inside the cooker
- Place the beaker onto the rack.
- On the stove and let the 6 whistles get released
- Allow the cooker to cool for half an hour.
- Take the beaker and allow it to cool in room temperature for 24hrs.
- After sterilization there can be loss of few amounts of milk

Figure 1: Standardized Preparation of Plain Yogurt



3.4.2 STANDARDIZATION FORMULATION OF POKKALI RICE-BASED FRUIT BLENDED YOGURT

Preparation of Rice Slurry

1. Boil 140grams (uncooked) of pokkali rice in a pressure cooker (6 whistle)
2. Then drain the excess rice water which can be used later for making slurry.
3. Smash the cooked rice and blend it with rice water.

Preperation of Fruit Pulp

Apple

1. Wash the apple and peel the skin.
2. Cut the apple into fine small piece.
3. To avoid oxidation apple is treated with sugar syrup.
4. To boiling water 1tablespoon of sugar is added, then add the cut apple to it.
5. Cook until there is a color change.
6. Blend it well like a pure.
7. Keep cooling until 40°c

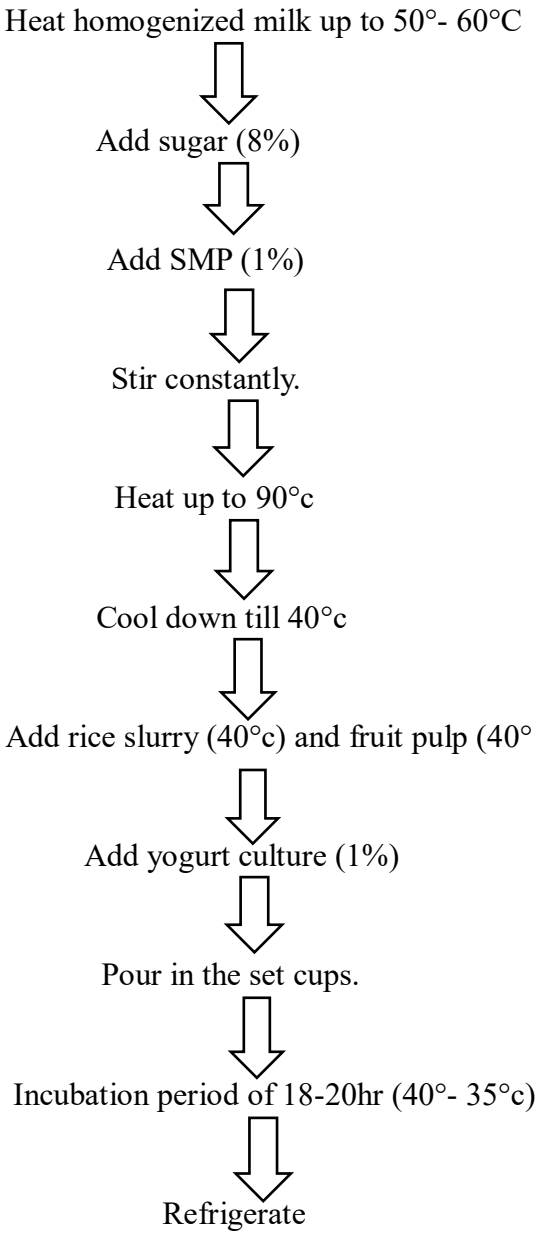
Passion fruit

1. Fresh and fully ripened fruit is taken
2. Wash it properly
3. The seeds are removed manually
4. Fruit pulp is extracted with help of blender.
5. Sugar (10grms) is added to the pulp
6. Pasturization of the pulp (heated at 90°c for 10 minutes)
7. Keep cooling until 40°c

Mango, Papaya, Pineapple, Banana (Robusta)

1. Fresh and fully ripened fruit is taken.
2. Wash the fruits properly.
3. The seeds and thorns (pineapple) are removed from the fruits.
4. Cut the fruits into very small pieces.
5. Blend it well.
6. Starin the puree
7. Heat the puree for 15 minutes (5 minutes in high flame and 10 minutes in low flame in 90°c and cool down until 40°C.

Figure 2: Standardized Preparation of Pokkali Rice Based Fruit Blended Yogurt



Proportion of Ingredients for The Pokkali Rice Based Fruit Blended Yogurt

Different proportions for the standardization pokkali rice-based fruit blended yogurt in 100 ml are given in the table. The composition of milk is 50ml in T1, T2, T3 & control. The proportion of added pokkali rice slurry is 25ml, 30ml &35ml in (T1, T2 &T3. The proportion of added fruit pulp (apple, banana, papaya, pineapple mango, passion fruit) 25ml, 20ml & 15ml in T1, T2 &T3 . Control is plain yogurt in 100ml milk and 1.5 % yogurt culture.

The amount of other ingredients such as sugar (11.76g), SMP (1.47g), yogurt culture (*lactobacillus bulgaricus* & *streptococcus* thermophilus) 1.5%

TABLE 2: Proportion of Ingredients Used For Pokkali Rice Based Fruit Blended Yogurt

SL no.	TREATMENT	INGREDIENTS (%)		
		Milk	Rice slurry	Fruit pulp
1.	T_1 A	50	25	25
2.	T_2 A	50	20	30
3.	T_3 A	50	15	35
4.	T_1 B	50	25	25
5.	T_2 B	50	20	30
6.	T_3 B	50	15	35
7.	T_1 P	50	25	25
8.	T_2 P	50	20	30
9.	T_3 P	50	15	35
10.	T_1 PA	50	25	25
11.	T_2 PA	50	20	30
12.	T_3 PA	50	15	35
13.	T_1 M	50	25	25
14.	T_2 M	50	20	30
15.	T_3 M	50	15	35
16.	T_1 PF	50	25	25
17.	T_2 PF	50	20	30
18.	T_3 PF	50	15	35
19.	T_0 (control)	100	0	0

A-Apple, B- Banana, P- Papaya, PA- Pineapple, M- Mango, PA- Passion fruit

3.5 ORGANOLEPTIC EVALUATION

Sensory evaluation has been defined as a scientific discipline used to evoke, measure, analyze, and interpret human reactions to meat sensory characteristics as perceived by sight, smell, taste, touch, and hearing by the Institute of Food Technologists (IFT)

From the standardized 3 proportion and 6 fruit flavor of pokkali rice based fruit blended yogurt the best proportion and most acceptable fruit flavor was selected by panel of judges. The sensory attributes tested in the product are appearance, color, flavour, taste, texture, overall acceptability.

Sensory evaluation of developed product was carried out by 10 panel of judges, with 9- Hedonic scale. (plate.16)

The data analysis for organoleptic attributes of different treatments were subjected to the Kruskal Wallis test for the selection of best combination.

The selected proportion and most acceptable fruit flavour was subjected to nutritional and shelf-life studies.

3.5.1 Score Card

Score cards consist of particulate such as,

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

1 stand for poor and 9 stands for excellent.

3.6 ANALYSIS OF NUTRITIONAL AND CHEMICAL QUALITIES OF "POKKALI RICE-BASED FRUIT BLENDED YOGURT"

TABLE:3 Method of Nutritional Analysis of Pokkali Rice Based Fruit Blended Yogurt

PARAMETERS	UNIT	TEST METHOD
Moisture	%	AOAC 21st Edn.2019;925.10
Energy	Kcal	Pearsons Composition and Analysis of Foods; 9th Edn.
Carbohydrate	%	AOAC 21st edn.2019;986.25; ch.50
Protein	%	AOAC 21st Edn. 2019; 920.87; ch.32
Vitamin C	mg/100g	AOAC 21st Edn. 2019; 967.21, ch.45
Calcium	mg/100g	IS 9497:1980 (RA 2015)
Iron	mg/100	AOAC 21st Edn. 2019; 944.02
Sodium	mg/100g	IS 9497: 1980 (RA 2015)
Potassium	mg/100g	IS 9497:1980 (RA 2015)

3.7 MICROBIAL ENUMERATION OF POKKALI RICE-BASED FRUIT BLENDED YOGURT

The shelf-life also indirectly reflects the micro capsules' storage stability. Nonetheless, most of the research concentrates on the food carrier's shelf life. The amount of time that food goods may be utilized while retaining their nutritional value is referred to as their shelf life. The shelf stability and perishability of food are determined by extrinsic elements such the gaseous environment, storage temperature, and relative humidity in conjunction with the intrinsic qualities of the food. (plate 17 &18)

The selected pokkali rice-based fruit blended yogurt was stored in refrigerator at a temperature of 4 °C to assess the storage stability. The products are analyzed on every 2 days interval for microbial parameters such as yeast and mould for 1 week. Subauroud dextrose agar media was used for enumeration according to the method of monitoring mycological media.

3.7 COST ANALYSIS

The aim of this project is to promote pokkali rice-based products into the market which help the farmers of Ezhikara, Ernakulam. Pokkali rice based fruit blended yogurt were subjected to cost analysis considering variable cost including the cost of raw materials, packaging, labour cost, fuel. The total cost is calculated by following equation.

TCP (total cost of product) = FC (fixed product) + VC (variable cost)

3.8 STATISTICAL ANALYSIS OF DATA

The generated data were subjected to statistical analysis using Complete Randomized Design (CRD). For organoleptic analysis the different preference as indicated by scores were calculated by Kruskal- Wallis test to get the mean rank value for all the treatments and One Factor Analysis of variance at 0.05% significance difference level of nutritional analysis.

4. RESULT AND DISCUSSION

The results of the present study entitled "Development and Quality Evaluation of Pokkali Rice-Based Fruit Blended Yogurt" is discussed below, under the following headings:

4.1 Nutritional and functional analysis of pokkali rice powder

4.2 Development of pokkali rice-based fruit blended yogurt

4.3 Quality evaluation of pokkali rice-based fruit blended yogurt

4.4 Nutritional analysis of pokkali rice-based fruit blended yogurt

4.5 Total microbial count of pokkali rice-based fruit blended yogurt

4.6 Cost analysis of developed products

4.1 NUTRITIONAL AND FUNCTIONAL ANALYSIS OF POKKALI RICE POWDER

Pokkali rice was collected from a local farmer at Ezhikkara, Ernakulam. The nutritional and functional analysis of pokkali rice was estimated at FQ lab, Ernakulam.

Macronutrients such as total carbohydrate (77.10%), protein (8.83g), dietary fibre (2.88g). Micronutrient such as calcium (45.27mg), iron (0.67mg), sodium (20.13mg), copper (0.4mg), manganese (0.3mg), phosphorus (179.7mg) and zinc (1.29mg) content of the pokkali rice powder. (table 4)

According to NIN, the nutritional content of white rice has 78.24g of carbohydrates, 7.94g of protein, 2.81g of fibre, 7.79mg of calcium, 0.72g of iron, 96mg of phosphorus, 0.73mg of manganese, 2.34mg of sodium and 1.21mg. By comparing nutrients contents of pokkali rice (Fig.3) and while rice, it is concluded that the nutritional contents is slightly greater in pokkali rice than white rice.

According to Shah and Bosco *et al.,* (2020) explains the difference between brown rice and white rice. Brown rice is more nutrient-dense than white rice and a better source of vitamins, minerals, fibre, oryzanol, and phytochemicals that can enhance human health. However, most of the brown rice health-promoting ingredients are removed during the polishing process. Compared to white rice, brown rice is becoming more and more popular among health-conscious customers. In the present study, pokkali rice is rich in phosphorus on par with carbohydrate followed by sodium, protein and then fibre, but it is lack in zinc, manganese, copper, iron. (Fig 3)

TABLE 4: NUTRITIONAL ANALYSIS OF POKKALI RICE POWDER

PARAMETERS	NUTRITIONAL COMPOSITION
Carbohydrates	77.10 %
Protein	8.83 g
Dietary fibre	2.88 g
Calcium	45.27 mg
Iron	0.67 mg
Sodium	20.13 mg
Copper	0.4 mg
Manganese	0.3 mg
Phosphorus	179.7 mg
Zinc	1.29 mg
CD (0.05)	1.82

(Results expressed are mean value of three replicates)

TABLE 5 : FUNCTIONAL ANALYSIS OF POKKALI RICE POWDER

TREATMENT	PROXIMATE VALUE			
	Water absorption capacity	Bulk density	Swelling property	Solubility
Pokkali rice	2.35%	0.79g	3.90g	0.003%
CD value	1.82			

(Results expressed are mean value of three replicates)

*significant @ 0.05%

Functional properties explain how ingredients act during preparation and cooking, and how they impact the final food products's appearance, flavour and texture. (Table 5) In the present study, pokkali rice has 2.35% of water capacity, 0.79g of bulk density, 3.90g of swelling property and 0.05% of solublity. (Fig.4).

According to the (Adeleke and Odedeji, 2010) the result of the investigation indicated that the functional properties of the flour blends were significantly affected by addition of sweet flour to wheat flour. So, wheat and sweet potato flour are utilized in bakery products.

4.2 Development of pokkali rice-based fruit blended yogurt

Post pardinal effect of yogurt which is enriched with anthocyanin after glucose intake (Anuyahong *et al.,* 2020). At fasting and intervals (0–3 h) following yoghurt consumption, postprandial plasma glucose, antioxidant status, and subjective assessments were assessed. Glycemic response was the main result, and plasma antioxidant capacity was the secondary result. After 30 minutes of eating, riceberry rice yoghurt lowered plasma glucose levels in comparison to the yoghurt control. After the riceberry rice yoghurt load, the incremental area under the curve (iAUC) was much smaller than after the control yoghurt load.

In the present study, the pokkali rice-based fruit blended yogurt were developed with optimum ripened selected fruits like apple, mango, papaya, pineapple, passion fruit and banana (robusta). Each pokkali rice fruit yogurt was developed with 3 different combinations. The best combination from each

treatment was identified using sensory scores obtained during sensory analysis and it was carried out using 10 semi-trained panellists. The 9-point hedonic scale used for sensory evaluation was comprised of sensory parameters viz., appearance, colour, aroma, texture and overall acceptability.

4.3 QUALITY EVALUATION OF POKKALI RICE-BASED FRUIT BLENDED YOGURT

4.3.1 Sensory evaluation

Sensory analysis brings together a variety of disciplines to better understand the sensory qualities of items and how consumers react to them. Sensory evaluation scores are the mean rank scores of 10 judges who were selected to evaluate the developed product. The different parameters like appearance, aroma,texture, taste, colour and overall acceptablity for the developed product was scored by panel of judges using 9 point hedonic rating scale. The maximum score that could be attained for each atribute was 9. Sensory scores of fruit flavour and control is given below.

4.3.1.1 Pokkali Rice Based Fruit Blended Yogurt (banana, robusta)

The sensory evaluation scores obtained for pokkali rice based banana (robusta) blended yogurt are given in table 6.

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer.

Three treatments of banana flavour and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of banana flavour ranged between 11.6-23.8 from the kruskal- wallis test, it was obtained that T_1B ranked first with mean rank value

of 23.8 and least rank T_3B with a mean value rank of 11.6. Control is more attractive than pokkali rice-based banana (robusta) blended yogurt. (Fig.5)

TABLE 6 : Sensory evaluation of banana flavour

Treatment	Appearance		Colour		Flavour		Texture		Taste		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1B	**23.8**	**7.3**	**25.7**	**7.6**	**20.1**	**6.9**	**20**	**7.5**	**19**	**6**	**21.4**	**6.1**
T_2B	16.4	6.4	15.2	6.3	11	6.4	14	7.2	10	5.9	12.4	6.0
T_3B	11.6	5.8	13.8	6.1	13	6.1	11	7.4	11	5.1	12.7	5.9
T_0	30.1	8.1	27.3	7.8	23.4	7.6	22.56	7.9	23.45	7.9	22	7.7
KW	15.3		11.1		6.17		10.5		19.7		17.2	
λ^2	7.81											

MRV- Mean Rank Value, MS- Mean Score, B-Banana, T_0- Control

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for banana (robusta) flavour ranged between 13.8-25.7. T_1B rank first with mean rank value 25.7 on par with T_2B 15.2. Control is being more appetizing than pokkali rice-based banana (robusta) blended yogurt. (Fig.5)

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_2B with mean rank value 11. Control has better flavour than pokkali rice-based banana (robusta) blended yogurt. (Fig.5)

Texture

From the sensory analysis, it was revealed that T_1B ranked first with mean rank value 20 on par with T_2B mean rank value 14. Control has the better texture than pokkali rice-based banana (robusta) blended yogurt. (Fig.5

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between 10-19. T_1B claimed the first rank with mean rank value 19 and least is T_3B. Control taste better than pokkali rice-based banana (robusta) blended yogurt. (Fig.5)

Overall acceptablity:

The proportion of T_1B ranked first. But comparing with control, pokkali rice-based banana (robusta) blended yogurt is less acceptable than control (plain yogurt). (Fig.5)

4.3.1.2 Pokkali Rice Based Fruit Blended Yogurt (apple)

The sensory evaluation scores obtained for pokkali rice-based apple blended yogurt are given in table 7.

TABLE 7 : Sensory evaluation of apple flavour

TR	APP		COLOUR		FLAVOUR		TEXTURE		TASTE		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1A	18.35	6.6	19.20	6.9	18.15	6.5	17.70	6.4	16.35	6.7	15.05	6.1
T_2A	**30.0**	**8.3**	**26.59**	**8**	**27.95**	**7.7**	**29.90**	**7.8**	**27.40**	**8.2**	**29.35**	**7.9**
T_3A	9.0	5.9	10.5	5.8	8.75	5.6	7.54	4.9	10.44	5.6	8.10	5.2
T_0	27.75	8.1	27.1	7.8	27.15	7.6	30.20	7.9	24.85	7.9	28.33	7.7
KW	21.74		13.38		19.03		27.29		13.99		25.31	
λ^2	7.81											

MRV- Mean Rank Value, MS- Mean Score, A- Apple, T_0- Control

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer. Three treatments of apple flavour and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of apple flavour ranged between 9.0- 30 from the kruskal- wallis test, it was obtained that T_2A ranked first with mean rank value of 30.0 and least rank T_3A with a mean value rank of 9.0. Pokkali rice-based apple blended yogurt is attractive than control. (Fig.6)

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for apple flavour ranged between 10.5- 26.59 . T_2A rank first with mean rank value 26.59 on par with T_1A 19.20 mean rank value. Pokkali rice-based apple blended yogurt is being more appetizing than control. (Fig.6)

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_3A with mean rank value 8.75 and highest rank T_2A with mean rank value 27.95. Pokkali rice-based apple blended yogurt has better flavour than control. (Fig.6)

Texture

From the sensory analysis, it was revealed that T_2A ranked first with mean rank value 29.90. Pokkali rice-based apple blended yogurt has more appetizing than control. (Fig.6)

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between 10.44- 27.40 . T_2A claimed the first rank with mean rank value 27.40 and least is T_3A. Pokkali rice based apple blended yogurt tastes better than control. (Fig.6)

Overall acceptablity

The proportion of T_2A is superior than other treatment and control. (Fig.6)

4.3.1.3 Pokkali Rice Based Fruit Blended Yogurt (papaya)

The sensory evaluation scores obtained for pokkali rice based papaya blended yogurt are given in table 8.

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer. Three treatments of papaya and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of papaya flavour ranged between 9.9- 23.25 from the kruskal- wallis test, it was obtained that T_3P ranked first with mean rank value of 23.25 and least rank T_1P with a mean value rank of 9.9. Control is more attractive than pokkali rice-based papaya blended yogurt. (Fig.7)

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for papaya flavour ranged between 12.10 – 24.70. T_3P rank first with mean rank value 21.60. Control is being more appetizing than pokkali rice-based papaya blended yogurt. (Fig.7)

TABLE 8 : Sensory evaluation of papaya flavour

TR	APP		COLOUR		FLAVOUR		TEXTURE		TASTE		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1P	9.90	5.2	12.1	5.8	13.85	5.9	12.20	5.5	10.75	4.6	9.6	5.2
T_2P	15.7	5.8	15.2	6.1	14.70	6.2	14.40	5.8	14.15	5	19.95	6.3
T_3P	**23.2**	**6.9**	**24.7**	**7**	**24.27**	**7**	**22.05**	**6.6**	**23.30**	**6.2**	**21.20**	**6.5**
T_0	33.1	8.1	30.0	7.8	28.72	7.6	33.35	7.9	33.80	7.9	34.30	7.7
KW	23.0		12.3		13.8		21.40		24.26		23.17	
λ2	7.81											

MRV- Mean Rank Value, MS- Mean Score, P-Papaya, T_0- Control

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_1P with mean rank value 13.8 and ranked first T_3P mean rank value 24.27. Control has better flavour than pokkali rice-based papaya blended yogurt. (Fig.7)

Texture

From the sensory analysis, it was revealed that T_3P ranked first with mean rank value 22.05 on par with T_2P mean rank value 14.40. Control has the better texture than pokkali rice-based papaya blended yogurt. (Fig.7)

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between . T_3P claimed the first rank with mean rank value 23.30 and least is T1P. Control taste better than pokkali rice-based papaya blended yogurt (Fig.7)

Overall acceptablity:

The proportion of T_3P ranked first. But comparing with control, pokkali rice-based papaya blended yogurt is less acceptable than control (plain yogurt). (Fig.7)

4.3.1.4 Pokkali Rice Based Fruit Blended Yogurt (mango)

The sensory evaluation scores obtained for pokkali rice based mango blended yogurt are given in table 9.

TABLE 9: Sensory evaluation of mango flavour

TR	APP		COLOUR		FLAVOUR		TEXTURE		TASTE		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1M	**28.20**	**8.5**	**28.45**	**8.1**	**29.15**	**7.8**	**27.20**	**8**	**23.85**	**7.8**	**28.45**	**8.1**
T_2M	13.60	7.1	14.65	6.5	16.80	6.5	16.0	6.8	13.75	6.5	14.94	6.7
T_3M	14.55	7.1	13.0	6.3	11.05	5.5	12.95	6.4	8.90	5.5	11.95	6.3
T_0	25.65	8.1	25.90	7.8	26.45	7.6	25.85	7.9	21.70	7.9	24.15	7.7
KW	13.64		14.08		15.70		11.98		12.38		14.69	
$\lambda 2$	7.81											

MRV- Mean Rank Value, MS- Mean Score, M-Mango, T_0- Control

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer.

Three treatments of mango flavour and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of mango flavour ranged between 13.60 – 28.20 from the kruskal- wallis test, it was obtained that T_1M ranked first with mean rank value of 28.20 and least rank T_2M with a mean value rank of 13.60. Pokkali rice-based mango blended yogurt is attractive than control. (Fig.8)

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for mango flavour ranged between 13.0- 28.45. T_1M rank first

with mean rank value 28.45 on par with T_2M 14.65 mean rank value. Pokkali rice-based mango blended yogurt is more appetizing than control. (Fig.8)

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_3M with mean rank value 11.05 and highest rank T_1M with mean rank value 29.15. Pokkali rice-based mango blended yogurt has better flavour than control. (Fig.8)

Texture

From the sensory analysis, it was revealed that T_1M ranked first with mean rank value 27.20. Pokkali rice-based mango blended yogurt has more appetizing than control. (Fig.8)

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between 8.90- 23.85. T_1M claimed the first rank with mean rank value 23.85 and least is T_3M. Pokkali rice based mango blended yogurt is more tastier than control . (Fig.8)

Overall acceptablity:

The proportion of T_1M is superior than other treatment and control (Fig.8)

4.3.1.5 Pokkali Rice Based Fruit Blended Yogurt (pineapple)

The sensory evaluation scores obtained for pokkali rice-based pineapple blended yogurt are given in table 10.

TABLE 10: Sensory evaluation of pineapple flavour

TR	APP		COLOUR		FLAVOUR		TEXTURE		TASTE		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1PA	**29.0**	**8.1**	**25.30**	**7.9**	**33.85**	**8.5**	**28.15**	**7.9**	**31.55**	**8.5**	**32.80**	**8.2**
T_2PA	13.20	6.3	20.50	7.5	10.50	5.8	12.65	6	12.20	5.8	10.80	5.6
T_3PA	10.80	5.9	12.30	6.3	14.35	5.9	13.40	6.1	11.30	5.3	11.70	5.6
T_0	29.0	8.1	23.90	7.8	24.90	7.6	27.80	7.9	26.95	7.9	26.70	7.7
KW	22.49		8.20		25.01		17.29		24.06		27.54	
λ2	7.18											

MRV- Mean Rank Value, MS- Mean Score, PA- Pineapple, T_0- Control

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer.

Three treatments of mango flavour and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of pineapple flavour ranged between 10.80- 29.0 from the kruskal- wallis test, it was obtained that T_1PA ranked first with mean rank value of 29.0 and least rank T_3PA with a mean value rank of 10.80. Pokkali rice-based pineapple blended yogurt is more attractive than control. (Fig.9)

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for pineapple flavour ranged between 12.30-25.30. T_1PA rank first with mean rank value 25.30 on par with T_2PA 20.50 mean rank value. Pokkali rice-based pineapple blended yogurt is more appetizing than control. (Fig.9)

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_3M with mean rank value 10.50 and highest rank T_2PA with mean rank value 33.85. Pokkali rice-based pineapple blended yogurt has better flavour than control. (Fig.9)

Texture

From the sensory analysis, it was revealed that T_1PA ranked first with mean rank value 28.15. Pokkali rice-based pineapple blended yogurt has more appetizing than control. (Fig.9)

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between 11.30 - 31.55. T_1PA claimed the first rank 31.55 with mean rank value and least is T_3PA. Pokkali rice-based pineapple blended yogurt is tastier than control. (Fig.9)

Overall acceptability:

The proportion of T1PA is superior than other treatment and control. (Fig.9)

4.3.1.6 Pokkali Rice Based Fruit Blended Yogurt (passion fruit)

The sensory evaluation scores obtained for pokkali rice-based passion fruit blended yogurt are given in table 11.

Appearance

The appearance of any food is the most important features, especially when it is linked to other aspects of food quality. Every raw food and manufactures product have an acceptable range of appearance that is determined by the factors associated with the consumer.

TABLE 11 : Sensory evaluation of passion fruit flavour

TR	APP		COLOUR		FLAVOUR		TEXTURE		TASTE		OAA	
	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS
T_1PF	10.50	5	15.05	5.9	12.85	6.3	17.60	6.8	14.80	5.7	13.5	6.8
T_2PF	**21.50**	**6.6**	**24.40**	**7.1**	**27.10**	**7.8**	**26.05**	**7.7**	**23.0**	**6.7**	**25.5**	**8.2**
T_3PF	14.85	5.7	13.0	5.7	19.20	7.1	10.55	5.9	12.55	5.3	17.55	7.2
T_0	32.20	8.1	29.50	7.8	24.50	7.6	27.80	7.9	31.65	7.9	24.40	7.7
KW	20.72		13.81		8.87		14.83		17.23		8.39	
λ2	7.18											

MRV- Mean Rank Value, MS- Mean Score, PF-Passion fruit, T_0- Control

.Three treatments of passion fruit and control were scored for selecting the best one. On analysis the data sensory evaluation revealed that the mean rank for the appearance of passion fruit flavour ranged between 10.50-21.50 from the Kruskal- Wallis test, as obtained that T_2PF ranked first with mean rank value of 21.50 and least rank T_1PF with a mean value rank of 10.50. Control is more attractive than pokkali rice-based passion fruit blended yogurt. (Fig.10)

Colour

For food, colour and appearance are often the first attributes to determine quality. As per sensory evaluation it was revelaed that the mean rank value for colour for passion fruit flavour ranged between 13.0-24.40 .T_2PF rank first with mean rank value 24.40. Control is being more appetizing than pokkali rice-based passion fruit blended yogurt. (Fig.10)

Flavour

Flavour is the substance which enhance the quality of product. As per the sensory evaluation it was revealed that the least rank T_1P with mean rank value 12.85 and ranked first T_3P mean rank value 27.10. Control has better flavour than pokkali rice-based passion blended yogurt. (Fig.10)

Texture

From the sensory analysis, it was revealed that T_2PF ranked first with mean rank value 26.05 on par with T_1PF mean rank value 17.60. Control has the better texture than pokkali rice-based passion blended yogurt. (Fig.10)

Taste

Taste is a chemical sensation caused by a taste stimulus that hits a taste receptor. Regarding the taste sensation, it was found that mean rank value range between 12.55 – 23.0. T_2PF claimed the first rank with mean rank value 23.0 and least is T_3PF. Control taste better than pokkali rice-based passion fruit blended yogurt. (Fig.10)

Overall acceptablity:

The proportion of T_2PF ranked first. But comparing with control, pokkali rice-based passion fruit blended yogurt is less acceptable than control (plain yogurt). (Fig.10).

4.4 NUTRITIONAL ANALYSIS OF POKKALI RICE-BASED FRUIT BLENDED YOGURT

Nutritional parameters of the selected proportions of most acceptable pokkali based fruit blended yogurt and control were evaluated. The nutritional qualities such as Moisture content, energy, total carbohydrate, protein, dietary fibre, vitamin C, calcium, sodium, iron and potassium content of the pokkali rice based fruit yogurt was estimated.

The moisture content detrmine the water present in a product. The statistical analysis revealed that the moisture content of apple (77.665%), pine apple (77.025 %) and control (77.95%) no significant variation was observed. Moisture content was higher in mango yogurt (78.32 per cent) Pokkali rice-based fruit blended yogurt has almost similar percentage 78.31% - 79.86% of moisture content. (Fig.11)

TABLE 12 : MACRONUTRIENTS OF POKKALI RICE BASED FRUIT BLENDED YOGURT

TREATMENT	PROXIMATE COMPOSITION				
	Moisture %	Energy Kcal	Total carbohydrates %	Protein %	Dietary fibre %
APPLE	77.66^{b}	117.3^{c}	9.16^{a}	1.78^{c}	2.27^{b}
PINEAPPLE	77.02^{b}	128.0^{a}	9.43^{a}	1.45^{d}	2.62^{a}
MANGO	78.32^{a}	127.0^{b}	7.41^{b}	2.69^{b}	2.12^{c}
CONTROL	77.95^{b}	76.90^{d}	6.28^{c}	3.32^{a}	0
CD	0.67	4.80	0.35	0.99	0.29

(Result represent mean values of three replication)

Significant @5%.

According to the study of (Amal, Matter *et al.,* 2016), the mositure content of papaya yogurt has (87.64%) and cactus pear has (84.79%). Including fruit yogurt will increase the moisture content, may be due the moisture content of fruits.

The result emphasize that there was significant differences ($p<5\%$) in the energy content of pokkali rice based fruit blended yogurt. The energy content of the developed pokkali rice based fruit blended yogurt has more energy than control, this may be due to higher content energy from fruits and pokkali rice. From the (Fig.12) pineapple flavour pokkali rice based yogurt (128kcal) have more energy on par with mango (127kcal) and followed by apple (117.3kcal). All pokkali rice based fruit blended yogurt has more energy than compared with control (76.90kcal) because energy content from fruit and pokkali rice increase the energy content of the product.

The macronutrients such as carbohydrates, protein and fat shown in (Fig.13).The statistical analysis revealed that the carbohydrates content of apple (9.16%), pineapple (9.43%), mango (7.41%) and control (6.28%) in which significant variation was observed.

The result emphasis that there was significant difference ($p<5\%$) in the carbohydrates content of pokkali rice based fruit blended yogurt. Carbohydrates level of pokkali rice based fruit blended yogurt is higher than control, among the blended yogurt pineapple has more carbohydrate level on par with apple followed by mango. The report by Akubor (2016) explain that the highest carbohydrate content was noted in pineapple flavour yogourt this may be because of higher carbohydrate content in pineapple .

The statistical analysis revealed that the protein content of apple (1.78%), pineapple (1.45%), mango (2.69%) and control (3.32%) in which significant variation was observed. The result emphasis that there was significant difference ($p<5\%$) in protein content of pokkali rice fruit blended yogurt.

The protein level of control yogurt was found to be higher than that of pokkali rice based fruit blended yogurt. The findings of Roy *et al.* (2015) support this conclusion. They discover that when the amount of fruit in fruit blended yogurt increases the protein level decreases. According to (Fig.13) control is highest on par with mango flavour followed by apple flavour and then the lowest is the pineapple.

The statistical analysis revealed that the dietary fibre content of apple (2.27%), pineapple (6.62%) and mango (2.12%) in which variation was observed. The result emphasis that there was significant difference ($p<5\%$) in dietary fibre content of pokkali rice-based fruit blended yogurt.

The dietary fibre is absent in the plain yogurt because milk is devoid of fibre by nature so as a result yogurt will be in lack of fibre. The presence of fruits is the explanation for enrichment of dietary fibre in yogurt. Hashim *et al.,* (2009). According to (Fig.13) pineapple flavour has the highest dietary fibre on par with apple and then followed by mango.

The statistical analysis revealed that the Vitamin C content of apple (0.12mg), pineapple (0.89mg), mango (0.11mg) and control (0). In which variation was observed. The result emphasis that there was significant difference (p<5%) in Vitamin C content of pokkali rice based fruit blended yogurt. Pineapple has highest amount of vitamin c on par with apple and mango control has no Vitamin C. (Fig 14)

TABLE 13: MICRONUTRIENTS OF POKKALI RICE BASED FRUIT BLENDED YOGURT

TREATMENT	**PROXIMATE COMPOSITION**				
	Vitamin C mg/100g	Calcium mg/100g	Iron mg/100g	Potassium mg/100g	Sodium mg/100g
APPLE	0.12^{c}	19.90^{c}	0.60^{a}	82.86^{d}	12.55^{d}
PINEAPPLE	0.89^{b}	27.17^{a}	0.31^{c}	119.79^{a}	15.17^{a}
MANGO	0.11^{c}	19.93^{c}	0.49^{b}	88.143^{c}	13.94^{c}
CONTROL	0	26.10^{b}	0.13^{d}	114.67^{b}	14.10^{b}
CD	0.04	0.98	0.07	1.59	1.57

(Result represent mean values of three replication)

Significant @5%

The statistical analysis revealed that the calcium content of apple is (19.90mg), pineapple (27.17mg), mango (19.93mg) and control (26.10mg). In which variation was observed. The result emphasis that there was significant difference (p<5%) in calcium. Pineapple has the highest amount of calcium on

par with control and apple and mango has almost similar amount of calcium. (Fig 14)

The statistical analysis revealed that the iron content of apple is (0.60mg), pineapple (0.31mg), mango (0.49mg) and control (0.13mg). Iron content in fruits and yogurt is much lesser than other nutrients. The result emphasis that there was significant difference between ($p<5\%$) in iron. As iron content is present in dark red and green colour fruits. (Fig 14)

According to Sanchez-Segarra *et al.* (2000), strawberry yoghurt contains 1.18 mg/kg of iron, blackberry yoghurt 3.46 mg/kg, fruit-flavored yoghurt 1.06 mg/kg, normal peaches 0.45 mg/kg, yellow peaches 0.86 mg/kg, red peaches 0.62 mg/kg, and pineapple yoghurt 0.78 mg/kg. (Fig 14)

The statistical analysis revealed that the potassium content of apple (82.86mg), pineapple (119.79mg), mango (88.143mg) and control (114.61mg). In which variation was observed. The result emphasis that there was significant difference ($p<5\%$) in potassium. Pineapple has highest amount of potassium on par with control and then followed by mango and apple. (Fig 14)

The statistical analysis revealed that the sodium content of apple (12.55mg), pineapple (15.17mg), mango (13.94mg) and control (14.10mg). In which variation was observed. The result emphasis that there was significant difference ($p<5\%$) in sodium. Pineapple has highest amount of sodium on par with control and then followed by mango and apple. (Fig 14)

Salih and Abdalla (2017) found that the total solids content of yoghurt decreased in direct proportion to the amounts of glucose and galactose during storage, and that this drop in total solids content may have been caused by the interaction of lactose and basic amino groups. Aly et al. (2004) also found that blending fruit yoghurt with high solids fruit preparations boosted the overall solids content.

Micronutrients such as Vitamin C, calcium, iron, potassium and sodium (Fig.14). among these nutrients pokkali rice-based fruit blended yogurt has highest amount of potassium on par with calcium and then followed by sodium. A small amount of iron and Vitamin C is present in the developed product. A small amount of Vitamin C is present only in pineapple. Trace amount of iron is seen in apple and mango followed by pineapple and control. Apple, mango and control lack of Vitamin C. Pineapple has highest amount of sodium on par with mango and control. Apple and mango has lesser amount of calcium than pineapple. The level of potassium is higher in pineapple on par with control and followed by mango and least amount is present in apple. (Fig 14)

4.5 TOTAL MICROBIAL COUNT OF POKKALI RICE BASED FRUIT BLENDED YOGURT

Fungal contamination of dairy products can happen at any point throughout the supply chain, from dairy processing plants to customer's home. The data obtained revealed that the yeast mould growth exhibited variation in their number and showed the growth of yeast mould within 10 days.

TABLE 14 : YEAST AND MOULD PROFILE OF POKKALI RICE BASED FRUIT BLENDED YOGURT DURING STOREAGE

Products	Yeast and mould growth ($x10^{3}$ $cfug^{-3}$)			
	Storage period			
	Initial	3rd day	6th day	9th day
Apple	Nil	1.66	4.05	6.25
Mango	Nil	1.72	5.59	7.32
Pineapple	Nil	2.68	4.89	7.65

In the present study, the selected product from organoleptic evaluation was stored under refridgerater for storeage analysis. According to evaluation, yeast and mould growth are absent on the 1st day.

On the third day of storage, the yeast colonies were higher in pineapple-based rice yogurt (2.68 cfu/g). On the sixth day the highest count was noticed in mango flavored rice yogurt (5.59cfu/g). On the 9th day the count was highest in pineapple yogurt (7.65cfu/g) and lowest was observed in apple based rice yogurt (6.25cfu/g). On the 10th day of observation, noticed that mould growth is present in all selected products. (Plate. 19,20,21,22)

The air and other environment sources in processing facilities appear to be the primary causes of yeast and mould contamination of dairy products (Kure *et al.,* 2001). The FSSAI recommended yeast and mould count in yogurt was up to 50 cfu/g. According to Tarakci and Kucukoner (2003), fruit flavoured yogurt promotes the growth of yeast and moulds.

4.6 COST ANALYSIS OF DEVELOPED PRODUCTS

The cost analysis of pokkali rice-based fruit blended yogurt was carried out based on the price of various commodities. This includes the cost of milk, fruits, pokkali rice, sugar, skimmed milk powder, yogurt starter culture and utensils as well as labour and fuel charges.

TABLE 15: Cost of the developed pokkali rice-based fruit blended yogurt

TREATMENT	**TOTAL COST (Rs/500ml)**
Pokkali rice-based **banana** blended yogurt	160
Pokkali rice-based **apple** blended yogurt	100
Pokkali rice-based **papaya** blended yogurt	170
Pokkali rice-based **mango** blended yogurt	180
Pokkali rice-based **pineapple** blended yogurt	200
Pokkali rice-based **passion fruit** blended yogurt	230
Plain yogurt	110

Table depicts the expenses incurred for the yogurts. The highest cost was to produce passion fruit flavour (230/-) on par with pineapple flavour (200/-) followed by mango flavour (180/-) and cost of apple flavour (100/-) was comparatively less. Plain yogurt (control) is comparatively less than other fruit except apple because others are seasonal fruits. In this present study, combining

pokkali rice with fruit yogurt is a bit costly than fruit yogurt. When compared with commercial fruit yogurt, pokkali rice based fruit blended yogurt is a bit expensive. Therefore, pokkali rice-based passion fruit blended fruit yogurt has a comparatively high cost. It could be remarked that the raw materials used to have direct contact with development of the product.

5. SUMMARY AND CONCLUSION

The summary of the present study entitled “Development and Quality Evaluation of Pokkali Rice-Based Fruit Blended Yogurt” was an attempt to evaluate the nutritive value of pokkali rice. The study was also aimed to develop a new value-added product of pokkali rice which is incorporated into yogurt which is a staple food and fruit pulp such as banana (robusta), apple, papaya, pineapple, mango, and passion fruit is added for improving the sensory ability. The developed product is compared with plain yogurt (control). Six products are developed with 3 different treatment T1, T2 and T3, which as same proportion of milk and pokkali rice slurry, but the proportion of fruit pulp varies 25%, 20% and 15% respectively.

Pokkali rice is a variety of brown rice which is cultivated at Ernakulam, it is cultivated in saline water. The aim was to develop a product with pokkali rice to increase its usage in the industry. In this study, explain about the nutritional and functional analysis of pokkali rice.

The collection of raw materials such as pokkali rice is from Ezhikkara, Ernakulam, yogurt culture was collected from KVASU college of dairy science & technology, Mannuthy, Thrissur. Sugar, skimmed milk powder, fruits were all purchased from local market, Ernakulam.

Nutritional and functional properties of pokkali rice was analyzed. The amount of nutrients present in 100g of pokkali rice powder are, 77.10% of total carbohydrates, 8.83g of protein, 2.88g of dietary fibre, 45.27g of calcium, 0.67g of iron, 20.13g of sodium, 0.4g of copper, 0.3g of manganese, 179.78g of phosphorus and 1.29g of zinc. According to one factor analysis, it is significant.

Pokkali rice has 235% of water absorption capacity, 0.793g of bulk density, 3.90g of swelling property and 0.05g of solubility. According to one factor analysis, it is significant.

With regard to organoleptic qualities the most acceptable first three pokkali rice-based fruit blended yogurt fruit was selected. Among the developed products the highest overall acceptability was pineapple on par with apple and then mango and the least overall acceptability was papaya.

The selected products are pokkali rice-based pineapple blended yogurt, pokkali rice-based apple blended yogurt and pokkali rice-based mango blended yogurt. Nutritional analysis of most acceptable flavour was analysed under AOAC 21st Edn and IS 9497 procedures.

The macrominerals such as, moisture content of apple (77.66%), pineapple (77.02%), mango (78.32%) and control (77.95%). Energy contents of apple (117kcal), pineapple (128.0kcal), mango (126.0 kcal) and control (76.90 kcal). Carbohydrates conetnt of apple (9.16%), pineapple (9.43%), mango (7.41%) and control (6.28%). Protein content of apple (1.78%), pineapple (1.45%) mango (2.69%) and control (3.32%). Dietary fibre content of apple (2.27%), pineapple (2.62%) mango (2.12%) and control (0%).

The micronutrients such as Vitamin C of apple (0.12mg), pineapple (0.89mg), mango (0.11mg) and control (2.26mg). Calcium content of apple (19.90mg), pineapple (27.17mg), mango (19.93mg) and control (0%). Iron content of apple (0.60mg), pineapple (0.31mg) mango (0.49mg) and control (0.13mg). Potassium content of apple (82.86mg), pineapple (119.79mg), mango (88.14mg) and control (114.67mg). Sodium content of apple (12.55mg), pineapple (15.17mg) mango (13.94mg) and control (14.10mg).

According to statistical Analysis (CRD), moisture content of the sample has no significant to each other. Nutrients such as total carbohydrates, protein, dietary fibre, Vitamin C, calcium, potassium, iron, zinc and sodium are significant to each other.

Total microbial count of yeast and mould was observed by monitoring mycological method, from the result from 6th day yeast mould growth is observed. Preservatives are not added to the product.

Cost analysis of the development product in comparison to plain yogurt.Compared with plain yogurt, pokkali rice-based fruit blended yogurt is bit costly, as the product consists of pokkali rice, fruits additionally. Among the developed products, pokkali rice-based passion fruit blended yogurt is high cost on par with pokkali rice-based pineapple blended yogurt and least cost is pokkali rice-based banana (robusta). Pokkali rice-based fruit blended yogurt is a bit high cost when compared to commercial fruit yogurt.

In this study, a probiotic product is developed using a rice variety called pokkali rice, which has better nutritional content than white rice and fruit pulp is included to enhance the taste for better consumption. It helps the consumer to get enriched with nutrients and also useful for the farmers who cultivate pokkali rice. Preservatives are not added in the developed product. Incorporating fruits into yogurt enhances nutritional qualities, organoleptic qualities. These types of probiotic products in the market show greater increase in yogurt consumption by consumers. Adding rice flour to milk while preparing yogurt will also enhance the nutritional qualities, also it is a good alternative for the conventional yogurt.

Yogurt helps to produce gut microflora which improve the digestive system. It also plays a role in immunity which help to fight diseases. Incorporation of fruit and cereals to yogurt is also acceptable, which helps to increase nutrients such as Vitamin C. Pokkali rice-based fruit blended yogurt gives satiety because yogurt has no dietary fibre but pokkali rice base fruit blended yogurt is rich in fibre so it can also be prescribed for weight loss diet plan. Therapeutic study of pokkali rice bases fruit blended yogurt can be analysed in future.

6. REFERENCES

Ali K. Mehmood M. H. Iqbal M. A. Masud T. Qazalbash M. Saleem S. Ahmed S. Tariq M. R. Safdar W. & Nasir M. A. (2019). Isolation and characterization of exopolysaccharide-producing strains of lactobacillus bulgaricus from curd. Food Science & Nutrition 1207–1213.

Ali, M. M., Hashim, N., Abd Aziz, S., & Lasekan, O. (2020). Pineapple (Ananas comosus): A comprehensive review of nutritional values, volatile compounds, health benefits, and potential food products. Food Research International, 137, 109675.

Ardiansyah (2021). A Short Review: Bioactivity of Fermented Rice Bran. Journal of oleo science, 70(11), 1565–1574.

Basu, A., & Athmaselvi, K. A. (2018). Characterisation of mango flavoured curd powder developed using spray drying technique. *The Journal of dairy research*, *85*(2), 243–246.

Bondonno, N. P., Bondonno, C. P., Ward, N. C., Hodgson, J. M., & Croft, K. D. (2017). The cardiovascular health benefits of apples: Whole fruit vs. isolated compounds. Trends in Food Science & Technology, 69, 243-256.

Buendia, J. R., Li, Y., Hu, F. B., Cabral, H. J., Bradlee, M. L., Quatromoni, P. A., Singer, M. R., Curhan, G. C., & Moore, L. L. (2018). Regular Yogurt Intake and Risk of Cardiovascular Disease Among Hypertensive Adults. American journal of hypertension, 31(5), 557–565.

Cardinali, F., Osimani, A., Milanović, V., Garofalo, C., & Aquilanti, L. (2021). Innovative Fermented Beverages Made with Red Rice, Barley, and Buckwheat. *Foods (Basel, Switzerland)*, *10*(3), 613.

Cichońska, P., Pudło, E., Wojtczak, A., & Ziarno, M. (2021). Effect of the addition of whole and milled flaxseed on the quality characteristics of yogurt. Foods, 10(9), 2140.

Cichońska, P., Ziębicka, A., & Ziarno, M. (2022). Properties of Rice-Based Beverages Fermented with Lactic Acid Bacteria and Propionibacterium. Molecules (Basel, Switzerland), 27(8), 2558.

Fernandez, M. A., & Marette, A. (2017). Potential Health Benefits of Combining Yogurt and Fruits Based on Their Probiotic and Prebiotic Properties. *Advances in nutrition (Bethesda, Md.)*, *8*(1), 155S–164S.

Fernandez, M. A., Panahi, S., Daniel, N., Tremblay, A., & Marette, A. (2017). Yogurt and Cardiometabolic Diseases: A Critical Review of Potential Mechanisms. *Advances in nutrition (Bethesda, Md.)*, *8*(6), 812–829.

Fisberg, M., & Machado, R. (2015). History of yogurt and current patterns of consumption. Nutrition reviews, 73 Suppl _1, 4–7.

Fonseca, H. C., Melo, D. S., Ramos, C. L., Menezes, A. G. T., Dias, D. R., & Schwan, R. F. (2022). Sensory and flavor-aroma profiles of passion fruit juice fermented by potentially probiotic Lactiplantibacillus plantarum CCMA 0743 strain. Food research international (Ottawa, Ont.), 152, 110710.

Gonzalez, N. J., Adhikari, K., & Sancho-Madriz, M. F. (2011). Sensory characteristics of peach-flavored yogurt drinks containing prebiotics and synbiotics. LWT-Food Science and Technology, 44(1), 158-163.

hadha, D., Hamid, N., Kantono, K., & Marsan, M. (2022). Changes in temporal sensory profile, liking, satiety, and postconsumption attributes of yogurt with natural sweeteners. Journal of Food Science, 87(7), 3190-3206.https://doi.org/10.1111/1750-3841.16224

Islam S. U. (2016). Clinical Uses of Probiotics. Medicine, 95(5), e2658.

Jovanović, M., Petrović, M., Miočinović, J., Zlatanović, S., Laličić Petronijević, J., Mitić-Ćulafić, D., & Gorjanović, S. (2020). Bioactivity and Sensory Properties of Probiotic Yogurt Fortified with Apple Pomace Flour. *Foods (Basel, Switzerland)*, *9*(6), 763.

Kaskens, J., & Manickavasagan, A. (2022). Pulse-Based Yogurt: Physicochemical, Microbial and Sensory Characteristics. In Plant Protein Foods (pp. 223-249). Springer, Cham.

Kok, C. R., & Hutkins, R. (2018). Yogurt and other fermented foods as sources of health-promoting bacteria. *Nutrition reviews*, *76*(Suppl 1), 4–15.

Li, M., He, Z., He, L., Li, C., Tao, H., Ye, C., ... & Ran, G. (2022). Effect of Fermentation Parameters on the Anthocyanin Content, Sensory Properties, and Physicochemical Parameters of Potato Blueberry Yogurt. Fermentation, 8(10), 489.

Mani-López, E., Palou, E., & López-Malo, A. (2014). Probiotic viability and storage stability of yogurts and fermented milks prepared with several mixtures of lactic acid bacteria. *Journal of dairy science*, *97*(5), 2578–2590.

Mohd Ali, M., Hashim, N., Abd Aziz, S., & Lasekan, O. (2020). Pineapple (Ananas comosus): A comprehensive review of nutritional values, volatile compounds, health benefits, and potential food products. Food research international (Ottawa, Ont.), 137, 109675.

Muhammad, Z. A., & Ahmad, T. (2017). Therapeutic uses of pineapple-extracted bromelain in surgical care - A review. *JPMA. The Journal of the Pakistan Medical Association*, *67*(1), 121–125.

Nagaoka S. (2019). Yogurt Production. Methods in molecular biology (Clifton, N.J.), 1887, 45–54.

Nandakumar, K., Bhavyasree, P. S., & Thomas, M. T. (2022). Development of rice based probiotic yogurt enriched with some fruit pulps and its quality analysis. *Journal of food science and technology*, *59*(3), 1024–1029.

Oroian, M., Codină, G. G., & Dabija, A. (2022). Quality Characteristics of Yogurt with Different Levels of Cranberries Powder Addition of Different Particle Sizes. Journal of Culinary Science & Technology, 1-13.

Pareek, S. (2016). Nutritional and biochemical composition of banana (Musa spp.) cultivars. Nutritional composition of fruit cultivars, 49-81.

Pereira, A., & Maraschin, M. (2015). Banana (Musa spp) from peel to pulp: ethnopharmacology, source of bioactive compounds and its relevance for human health. *Journal of ethnopharmacology*, *160*, 149–163.

Pereira, Z. C., dos Anjos Cruz, J. M., Corrêa, R. F., Sanches, E. A., Campelo, P. H., & de Araújo Bezerra, J. (2023). Passion fruit (Passiflora spp.) pulp: a review on bioactive properties, health benefits and technological potential. Food Research International, 112626.

Rebouças, M. C., Rodrigues, M.doC., & Afonso, M. R. (2014). Optimization of the acceptance of prebiotic beverage made from cashew nut kernels and passion fruit juice. *Journal of food science*, *79*(7), S1393–S1398.

Santana, L. F., Inada, A. C., Espirito Santo, B. L. S. D., Filiú, W. F. O., Pott, A., Alves, F. M., Guimarães, R. C. A., Freitas, K. C., & Hiane, P. A. (2019). Nutraceutical Potential of *Carica papaya* in Metabolic Syndrome. *Nutrients*, *11*(7), 1608.

Sasidevan ,Devisha, Sunil.D.Santha (2020) understanding local knowledge of pokkali rice , ,Tata institute of social science .

Shah, K. A., Patel, M. B., Patel, R. J., & Parmar, P. K. (2010). Mangifera indica (mango). Pharmacognosy reviews, 4(7), 42–48.

Vij, T., & Prashar, Y. (2015). A review on medicinal properties of Carica papaya Linn. Asian Pacific Journal of Tropical Disease, 5(1), 1-6.

Yang, S. Y., & Yoon, K. S. (2022). Effect of Probiotic Lactic Acid Bacteria (LAB) on the Quality and Safety of Greek Yogurt. Foods, 11(23), 3799.

APPENDIX 1

SENSORY EVALUATION

TITLE: DEVELOPMENT AND QUALITY EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

TREATMENTS	PARTICULARS	PROPORTIONS		
		T1	T2	T3
BANANA	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			
APPLE	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			
MANGO	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			
PAPAYA	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			
PINEAPPLE	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			

(Continued)

TREATMENTS	PARTICULARS	PROPORTIONS		
		T1	T2	T3
PASSION FRUIT	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			
CONTROL (PLAIN YOGURT)	Appearance			
	Colour			
	Flavor			
	Taste			
	Texture			
	OAA			

***kindly indicate your rating between 1-9 (1 stands for poor and 9 stands for excellent)**

9. Like extremely

8.Like very much

7.Like moderately

6.Like slightly

5.Neither like nor dislike

4.Dislike slightly

3.Dislike moderately

2.Dislike very much

1.Dislike extremely

APPENDIX 2

STORAGE STUDY – MICROBIAL ANALYSIS

Yeast and mold count

Sabouraud dextrose agar media was used for enumeration according to the method of monitoring mycological media. 0.5 ml sample was taken and diluted up to 10 ml by uding peptone water. Then 1 ml of that preparation was inoculated on sabouraud dextrose agar plate. finally it was incubated at 37 ℃ for 2-5 days.

Materials:

Sabauroud dextrose sugar

Peptone water

Petri plate

Conical flask

Autoclave

Laminar flow

Pipette

Glass bend rod

Incubator

Procedure :

1. Making sabauroud dextrose sugar crystal and peptone water crystal into liquid by mixing with distilled water
2. Sterilize the glasswares, agar and peptone water in autoclave 121℃
3. Fill the plate with sabauroud dextrose agar of 20-25ml and leave for 10-20 minutes for solidification
4. According to the method of monitoring mycological media, 0.1ml of sample is taken and diluted upto 10ml using peptone water.
5. 1ml of solution is pipetted
6. Inoculated on sabauroud dextrose agar plate
7. Spread with bent glass rod
8. Incubate at 37℃
9. Yeast and mould take 24-48 hrs to grow on the media.

COLLECTION OF MATERIAL

PLATE 1: YOGURT CULTURE

PLATE 2: POKKALI RICE

FUNCTIONAL ANALYSIS OF POKKALI RICE

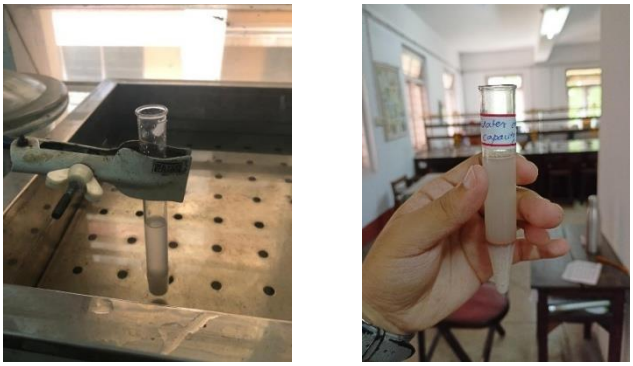


PLATE 3: WATER ABSORPTION CAPACITY

PLATE 4 : BULK DENSITY

PLATE 5 : SOLUBILITY

PREPERATION OF SUBCULTURE

PLATE 6: SUBCULTURE

DEVELOPMENT OF POKKALI RICE BASED FRUIT BLENDED YOGURT


POKKALI RICE


BOILING


POKKALI RICE SLURRY

PLATE 7: PREPARATION OF POKKALI RICE SLLURY


PASSION FRUIT


STRAINING OF JUICE


PASTEURIZED PUREE

PLATE 8: PREPARATION OF PASSION FRUIT PUREE


APPLE


CUBES OF APPLE


SUGAR TREATMENT


PUREE

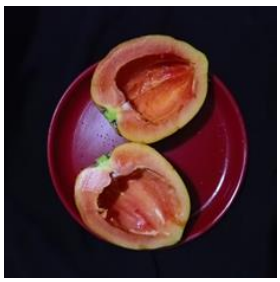
PLATE 9: PREPERATION OF APPLE PUREE


MANGO


CUBES OF MANGO


PASTEURIZED PUREE

PLATE 10: PREPERATION OF MANGO PUREE


PAPAYA


CUBES OF PAPAYA


PASTEURIZED PURE

PLATE 11: PREPERATION OF PAPAYA PUREE


PINEAPPLE


CUBES OF PINEAPPLE


PASTEURIZED PUREE

PLATE 12: PREPERATION OF PINEAPPLE PUREE



BANANA(ROBUSTA) **CUBES OF BANANA** **PASTEURIZED PUREE**

PLATE 13: PREPERATION OF BANANA (ROBUSTA) PUREE

PREPERATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

PASTURIZATION OF MILK

SUGAR

SKIMMED MILK POWDER

POKKALI RICE SLURRY

PASTURIZED FRUIT PULP

CULTURE

BLENDING

POUR TO SET CUPS

INCUBATOR (PRESSURE COOKER)

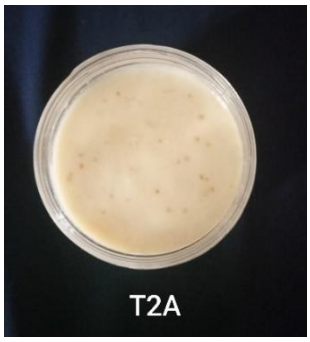
AFTER INCUBATION

PLATE 14: PREPERATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

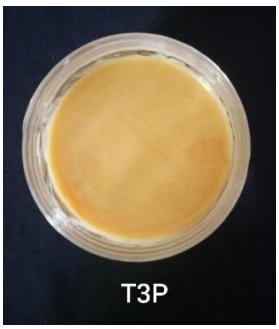
DIFFERENT PROPORTION OF DEVELOPED PRODUCT

POKKALI RICE BASED BANANA BLENDED YOGURT

POKKALI RICE BASED APPLE BLENDED YOGURT



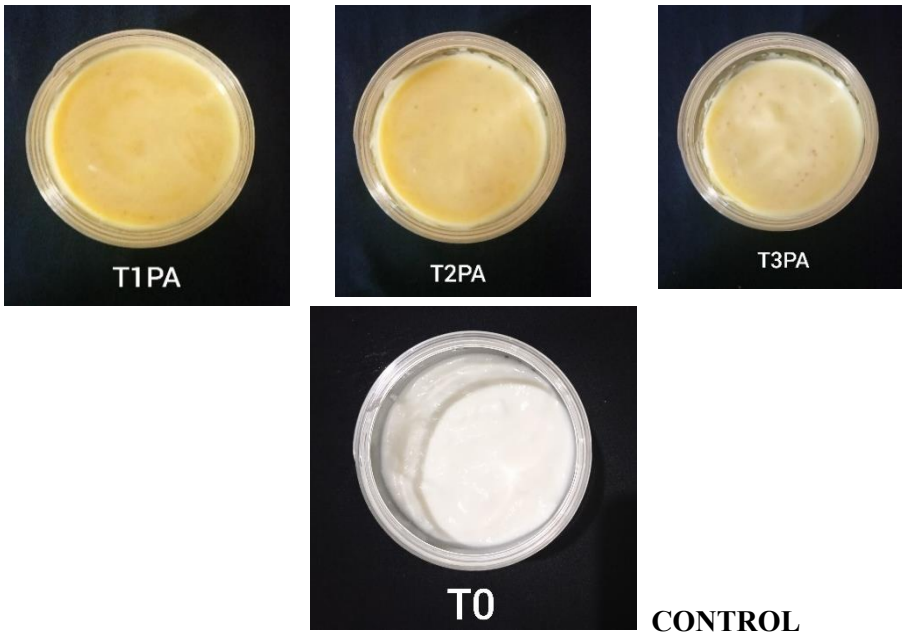
POKKALI RICE BASED PAPAYA BLENDED YOGURT



POKKALI RICE BASED MANGO BLENDED YOGURT

POKKALI RICE BASED PASSION FRUIT BLENDED YOGURT

POKKALI RICE BASED PINEAPPLE BLENDED YOGURT



CONTROL

PLATE 15: TREATMENTS OF POKKALI RICE BASED FRUIT BLENDED YOGURT

ORGANOLEPTIC EVALUATION

PLATE 16: ORGANOLEPTIC EVALUATION

YEAST AND MOULD GROWTH

SABAROUD DEXTROSE AGAR

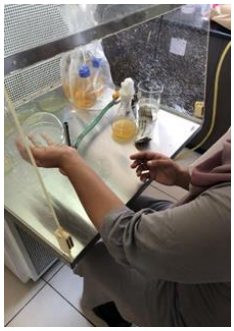
PEPTONE WATER

SUPERNATANT SOLUTION

STERLIZATION OF MATERIALS

PLATE 17: MATERIALS FOR MONITORING MYCOLOGICAL MEDIA

PROCEDURE




STERILIZE THE MOUTH OF PLATE AND CONICAL FLASK

POUR THE AGAR TO PETRI PLATE

SOLIDIFICATION

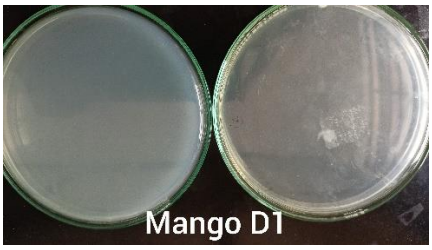
INOCULATION

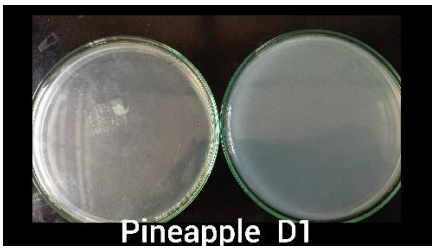
SPREADING

INCUBATION

PLATE 18: PROCESS OF MONITORING MYCOLOGICAL MEDIA

YEAST AND MOULD GROWTH





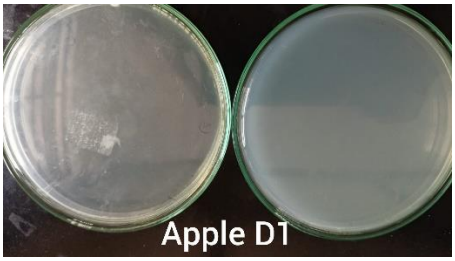


PLATE 19 : GROWTH ON INITIAL DAYS

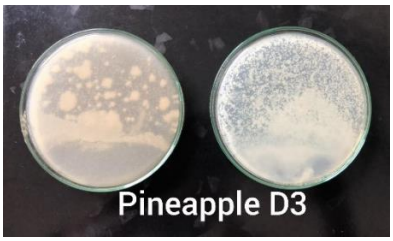


PLATE 20:GROWTH ON 3RD DAY

PLATE 21:GROWTH ON 6TH DAY

PLATE 22: GROWTH ON 9TH DAY

FIGURE 3: NUTRITIONAL ANALYSIS OF POKKALI RICE

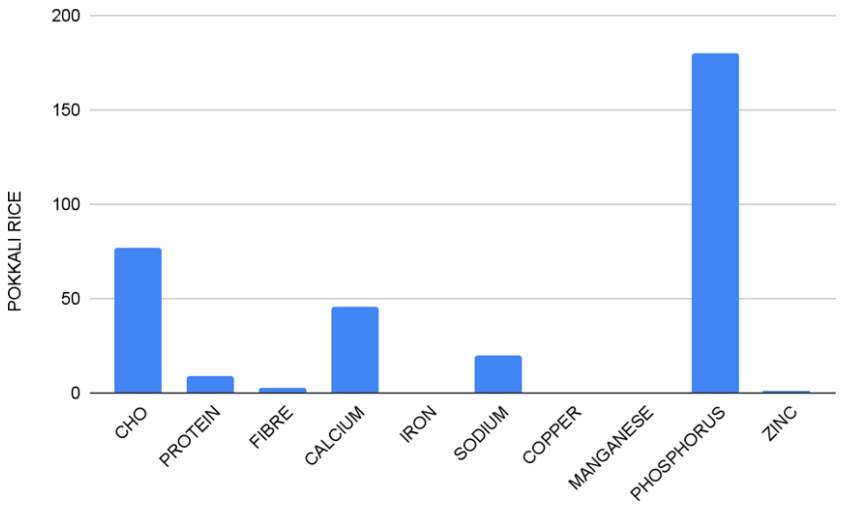


FIGURE 4: FUNCTIONAL ANALYSIS OF POKKALI RICE

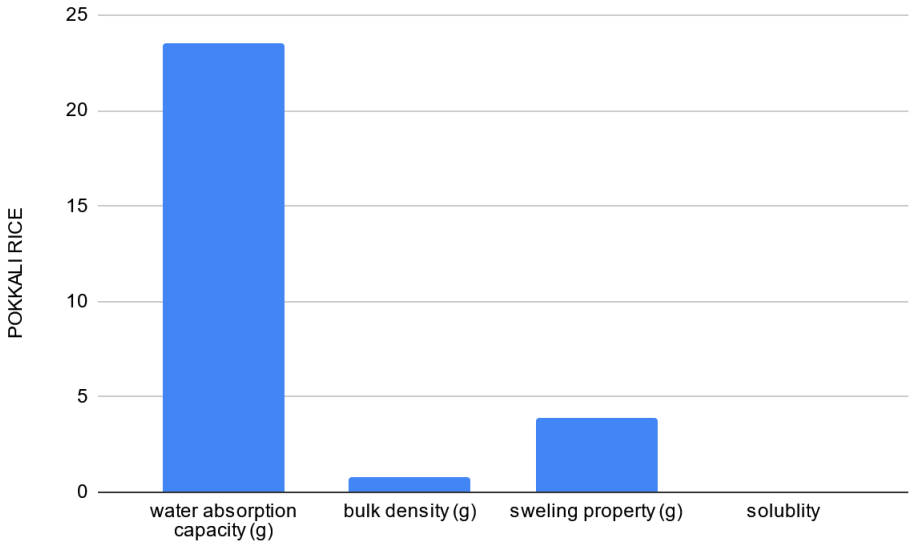


FIGURE 5: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (BANANA)

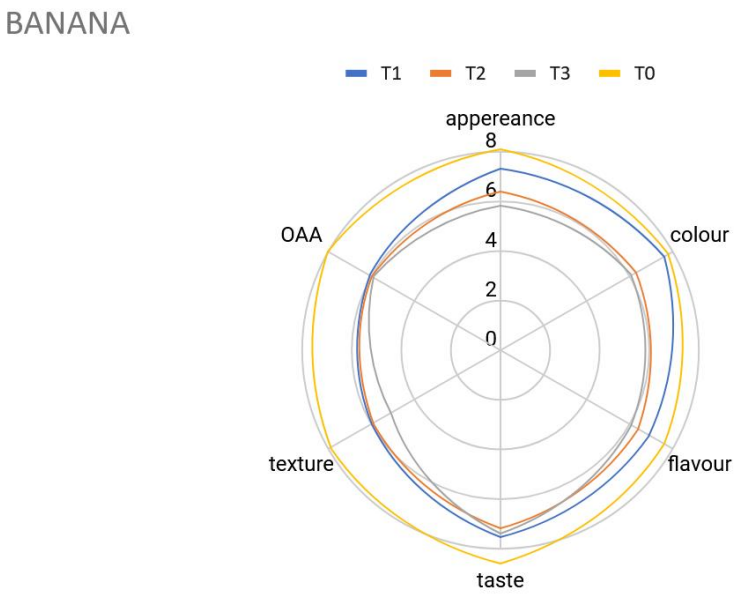


FIGURE 6: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (APPLE)

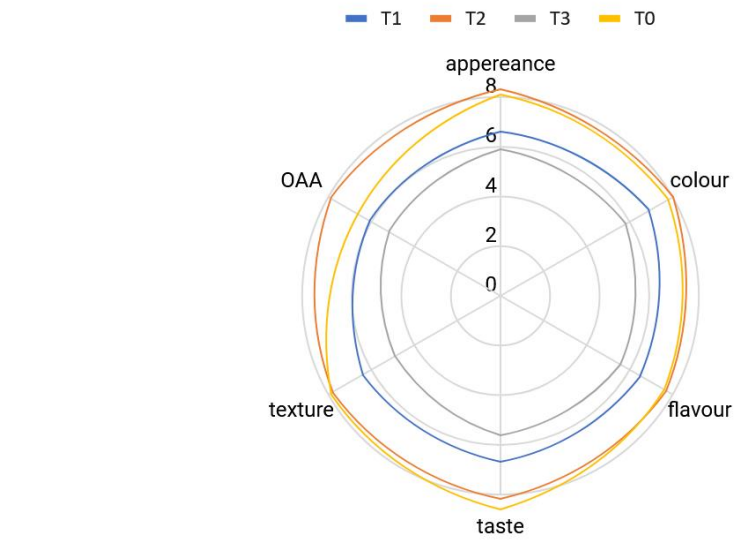


FIGURE 7: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (PAPAYA)

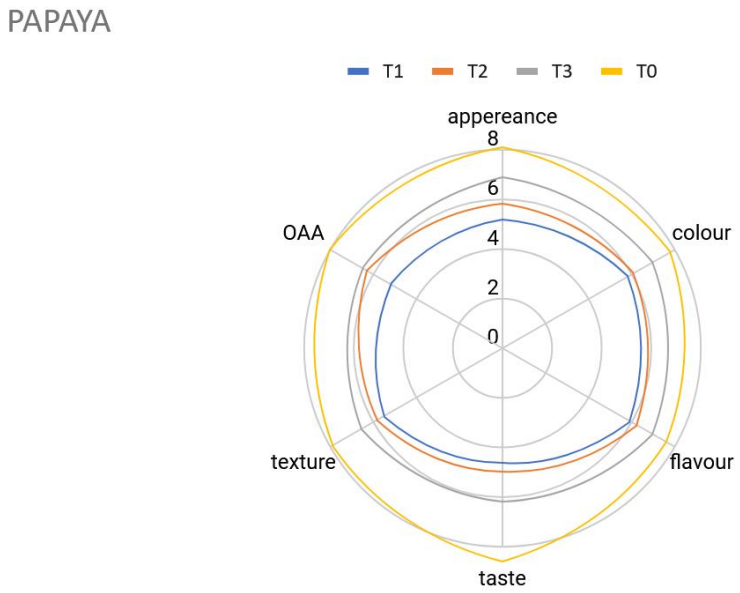


FIGURE 8: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (MANGO)

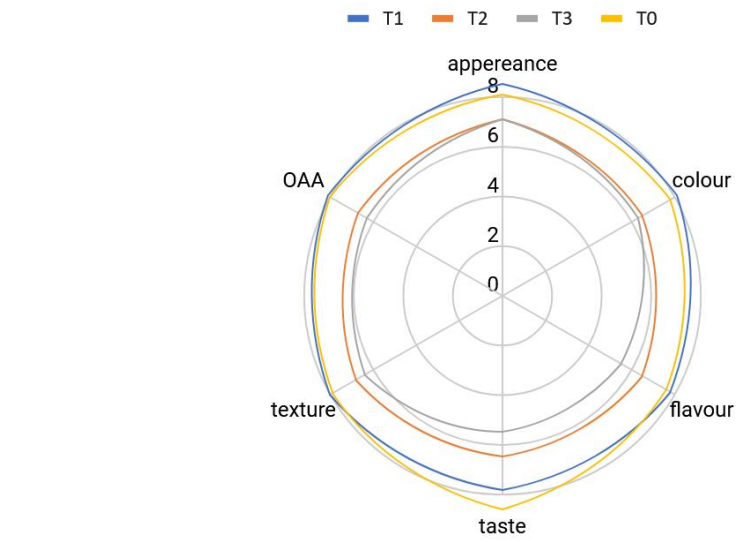


FIGURE 9: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (PINEAPPLE)

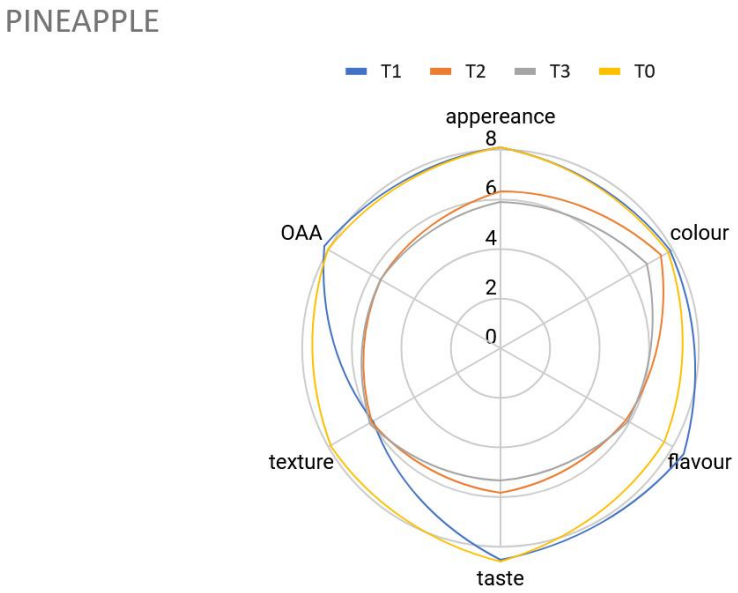


FIGURE 10: ORGANOLEPTIC EVALUATION OF POKKALI RICE BASED FRUIT BLENDED YOGURT (PASSION FRUIT)

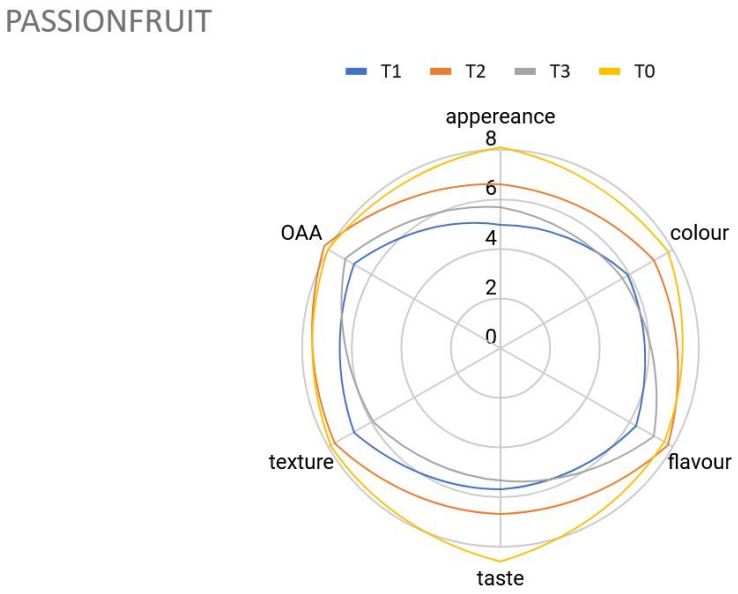


FIGURE 11: MOISTURE CONTENT OF THE SELECTED POKKALI BASED FRUIT BLENDED YOGURT

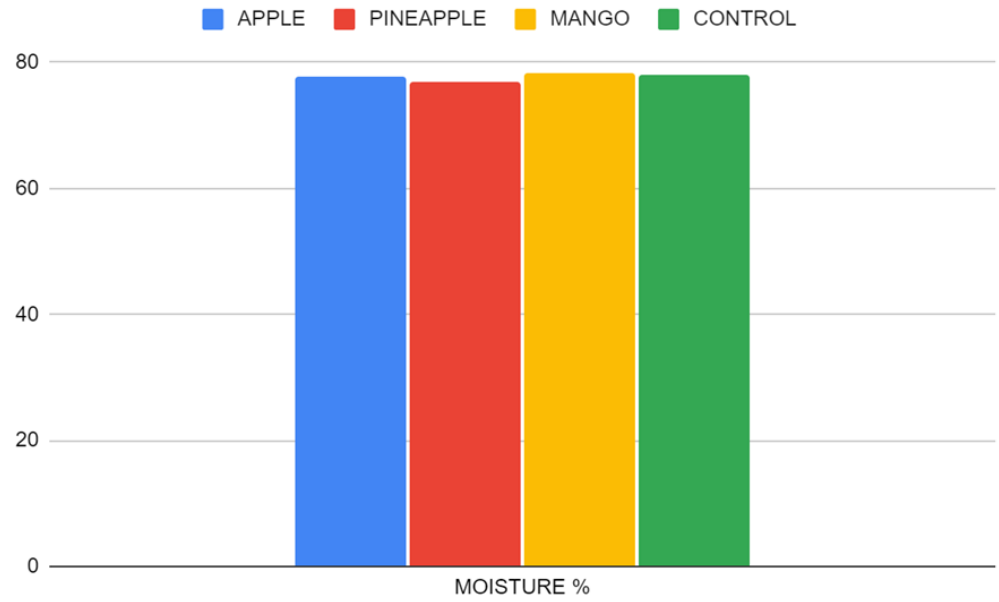


FIGURE 12: ENERGY CONTENT OF THE SELECTED POKKALI BASED FRUIT BLENDED YOGURT

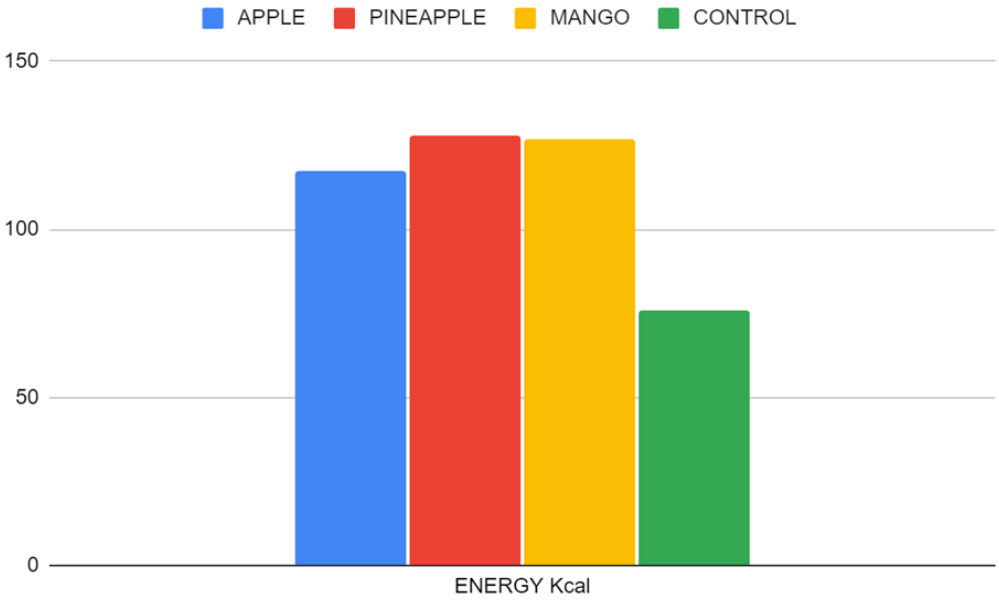


FIGURE 13: MACRONUTRIENTS COMPOSITION OF POKKALI RICE BASED FRUIT BLENDED YOGURT

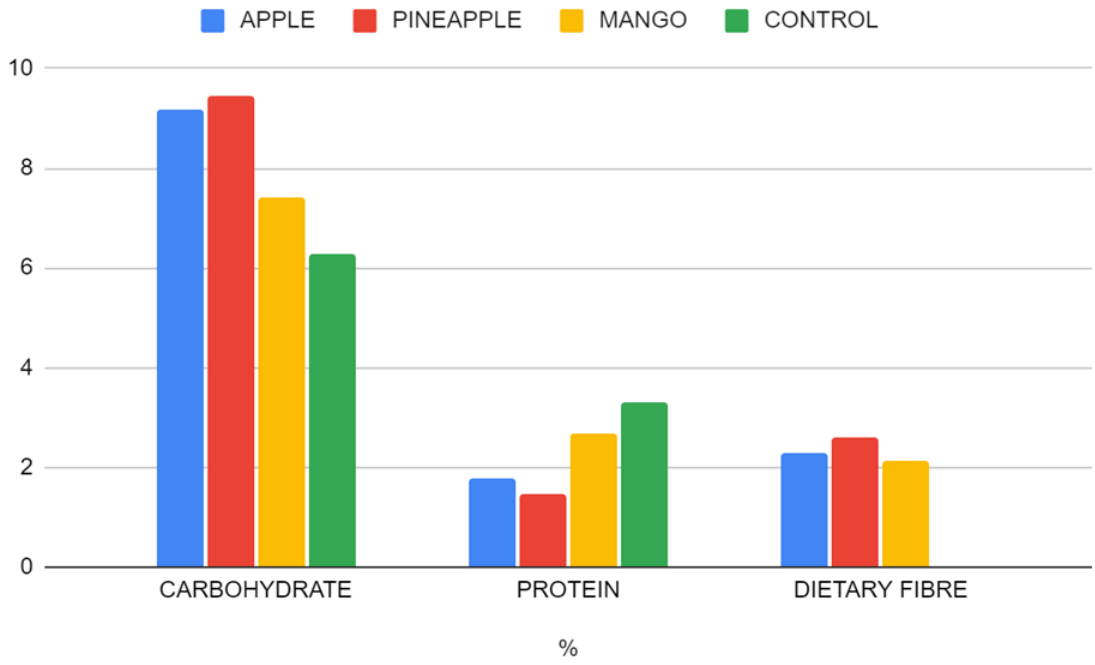


FIGURE 14: MICRONUTRIENTS COMPOSITION OF POKKALI RICE BASED FRUIT BLENDED YOGURT