DEVELOPMENT OF JACKFRUIT SEED-BASED FUNCTIONAL AND INSTANT ETHNIC DESSERT MIX

by

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THESIS

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DECLARATION

I, here by declare that this thesis entitled **"Development of jackfruit seed-based functional and instant ethnic dessert mix"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award for any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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APEDA	Agricultural and Processed Food Products Export Development Authority
WHO	World Health Organization
DNA	Deoxyribose Nucleic Acid
LDL	Low density Lipoprotein
°C	Degree celsius
UMAE	Ultrasonic Microwave Assisted Extraction
et al.,	Co-workers
TBA	Thiobarbituric Acid
MIC	Minimum Inhibitory Concentrations
MBC	Minimum Bacterial Concentrations
RAW	Research and Analysis Wing
LAB	Latic Acid Bacteria
EFA	Essential Fatty Acid
TSS	Total Soluble Solids
RS	Resistant Starch
KAU	Kerala Agricultural University
AOAC	Association of official Analytical Collaboration
CRD	Customized Random Design
TLTC	Too Low to Count
FSSAI	Food Safety and Standard Authority of India
L	Litre
mg	Milligram
ml	Millilitre
g	Gram

INTRODUCTION

1. INTRODUCTION

Post globalization, India has witnessed a dramatic change in the eating habits of people. Globalization forces people to move from old traditional foods to new fast and junk foods. Customers are becoming more value-conscious and health-conscious in addition to cost-consciousness. The food industry offers a wide range of rapid meal products. Instant meals are becoming a common occurrence in daily life. Instant meals are the most sought-after foods in modern times. It is referred to as the "food revolution." Instant meal mixes are a handy way to prepare a variety of foods for homes. They do not require further processing, and women find them convenient to use. It helps them to lessen the tiresome task of assembling different materials, cleaning, and meal preparation, in addition to saving time and effort. With the rise of nuclear families with two incomes, consumer behaviour towards food has altered significantly due to lifestyle and spending patterns. Instant food products have taken up a lot of shelf space in homes within the processed food industry (Vasan *et al.,* 2019).

In recent years, people have gone in search of novel products and are anxious to taste the flavour of new products available in markets (Ajisha *et al.,* 2018). One basic traditional dish that is enjoyed by all members of the community and works in any circumstance is '*Payasam*'. Rice is cooked with sugar or jaggery in milk, until the starch gelatinizes, as in the conventional method (Praveen *et al.,* 2021). "*Payasam"* is an indispensable food item during celebrations among South Indians, where no one will miss an opportunity to savour the delicacy. The process of making the delectable treat is a laborious procedure that takes a lot of time and effort. There is a great opportunity for sophisticated food products to become instant ethnic dessert mixes that are feasible for people to make.

It is advised that fruits be consumed whole, without the requirement for processing; yet, some fruits are best consumed after being processed in order to alter their flavor, texture, or the amount and caliber of bioactive chemicals, such phenols, that they contain. According to Minatel *et al.* (2017), biological, physical, and chemical changes that arises during various processing techniques, like cooking, particularly in regard to sensory, nutritional, and textural alterations, may be advantageous or detrimental to human health. According to a study on jackfruit by Ajisha *et al.,*

(2018) the sensory characteristics of *payasam* and vermicelli improved as jackfruit flour was used to a greater extent. Because roasted jackfruit flour is less soluble than raw jackfruit flour, it may be used to create extruded items (Odoemelam, 2015).

The biggest fruit that grows on trees, the jackfruit (*Artocarpus heterophyllus* Lam), is a member of the Moraceae family and is found in tropical and subtropical climates worldwide. Their scent is unique, fruity, and sweet. In addition, the whole jackfruit influences the agriculture sector and is utilized as a food source and traditional medicine. Secondary metabolites found in it have biological activity and are generating a lot of scientific interest (Srivastava *et al.,* 2017).

The fruit, which is consumed both when it is young and when it is ripe, is the main economic product of jackfruit. Fruit pulp is used as a dessert or preserved in syrup since it is sweet and pleasant. The seeds that are included within the ripe fruits are also roasted. In addition, the fruits and seeds are processed in a number of ways to provide food and other goods. Because of its high dietary fibre content, jackfruit functions well as a bulk laxative. By shortening the duration of exposure and binding to substances in the colon that cause cancer, the fibre content of jackfruit contributes to the protection of the mucous membrane lining the colon. Vitamin A and flavonoid pigments, including carotene-α, xanthin, lutein, and cryptoxanthin-α, are present in trace levels in fresh fruit. Collectively, these substances are essential for antioxidant and visual processes (Mondal *et al*., 2013).

According to World Health Organization (WHO), more than 80 per cent of people in underdeveloped nations rely on plant-based medications to meet their medical needs. The world's rapidly expanding population has led to a rise in food consumption, which has presented a significant challenge for established industries, food producers and also academics, to optimize the use of already available plant or food resources. Majority of jackfruits are wasted because of supply chain gaps, ignorance, and a lack of postharvest equipment, making it an underutilized fruit. There is a large market gap for jackfruits and their waste, but these may be filled with processed value-added goods that can provide both additional revenue and food security (Sundarraj *et al.,* 2017).

Although people do not use or recognize jackfruit seeds as much, they are a significant source of nourishment and make about 10 to 15 per cent of the fruit's weight. The seeds have a one-month shelf life when kept in a cold, damp environment, but because they are perishable, they are typically thrown out as trash. The roasted seeds can be ground into a powder and used in various items to increase their shelf life. When combined with wheat flour and other inexpensive flours, jackfruit seed powder can be used as a substitute for flours in baked goods and confections. (Hossain,2014). Some regions of India utilize the seeds as a potato supplement or boil or roast them for consumption (Banerjee and Datta, 2015).

Inadequate consumption of protein leads to malnutrition, which is one of the main issues in India. One potential cost-effective substitute protein source to address malnutrition is jackfruit seeds (Chowdhury *et al.,* 2012). The demand for jackfruit seeds has increased due to increased consumer awareness, regarding the diet-disease relationship. It is thought to be a powerful functional food element, since it imparts additional physiological benefits in addition to basic nutrition.

With jackfruit's high potential for value addition, post-harvest losses can be reduced and its availability increased outside peak seasons (Satheeshan *et al.,*2019). Pickles, chips, papad, brined jackfruit, RTC jackfruit, dehydrated jackfruit, and other value-added goods made from various jackfruit portions are among them. Semi-ripe fruits are used to make candies. Fruits that are fully ripe can be processed into jam, leather, jelly rind, squash, and honey RTE (ready-to-eat) bulbs, canned beans, RTS (ready-to-serve) beverages, cake, custard, ice cream, gulab jamun, halwa, toffee, wine, and dried pulp. Seeds are used to make pakoda, kheer, starch flour, and powdered flour (Srivastava *et al.,* 2017).

Jackfruit seed's high phytonutrient content makes it a unique functional element with promising nutraceutical potential (Conforti and Cachaper, 2009). A high concentration of saponins (6.32 g/100 g) was found in jackfruit seeds. According to phytochemical examination of jackfruit seeds using ferric-reducing antioxidant power, metal chelating, free radical scavenging, and reducing power tests, their antioxidant activity was assessed. It was shown that jackfruit seeds had significant antioxidant qualities as well as a reasonable concentration of phytochemicals (Gupta *et al.,* 2011).

Promising cultivars that yield higher-quality fruits appropriate for value-addition and product diversification might elevate jackfruit from the "neglected" category to an export-focused commodity. The miracle fruit's use will increase prospects for self-employment and financial stability. Convenience foods like *Ada Payasam* Mix could provide jackfruit with a tremendous deal of potential for modern applications.

Instant dessert mixes are often an opportune way to meet the expectations of consumers who are searching for new items and eager to try the flavours of those that are available on the market. The creation of instant dessert mixes results from this concept. Since *payasam* is an indispensable ethnic dish that aims to be both nutritious and health-giving to consume. Maintaining the ethnicity of preparing the dish with seasonal fruits and other ingredients will enhance the quality of food; Besides there is not much research being done in Kerala regarding dessert formulations, especially with jackfruit seeds.

Therefore, the objective of the current study is to create an ethnic dessert mix using jackfruit seeds and to assess it’s functional, nutritional, sensory, and shelf-life qualities.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The literature reviewed which is admissible to the study entitled **“Development of Jackfruit seed-based functional and instant ethnic dessert mix”** is presented under the following subheads:

2.1 Jackfruit's potential impact on food security

2.2 Health benefits of jackfruit

2.3 Pharmacological values of jackfruit

2.4 Underutilized parts of jackfruit and its nutritional aspects

2.5 Utilization of jackfruit as a food

2.6 Utilization of jackfruit seeds

2.7 Application of jackfruit seed as an alternative source of starch and fibre

2.8 Applications of underutilized parts of jackfruit

2.9 Jackfruit as a versatile food source

2.10 Application of jackfruit in the food industry

2.11 Significant role of desserts in meals

2.1 JACKFRUIT'S POTENTIAL IMPACT ON FOOD SECURITY

The rising demands of a growing global population and the difficulties presented by climate change require an increase in food production. Increased frequency of drought and extreme weather events, fluctuating rainfall and weather patterns, altered growing seasons, and rising temperatures are all putting more burden on agriculture. According to mounting data, increasingly erratic and unfavorable weather patterns brought on by climate change has resulted in changes in food production and yield loss. A more diverse agricultural system and food sources would result from fully using the vast stock of minor and underused crop species. Issues related to food and nutrition security must be addressed in light of climate change (Massawe *et al.,* 2015).

It is estimated that in 2019, companies, restaurants, and other food services wasted 931 million metric tonnes of food, which from 17% of all the food that was available to consumers. This suggests that 17% of the food produced globally may be wasted with families accounting for 11%, food service accounting for 4%, and retail accounting for 2% (Zhongming, 2021). Every food source contains some amount of waste, both edible and non-edible. Modern agriculture focuses on agro-processing to fulfill the increasing demand for food and feed, while using the greatest amount of plant or animal resources possible. One of the food crops that is very much underutilized is jackfruit. Processing waste materials can provide important materials like vitamins, antioxidants, antimicrobials, phytochemicals (carotenoids, phenolics, and flavonoids), or dietary fats with advantageous technical or nutritional qualities (Kasapidou *et al.,* 2015). Even though only 20% of the fruits (berries) are used as food product, 'the Food and Agriculture Organization (FAO) estimated global jackfruit production' at 3.7 million 86 tons in 2015–2017. In 2018, 2.96 million 87 tons of potential bioenergy feedstock were produced (Alves *et al.,* 2020).

Indian jackfruit, or *Artocarpus heterophyllus*, is one of the most valuable and popular fruits. It is a member of the Moraceae family. Of all the edible fruits, it is the biggest. Although jackfruit was originally cultivated in tropical parts of both hemispheres, it is now mostly endemic to India. With regards to production of jackfruit, the top ten producing states in India include Kerala, Assam, West Bengal, Chattisgarh, Madhya Pradesh, Tamil Nadu, Tripura and Karnataka, among others (APEDA). It is mostly preferred for homesteads in other sections of the nation, where plantations seldom ever cultivate it. Around 8,000 hectares of surface area in Assam is covered by jackfruit trees. There are over 4,000 hectares of trees in Bihar, while about 2000 hectares of trees are found in South India. Jackfruit is produced in the Himalayan foothills of northern India. It grows up to 2,400 metres in elevation in South India.

The rind, peel, and seeds of jackfruit are usually thrown away as trash by food manufacturers and dealers. Because of its limited use, a significant amount of the peel is thrown away as waste. It is estimated that each tree will produce between 2714 Kg and 11,800 kg of jackfruits annually. The dual objectives of environmental preservation and value generation will be met by converting these wastes into commodities with value added and by-product recovery (Noranizan *et al*., 2014).

2.2 HEALTH BENEFITS OF JACKFRUIT

Consuming jackfruit can help treat sleeping difficulties as it contains high levels of iron and magnesium, which enhance sleep quality in general. Additionally, one of the main reasons of insomnia is anaemia, which magnesium helps to avoid. Despite having a very sweet flavor, diabetic individuals can safely eat jackfruit because it releases sugar value slowly into the bloodstream, allowing them to get all of the fruit's health advantages. It also improves both forms of diabetes and glucose tolerance. In addition to its high vitamin A content, the fruit aids in maintaining excellent vision by improving vision and preventing macular degeneration and cataracts. It is also thought to be an effective anti-ageing ingredient for skin brightness. It repairs wrinkles and protects skin that has been harmed by sun exposure. Jackfruit is the best treatment for ulcer issues because it has potent anti-ulcerative, antimicrobial, anti-inflammatory, and antioxidant qualities. Typical ulcer prescription treatments have several negative effects. For strong bones, jackfruit is a highly recommended calcium supplement. In addition to calcium, it also has magnesium and vitamin C, which helps the body to absorb calcium. Thanks to its abundance of vitamins like niacin and thiamine (100 g of jackfruit pulp contains 4 mg of niacin), jackfruit may also be used as a treatment for fatigue, stress, and muscle weakness. It is an ideal energy source (Tejpal *et al.,* 2016).

Based on its abundance of antioxidants, phytonutrient qualities, and vitamin C, jackfruit can treat a variety of cancers, including skin, prostate, stomach, lung, and breast cancers. These qualities have the ability to heal damaged cells and build resistance. Jack fruit has little calories and no fat. It can support comfortable and safe weight loss. Consumption facilitates getting the most out of all other nutrients. Because of its high potassium content, this fruit helps to regulate blood pressure, which reduces the risk of heart attacks, strokes, and cardiovascular disease in general. Since jackfruit has a high fibre content (3.6g/100g), frequent consumption helps to enhance digestive system function. Additionally, it strengthens the colon's defenses against cancer by clearing the large intestine of hazardous substances (Maurya *et al.,* 2016).

Seeds are rich in fibre, vitamins, and minerals. In addition to making weight loss easier, fiber may lower blood pressure, cholesterol, and heart disease risk. It also helps treat constipation. Additionally, resistant starch from jackfruit seeds contributes to intestinal health and blood sugar management. Having high thiamine and riboflavin content helps to maintain healthy skin, eyes, and hair as well as help the body convert food into energy. Another antioxidant that aids in defending cells against harm from free radicals is riboflavin. The production of red blood cells, strong bones, and immunological function all depend on minerals including zinc, iron, calcium, copper, potassium, and magnesium. Magnesium and potassium are necessary for the human body to maintain healthy blood sugar and blood pressure, respectively. Eating jackfruit seeds offers a range of phytochemicals, or plant chemicals, some of which, like polyphenols, may have antioxidant activity. Other phytochemicals in jackfruit seeds include flavonoids, which may help prevent blood clots, and saponins, which may have some anticancer activity.

Jackfruit seeds contain laxative and diuretic properties. It can be used to prevent night blindness and cure ulcers. Antibacterial, anti-inflammatory, anti-diabetic, antioxidant, and antipyretic are just a few of the fruit's many qualities. It strengthens immunity and treats snakebite injuries. Livestock is fed with the fruit's leaves and other byproducts. In order to treat glandular swellings, snake bites, and abscesses, the fruit's latex can also be used with vinegar. Both latex and the leaf decoction work well to cure asthma. Gardens are landscaped with jackfruit trees. Because the fruit's leaves are such good adsorbents, they are also utilized to extract color from aqueous solutions (Tejpal and Amrita, 2016).

2.3 PHARMACOLOGICAL VALUES OF JACKFRUIT

Artocarpus species have been used in traditional medicine for their antibacterial, anti-diabetic, anti-inflammatory, and anti-helminthic qualities (Haleel *et al.,* 2018). The fruit has lignans, flavones, and saponins, which have anti-cancer, anti-ulcer, antihypertensive, and anti-aging qualities. It is also strong in carbs, minerals, and vitamins (Khan *et al.,* 2021). It is very valuable medicinally. The lectins found in the seeds, such as jacalin and artocarpin can be utilized to evaluate a patient's immunological function, if they have HIV infection (Sowmyashree *et al.,* 2022).

2.3.1 Anti-inflammatory and anti-viral activity

The biological activity of jackfruit seeds includes cytotoxicity and anti-inflammatory properties. At 30 μg mL−1 of extract, the inflammatory response elicited in RAW 264.7 cells may be inhibited by the triterpenes and sterols found in jackfruit seed (Tramontin *et al.,* 2021). On the other hand, substances called flavonoids have immunomodulatory properties. Their derivatives have the ability to block a variety of transcriptional factors that regulate immune cell differentiation, proliferation, and activation, as well as enhance the control of T cell production (Lowery *et al.,* 2009). Citrus flavonoids and their derivative phytochemicals may be utilized to treat 2019-CoV infection, since they possess antiviral and anti-inflammatory properties (Cheng *et al.,* 2020). Flavonoids found in jackfruit (*Artocarpus heterophyllus*) seeds are recommended for the treatment of COVID-19 (Kusumaningtyas *et al.,* 2021). Higher levels of flavonoids were found in a 100 mg ethanolic fraction of jackfruit seed extract, compared to the acetone fraction, ethyl acetate and water (Shanmugapriya *et al.,* 2011). Jacalin is a secondary metabolite found in jackfruit seeds that has anti-angiogenic and anti-inflammatory properties (Oktavia *et al.,* 2017).

2.3.2 Antioxidant activity

The slimy coating of jackfruit seeds is a significant source of pectin, which has been shown to have outstanding phenolic content and antioxidant qualities (Kumar *et al.,* 2021). The most potent antioxidant is jackfruit axis extract, which is more effective than vitamin C at preventing alcohol-induced cytotoxicity (Li *et al.,* 2021). Through the phytonutrient carotenoids, jackfruit demonstrates antioxidative action and protects tissues from oxidative damage (Ranasinghe *et al.,* 2019).

Jackfruit protects tissues from oxidative damage by displaying antioxidative activity through its phytonutrients, such as carotenoids (Masibo *et al.,* 2009). The high-density lipoprotein ratio is one of the coronary heart disease risk factors. On the other hand, atherosclerosis which is marked by a series of inflammatory reactions and tissue damage, protein oxidation, DNA damage, and pro-inflammatory responses is facilitated by LDL oxidation (Greig *et al.,* 2012). Antioxidants are substances that either stop or slow down the oxidation process. The antioxidant effects of fresh jackfruit seed and meat are comparable to those of ascorbic acid, and the fruit contains gallic acid, which makes up around 70% of the total antioxidant activity (Jagtap *et al.,* 2010).

2.3.3 Anti-cancerous activity

Jackfruit contains phytonutrients called isoflavones, lignans, and saponins that have anti-aging, anti-cancer, and anti-hypertensive properties. The chemoprotective properties of jackfruit prevents the mutagenicity of aflatoxin B1 and the growth of cancer cells. Compounds in jackfruit flesh may be able to prevent or treat lymphoma cancer (Baliga and Ruiz-Montanez, 2015).

2.3.4 Anti-bacterial and anti-fungal activity

Traditional medicine uses jackfruit leaf extract to treat foodborne illnesses because it has antibacterial properties that lessen adverse effects. Furthermore, it was discovered that jackfruit nanoparticles were effective against *Bacillus megaterium*, and that the bacteria *Escherichia coli*, ATCC 25922, E. coli EPEC, CDC 086H35, and *Salmonella enteric* bacteria, which were all susceptible to the antibacterial properties of jackfruit tree leaves (Sousa *et al.,* 2021). When meat is treated with jackfruit seed extract, antibacterial and antioxidant activity is seen, as the TBA value is seen to decrease, indicating that jackfruit extract may be utilized to regulate shelf-life of meat

(Ramli *et al.,* 2021). There is a folk medicine associated with jackfruit. *Vibrio cholera* (moderate) and *Escherichia coli* (MIC and MBC values of 3.9 and 7.8 μg/mL) were the diarrheal pathogenic bacteria that artocarpanone from jackfruit heartwood showed antibacterial efficacy against via changing membrane cell (Septama *et al.,* 2017). In addition, jackfruit contains jacalin, which has the ability to prevent the growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae*. Hemagglutination activity against human and rabbit erythrocytes is another feature it demonstrates (Trindade *et al*., 2006).

2.3.5 Traditional therapeutic properties

Traditional medicine uses all parts of the jackfruit tree to cure a variety of conditions, including dermatitis, kidney stones, infected wounds, diarrhea, asthma, and malaria. Its seeds are also used to treat sexual issues since they have aphrodisiac effects (Jagtap *et al*., 2010). Jackfruit leaves have hypoglycemic and hypolipidemic compounds that make them beneficial for diabetic patients (Baliga *et al.,* 2011). Vinegar and latex-derived testosterone control glandular swelling and the healing process after a snake bite (Mandhare *et al.,* 2020). Asthma and skin conditions can be treated with its root extracts, and its calming qualities may also help treat fever, diarrhea, and abortions. Lectin (Jaclin), which is found in seeds, evaluates the immune system of HIV-positive individuals (Suryadevara *et al.,* 2017). In Sri Lanka, the formulation of sausages coupled with jackfruit and other spices preserve the high immune boosting potential (Wijegunawardhana *et al.,* 2021). Jackfruit plants are traditionally used to treat a variety of ailments, including inflammation, malarial fever, diarrhea, diabetes, and tapeworm infection. This is because the plants contain a variety of constituents, including protein, jacalin, flavonoids, stilbenoids, coloring agents, morin, dihydromorin, cynomacurin, artocarpin, isoartocarpin, carotene, and essential amino acids. Additionally, artocarpus, which is derived from the leaves, bark, and stem, contain several bioactive compounds, which are used in a variety of biological activities, such as anti-bacterial, anti-tubercular, anti-viral, anti-fungal, anti-platelet, anti-arthritic (Haleel *et al.,* 2018).

2.4 UNDERUTILIZED PARTS OF JACKFRUIT AND ITS NUTRITIONAL ASPECTS

There is a lot of opportunity for the food industry to use jackfruit byproducts. When used in goods like bread, biscuits, cakes, cookies, ice creams, and so on, it enhances the nutritional content of the product. Beneficial chemicals are also extracted from rags, rinds, and seed powder of jackfruit using its by-products. Higher levels of protein and dietary fiber were found in the produced nutritional makeup of meat analogs. An analysis of the textural characteristics of meat substitutes revealed that chewiness and hardness significantly decreased when wheat gluten levels decreased. There is a lot of waste produced during the consumption of fresh jackfruit and its preparation, including the skin and central axis, as well as edible byproducts such seeds and perianth (Akter *et al.,* 2019).

2.4.1 Jackfruit peel

The peel, rind, or skin of jackfruit refers to its outer layer of protection. About half of the mature jackfruit is made up of the outer peel (Moorthy *et al.,* 2017). Ecology is severely harmed when peel is disposed of improperly. On the other hand, appropriate by-product utilization reduces the cost of disposal while simultaneously increasing the economic value. There's much of calcium in the peel. According to Adetunji *et al.* (2017), pectin is a form of heteropolysaccharide that is present in the intermediate lamellae and cell walls of plants cultivated in soil. Peel extract had a higher total phenolic and flavonoid concentration than pulp, flake, or seed extracts, with phenolics being more prevalent. According to Zhang *et al.* (2017), the results indicated that jackfruit peel offers great promise as a novel source of naturally occurring antioxidants and hypoglycemic agents.

2.4.2 Central core or axis of jackfruit

The jackfruit's edible bulbs are divided into divisions by "rags," or perianth, which are latex-like filaments. This waste part makes up around 25% of the weight of the fruit altogether. The perianth and seed of jackfruit contain a high amount of starch when they are young. As the meat ages, its starch and dietary fiber level rises (Dam and Nguyen, 2013). The rags, which are subsequently adhered to the rind of the syncarp, form a longitudinal axis with the non-edible core. The three primary ingredients are fiber, crude protein, and carbohydrates. A fruit axis that is somewhat fleshy, rigid, and dome-shaped is present in the modified mature inflorescence axis (Cruz-Casillas *et al*., 2021). After preparing a meal from the center core of jackfruit, Subburamu *et al.* (1992) discovered that the main approximate components are carbohydrates (20.5%), crude protein (10.6%), and crude fiber (15.9%).

2.4.3 Jackfruit seeds

The seeds of a jackfruit make up around 10 to 15 percent of its weight. Edible byproducts like jackfruit seeds are generally underused, aside from the inedible portions like the skin and axis. Typically, seeds are discarded or cooked and used as a snack or in some regional cuisines. It is not possible to keep fresh seeds in storage for a long time. The jackfruit has round, light brown seeds. They are covered in a thin layer of brown endoderm that encircles the fleshy white cotyledon and is surrounded by a white aril. These have a lot of proteins and carbohydrates (Ranasinghe *et al.*, 2019). Jackfruit seeds include resistant starch, which aids in blood sugar regulation and intestinal health maintenance. According to Maurya *et al.* (2016), jackfruit seeds have antibacterial properties, that help prevent foodborne infections and include a crucial lectin called jacalin, which is utilized to evaluate the immune system of HIV patients. The seeds are part of an antidote for heavy drinkers in India, and they are known to assist patients recover from alcohol poisoning in China (Waghmare *et al.,* 2019).

2.4.4 Jackfruit perianth

The edible bulbs of jackfruit are divided into sections by filaments that resemble latex and are referred to as "rags" or perianth. The perianth, which makes up the bulk of the fruit, is its most important component. The three sections are: the bottom fleshy edible component, which is commonly called as the bulbs; the middle-fused region, which forms the rind of the syncarp; and the top free and horny non-edible region. The meat content of jackfruit varies with maturity, and the perianth has a high starch level and nutritional fiber content. The fleshy perianth and the carpels, or ovaries make up the real fruit. Approximately 25% of the total weight of the fruit is made up of this waste component (Dam *et al.,* 2013).

2.5 UTILIZATION OF JACKFRUIT AS A FOOD

The best ways to promote jackfruit cultivation and consumption along with waste management in the jackfruit processing industries would be to introduce high-yielding jackfruit varieties: followed by proper harvesting and postharvest practices like appropriate handling, transportation, and storage, developing novel processing technologies, and looking for new applications to minimize postharvest and production losses. Preventing mechanical damage can be achieved by harvesting jackfruit in its green, mature state. Additionally, by extending shelf life, adaptation to suitable postharvest practices may allow exporting. When entire jackfruit is stored at 10° C and 85-90% humidity, the crop's shelf life can be extended by around two weeks. By processing jackfruit into value-added goods like precut or ready-to-eat bulbs, jackfruit may be made more commercially viable for urban populations by eliminating the hassle of removing the bulbs from the rind and saving time. Additionally, it increases the crop's potential on a local and global scale by lowering the expenses of packaging and shipping, preserving the crop's quality and freshness, and lowering the quarantine restrictions in some importing nations (Ramli and Saxena, 2009). A combination of low temperature storage and modified atmospheric packaging can effectively increase the shelf life of minimally processed jackfruit.

The capacity to preserve precut jackfruit at 5°C for up to 12 days after pretreating it with 1-methylcyclopropene and applying edible coatings (xanthan, sodium alginate, or gellan) without compromising its quality has been studied. The application of edible coating and pretreatments were able to preserve the intended sensory and nutritional qualities, such as color, firmness, pH, total soluble solids, and titratable acidity, while lowering the rates of weight loss, respiration, and ripening (Vargas-Torres *et al.,* 2017). The impact of drying, osmo-blanching, and calcium treatment on the physical, chemical, and sensory characteristics of jackfruit slices demonstrated how improving pretreatment conditions and a mix of freeze-drying and hot-air drying produces jackfruit bulb slices with improved sensory qualities, opening the door to processing on a commercial scale. Additionally, the powdered dehydrated jackfruit bulbs could be added to various culinary items (Saxena *et al.,* 2009).

The development of salty foods like chips with the optimal physicochemical quality characteristics made from jackfruit meat could encourage people to eat jackfruit as it would provide some diversity to their diet. The yield and quality of the final product are significantly influenced by the amounts of dry matter, starch, total soluble solids, and reducing sugar. The appearance, appropriateness for processing, and consistency of frying operations were more significantly influenced by the morphological traits and physical factors, such as thickness and size, of jackfruit bulbs. For the production to be sustainable, it was therefore essential to choose jackfruit genotypes with the right traits (Jagadeesh *et al.,* 2006). An intriguing substitute for making wine out of extra or over ripe jackfruit would be to ferment it. This would allow for more efficient use of the fruit.

It is said that jackfruit wine has strong antioxidant qualities and protects against DNA damage caused by radiation (Jagtap *et al.,* 2011). Furthermore, novel culinary items based on jackfruits have been developed with the application of cutting-edge processing techniques such as vacuum frying, cryogenic freezing and freeze-drying (Ramli *et al.,* 2009).

2.6 UTILIZATION OF JACKFRUIT SEEDS

In India, the organized food industry with the quickest rate of growth is the bakery sector. The popularity of baked goods is rising steadily since they are affordable, easily accessible in a wide range of flavors and textures, handy, and have a high nutritional content. The main benefit of bakery products is its simple to fortify them with useful components. Therefore, bakery goods are a useful way to give customers powerful components that have positive health effects (Waghmare *et al.,* 2019).

The impact of adding different amounts of jackfruit seed flour to chocolate cake and adjusting the ratios of wheat flour and jackfruit seed flour on quality criteria was analysed. When 10 g of jackfruit seed flour was added to 100 g of wheat flour to make chocolate cake, the amount of protein and ash increased but the amount of fat decreased. When jackfruit seed flour was added to biscuits, the proportion of ash and crude fiber increased. A high ash level indicates that there is a lot of mineral particles in the flour. The addition of jackfruit seeds increased the amount of crude fiber in the biscuits since they were high in crude fiber; however, the addition also caused the biscuits' protein and carbohydrate contents to decrease. When jackfruit seed flour was added to bread, the amount of crude fiber increased, which is unusual for baked goods because they often lack nutritional fiber (Islam *et al*., 2015). While the bread colored the same when 25% less jackfruit seed flour was used than in the control sample, adding more jackfruit seed flour caused the color to shift from light brown to dark brown. Comparably, the control sample and the sample containing 25% seed flour were both better in terms of flavor. The bread with 25% seed flour was preferable in texture, and flavours of the control sample and the one supplemented with it were identical (Hossain, 2014). Overall acceptance of bread and biscuits manufactured with less than 30% jackfruit seed flour was acceptable; however, the overall acceptability of the breads and biscuits declined with additional increase in the jackfruit seed flour concentration (Butool and Butool, 2015).

Noodles made from jackfruit seed flour demonstrated useful qualities. When noodles were developed using a feeder speed of 16 rpm and a drying temperature of 60 °C, the addition of 10 and 20% jackfruit seed flour led to decreased calorie and carbohydrate contents, but increased protein, fiber, and mineral contents, as well as improved sensory qualities (Kumari *et al.,* 2015). Incorporating 20% jackfruit seed flour into the extruded noodles led to higher yields and faster cooking periods. The color of the pasta changed when the jackfruit seed flour was added. The taste of the jackfruit seed was detectable when 15% and 20% of seed flour were added to pasta. It was also said that the addition of seed flour increased the pasta's rigidity (Kumari and Divakar, 2017).

Packed with convenience and extended shelf life, processed snack foods give a substantial reduction in calories compared to a typical meal. Innovative product development is of great importance to the processed food business as a means of drawing in customers. Cereal bars with 30% and 40% jackfruit seed meal demonstrated higher fiber levels, improved sensory qualities, and nutritional benefits comparable to other bars on the market (Santos *et al.,* 2011). When compared to commercially available cereal bars without the addition of this exotic fruit, the development of a cereal bar using 15% jackfruit seed flour maintained the hardness and crispness (Torres *et al.,* 2011) and when jackfruit seed flour was added, the snack bar's protein level increased (Meethal *et al.,* 2017). In order to make chapatis, jackfruit seed flour, Bengal gram flour, and whole meal wheat flour were combined in various ratios; the inclusion of 10% jackfruit seed flour demonstrated the best acceptability overall (Sultana *et al.,* 2014).

2.7 APPLICATION OF JACKFRUIT SEED AS AN ALTERNATIVE SOURCE OF STARCH AND FIBRE

The use of alternative starch sources in industrial applications has garnered more attention in recent years. Therefore, jackfruit seeds has drawn the interest of several studies as a powerful source of starch. One effective method to increase its use is to convert fresh seeds into flour. The jackfruit seed flour's water and oil absorption capabilities have been determined to be 200% and 90%, respectively, which provide it the ideal functional qualities for use in the food industry (Mahanta and Kalita, 2015). The carbohydrate content of jackfruit seeds is high- roughly 20% on a dry basis (Tulyathan *et al.,* 2002). The potential application of jackfruit seeds as a powerful source of starch in the food and pharmaceutical sectors is suggested due to the approximately 77% yield of starch recovered from the seeds. When compared to starch from other sources, the gelatinization temperature of jackfruit seed starch was greater. Through chemical modification, jackfruit starches can have their qualities changed or enhanced, such as their resistance to enzymatic degradation and their capacity to absorb water and gelatinize at a temperature that is higher than normal (Kittipongpatana *et al.,* 2011).

Jackfruit starch gels have a high degree of freeze stability, as demonstrated by the effects of various extraction conditions on the characteristics of acid-alcohol modified jackfruit seed starch. These features may find use in the confectionery, paper, and textile sectors (Dutta *et al.,* 2011). Incorporating jackfruit seed starch at 1% level has been found to preserve the pH, titratable acidity, and total soluble solids in chilli sauce. In comparison to chilli sauce that was combined with maize starch, chilli sauce that included jackfruit seed starch has shown signs of improved quality. The combination of 27% dehydrated jackfruit pulp with 11% jackfruit seed four has produced cereal bars with high sensory and nutritional qualities (Santos *et al.,* 2011).

Jackfruit seed is an excellent source for use in prebiotics, since it also includes a considerable quantity of nonreducing carbohydrates (Bhornsmithikun *et al.,* 2010). The use of jackfruit seed powder as a carbon source in *Aureobasidium pullulans* synthesis AMC2195 was identified as one of the most relevant medium components with the significant level of 98.6 % followed by $ZnSO_47H_2O$ (93.5 %), K_2HPO_4 (91.5 %) and yeast extract (85.8 %) on pullulan production. The fact that the microbes can use jackfruit seed powder as a source of both carbon and energy was found to be distinctive. (Govindasamy *et al.,* 2013) *Streptococcus equinus* was used to produce lactic acid using jackfruit seed powder as a substrate so as to provide value to an agricultural waste item through biotechnology intervention (Nair *et al.,* 2016). The potential to use jackfruit seed starch powder in irbesartan fast-dissolving tablets as a unique natural super disintegrant has been successful (Suryadevara *et al.,* 2017).

2.8 APPLICATIONS OF UNDERUTILIZED PARTS OF JACKFRUIT

2.8.1 Feed for animals

The jackfruit peel, which contains 24%, 8.7%, and 17.3% of carbohydrates, protein, and fiber, respectively, is a valuable raw material for cattle feed. (Subburamu *et al.,* 1992). By adding nitrogen and fermenting with yeast (*S. boulardii*) and *lactobacillus acidophilus* (LAB), jackfruit waste may be utilized to create nutrient-enriched animal feed. The jackfruit waste feed added with 2% ammonium sulfate and fermented by mixed yeast and LAB had the greatest levels of crude protein (22.34%) and crude fiber (23.37%). Ajey *et al.* (2013) reported that the dry powder feed made from jackfruit waste had the following composition: moisture 5.42%, carbohydrate 71.40%, protein 23.81%, crude fiber 22.63%, crude fat 6.37%, and ash 6.5%. The peel and axis of jackfruit waste have great promise as ruminant fodder, particularly for sheep and steers. The sheep diets were made using a variety of combinations of rice straw, urea, and jackfruit waste. Sheep's consumption of jackfruit waste decreased when urea was added, but their intake of rice straw increased their response. The rumen ammonia contents of sheep receiving "N" supplementation were positively correlated with the higher digestibility of the meal ingredients. According to Kusmartono *et al.* (2007), the authors recommended supplementing cattle feed with molasses-urea cake instead of combining urea with jackfruit waste to maximize digestion.

2.8.2 Synthesizing bio-oil

Through the application of a fixed-bed reactor for the pyrolysis process, waste jackfruit peel could be converted into bio-oil. The peel exhibits a significant concentration of volatile chemicals during pyrolysis at temperatures between 400 and 700 °C, suggesting that the biomass is a promising precursor for the synthesis of bio-oil. According to Soetardji *et al.* (2014), low levels of sulfur (0.03%) and nitrogen (0.61%) were clear indicators that the bio-oil was environmentally benign. At 550°C, the biofuel with the highest organic content (85.2%) and the lowest water content (14.8%) was of the highest quality. According to Babu *et al.* (2017), jackfruit seed oil is high in EFA (1.35 g/100 g), with linolenic and alpha-linoleic acids standing out for their antioxidant qualities. EFA supports the body's normal operation, particularly that of the brain, neurological system, hormone synthesis, and other regulatory systems, including blood circulation, all of which help ward off chronic illnesses.

Jackfruit peel may be fermented to produce bio-ethanol (oxygenated fuel) with the help of *Saccharomyces cerevisiae* yeast. The primary basic materials used in the biological process of producing ethanol were sugar, carbohydrates, and cellulose. The ideal circumstances were found by examining the effects of several factors, including the nutrients, temperature, shaking rate, fermentation period, and peel composition of the jackfruit. The outcome shows that raising the temperature reduced ethanol extraction while raising the composition of jackfruit peel enhanced it (Yuvarani and Das, 2017).

2.8.3 Bio-char

For anaerobic digestion and gradual pyrolysis, jackfruit peels and seed types as feedstocks were used. Thus, revealed that the peels and seeds of jackfruit were suitable feedstocks for slow pyrolysis. A gradual pyrolysis regime is applied to seeds and peels. Their conclusion was that there is a chance to produce biochar from jackfruit peels and seeds (Nsubuga *et al.,* 2021). According to Ibrahim's (2019) research, heavy metals from aqueous solutions might be effectively adsorbed by activated Jackfruit peel biochar. According to this study, jackfruit peel is a practical and affordable way to remove heavy metals from aqueous solutions, including Cd, Pb, Cu, Fe, and Mn. Functional groups in the biochar allowed metal ion binding. Abid (2019) synthesized biochar using peels and seeds to remove copper metal ions from water. The peel-derived biochar demonstrated a high adsorption capability.

2.8.4 Extraction of pectin from jackfruit peel

Utilizing several organic and mineral acids, jackfruit peel was examined for pectin content (Xu *et al*., 2018). They presented a novel technique for extracting pectin called Ultrasonic Microwave Assisted Extraction and evaluated how well it performed in comparison to a traditional heating approach. The optimized ideal circumstances were 86 °C for the extraction, 29 minutes for the duration, and a solid-liquid ratio of 1:48 (w/v). The UMAE technique performed better. A decent amount of calcium pectate (1.74-1.92%) was produced by characterizing the pectin from the core of jackfruit waste that had been treated with sodium hexametaphosphate, ammonium oxalate, and diluted sulfuric acid. But when compared to commercial pectin, the extracted pectin had a higher ash content and was less soluble (Begum *et al*., 2014). Conventional isolation (14.59%) and microwave isolation (17.63%) gave the highest pectin yields.

Isolating the pectin quality via microwave isolation takes less time than traditional isolation. Pectin is extracted from the peels of *Mangifera indica* and *Artocarpus heterophyllus* from jackfruit wastes, and it is widely used in food industries as a gelling agent and stabilizer. Methoxyl anhydrouronic acid concentration and esterification degree were analyzed qualitatively and quantitatively using powdered pectin. Peels from jackfruit and mango were discovered to be rich sources of pectin, yielding 7.33% for jackfruit wastes and 10.33% for mangoes.

2.8.5 Extraction of bio-potent substance

Zhang *et al.* (2017) conducted a comparative analysis to measure the antioxidant and hypoglycemic contents of jackfruit peel, pulp, and seeds. When the extracts were subjected to a High-Performance Liquid Chromatography analysis, it was discovered that the peel extract had higher levels of total phenolic and total flavonoid components than the pulp and seed extracts. The primary bioactive components of peel extract, such as glycosides, hydroxy cinnamic acids, and prenylflavonoids, were also present. A novel source of natural antioxidants and hypoglycemic agents was found in the peels of jackfruit.

2.8.6 Nano-porous adsorbent

The jackfruit peel is utilized as a nano porous adsorbent to remove rhodamine (Rd) dye from wastewater in the race to identify organic compounds to remove industrial dyes. The degree of dye elimination by the jackfruit peels at various doses, temperatures, and pH levels was demonstrated by the Freundlich isotherm model (Jayarajan *et al.,* 2011). According to the study, jackfruit peel is an inexpensive substitute that may be used to eliminate red color from commercial wastewater.

The application of jackfruit seeds as an adsorbent against malachite green, a dye with several uses in the textile industry (Kooh *et al.,* 2018), Their investigation revealed that neither temperature changes nor salt had an effect on the dye's ability to be adsorbed by seeds. Because seeds could be repurposed by employing water and base, this approach also proved to be a workable and affordable alternative. Turbid water may be treated with the help of starch derived from leftover jackfruit seeds. Chromium may be efficiently extracted from aqueous solutions using biosorbents (Giri *et al.,* 2021).

2.8.7 Extraction of jackfruit seed oil

Babu (2017) conducted a study on the conventional milling method used to obtain oil from jackfruit seeds. It took around 6 kilograms of the seeds to extract 2 litres of oil. He said that the oil from jackfruit seeds was high in linoleic and alpha-linolenic acids, two types of essential fatty acids. The free fatty acid content of the jackfruit seed oil was calculated to be 1.35 g/100 g. Jackfruit seed oil was rich in carbs, proteins, and antioxidants. It also had a lot of potassium.

2.9.8 Usage of jackfruit perianth

The edible bulbs of jackfruit are divided into sections by filaments that resemble of latex and are usually referred to as "rags" or perianth. This waste part makes up around 25% of the weight of the fruit overall. Dam and Nguyen (2013) produced a fermented drink utilizing fruit rags and examined the impact of varying pectinase rates and temperatures. The study discovered that using 0.3% pectinase at 90°C was the ideal temperature for juice extraction. When the beverage was held at 25°C for 84 hours, the optimal fermentation condition was reached. Important nutrients found in perianth meal included 12.7% crude fibre, 10.3% protein, and 28.9% carbohydrates (Subburamu *et al.,* 1992).

2.9.9 Cellulose

The process of isolating cellulose from a variety of agricultural wastes, including lotkon (*Baccaure aramiflora* Lour.) skins, lychee (*Litchi chinensis* Sonn.) skins, and non-edible parts of jackfruit (*Artocarpus heterophyllus* Lam) was standardized. From those separated cellulosic components, cellulose acetate and carboxymethyl cellulose were produced. The produced cellulose derivatives, could be employed for a variety of commercial and industrial uses, which were distinguished by FTIR spectrum analysis and titrimetric method analysis (Rahman *et al.,* 2014).

2.9.10 Cosmetic and pharmaceutical industries

According to Patowary (2022), the only medium required for the generation of noncytotoxic rhamnolipids is jackfruit waste. The results of the studies showed that the final product significantly inhibited *Alternaria solani* growth. The nontoxicity of the generated rhamnolipids suggests that cosmetics and medicines could employ them. Polysaccharides from jackfruit seeds were extracted by Nayak (2015), who discovered that these compounds may be utilized as medicinal excipients in a range of pharmaceutical formulations. Jackfruit pectin is a polysaccharide with several uses. It may be used as a binder in tablet formulations and as a flexible delivery agent to encapsulate medications (Khedmat *et al.,* 2020). The purpose of the calcium pectinate-jackfruit seed starch mucoadhesive beads that Nayak and Pal (2013) created was to assess the drug's encapsulating properties as well as its cumulative release over time. After oral dosing, this study observed favorable impacts on yields, mucoadhesive properties, and a substantial hypoglycemic effect in diabetic rats.

Chromium could be successfully extracted from aqueous solutions using the jackfruit seed kernel bio-sorbents (Giri *et al*., 2021). Protein from fungus biomass was discovered in leftover jackfruit seeds. The starch from leftover jackfruit seeds were used as coagulants to help treat murky water. Utilizing jackfruit seed as bio-adsorbent, cadmium could be adsorbed from aqueous solutions, aiding in the reduction of pollution.

2.9 JACKFRUIT AS A VERSATILE FOOD SOURCE

In India, Jackfruit (*Artocarpus heterophyllus* Lam) is one of the most valuable and popular fruits. Of all the edible fruits, it is the biggest. The jackfruit tree is unique among moraceae trees in that it yields more fruits than any other tree in the family. The jackfruit tree serves several purposes for farmers and is valued greatly for its many benefits, including fruit, fodder, lumber, food, medicine, fragrance, and veggies. It is often referred to as poor man's fruit (Khan *et al.,* 2021). Although fruits and vegetables contain bioactive chemicals, the benefits of eating them for the prevention of certain diseases are now greatly acknowledged (Galaverna *et al.,* 2008). In recent years, consumers, experts and the food industry have all become more interested in the ways that food items might support a healthy lifestyle (Vinuda *et al.,* 2010). The fruit, seeds, bark, wood, and leaves of the jackfruit plant can have varying degrees of antibacterial action. Therefore, jackfruit seeds may be used for producing medicinal compounds, that can cure infectious disorders and stop food-borne viruses from contaminating food. The antibacterial properties of jackfruit seed prevents the growth of bacteria such as *E. Coli, F. moniliforme, S. cerevisiae, and B. megaterium* (Swami *et al.,* 2012).

Due to the high pectin and cellulose content of jackfruit wastes, such as the perianths of unfertilized fruits, they are typically processed to create syrups and jellies. It may be used for the preparation of animal feeds, and cattle may benefit from ingesting the remaining parts of fruits, such as their rinds. It is vital to ensure optimum digestion (Feili *et al.,* 2014). For greater digestion, cattle are fed molasses-urea cake in addition to jackfruit waste (Haq *et al.,* 2006). However, it makes up just around 16% of the entire breadth of the fruit. As the fruit ripens, the amount of latex in the core increases, yet it still becomes compact. The overall worth and safety of whole jackfruit or different extracts made from its parts are comparable to those of therapeutic plants (Ejiofor *et al.,* 2014).

Although people do not use or recognize jackfruit seeds as much, they are a significant source of nourishment and make about 10% to 15% of the fruit's weight. The seeds are extracted from the mature fruit, sun-dried, and suitably stored in various regions of South India for preparation in the rainy season. A significant number of seeds are wasted every year as a result of the challenges involved in processing and storage. The seeds have a one-month shelf life when kept in a cold, damp environment, but because they are perishable, they are typically thrown out as trash. The roasted seeds can be ground into a powder and used to various items to increase their shelf life. When combined with wheat flour and other inexpensive flours, jackfruit seed powder can be used as a substitute for flour in baked goods and confections (Hossain, 2014). Malnutrition is one of the major problems in India due to inadequate protein intake.

In addition to vitamins B complex group such as thiamin, riboflavin, and niacin, jackfruit also includes minerals such as calcium and potassium. It's said that jackfruit seeds are more nutrient-dense than the fruit's bulb. Seeds include a reasonable quantity of calcium and phosphorus and are high in potassium, protein, fat, and carbohydrates (Rahim and Quaddus, 2000). Vitamin C may be found in good amounts in jackfruit. It was found that 100g of mature jackfruit pulp contains 1.9 g of proteins and several amino acids, including arginine, cystine, histidine, leucine, lysine, methionine, threonine, and tryptophan (Theivasanthi *et al.,* 2011). The protein content in jackfruit seeds can range from 5.3% to 6.8% (Chrips *et al.,* 2008). The protein percentage of the pulp and seed of several jackfruit types has varied, ranging from 17.8–37% and 0.57–0.97%, respectively (Swami *et al.,* 2012).

One potential cost-effective substitute protein source to address malnutrition is jackfruit seeds (Chowdhury *et al*., 2012). Consumer knowledge of the diet-disease association has raised the market for jackfruit seeds. Since it provides extra physiological advantages in addition to basic nourishment, it is thought to be a powerful functional food element.

2.10 APPLICATION OF JACKFRUIT IN THE FOOD INDUSTRY

Several studies have demonstrated the antioxidant, anti-cancer, and protective effects of jackfruit and its derivatives (peel, seed, flour, chips, and wafers, among others) as functional foods for conditions of the skin and blood vessels. Bulk jackfruit may be used to make a wide variety of dishes and drinks, including jams, juices, wines, concentrates, and functional drinks. Moreover, these molecules have the ability to taste or color food (Bapat *et al.,* 2021). Zhu (2018) discovered that jackfruit seed starch has a lot of promise for use in the food sector as a material for microcapsule shells.

According to Odoemelam (2005), jackfruit seed flour may be utilized as a functional ingredient since it lowers the amount of gluten in baked foods. Nanoparticles made from jackfruit seeds with antimicrobial qualities have been suggested as agents against foodborne infections. According to published research, adding jackfruit flour to chocolate cream improved its sensory qualities like viscosity and color. It also significantly increased the number of polyphenols (127.00 mg/g), carotenoids (160.16 mg/g), and antioxidant activity (IC50 = 42.75 g/mL). High quantities of protein have also been found in jackfruit seed flour, according to recent studies on its nutritional qualities (Abedin *et al.,* 2012). Since jackfruit seed starch contains more amylose than modified starch, it might be used in its place. High levels of phytochemicals and saponins have been detected in jackfruit seeds (Gupta *et al.,* 2011). Plant-based pharmaceutical products and functional medicines may be made from jack fruit seeds, which have a high concentration of flavonoids and reduction potential (Shanmugapriya *et al.,* 2011).

According to Cagasan (2020), the sensory panel approved the dinner wine made from jackfruit byproducts such seed coat, pith, rags, peel, and overripe pulp. They had a strong chance of becoming components that might be utilized to prepare wine after just two weeks of fermentation. Low-glycemic diets are often advised for the general public that offer therapeutic benefits for diabetes patients. With jackfruit seeds in place of cocoa powder, Ravindran (2020) created chocolate that had a low glycemic index and exhibited encouraging outcomes. Hamid (2020) used the byproducts of jackfruit to create a nutritious meat substitute. Rags, rinses, and seed powder were used. Higher levels of protein and dietary fiber were found in the produced meat analogue's nutritional makeup. An analysis of the textural characteristics of meat substitutes revealed that chewiness and hardness significantly decreased when wheat gluten level decreased.

The industrial use of underutilized parts of jackfruit can minimize the wastage and environmental pollution. The nutrient and pharmacological profile of jackfruit makes it a highly desirable fruit tree with the potential to reduce diseases among people. From root to leaves, it has been used for medicinal purpose, timber, food etc. Value addition of jackfruit to different products and renewable energy sources can extend its shelf life during off-seasons.

Artocarpus species contributes to the valuable nutrition of the people in each and every country as a source of vitamins, minerals and calories. Jackfruit has food value with various culinary uses. The wood of the tree is used for making melodious instruments and furniture. Many activated carbons and dyes prepared from jackfruit peel will help avoid environmental issues. Proper utilization of jackfruit wastes can increase economic value of the jackfruit and reduce cost of waste disposal. Jackfruit is the good raw material for the isolation or extraction of dye, carbons, fibers and various carbohydrates like pectin, protein, starch, cellulose and its derivatives for various industrial applications.

2.11 SIGNIFICANT ROLE OF DESSERTS IN MEALS

Several inventive mixtures are utilized in traditional Indian items to create a diverse range of delectable milk-based dishes. Kheer, or heat-desiccated and sweetened milk, is a popular dish in India's northwest, central, and eastern regions. In the south, it is known as *payasam*. Another cereal-based dairy treat that is particle-based is kheer. It is a distinctive product that symbolizes the relationship between dairy and food manufacturing (Shivakumar *et al*., 2014). When rice is boiled in milk, a starch-milk interaction forms a thick substance known as "Kheer," a famous traditional milk product in India. Traditionally, it is made by partially dehydrating whole milk in an open pan over a low flame, then gradually adding sugar (Kadam and Gulati, 2013). The dessert known as kheer, which is made of concentrated milk has been sweetened and is popular in South-east Asia, but it is not produced on a big scale because of its short shelf life (Jha *et al*., 2011).

'Kheer' has a reasonably high dietary and nutritional value since it contains whole milk solids together with additional sugar and dried fruits (Manay and Shadaksharaswami, 2001). Due to being laborious, it is made only on auspicious and exceptional days. The procedure necessitates a lengthy period of base (rice) soaking, frequent stirring, scraping, and concentration. A novel approach of instantaneous Kheer preparation was created to address these issues by a farm woman (Sarma *et al.,* 2016).

One of the main topics of study for the food science is the creation of innovative and relatively unique methods, as well as rational technologies for processing raw milk based on deep component separation. Enhancing the nutritious value of food products with addressing various concerns of sensible raw material usage and environmental safety is possible only through technical process improvement and extensive processing of secondary dairy raw materials. The research that aims to create and introduce food items based on the principles of complete non-waste milk processing are pertinent in this contact (Evdokimov *et al.,* 2015).

Dairy items that are nearly always consumed on a regular basis by various consumer groups are known as milk sweets. Because of this, milk desserts may be considered a promising substitute for the development of functional foods that are enhanced with fiber. A study conducted by the addition of Resistant Starch added to vanilla milk desserts found that the off-flavors brought on by this functional component could not be covered up by the vanilla flavor (Ares *et al.,* 2009).

It is only reasonable to assume that consumers will have thoughts to consider consuming functional foods only if they believe them to be healthier than traditional foods. Nonetheless, a consumer's adoption of functional food is influenced by factors other than their health-related interests. Because consumers must include functional foods into their regular diet for a considerable amount of time to reap the health advantages of doing so (Sarubin *et al.,* 2000), the sensory qualities of these meals should not come in the way of its long-term use. When a lot of functional substances are added, disruptive flavors start to emerge, which lowers the product's sensory quality (Urala *et al.,* 2004).

In light of its possible health advantages and functional qualities in food, resistant starch has lately attracted interest as a functional food component (Sajilata *et al.,* 2006). Resistant Starch is a component of insoluble dietary fiber and is the total amount of starch and products of starch breakdown that are not absorbed in healthy people's small intestine (Asp *et al.,* 1992). Certain firms are currently offering and marketing certain components (source of RS), which have certain benefits over other sources of insoluble fiber (Sajilata *et al.,* 2006). An intriguing technique for the production of functional foods takes into account the percentage of customers who lower their overall likes or desire to purchase healthy foods. This allows for the selection of the optimum concentration of functional ingredient to be added to the product. Compared to the conventional milk dessert, just 25% appreciated a chocolate milk dessert with 4% of RS (Ares *et al.,* 2011).

Individual lifestyle changes and dietary preferences have increased the need for nutrient-dense, low-cost food that requires less time to prepare. Therefore, it becomes convincing to develop "ready to eat" or "ready to serve" food sources and ready mixes for multiple food items, which are becoming progressively more prevalent these days (Kadam *et al.,* 2011).

With a background of jackfruit and its various application with particular reference to food industry, the methodology for this study was outlined as depicted in the next chapter.

MATERIALS AND METHODOLOGY

3. MATERIALS AND METHODOLOGY

The present study entitled **"Development of jackfruit seed-based functional and instant ethnic dessert mix"** was aimed at developing an instant dessert mix with jackfruit seed flour, improving its functional properties and evaluation of its quality and sensory attributes. The following headings provide an overview of the present study's methodology.

3.1 Standardization of jackfruit seed-based ethnic base (*Ada*)
3.2 Processing of ethnic dessert base (*Ada*)
3.3 Selection of best dessert base (*Ada*)
3.4 Standardization and quality evaluation of jackfruit seed-based functional and instant ethnic dessert (*Ada Payasam*) mix
3.5 Development of instant ethnic dessert mix
3.6 Functional quality analysis of dessert mix
3.7 Sensory evaluation of ethnic dessert mix
3.8 Quality analysis of ethnic dessert mix
3.9 Storage stability of ethnic dessert mix
3.10 Cost of the products developed
3.11 Statistical analysis

The study was conducted as two experiments:

1. Standardization of Jackfruit seed-based base for ethnic dessert (*Ada*)

2. Standardization and quality evaluation of jackfruit seed-based functional and instant ethnic dessert (*Ada Payasam*) mix.

3.1 STANDARDIZATION OF JACKFRUIT SEED-BASED ETHNIC BASE (*ADA*)

Jackfruit (*Artocarpus heterophyllus* Lam) belonging to the family Moraceae is one of the most popular and evergreen trees. Jackfruit is rich in both macro and micronutrients including carbohydrates, proteins, vitamins as well as minerals that could be a valuable part of food (Ranasinghe *et al.,* 2019). Due to its higher percentage of inedible portion that generates waste, difficulty in peeling and separating edible bulbs from the rind, ignorance of proper postharvest practises, and inadequate processing facilities in the areas where they are grown, it is regarded as an underutilised fruit on a commercial scale. Jackfruit needs to be transformed into minimally processed goods by following proper postharvest procedures. By using standardised jackfruit products, customers may take advantage of the wide range of health benefits that this fruit provides (Srivastava *et al.,* 2020).

3.1.1. Development of Dessert from Jackfruit Seeds

Majority of people with micronutrient deficiencies (mostly of iron and zinc) reside in low-income South Asian nations, including India. A potential solution to this problem is diet diversification, especially by encouraging the use of seeds other than rice and wheat, like coarse cereals and pulses (Rao *et al.,* 2018). Plant seeds are unexplored items that might be a beneficial addition to people's regular diets (Cervera *et al*., 2022) besides Indians have vegetarian diets (Devi *et al.,* 2014), with high consumption of wheat and rice (Khat-kar *et al.,* 2016).

3.1.1.1. *Collection of raw materials*

The seeds of the two popular jackfruit cultivars in Kerala, *koozha* cv. and *varikka* cv., were selected for the study. Mature fruits were selected in order to collect seeds and the fruit bulbs were used for making jackfruit preserve. The ripened fruit was procured from the local markets and the Instructional farm at the College of Agriculture, Vellayani. Banana, Milk powder, Coconut milk powder, Sugar and Jaggery were procured from the local market.

3.1.1.2 *Preparation of raw materials and processing Treatments*

The seeds from both varieties were cleaned manually, seed coat and testa were peeled off manually before processing. The pre-processing for the ethnic dessert base was done using three treatments.

p_1 - Boiling and grinding

p_2 - Drying and powdering

p_3 – Flaking

Seeds from both cultivars were subjected to the following treatments.

Plate 1. Two common cultivars of jackfruit

Varikka

Koozha

Plate 2. Boiling and grinding treatment

Boiling

Varikka batter

Koozha batter

Plate 3. Drying and powdering

Sliced

Tray dried

Ground into powder

Plate 4. Flaking

Tray dried

Roasted

Flaking machine

Jackfruit seed flakes

For the treatment p_1, the peeled jackfruit seeds, were finely diced and reduced in size and boiled for five to ten minutes followed by grinding into paste using sufficient amount of water.

For p_2, the jackfruit seeds were tray dried in cabinet driers at 70°C for 2 hours after dicing and ground to fine powder.

For p_3, the seeds were soaked for about 15 minutes, dried at 60°C for half an hour, roasted for 10 minutes in an open pan at low flame and then flaked using the flaker machine (2mm diameter). Jackfruit seed flakes thus obtained were directly used with other ingredients instead of cooking for instant dessert mix. The time and temperature for each treatment was standardised.

3.12 PROCESSING OF ETHNIC DESSERT BASE (*ADA*)

Jackfruit seed-based ethnic dessert was prepared using the bases (p_1 & p_2) obtained from processing treatments mentioned in 3.1.1.2. The methods of cooking the base (*Ada*) were as follows:

c_1 - Steaming

c_2 – Boiling

For the treatments c_1, the base material was blended with water to form the required consistency. The batter was then spread over thin aluminium foil/ butter paper. The butter paper was then placed in a steamer by covering with a lid and it was steamed for 10 –15 min respectively.

For the treatment c_2, the base material was blended with water to form the required consistency. The batter was then spread over thin aluminium foil/ butter paper. The aluminium foil was rolled after spreading the batter and it was immersed in the boiling water (100°C) for 10 –15 minutes respectively.

After cooling, the base (*Ada*) was separated from the aluminium foil/ butter paper, cut into small pieces and dehydrated to constant weight and required moisture content. The time and temperature of dehydration was standardized. The *Adas* obtained from p_3 was directly used for preparing instant dessert mix.

Table: 1 Treatments– cultivars x processing treatment x cooking methods

$v_1p_1c_1$	$v_2p_1c_1$
$v_1p_1c_2$	$v_2p_1c_2$
$v_1p_2c_1$	$v_2p_2c_1$
$v_1p_2c_2$	$v_2p_2c_2$
v_1p_3	v_2p_3

v_1 – *Varikka* v_2 –*Koozha*

p_1– Boiling and grinding p_2 –Drying and powdering p_3 –Flaking

c_1 – Steaming c_2– Boiling

3.3 SELECTION OF BEST DESSERT BASE (*ADA*)

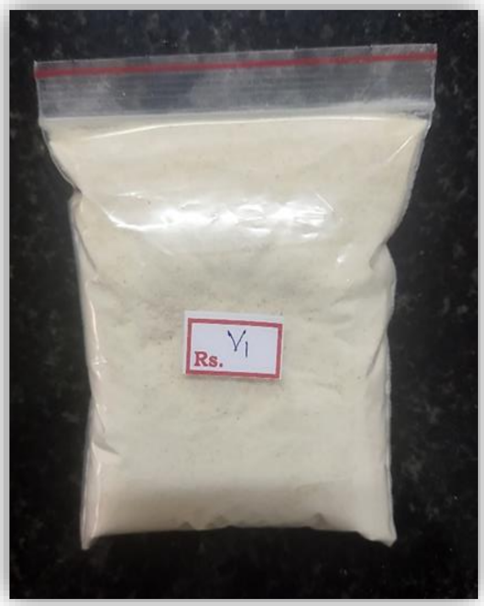
For selecting the best ethnic dessert base ingredient (*Ada*) standardized from the above treatments, the functional properties like rehydration ratio, yield ratio, solubility index and organoleptic evaluation of each combination was conducted and compared with the instant rice *ada* available in the market. The best ethnic dessert base (*Ada*) formulated from each cultivar was selected for the next experiment.

3.3.1. Assessment of functional qualities of ethnic dessert base ingredient (*Ada*)

Functional properties are the essential physicochemical properties of foods that reflect the complex interactions between the structures, molecular conformation, compositions, and physico-chemical properties of food components with the nature of the environment and conditions in which these are measured and associated (Suresh and Samsher, 2013). Functional properties also describe the behavior of ingredients during preparation and cooking, as well as how they affect the finished food products in terms of how it looks, feels and tastes.

Functional qualities such as rehydration ratio, yield ratio and solubility index of the 10 samples were analyzed.

Plate 5. Steaming method of cooking



Jackfruit seed flour

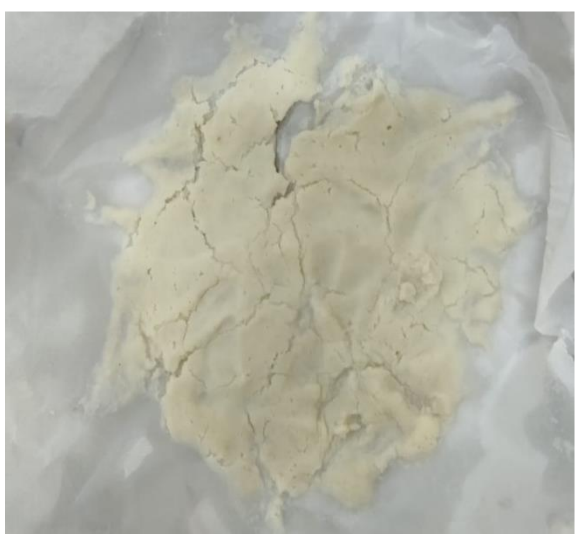

Blended with water (Batter)


Steamer


Ada

Plate 6. Boiling method of cooking

Batter



Starchy consistency

3.3.1.1 Rehydration ratio

To ascertain the rehydration ratio of jackfruit seed-based dessert base, ten grams of the sample were taken, combined with 100 milliliters of distilled water, stirred, and allowed to stand for five minutes. Paper filters were used to filter the contents. Using the formula (Ranganna, 1995), the rehydrated sample was weighed and the rehydration ratio was computed.

$$\text{Rehydration ratio} = \frac{\text{Weight of the sample (g)}}{\text{Drained weight of the sample (g)}}$$

3.3.1.2 Yield ratio

Yield ratio of the developed products was analyzed using the formula.

$$\text{Yield ratio} = \frac{\text{Final weight of product (g)}}{\text{Weight of the ingredients (g)}}$$

(Krishnaja, 2014)

3.3.1.3 Solubility index

Considering only a few modifications, the solubility index was calculated using Anderson *et al.* (1969)'s methodology. After one gram of material was suspended in ten milliliters of distilled water in a centrifuge tube, it was centrifuged for ten minutes at 3000 rpm for 30 minutes at room temperature with moderate stirring in between. After being weighed out, the supernatant was placed in a petri dish and dried at 110°C in a hot air oven. The weight of the dry soluble solids in supernatant, or g/g, is the solubility index. It is represented as a percentage of the initial sample weight.

The percentage solubility of the supernatant was calculated by

$$\text{Solubility} = \frac{\text{Weight of dry solids}}{\text{Volume of supernatant}} \times \frac{100}{\text{Weight of sample}}$$

3.3.2 Sensory evaluation of dessert base ingredient (*Ada*)

The sensory quality of food has been considered an important parameter from the start of the food industrialization process since it affects the product's overall quality. Characterizing and quantifying a product's sensory qualities is done through sensory evaluation. Sensory evaluation is a scientific discipline that aims to elicit, measure, analyse and, interpret consumer reactions to products as they are experienced through the senses of sight, smell, touch, taste and hearing (Sidel and stone, 1993). When procuring foods, sensory assessment is used to determine preferences, pinpoint the most crucial food qualities that influence purchases, and also get to know the customer (Kraus, 2015). A crucial element of sensory analysis involves the panelists. It's worth is determined by how accurate, unbiased, and trustworthy its judgments are. Panelists must be carefully selected, trained, calibrated, and validated. Food products' shelf lives can be evaluated through the use of sensory evaluation techniques. Changes in a food product's sensory qualities can shorten its shelf life, and customers are becoming increasingly picky about the freshness, safety, and quality of items.

Sensory evaluation of the dessert base was carried out by cooking 15g of the developed dessert base (*ada)* with 20g of milk powder in 200ml water and 5 g of sugar. Sensory evaluation was performed by 15 semi-trained panelists after evaluating their sensitivities on a test of fundamental taste and aroma recognition.

3.3.2.1 Preparation of score card

Sensory acceptability of the dessert mix was evaluated by panelists on a nine-point hedonic scale to evaluate the sensory attributes such as color and appearance, taste, texture, flavour, and overall acceptability of the samples.

Where 9 indicates like extremely, 8 indicates like very much, 7 indicates like moderately, 6 indicates like slightly, 5 indicates neither nor dislike, 4 indicates dislike slightly, 3 indicates dislike moderately, 2 indicates dislike very much and 1 indicates dislike extremely (Ndife *et al.,* 2011).
The differences in scores were analysed using Kruskal-Wallis test.

Plate 7. Sensory evaluation of dessert base

3.3.3 Selection of best treatment

From the 10 samples, the best treatment from each variety was selected based on the results of functional quality analysis and sensory evaluation. The best treatment was selected for the development of ethnic dessert mix.

Design: CRD

Treatment: (2×2×2) +2 = 10

Replication: 3

3.4 STANDARDIZATION AND QUALITY EVALUATION OF JACKFRUIT SEED-BASED FUNCTIONAL AND INSTANT ETHNIC DESSERT (*ADA PAYASAM*) MIX

As the second experiment, the best base ingredient from the previous experiment was used to formulate the jackfruit seed-based functional and instant ethnic dessert mix. The Ada was combined with the different ingredients as follows:

f_1 – JSBM + Sugar + Jackfruit Preserve + Milk Powder

f_2 – JSBM +Sugar + Jackfruit Preserve + Coconut Milk Powder

f_3 – JSBM +Jaggery + Jackfruit Preserve + Milk Powder

f_4 – JSBM + Jaggery + Jackfruit Preserve + Coconut Milk Powder

f_5– JSBM + Sugar + Banana Preserve + Milk Powder

f_6 – JSBM +Sugar+ Banana Preserve + Coconut Milk Powder

f_7– JSBM +Jaggery + Banana Preserve + Milk Powder

f_8 – JSBM + Jaggery+ Banana Preserve + Coconut Milk Powder

Design: CRDs

Treatment: 8×2=16

Replication: 3

Table: 2 Treatment x cultivar

f_1v_1	f_1v_2
f_2v_1	f_2v_2
f_3v_1	f_3v_2
f_4v_1	f_4v_2
f_5v_1	f_5v_2
f_6v_1	f_6v_2
f_7v_1	f_7v_2
f_8v_1	f_8v_2

3.4.1. Preparation of functional ingredient

Foods can be considered "functional" if they aid in the efficient execution of one or more specific processes in the body, providing beyond simply sufficient nourishment, enhancing overall health and well-being, or lowering the risk of disease. It simply implies that foods can be referred to as functional foods if they include pertinent functional components (Gibson *et al.,* 2000).

Fruits are primarily the sweet, meaty, and sometimes seed-containing product of trees or other plants that are meant to be consumed whole as food. It belongs within the category of conventional foods, whereas its processed counterparts fall under other categories. Fruits have their own benefits when it comes to being a functional food. For example, apples are helpful for the body's general development and growth. It has a large number of vitamins and antioxidants. Another fruit high in simple sugars that gives undernourished kids and athletes rapid energy is the banana. Grapes contain the highest concentration of phenolic chemicals. Grape juice can reduce the body's free radical burden when consumed on a regular basis. Underutilized guava has been proposed as a treatment for diabetes and diarrhea. Another crop that is high in energy and can restore lost physical energy is jackfruit. A great midsummer snack, mangoes are also used medicinally to treat diarrhea, dysentery, hiccups, and sore throats (Divya and Eskin, 2014).

The fruits of the two popular tropical crops in Kerala, Banana cultivar *Nendran* and Jackfruit cultivar *Varikka*, were selected for the making preserve. Mature fruits were procured from the local markets and the Instructional farm at the College of Agriculture, Vellayani. The bananas were peeled, the fibrous core threads were cut out, and then chopped into tiny pieces. The seeds of jackfruit were taken out and the bulb was finely chopped.

3.4.1.1. Preparation of jackfruit preserve:

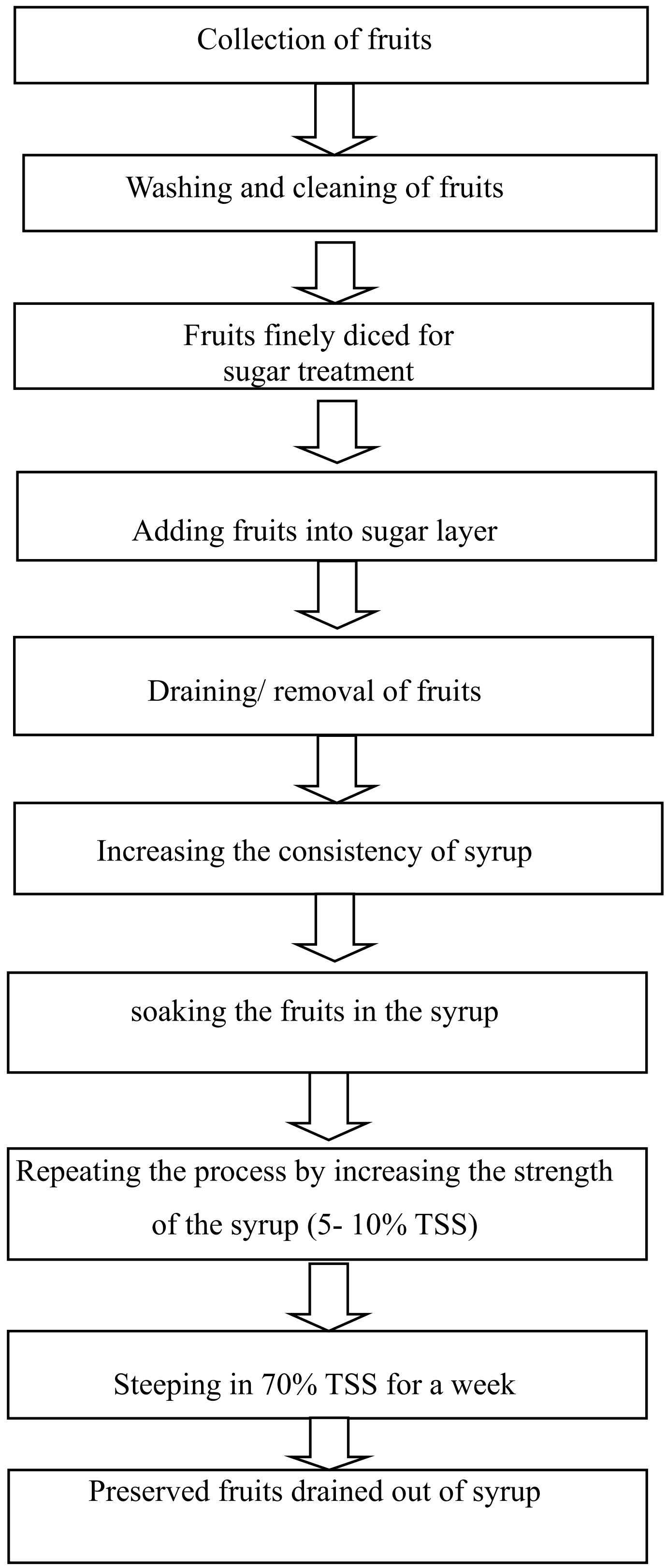
The sliced fruits were blanched in order to soften them. After that, sugar was added to the fruit in alternating layers equal to the weight of the fruit, and the combination was left to stand for a full day. The fruit released water during this time, allowing the sugar to dissolve and form a syrup with 37–38% total soluble solids. After the fruits are removed, the syrup was boiled the next day to increase its strength to around 60% total soluble solids. To avoid crystallization, a tiny amount of citric or tartaric acid (1 to 1.5 g per kg of sugar) was also added in order to invert a portion of the cane sugar. The entire mass was then preserved for 24 hours after boiling it for 4–5 minutes. Boiling the syrup on the third day brought its strength up to around 65 percent of the total soluble solids. After that, the fruit was kept in the syrup for a day. The fruits were then immersed in the syrup for a week after the syrup's strength increased to 70% total soluble solids. The preserves thus prepared, were sealed in jars.

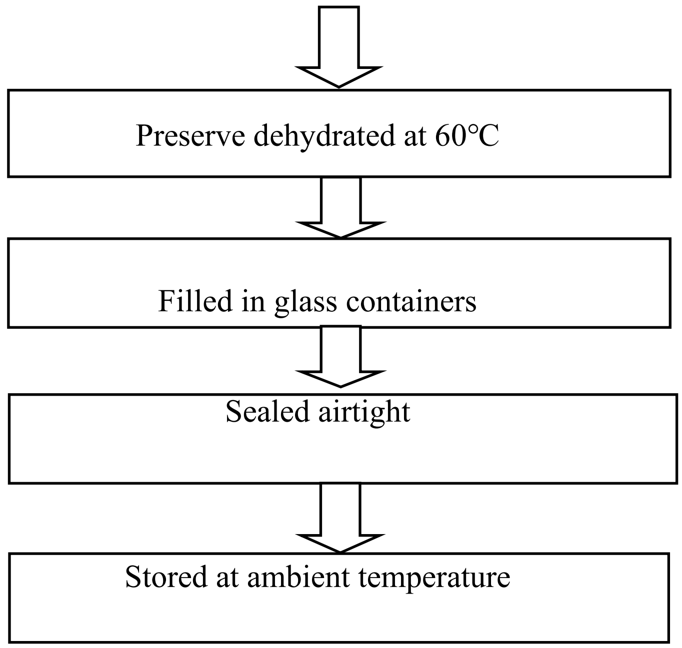
The fruits were covered with syrup both during and after cooking to prevent drying out and compromising the product's flavor. After the final boiling, the product was cooled down quickly to avoid discoloration during storage. The osmotically dehydrated fruits are placed in dry jars or containers made of glass after being drained of syrup and sealed tightly (Swami *et al.,* 2014).

3.4.1.2. Preparation of banana preserve:

The same method used in 3.4.1.1 was used to prepare banana preserve.

Figure: 1 Flow diagram for preparation of functional ingredient (preserve)


Collection of fruits
Washing and cleaning of fruits
Fruits finely diced for sugar treatment
Adding fruits into sugar layer
Draining/ removal of fruits
Increasing the consistency of syrup
soaking the fruits in the syrup
Repeating the process by increasing the strength of the syrup (5- 10% TSS)
Steeping in 70% TSS for a week
Preserved fruits drained out of syrup



3.5 DEVELOPMENT OF INSTANT ETHNIC DESSERT MIX

Figure: 2 Flow diagram for preparation of ethnic dessert mix

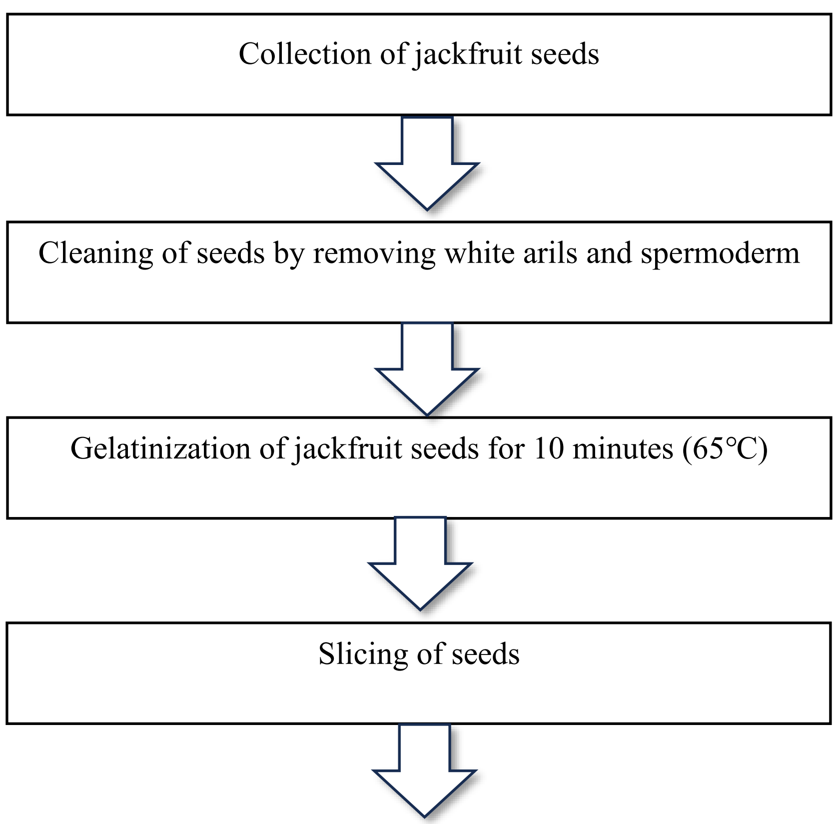
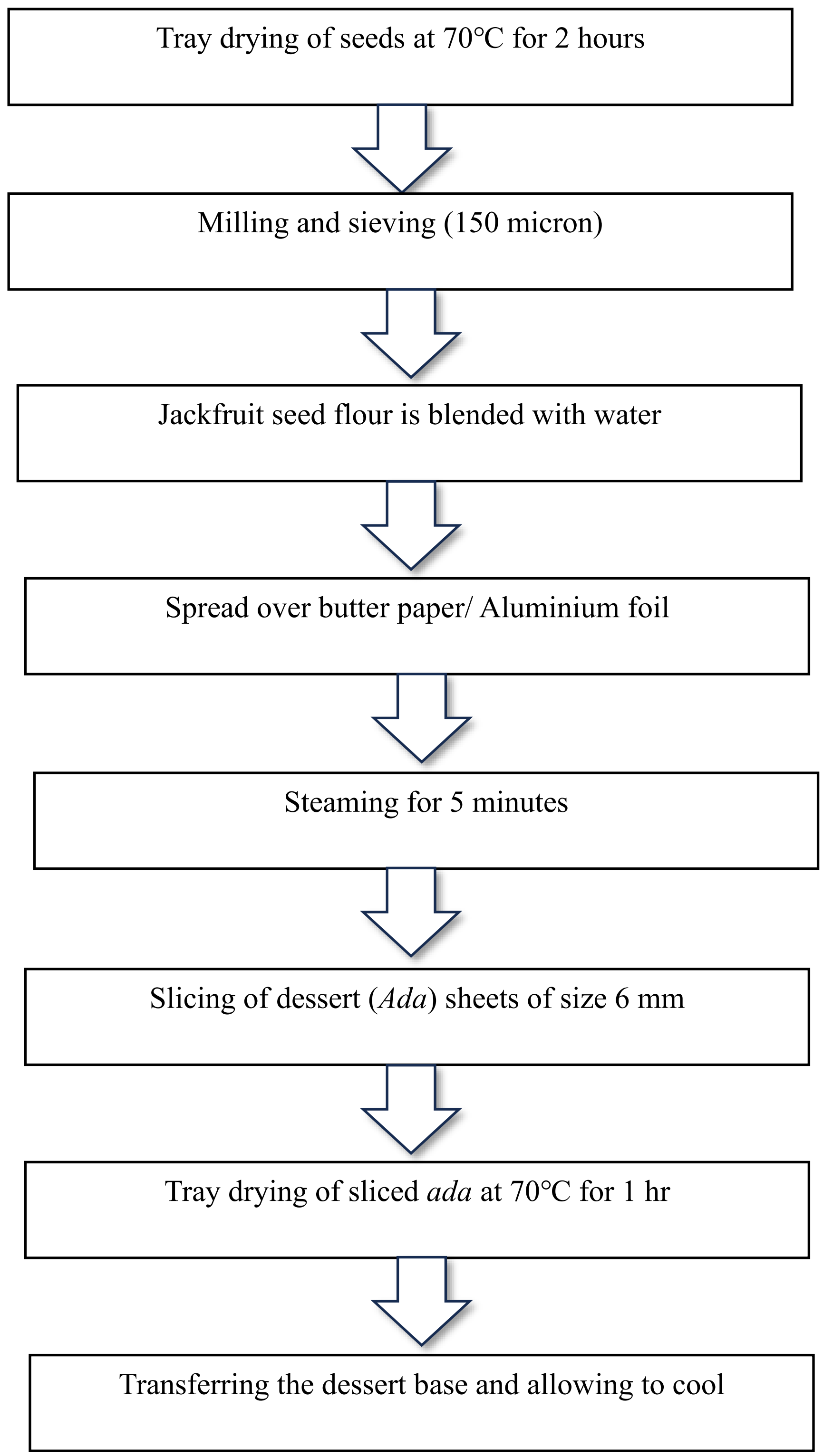


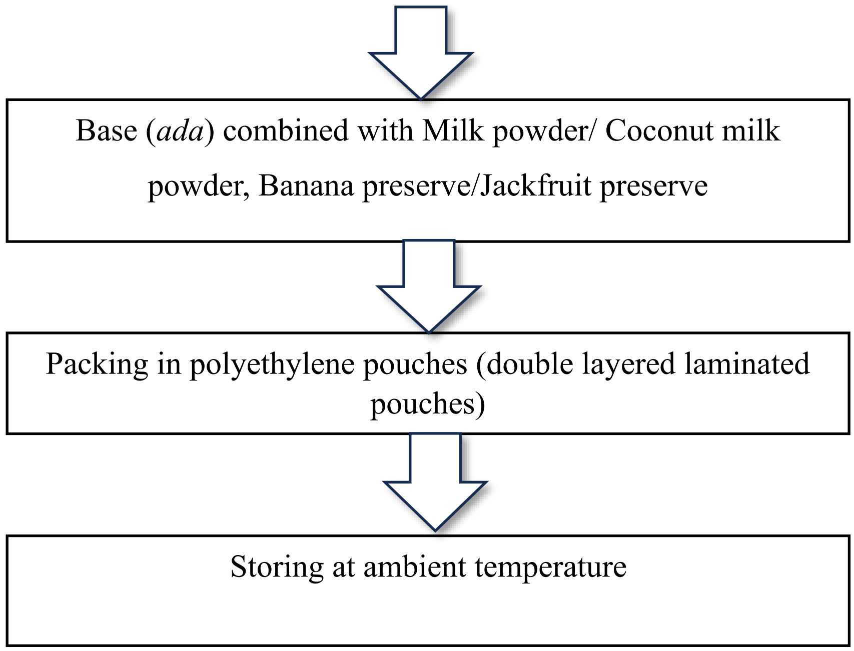
Plate 8. Preparation of functional ingredient

Banana preserves

Jackfruit preserves

Plate 9. Steps followed while processing dessert base


Tray drying of seeds at 70°C for 2 hours
Milling and sieving (150 micron)
Jackfruit seed flour is blended with water
Spread over butter paper/ Aluminium foil
Steaming for 5 minutes
Slicing of dessert (*Ada*) sheets of size 6 mm
Tray drying of sliced *ada* at 70°C for 1 hr
Transferring the dessert base and allowing to cool



3.6 FUNCTIONAL QUALITY ANALYSIS OF DESSERT MIX

3.6.1 Rehydration ratio

The procedure mentioned in 3.3.1.1 was followed.

3.6.2 Swelling power

Swelling power was calculated using a slightly modified version of the approach of Leach *et al*., (1959). one gram of the material and ten millilitres of distilled water was taken in a centrifuge tube and heated for thirty minutes at 80°C. Throughout the heating process, the mixture was mixed frequently. Following heating, the suspension was centrifuged for 15 minutes at 1000 rpm. After removing the supernatant, the paste's weight was measured.

$$\text{Swelling power} = \frac{\text{Weight of the paste}}{\text{Weight of dry sample}}$$

3.6.3 Yield ratio

Yield ratio of the developed products was calculated as mentioned in 3.3.1.2

3.6.4 Water absorption capacity

The technique of Sathe and Salukhe (1981) was employed to determine the water absorption capacity, with a few changes. A weighted centrifuge tube was filled with one gram of sample and ten millilitres of distilled water. After five minutes of continuous shaking, the tube was let to remain at room temperature for fifteen minutes. It was centrifuged for 30 minutes at 5000 rpm after that the supernatant was thrown away. After gently siphoning adhering water droplets over absorbent paper while the tube was inverted, the tube was weighed again. One gram of dry sample powder was used to represent the weight of water bound by the water absorption capacity.

3.6.5 Solubility index

The solubility index of the ethnic dessert mix was analyzed as described in 3.3.1.3

3.7 SENSORY EVALUATION OF ETHNIC DESSERT MIX

While sensory evaluation is the most important aspect of quality assessment, taste evaluations are not practical for routine quality control. Sensory evaluation is also necessary to ensure the success of food products in the market. Without appropriate sensory analysis, there is a high risk of market failure. A quantitative approach that enables the formation of rejection points by sensory techniques is always preferred (Maina, 2018).

Sensory evaluation of jackfruit seed-based ethnic dessert mix was carried out by cooking 15g of dessert base (*ada*) with 20g of milk/coconut powder in 200ml water, 10 g of sugar/jaggery and 5 g of jackfruit/banana preserve.

Sensory evaluation was performed by 10 semi-trained panelist. The differences in scores were analyzed using Kruskal-Wallis test.

Plate 10. Sensory evaluation of dessert mix

3.7.1 Selection of best treatment

Based on the results of functional quality analysis and sensory evaluation one dessert mix from each cultivar of jackfruit was selected as the best and they were subjected for quality analysis and shelf-life study.

3.8 QUALITY ANALYSIS OF ETHNIC DESSERT MIX

After selecting the best dessert mix, the major nutrients like protein, carbohydrate, fat, crude fibre, calcium, moisture and beta-carotene of the selected mixes were analyzed using standard techniques. The techniques are mentioned in table: 3

Table: 3 Method of analysis of nutrient composition of jackfruit seed dessert mix

Constituents	Method adopted
Moisture %	AOAC (1990)
Carbohydrate (g)	Anthrone method
Protein (g)	Kjeldhal plus method
Fat (g)	Soxhlet extraction method
Crude fiber (g)	AOAC (1990)
Calcium (mg)	Jackson (1973)
Beta-carotene (mg)	AOAC (1990)

3.9 STORAGE STABILITY OF ETHNIC DESSERT MIX

The commercial success of a product is contingent upon its stability during storage. When it comes to both microbiological attack and sensory quality stability, the product must be deemed safe for ingestion. To observe the shelf-life quality, the two selected dessert mixes in triplicates were stored separately in double layered laminated pouches at room temperature. Nitrogen gas flushing was also tried before packaging in one set. One pouch from each mix was taken randomly and analyzed. Moisture and microbial profile were analyzed periodically for one month.

3.8.1 Moisture

Moisture content of mixes was determined by thermostatically controlled electric oven dry method. One gram of sample was weighed and placed into an oven at 105°C for overnight. Dishes were removed, covered on the top and placed in desiccators and cooled. Removed from desiccator and weighed as quickly as possible. The percentage of moisture content were then calculated.

3.8.2 Microbial profile

The final two jackfruit seed-based dessert mixes were stored in double layered laminated pouches for a period of 7 days. Total viable count, Yeast and Mold count and Total coliform count were analyzed and number of individual microbes were counted and reported as cfu/g during storage.

3.8.2.1 Composition of total viable count

The selected dessert mixes were analyzed periodically for the presence of mold, coliforms, bacteria, and yeast using the plate count method as outlined by Agarwal and Hasija, 1986. After adding 10 g of the sample to 90 ml of sterile water, the mixture was agitated for 20 minutes. One millilitre of this solution was added to a test tube that held nine millilitres of sterile water, allowing for ten dilutions at once.

3.8.2.2 Composition of bacterial colony

The total number of bacterial colonies in the nutrient agar medium were counted at a 10^{-2} dilution. Melted nutrient agar media was poured into clean petri dish. One ml of 10^{-2} dilution using a micropipette was poured into the petri dish. The inoculum was spread or equally distributed in the petri dish by spinning clockwise and anti-clockwise on the surface of the solidified agar. The enumerated petri dish was incubated for 24 hours at room temperature for bacterial colonies. The total number of bacterial colonies were counted and expressed in colony forming units per gram (cfu/g).

3.8.2.3 Composition of fungal colony

The total number of fungal colonies in the rose bengal agar medium was counted at a 10^{-2} dilution. Pour the melted rose bengal agar media into clean petri dish. One ml of 10^{-2} dilution using a micropipette was poured into the petri dish. The inoculum was spread or equally distributed in the petri dish by spinning clockwise and anti-clockwise on the surface of the solidified agar. The enumerated petri dish was incubated for 48 hours at room temperature for bacterial colonies. The total number of bacterial colonies were counted and expressed in colony forming units per gram (cfu/g).

3.8.2.4 Composition of yeast and mold colony

The total number of yeast colonies in the yeast extract peptone dextrose medium was counted at a 10^{-2} dilution. The melted yeast extract peptone dextrose media was poured into clean petri dish. One ml of 10^{-2} dilution using a micropipette was poured into the petri dish. The inoculum was spread or equally distributed in the petri dish by spinning clockwise and anti-clockwise on the surface of the solidified media. The enumerated petri dish was incubated for 48 hours at room temperature for yeast colonies. The total number of yeast colonies were counted and expressed in colony forming units per gram (cfu/g).

3.8.2.5 Composition of coliform count

The total number of coliform colonies in the eosin methylene blue agar medium was counted at a 10^{-2} dilution. The melted eosin methylene blue agar media was poured into clean petri dish. One ml of 10^{-2} dilution using a micropipette was poured into the petri dish. The inoculum was spread or equally distributed in the petri dish by spinning clockwise and anti-clockwise on the surface of the solidified agar. The enumerated petri dish was incubated for 48 hours at room temperature for coliform colonies. The total number of coliform colonies were counted and expressed in colony forming units per gram (cfu/g).

Design: CRD

Treatment: $2 \times 2 = 4$

Replication: 4

3.10 COST OF THE PRODUCTS DEVELOPED

Cost of the selected two jackfruit seed-based dessert mixes were calculated. Variable cost of products includes cost of food materials, packaging charge and labour cost. The cost of dessert mixes was compared with the cost of other dessert mixes available in the market.

Plate. 11 Developed functional and ethnic dessert mix

Varikka

Koozha

3.11 STATISTICAL ANALYSIS

Data analysis was carried out after tabulating and analyzing the observations of functional quality and nutrient analysis using Completely Randomized Design (CRD). The scores of sensory evaluations of dessert base and mix were estimated using the non-parametric test, Kruskal-Wallis from observed values of mean.

RESULTS

4. RESULTS

The results of the present study entitled **“Development of Jackfruit seed-based functional and instant ethnic dessert mix”** are explained in this chapter under the following headings.

4.1 Standardization of base ingredient for ethnic dessert base (*Ada*)

4.2 Processing of ethnic dessert base (*Ada*)

4.3 Selection of best dessert base (*Ada*)

4.4 Standardization and quality evaluation of jackfruit seed-based functional and instant ethnic dessert (*Ada Payasam*) mix

4.5 Development of instant ethnic dessert mix

4.6 Functional quality analysis of dessert mix

4.7 Sensory evaluation of ethnic dessert mix

4.8 Quality analysis of ethnic dessert mix

4.9 Storage stability of ethnic dessert mix

4.10 Cost of the products

The study was conducted as two experiments:

1. Standardization of Jackfruit seed-based ethnic dessert (*Ada*)

2. Standardization and quality evaluation of jackfruit seed-based functional and instant ethnic dessert (*Ada Payasam*) mix.

4.1 STANDARDIZATION OF BASE INGREDIENT FOR ETHNIC DESSERT BASE (*ADA*)

Over 60 nations commercially produce and nurture the versatile jackfruit tree. In places with constant light and water, jackfruit grows both flowers and fruits throughout the year. The jackfruit has broad climatic adaptability throughout several agro-ecological zones. Although jackfruit can withstand some shade, in its early stages, it requires light and room to grow

(Nakintu *et al.,* 2019). The jackfruit ripens in Asia between July and August, and the seeds range in size and weight from 4 to 14 grams (Gomes *et al.,* 2021).

The extreme perishability of jackfruit results in a significant proportion of post-harvest loss being recorded (Kumar *et al.,* 2021). The edible portions of jackfruit, are the fruit bulbs and seeds, which may be eaten raw or cooked in a multitude of ways. The pulp can also be eaten in its natural state. Fruit that reaches maturity but has not ripened can be cooked like a vegetable since it's high in carbohydrates. The seeds are high in carbohydrate and protein content which makes them suitable for boiling, roasting, and grinding into flour. The rind can be used to make jelly (Madruga *et al*., 2014).

4.1.1 Development of Dessert Base from Jackfruit Seeds

Although people don't use or recognize jackfruit seeds as well, they are a significant source of nourishment and make about 10% to 15% of the fruit's weight. The seeds are taken out from the mature fruit, sun-dried, and suitably stored in various regions of South India in preparation for the rainy season. A significant number of seeds are wasted every year as a result of the challenges involved in processing and storage. The seeds have a one-month shelf life when kept in a cold, damp environment, because they are perishable, they are typically thrown out as trash. The roasted seeds can be ground into a powder and incorporated to various food items to increase their shelf life. By bringing together it with wheat flour and other convectional flours, jackfruit seed powder may be used as a substitute for flour in baked goods and confections (Hossain *et al.,* 2014).

4.1.1.1. *Collection of raw materials*

The seeds of the two popular jackfruit cultivars in Kerala, *koozha* cv. and *varikka* cv., were chosen for the study. Mature fruits were selected in order to collect seeds, and ripe fruit were procured from the Instructional farm at the College of Agriculture, Vellayani, besides the local market.

4.1.1.2 *Preparation of raw materials and processing Treatments*

The seeds from both cultivars were cleaned manually, seed coat and testa were peeled off using a stainless-steel knife before processing. The base for the ethnic dessert mix was processed using three treatments.

p_1 – Boiling and grinding

p_2 –Drying and powdering

p_3 – Flaking

Seeds from both cultivars were subjected to the following treatments.

For p_1, the pre-processed jackfruit seeds, around were finely diced and size reduced, was boiled for five to ten minutes and ground into paste using sufficient amount of water.

For p_2, the jackfruit seeds were gelatinized for 10 minutes in order to remove the anti-nutritional factors which will inhibit nutrient absorption and sensory parameters. After gelatinization, the excess water was drained out. The seeds were then finely diced and tray dried in cabinet driers at 70◦C for 2 hours. The time and temperature were standardized. After tray drying, the seeds were allowed to cool and ground to fine powder.

For p_3, the seeds were soaked for about 15 minutes, dried at 60◦C for half an hour, roasted for 10 minutes in an open pan at low flame and then flaked using the flaker machine. Jackfruit seed flakes obtained was directly used with other ingredients instead of cooking for instant dessert mix. The standardised time and temperature for each treatment is depicted in table: 3.

Table: 3 Standardized time and temperature for each treatment

Treatment	Methods	Time	Temperature
p_1	Boiling	10 min	60◦C
p_2	Drying	2 hr	70◦C
p_3	Drying	30 min	60◦C
	Roasting	10 min	60◦C

For p_1 treatment, the boiling time carried out for both cultivars were standardized as 10 minutes. The seeds from both cultivars were boiled for 10 minutes. The time and temperature of p_2

treatment were also standardized as 120 minutes at 70◦C. Various drying time and temperature were attempted. Finally, for p3 treatment, the seeds were dried for 30 minutes at 60◦C and roasted for 10 minutes at 70◦C.

4.2 PROCESSING OF ETHNIC DESSERT BASE (*ADA*)

Jackfruit seed-based ethnic dessert was prepared using the bases (p_1 & p_2) obtained from processing treatments mentioned in 4.1.1.2. The methods of cooking the base (*Ada*) were as follows:

c_1 - Steaming

c_2 – Boiling

For c_1 & c_2, the base material was blended with water to form the required consistency. The batter was then spread over thin aluminium foils/ butter paper, rolled and steamed/ boiled for 10 minutes respectively.

After cooling, the base (*Ada*) was separated from the butter paper, cut into small pieces of size (6mm) and dehydrated to constant and required moisture content. The time and temperature of dehydration was standardized. The *Adas* obtained from p_3 was directly used for preparing instant dessert mix.

The base obtained from $v_1p_1c_1$ (*varikka* x Boiling and grinding x Steaming) and $v_2p_1c_1$ (*koozha* x Boiling and grinding x Steaming) were gelatinized after cooking. As for $v_1p_1c_2$ (*varikka* x Boiling and grinding x Boiling) and $v_2p_1c_2$ (*koozha* x Boiling and grinding x Boiling), the batter got leached into boiling water and fell into bits. As for $v_1p_2c_1$ (*varikka* x Drying and powdering x Steaming) and $v_2p_2c_1$ (*koozha* x Drying and powdering x Steaming), the *ada* sheets were obtained in less than 5 minutes when the batter was spread over and steamed.

After cooling the *ada* sheets were cut into small pieces about 6mm size and dehydrated for 2 hours in cabinet drier at a temperature of 60°C. The dehydrated base was packed in poly propylene pack and stored at ambient temperature. As for $v_1p_2c_2$ (*varikka* x Drying and powdering x Boiling) and $v_2p_2c_2$ (*koozha* x Drying and powdering x Boiling), the starch granules got thickened with the formation of lumps. The jackfruit seed lacks gluten which is a binding agent of flours used in confectionaries (Akter *et al.,* 2018).

As for the v_1p_3 (*varikka* x Flaking) and v_2p_3 (*koozha* x Flaking), the seeds were flaked with a flaking machine. The machine rotator was adjusted to 2mm in order to get the desired size. Even after many trials, the end product resembled the rice flakes which was thin and dry, and did not have the consistency of the traditional *ada* base.

4.3 SELECTION OF BEST DESSERT BASE (*ADA*)

For selecting the best ethnic dessert (*Ada*) base standardized from the above treatments, the functional properties like rehydration ratio, yield ratio, solubility index and organoleptic evaluation of each combination was conducted and compared with the instant rice *ada* available in the market.

4.3.1 Assessment of functional qualities of ethnic dessert base

The composition, acceptability, nutritional value, texture, structure, and appearance of food products define its functional properties. The jackfruit seed-based dessert base of *varikka* and *koozha* cultivars were analyzed for various qualities such as rehydration ratio, yield ratio and solubility index.

4.3.1.1 Rehydration ratio

Rehydration qualities are used to evaluate the quality of dehydrated products. Rehydration ratio of 10 samples (Table: 01) were calculated as described in 3.3.1.1 and is presented in table: 5.

Table: 5 Rehydration ratio of ethnic dessert base

Treatments	Values	Treatments	Values
$v_1p_1c_1$	1.173^{a}	$v_2p_2c_1$	0.453^{d}
$v_2p_1c_1$	1.233^{a}	$v_1p_2c_2$	1.033^{bc}
$v_1p_1c_2$	1.127^{ab}	$v_2p_2c_2$	0.917^{c}
$v_2p_1c_2$	1.103^{ab}	v_1p_3	1.023^{bc}
$v_1p_2c_1$	0.387^{d}	v_2p_3	1.030^{bc}
c	0.377^{d}		
±SE(m)	0.046		
CV (%)	8.981		

Values are means of triplicates

Treatments with same letters are not significantly different

The table represents rehydration ratio of ethnic dessert base for the formulation of dessert mix.

From the above table it is clear that treatment $v_1p_1c_1$, $v_2p_1c_1$, $v_1p_1c_2$ and $v_2p_1c_2$ has the highest rehydration ratio. The treatment $v_1p_2c_1$, $v_2p_2c_1$ and control have the least value.

4.3.1.2 Yield ratio

Yield ratio of the 10 samples (Table: 01) were calculated as described in 3.3.1.2. The results of yield ratio are depicted in the table: 5 and 6 respectively.

Table: 6 Yield ratio of ethnic dessert base before and after cooking

Treatments	Before cooking	After cooking
$v_1p_1c_1$	1.147^{b}	1.333^{d}
$v_2p_1c_1$	1.210^{a}	1.463^{bc}
$v_1p_1c_2$	1.230^{a}	1.527^{ab}
$v_2p_1c_2$	1.247^{a}	1.603^{a}
$v_1p_2c_1$	0.557^{d}	1.380^{cd}
$v_2p_2c_1$	0.580^{d}	1.473^{bc}
$v_1p_2c_2$	0.593^{d}	1.467^{bc}
$v_2p_2c_2$	0.587^{d}	1.467^{bc}
v_1p_3	0.380^{e}	0.813^{e}
v_2p_3	0.430^{e}	0.773^{e}
c	1.000^{c}	1.600^{a}
±SE(m)	0.02	0.034
CV (%)	4.199	4.401

Values are means of triplicates

Treatments with same letters are not significantly different

The table represents yield ratio before cooking of 10 dessert base samples. From the above table it is clear that treatment $v_2p_1c_2$, $v_1p_1c_2$ and $v_2p_1c_1$ has the highest yield ratio and v_1p_3 has the least yield ratio.

The table represents yield ratio after cooking of 10 dessert base samples. From the above table it is clear that treatment $v_1p_1c_2$, $v_2p_1c_2$ has the highest yield ratio and v_2p_3 has the least yield ratio.

4.3.1.3 Solubility index

Solubility index of the 10 samples (Table: 01) were calculated as described in 3.3.1.3. The results of solubility index are depicted in the table: 8

Table: 7 Solubility index of ethnic dessert base

Treatments	Values
$v_1p_1c_1$	0.9421^{bc}
$v_2p_1c_1$	0.9486^{bc}
$v_1p_1c_2$	0.9277^{c}
$v_2p_1c_2$	0.9491^{bc}
$v_1p_2c_1$	0.9538^{b}
$v_2p_2c_1$	0.8970^{d}
$v_1p_2c_2$	0.9275^{c}
$v_2p_2c_2$	0.9345^{bc}
v_1p_3	0.9575^{ab}
v_2p_3	0.9499^{bc}
c	0.9818^{a}
±SE(m)	0.856
CV (%)	1.573

Values are means of triplicates

Treatments with same letters are not significantly different

The table represents solubility index of 10 dessert base samples. From the above table it is clear that control had more solubility index than other treatments, followed by v_1p_3, $v_1p_2c_1$ and v_2p_3.

4.3.2 Sensory evaluation of dessert base from various treatments

During ingestion of a food product, sensory evaluation is used to determine the reaction to stimuli. In the food industry, sensory testing is widely utilized for development of products, recipe modification, and product evaluation. In general, preferences and perceptual abilities depend on how one makes use of sense organs. By regulating the physical environment, carefully organizing experiments, and carefully choosing human participants, sensory evaluation assists in eliminating or managing sources of unfavourable error (Maina, 2018).

Sensory evaluation of the dessert base was carried out by cooking 15g of the developed ethnic dessert base (*ada)* with 20g of milk powder in 200ml water and 5 g of sugar. Sensory evaluation was performed by 15 semi-trained panelists after evaluating their results on a test of fundamental taste and aroma recognition.

4.3.2.1 Preparation of score card

Sensory acceptability of the dessert base developed from various treatments was evaluated by 15 panelists on a nine-point hedonic scale to evaluate the sensory attributes such as color and appearance, taste, texture, flavour, and overall acceptability of the samples.

Where 9 indicates like extremely, 8 indicates like very much, 7 indicates like moderately, 6 indicates like slightly, 5 indicates neither nor dislike, 4 indicates dislike slightly, 3 indicates dislike moderately, 2 indicates dislike very much and 1 indicates dislike extremely (Ndife *et al.,* 2011).

4.3.2.1.1 Colour and Appearance

Ultimately, recognizing and selecting a food depends on its look, which is the first thing that the human senses take note of about something. Food's color, shape, size, gloss, dullness, and transparency are all considered while judging it visually. Craveability and acceptability of food and beverages are influenced by their look even before they are consumed. The reason is due to the fact that before we smell or taste, we eat by sight (Kim *et al*., 2016).

Appearance scores of the 10 samples were analyzed using Kruskal- wallis test and the results are depicted in (Table no: 9). It was analyzed that the mean value for colour and appearance of jackfruit seed dessert base ranged between 5.4 – 8.5. The treatment $v_2p_2c_1$ (8.4) from *koozha* cultivar and $v_1p_2c_1$ (7.9) from *varikka* cultivar obtained highest score which shows these two treatments are on par with control (7.7). While the treatment $v_1p_2c_2$ (5.6) got the lowest score.

4.3.2.1.2 Taste

Taste is the main parameter for accepting or rejecting a food item. Taste is a sensation that is produced by a substance's chemical interaction with the tongue's receptors for taste (Leder *et al.,* 2004). From the result it was clear that the mean value for taste ranged between 5.6- 8.3. The treatment $v_2p_2c_1$(8.3) and $v_1p_2c_1$(7.6) has got the highest score for the attribute of taste. The least ranked treatment was $v_1p_2c_2$ (5.6).

4.3.2.1.3 Texture

Among the senses that collaborate to identify texture are touch, taste, sight, and hearing. It is among the most crucial components of food. If a consumer eats sand-textured ice cream or bit into a mushy croissant, they are unlikely to come back. It also considers the texture, thickness, chewiness, brittleness, and size and shape of the food's particles (Tauferova *et al*., 2015). The mean score for the attribute for the texture ranged from 6.2 – 8.5. From the result it was evident that the treatment $v_2p_2c_1$ (8.5) and $v_1p_2c_1$ (8.0) had highest score. The least preferred treatment was $v_2p_2c_2$ with a score of 6.2.

4.3.2.1.4 Aroma

Aromas are odors that are detectable, distinguishable, and recognizable by humans. While off-putting scents and odors help buyers recognize hazards such as rotten food, stimulating scents and odors also serve to increase appetite. A minuscule portion of the flavor is attributed to the unique stimuli (the sum of all gustatory, olfactory, haptic, and trigeminal stimuli) that are detected by the tongue and inside the oral cavity during ingestion. The mean score for the attribute aroma ranged between 5.4- 8.4. From the result it is evident that the treatment $v_2p_2c_1$(8.4) and $v_1p_2c_1$ (7.9) had got the highest score while the treatment $v_1p_2c_2$ (5.4) got the least rank.

4.3.2.1.5 Mouth Feel

The nerves in the mouth respond chemically or thermally, giving rise to mouth feel. Mouthfeel sensations can also be referred to as oral-tactile. The structural integrity of the salivary film that is seen by the filiform papillae is altered by the food which is ingested, and this is the primary cause of oral-tactile sensations (DeMiglio *et al.,* 2002). The treatment $v_2p_2c_1$(8.3) and $v_1p_2c_1$ (7.8) had got the highest score, they are on par with each other for the mouthfeel attribute. The least scored treatment was $v_1p_2c_2$ (5.6) and $v_2p_2c_2$(5.6), they were on par with the $v_1p_1c_1$ (6.4), $v_2p_1c_1$(6.3), $v_1p_1c_2$(6), $v_2p_1c_2$(6.2), v_1p_3(6.5), v_2p_3(6.4) treatments.

4.3.2.1.5 Overall Acceptability

A product's overall acceptability can be assessed based on its appearance, mouthfeel, taste, texture, aroma, and overall acceptability. From the result, it was analyzed that the treatment $v_2p_2c_1$(8.4) from *koozha* cultivar and $v_1p_2c_1$ (7.9) from *varikka* cultivar were superior in overall acceptability and showed maximum acceptance. While the treatment $v_1p_2c_2$ (5.6) had got the least score among all.

4.3.3 Selection of best treatment

From the results of sensory evaluation, it is clear that $v_2p_2c_1$ from *koozha* cultivar and $v_1p_2c_1$ from *varikka* cultivar had got higher scores in the attributes such appearance, texture, taste, aroma, mouthfeel and overall acceptability. There was significant difference between control and treatments for the functional quality rehydration ratio and yield ratio. For solubility index control had more solubility index value than other treatments. so $v_2p_2c_1$ and $v_1p_2c_1$ (Drying and Powdering along with steaming method was adopted) were selected as the best treatments, based on the results of Sensory evaluation and Functional quality analysis.

Table: 8 Sensory evaluation of dessert base

Treatment	Color & Appearance	Texture	Aroma	Taste	Mouthfeel	Overall Acceptability
$v_1p_1c_1$	6.4^{c}	6.3^{c}	6.8^{ac}	6.7^{acd}	6.4^{b}	6.5^{b}
$v_2p_1c_1$	6.2^{ab}	6.5^{c}	6.5^{acd}	6.6^{cd}	6.3^{b}	6.4^{b}
$v_1p_1c_2$	6.3^{c}	6.4^{ac}	6.3^{cd}	6.5^{acd}	6.0^{b}	6.3^{b}
$v_2p_1c_2$	6.7^{bc}	6.6^{ac}	6.6^{ac}	6.4^{cd}	6.2^{b}	6.5^{b}
$v_1p_2c_1$	8.0^{a}	8.0^{b}	7.9^{be}	7.6^{abc}	7.8^{a}	7.9^{a}
$v_2p_2c_1$	8.4^{a}	8.5^{b}	8.4^{e}	8.3^{b}	8.3^{a}	8.4^{a}
$v_1p_2c_2$	6.0^{ab}	6.3^{c}	5.4^{d}	5.6^{d}	5.6^{b}	5.6^{b}
$v_2p_2c_2$	6.2^{c}	6.2^{c}	5.6^{cd}	5.8^{d}	5.6^{b}	6.0^{b}
v_1p_3	6.6^{ab}	6.5^{c}	6.3^{cd}	6.2^{d}	6.5^{b}	6.4^{b}
v_2p_3	6.3^{c}	6.4^{c}	6.3^{cd}	6.2^{d}	6.4^{b}	6.3^{b}
c	7.9^{c}	7.8^{ab}	7.5^{ab}	7.8^{ab}	7.8^{a}	7.7^{a}
x^2	42.598	45.583	57.868	45.528	52.288	57.734
P-value	0	0	0	0	0	0

4.4 STANDARDIZATION AND QUALITY EVALUATION OF JACKFRUIT SEED-BASED FUNCTIONAL AND INSTANT ETHNIC DESSERT (*ADA PAYASAM*) MIX

As the next experiment, best base from the previous experiment was used to formulate the jackfruit seed-based functional and instant ethnic dessert mix. The *Ada* was combined with the different ingredients as follows:

Table: 9 Combination and proportion of the ingredients for the development of ethnic dessert mix.

Combination	Ada (%)	Sugar (%)	Jaggery (%)	MP (%)	CMP (%)	JFP (%)	BP (%)
f_1	35	25	-	30	-	10	-
f_2	35	25	-	-	30	10	-
f_3	35	-	25	30	-	10	-
f_4	35	-	25	-	30	10	-
f_5	35	25	-	30	-	-	10
f_6	35	25	-	-	30	-	10
f_7	35	-	25	30	-	-	10
f_8	35	-	25	-	30	-	10

(MP- Milk powder, CMP- Coconut Milk Powder, JFP- Jackfruit Preserve, BP- Banana Preserve)

4.5 DEVELOPMENT OF INSTANT ETHNIC DESSERT MIX

People are eager to try various kinds of novel products that are hitting the market and have been looking for unique products in recent years. For South Indians, "*Payasam*" is an essential dish to have at celebrations. It takes a lot of time and work to make the delicious dessert, and the process is tedious. Sophisticated culinary items have a tremendous chance to become consumer-accessible instant ethnic dessert mixes. Within the processed food sector, instant food products have taken up a lot of shelf space in homes (Vasan *et al.,* 2019).

Treatment $v_2p_2c_1$ from *koozha* cultivar and $v_1p_2c_1$ from *varikka* cultivar were selected as the best *ada* base for the development of the instant ethnic dessert mix. Eight different dessert mixes were developed. Standardization proportions of the ingredients were carried out for each combination of mixes after through trial and error. The proportions have been compared with dessert mixes that are available commercially. Sensory evaluation was conducted for each combination of mix. The best combinations from each cultivar were selected on the basis of sensory evaluation scores.

4.6 FUNCTIONAL QUALITY ANALYSIS OF DESSERT MIX

A food's functional qualities are crucial to its quality. Food components, including carbs, proteins, fats and oils, moisture, fiber, and ash, together with their structural variations, influence the functional properties of food and flours (Awuchi, 2017). Functional qualities of the 16 mixes (8 each from *varikka* and *koozha* cultivar) were examined, including rehydration ratio, yield ratio, swelling power, water absorption capacity and solubility index. The results are shown in the following tables 11 to 22 respectively.

4.6.1 Rehydration ratio

Rehydrating dried powder is a challenging procedure that is influenced by a number of factors, including temperature, immersion medium composition, drying techniques, and chemical composition, all of which have a major effect on the quality attributes of the final product (Kaymak, 2002).

The weight difference between the dehydrated and rehydrated samples is known as the rehydration ratio. Rehydration ratio of 16 dessert mixes were analysed as described in 3.3.1.1. and is presented in table: 10 and 11 respectively.

Table: 10 Rehydration ratio of *varikka* cultivar-based dessert mixes

Treatment	Rehydration ratio	Treatment	Rehydration ratio
f_1v_1	0.413	f_5v_1	0.407
f_2v_1	0.407	f_6v_1	0.417
f_3v_1	0.417	f_7v_1	0.430
f_4v_1	0.390	f_8v_1	0.463
±SE(m)	0.017		
CV (%)	7.228		

Values are means of triplicates

Treatments are not significantly different

The rehydration ratio for each of the eight dessert mixes is shown in the above table. Though there were no significant differences between the treatments. Rehydration ratio was highest (0.463) for the treatment f_8v_1 and lowest for the treatment f_4v_1 (0.390) according to the results.

Table: 11 Rehydration ratio of *koozha* cultivar-based dessert mixes

Treatment	**Rehydration ratio**
f_1v_2	0.470
f_2v_2	0.430
f_3v_2	0.420
f_4v_2	0.433
f_5v_2	0.460
f_6v_2	0.420
f_7v_2	0.447
f_8v_2	0.447
±SE(m)	0.018
CV (%)	7.083

Values are means of triplicates

Treatments are not significantly different

The rehydration ratio for each of the eight dessert mixes is shown in the previous table. Rehydration ratio was highest (0.470) for the treatment f_1v_2 and lowest for the treatments f_3v_2 (0.420) and f_6v_2 (0.420) according to the results.

4.6.2 Swelling power

The ability of starch to absorb water and swell is measured by its swelling capacity, which also indicates the strength of the associative forces found in the granules. In certain culinary products, such baked goods, swelling capacity is thought to be a good predictor of quality. It is an indication of the non-covalent bonds bridging the molecules within the starch granules and a factor influencing the proportions of amylopectin to alpha amylose (Iwe *et al.,* 2016). Particle size, species diversity, and processing method, or unit operations, all affect how much a flour may swell (Chandra and Samsher, 2013). Swelling power of the 16 mixes were analysed as described in 3.6.2. the results are depicted in the following table: 12 and 13 respectively.

Table: 12 Swelling power of *varikka* cultivar-based dessert mixes

Treatment	Swelling power (g/g)
f_1v_1	1.733^a
f_2v_1	1.386^b
f_3v_1	1.373^b
f_4v_1	1.363^b
f_5v_1	1.680^a
f_6v_1	1.800^a
f_7v_1	1.240^b
f_8v_1	1.920^a
±SE(m)	0.09
CV (%)	10.011
CD	0.271
t-value	2.12

Values are means of triplicates

Treatments with same letters are not significantly different

The swelling power for each of the eight dessert mixes is shown in the previous table. Swelling power was highest (1.920) for the treatment f_8v_1 and lowest for the treatment f_7v_1 (1.240) according to the results.

Table: 13 Swelling power of *koozha* cultivar-based dessert mixes

Treatment	Swelling power (g/g)	Treatment	Swelling power (g/g)
f_1v_2	2.200^a	f_5v_2	1.653^{bc}
f_2v_2	1.900^{ab}	f_6v_2	1.226^d
f_3v_2	1.800^b	f_7v_2	1.360^{cd}
f_4v_2	1.720^b	f_8v_2	2.146^a
±SE(m)	0.109		
CV (%)	10.829		
CD	0.328		
t-value	2.12		

Values are means of triplicates

Treatments with same letters are not significantly different

The swelling power for each of the eight dessert mixes is shown in the previous table. Swelling power was highest (2.200) for the treatment f_1v_2 and lowest for the treatment f_6v_2 (1.226) according to the results.

4.6.3 Yield ratio

Yield ratio of the 16 dessert mixes were analysed as described in 3.3.1.2. The results are depicted in the following table: 14, 15, 16 and 17 respectively.

Table: 14 Yield ratio of *varikka* cultivar-based dessert mixes (Dry basis)

Treatment	Yield ratio
f_1v_1	1.277
f_2v_1	1.287
f_3v_1	1.297
f_4v_1	1.367
f_5v_1	1.393
f_6v_1	1.283
f_7v_1	1.327
f_8v_1	1.290
±SE(m)	0.027
CV (%)	3.57

Values are means of triplicates

Treatments are not significantly different

The yield ratio for each of the eight dessert mixes is shown in the previous table. Yield ratio was highest (1.393) for the treatment f_5v_1 and lowest for the treatment f_1v_1 (1.277) according to the results.

Table: 15 Yield ratio of *varikka* cultivar-based dessert mixes (Wet basis)

Treatment	Yield ratio
f_1v_1	3.067^{c}
f_2v_1	3.150^{bc}
f_3v_1	3.200^{bc}
f_4v_1	3.466^{b}
f_5v_1	3.866^{a}
f_6v_1	3.133^{bc}
f_7v_1	3.416^{bc}
f_8v_1	3.133^{bc}
±SE(m)	0.121
CV (%)	6.33
CD	0.362
t-value	2.12

Values are means of triplicates

Treatments with same letters are not significantly different

The yield ratio for each of the eight dessert mixes is shown in the previous table. Yield ratio was highest (3.866) for the treatment f_5v_1 and lowest for the treatment f_1v_1 (3.067) according to the results.

Table: 16 Yield ratio of *koozha* cultivar-based dessert mixes (Dry basis)

Treatment	Yield ratio	Treatment	Yield ratio
f_1v_2	1.277	f_5v_2	1.363
f_2v_2	1.340	f_6v_2	1.353
f_3v_2	1.323	f_7v_2	1.353
f_4v_2	1.320	f_8v_2	1.313
±SE(m)	0.028		
CV (%)	3.595		

Values are means of triplicates

Treatments are not significantly different

The yield ratio for each of the eight dessert mixes is shown in the previous table. Yield ratio was highest (1.363) for the treatment f_5v_2 and lowest for the treatment f_1v_2 (1.277) according to the results.

Table: 17 Yield ratio of *koozha* cultivar-based dessert mixes (Wet basis)

Treatment	**Yield ratio**
f_1v_2	3.150
f_2v_2	3.367
f_3v_2	3.233
f_4v_2	3.217
f_5v_2	3.700
f_6v_2	3.400
f_7v_2	3.467
f_8v_2	3.250
±SE(m)	0.136
CV (%)	7.051

Values are means of triplicates

Treatments are not significantly different

The yield ratio for each of the eight dessert mixes is shown in the previous table. Yield ratio was highest (3.700) for the treatment f_5v_2 and lowest for the treatment f_1v_2 (3.150) according to the results.

4.6.4 Water absorption capacity

Water absorption capability is a vital functional need for food, particularly those that involve interacting with dough (Iwe *et al.,* 2016). According to Kuntz (1971), some flours may have less polar amino acid available, which would account for why some flours absorb less water. The greater ability of the flours to absorb water may also be attributed to the increased solubility and leaching of amylose as well as the starch's crystalline structure deterioration.

Water absorption capacity of the 16 dessert mixes were analysed as described in 3.6.4. The results are depicted in the following table: 18 and 19 respectively.

Table: 18 Water absorption capacity of *varikka* cultivar-based dessert mixes

Treatment	Water absorption capacity
f_1v_1	2.633[a]
f_2v_1	2.616[a]
f_3v_1	2.230[abc]
f_4v_1	1.960[c]
f_5v_1	2.513[a]
f_6v_1	2.406[ab]
f_7v_1	2.530[a]
f_8v_1	2.063[bc]
±SE(m)	0.143
CV (%)	10.467
CD	0.429
t-value	2.12

Values are means of triplicates

Treatments with same letters are not significantly different

The Water absorption capacity for each of the eight dessert mixes is shown in the previous table. Water absorption capacity was highest (2.633) for the treatment f_1v_1 and lowest for the treatment f_4v_1 (1.960) according to the results.

Table: 19 Water absorption capacity of *koozha* cultivar-based dessert mixes

Treatment	Water absorption capacity	Treatment	Water absorption capacity
f_1v_2	2.233	f_5v_2	2.473
f_2v_2	2.283	f_6v_2	2.463
f_3v_2	2.603	f_7v_2	2.347
f_4v_2	2.200	f_8v_2	2.283
±SE(m)	0.163		
CV (%)	11.924		

Values are means of triplicates

Treatments are not significantly different

The Water absorption capacity for each of the eight dessert mixes is shown in the previous table. Water absorption capacity was highest (2.603) for the treatment f_3v_2 and lowest for the treatment f_4v_2 (2.200) according to the results.

4.6.5 Solubility index

Solubility in the food system refers to a certain food ingredient's capacity to dissolve in liquid, gaseous, or solid solvents. This category includes solid, liquid, and gaseous substances. The solubility of a material is primarily determined by its physical and chemical properties in the solvent and solute, as well as by temperature, pressure, pH, and the presence of other compounds in the solution. Lipids inhibit food's capacity to absorb water (such as in flours), which can also have an impact on the food's solubility and capacity to swell. High solubility can be a sign of excellent digestion and exceptional compatibility for food and baby formula (David et al., 2015). The solubility index of 16 dessert mixes were analyzed as described in 3.3.1.3. The results are depicted in the following table: 20 and 21 respectively.

Table: 20 Solubility index of *varikka* cultivar-based dessert mixes

Treatment	Solubility index
f_1v_1	0.971
f_2v_1	0.969
f_3v_1	0.979
f_4v_1	0.974
f_5v_1	0.969
f_6v_1	0.966
f_7v_1	0.970
f_8v_1	0.959
±SE(m)	0.005
CV (%)	0.907

Values are means of triplicates

Treatments are not significantly different

The Solubility index for each of the eight dessert mixes is shown in the previous table. Solubility index was highest (0.979) for the treatment f_3v_1 and lowest for the treatment f_8v_1 (0.959) according to the results.

Table: 21 Solubility index of *koozha* cultivar-based dessert mixes

Treatment	Solubility index
f_1v_2	0.975
f_2v_2	0.946
f_3v_2	0.976
f_4v_2	0.965
f_5v_2	0.956
f_6v_2	0.972
f_7v_2	0.967
f_8v_2	0.962
±SE(m)	0.01
CV (%)	1.859

Values are means of triplicates

Treatments are not significantly different

The Solubility index for each of the eight dessert mixes is shown in the previous table. Solubility index was highest (0.976) for the treatment f_3v_2 and lowest for the treatment f_2v_1 (0.946) according to the results.

4.7 SENSORY EVALUATION OF ETHNIC DESSERT MIX

An integral part of any research product or product development process is sensory evaluation. Sensory evaluation is a scientific field that uses ideas of statistical analysis and experimental design to evaluate consumer items via the use of human senses (sight, smell, taste, touch, and hearing).

Ten personnel of the Department of Community Science and chosen students evaluated the items using the hedonic scale. They evaluated the items' general acceptability as well as their color and look, taste, texture, and flavor. The acceptability of the sixteen (8 each from two cultivars of jackfruit) goods was assessed using a 9-point hedonic rating system, where a score of 9 indicated severe like, a score of 1 indicated extreme disliking, and the medium values indicated moderate assessments. The Kruskal-Wallis test was used to examine the score difference. The result of sensory evaluation is depicted in the following tables.

4.7.a Sensory evaluation of ethnic dessert mix from Varikka cultivar

Table: 22 Sensory evaluations of *Varikka* cultivar-based dessert mix.

Treatment	Appearance	Texture	Aroma	Taste	Mouthfeel	Overall Acceptability
f_1v_1	8.2^{a}	7.2	7.3	8.0^{ab}	7.6	7.6
f_2v_1	8.3^{a}	7.2	7.2	6.2^{c}	6.7	7.1
f_3v_1	7.8^{abc}	7.1	7.0	7.4^{abc}	7.4	7.3
f_4v_1	7.2^{bc}	6.6	7.0	6.7^{ac}	6.5	6.8
f_5v_1	8.3^{a}	7.9	7.7	8.0^{b}	7.7	7.9
f_6v_1	7.8^{abc}	6.9	6.8	6.7^{abc}	6.9	7.0
f_7v_1	8.1^{ab}	7.7	7.2	7.2^{abc}	7.1	7.4
f_8v_1	7.0^{c}	6.6	7.1	6.4^{c}	6.1	6.6
x^2	14.405	8.926	3.368	14.308	7.443	8.426
P-value	0.044	0.258	0.849	0.046	0.384	0.297

4.7.a.1 Appearance

From the result of sensory evaluation, it was clear that the mean rank value for appearance range from 7- 8.3. The combination f_5v_1 (8.3) had got the highest score for appearance. The combination f_8v_1(7) had the least score among all.

4.7.a.2 Texture

From the result it was observed that maximum score for texture was noted for the combination f_5v_1(7.9). while the least score was noted for the combination f_4v_1 (6.6) and f_8v_1 (6.6).

4.7.a.3 Taste

The mean rank value for the attribute taste ranged between 6.2- 8. From the above table it is evident that the combination f_5v_1 (8) and f_1v_1 (8) got highest rank for taste among all and combination f_2v_1 (6.2) has got the least rank.

4.7.a.4 Aroma

The mean rank value for aroma ranged between 6.8- 7.7. From the result it was evident that the combination f_5v_1 (7.7) had got the highest rank and f_6v_1 (6.8) had got the least rank among all combinations.

4.7.a.5 Mouthfeel

From the result, it is clear that the combination f_5v_1 (7.7) had got the highest score and combination f_8v_1(6.1) has got the least value among all.

4.7.a.6 Overall Acceptability

From the statistical analysis of overall acceptability, it was found that the combination f_5v_1 (7.9) was most preferred than the other combinations. The combination f_8v_1(6.6) had got the least preference from the sensory panelists.

4.7.b Sensory evaluation of ethnic dessert mix from Koozha cultivar

Table: 23 Sensory evaluations of *Koozha* cultivar-based dessert mix.

Treatment	Appearance	Texture	Aroma	Taste	Mouthfeel	Overall Acceptability
f_1v_2	7.8	7.3	7.6	8.2^{c}	7.0	7.5
f_2v_2	7.7	7.2	6.8	7.3^{abcd}	6.4	7.0
f_3v_2	7.6	7.1	7.6	7.8^{abc}	7.0	7.4
f_4v_2	7.7	7.7	7.1	6.6^{abde}	6.4	7.1
f_5v_2	8.0	7.8	7.9	7.9^{ac}	7.6	7.8
f_6v_2	7.1	6.7	6.5	6.0^{de}	5.7	6.4
f_7v_2	7.5	6.9	6.8	6.4^{bde}	6.6	6.8
f_8v_2	6.9	6.6	5.8	5.6^{de}	6.0	6.1
x^2	4.668	3.785	10.537	23.306	9.332	10.116
p-value	0.7	0.804	0.16	0.002	0.23	0.182

4.7.b.1 Appearance

Some of the visual characteristics of a food product may be evaluated at a glance: color, consistency, body and texture, overall look, neatness and cleanliness, package exterior design, and the beauty of the product finish. It is important to consider a product's color and aesthetics since these may influence its acceptance or rejection. An attribute's appearance influences consumers' decisions to purchase or use it (Bloch *et al.,* 2003). From the result of sensory evaluation, it was clear that the mean score for appearance ranged from 6.9- 8. The combination f_5v_2 (8.0) had got the highest score for appearance. The combination f_8v_2 (6.9) had the least score among all.

4.7.b.2 Texture

Texture is an important component in the sensory evaluation process. The evaluation of texture is a dynamic, intricate process that considers the product's apparent surface, how it behaves after prior handling, and how it integrates the in-mouth sensations felt during mastication and, subsequently, swallowing. The human mind combines all of these to produce a whole new sense

(Tauferova et al., 2015). From the result it was observed that highest score for texture was noted for the combination f_5v_2 (7.8). while the least score was noted for the combination f_8v_2 (6.6).

4.7.b.3 Taste

Taste is one of the five senses that humans are able to utilize. It is essential to human survival since it gives each individual the ability to choose the right food, which is required for their continuous life, maintenance, and functionality. Taste is important in sensory assessment because it influences whether food is considered acceptable (Allen et al., 2008). The mean score for the attribute taste ranged between 5.6- 8.2. From the above table it is evident that the combination f_1v_2 (8.2) got highest score for taste among all and combination f_8v_2 (5.6) has got the least score.

4.7.b.4 Aroma

The mean score for aroma ranged between 5.8- 7.9. From the result it was evident that the combination f_5v_2 (7.9) had got the highest score and f_8v_2 (5.8) had got the least score among all combinations.

4.7.b.5 Mouthfeel

The mouthfeel of a substance is the sensation it gives on the mouth after ingestion. Taste and smell receptors, as well as general pain, touch, and temperature receptors in the mouth, are the main ways that it is recognized. The mouthfeel is the culmination of a substance's properties that results in that feeling. Flavor is one of the three main sensory factors that affects a person's decision to select, accept, and consume food (Bosmans, 2006). From the result, it is clear that the combination f_5v_2 (7.6) had got the highest score and combination f_6v_2 (5.7) has got the least score among all.

4.7.b.6 Overall Acceptability

The sensory attributes of the product and the customer's attitude toward the meal both play a major role in determining how acceptable a food is overall. It is believed that a person's decision to accept or reject food is influenced by a variety of factors. Taste, texture, flavor, and appearance are among the sensory aspects of food that have distinct and substantial influence on how palatable food is overall (Charters, 2006). From the statistical analysis of overall acceptability, it was found that the combination f_5v_2 (7.8) was most preferred than the other combinations. The combination f_8v_2 (6.1) had got the least preference from the sensory panelists.

4.7.1 Selection of best treatment

From the results of sensory evaluation, it is clear that f_5v_2 from *koozha* cultivar and f_5v_1 from *varikka* cultivar had got higher scores in the attributes such appearance, texture, taste, aroma, mouthfeel and overall acceptability. There was significant difference between treatments for the functional qualities like water absorption capacity, swelling power and yield ratio. so f_5v_2 and f_5v_1 (*Ada* + sugar + banana preserve + milk powder) were selected as the best treatments, based on the results of Sensory evaluation and Functional quality analysis.

4.8 QUALITY ANALYSIS OF ETHNIC DESSERT MIX

Nutrient analysis, which offer exact information on the nutritionally essential components of food, provide the value of energy, nutrients like carbohydrate, protein, and fat, vitamins, and minerals, as well as other important dietary components like fiber. The nutrients like carbohydrate, protein, fat, calcium, crude fiber and moisture content of the selected dessert mixes (f_5v_2 and f_5v_1) were analysed using standard techniques as mentioned in table no: 24.

Table: 24 Nutrient composition of dessert mixes

Dessert mixes	Carbohydrate (g/100g)	Fat (g/100 g)	Protein (g/100g)	Crude Fiber (g/100g)	Moisture content (%)	Calcium (mg/100 g)	Beta-carotene (mg/100 g)
f_5v_1	56.19	0.011	9.9^b	2.7^a	21.8	40^b	0.001
f_5v_2	57.11	0.020	10.6^a	1.2^b	22.7	70^a	0.002
±SE(m)	0.409	0.003	0.753	0.175	0.777	0.009	0
CV (%)	1.249	29.017	16.96	15.178	6.045	2.875	38.203
CD	NS	NS	2.955	0.686	NS	0.036	NS
t- value	NS	NS	2.776	2.776	NS	2.776	NS

4.8.1 Carbohydrate

Carbohydrates have several functions in living things. Carbohydrates are the sugar, starch, and fiber found in common meals including cereals, fruits, and dairy products. It is among the three macronutrients required by the human body for energy production. The human body's cells, central nervous system, and working muscles mostly use carbohydrates as fuel. Polysaccharides not only supply energy but also serve as structural elements. The carbohydrate content was higher in f_5v_2 (57.11g/100g) and was comparatively lower in dessert mix f_5v_1 (56.19g/100g).

4.8.2 Fat

The body uses fat as a fuel source and stores most of its energy in this form. For several other crucial processes in the body, fat is needed in the diet for optimal health. Fat is essential for the body's energy storage, insulation, and protection. It also plays a critical role in regulation and signaling. From the analysis fat content was comparatively higher in f_5v_2 (0.020g). The dessert mix f_5v_1 (0.011g) had the lowest value. It shows that all the dessert mixes are very low in fat content.

4.8.3 Protein

Amino acid constituents make up the enormous molecules known as proteins. The body needs proteins in order to function properly. They are the building blocks of molecules like enzymes, cytokines, and antibodies, and they are found in a variety of body tissues, including skin and hair. In addition to acting as hormones and enzymes, proteins also produce antibodies, regulate fluid and acid-base balance, carry nutrients, aid in wound healing and tissue regeneration, and provide energy when the body doesn't get enough energy from carbs and fats. From the result it is analysed that the dessert mix f_5v_2 (10.6g/100g) got the highest value for protein and f_5v_1 (9.9g/100g) got the least value for protein. The dessert mixes were lower in calcium.

4.8.4 Crude fiber

The sort of dietary fiber that is left behind as a residue after food is submitted to a standardized laboratory treatment using diluted acid and alkali is known as "crude fiber." The main ingredients of crude fiber are cellulose and lignin. From the result it is clear that f_5v_1 (2.7 g) contained highest amount of crude fiber, whereas f_5v_2 contained least amount (1.2g) of crude fiber. Crude fiber was found to be lower in the dessert mixes.

4.8.5 Moisture

One of the most often assessed aspects of food goods is their moisture content. This affects the taste, texture, weight, and shelf life of the products. It is evident from the above table that f_5v_2 (22.73%) had highest moisture content, while f_5v_1 (21.81%) has got the least moisture content.

4.8.6 Calcium

Calcium is one of the most essential minerals for human health. The mineral calcium is most often associated with healthy bones and teeth, but it also has important functions in blood coagulation, muscle contraction, normal heartbeat regulation, and nerve activity. A lifetime of good calcium consumption can help prevent osteoporosis. From the result it is analysed that the dessert mix f_5v_2 (70mg/100g) got the highest value for calcium and f_5v_1 (40mg/100g) got the least value for calcium. The dessert mixes were lower in calcium.

4.8.7 Beta-carotene

Vegetables receive their vibrant yellow, orange, and red color from a substance called beta carotene. Beta-carotene is transformed by the body into vitamin A (retinol). One of the most important nutrients for eyesight, vitamin A is also essential for cell growth and for the proper functioning of heart, lung, and kidney. From the result it is analysed that the dessert mix f_5v_2 (0.002mg/100g) got the highest value and f_5v_1 (0.001mg/100g) got the least value. The dessert mixes were lower in beta-carotene.

Customers anticipate that their food will remain of a high caliber during the time between purchase and consumption, as their demands for high-quality food become more and more rigorous. All foods, including their raw materials, elements, and processed goods, should have a long shelf life. It is a period of time that a food product will continue to be safe, ensure that it will maintain the intended sensory, chemical, physical, and microbiological qualities, adhere to any nutritional data label declarations, and be palatable to the consumer (Earle and Earle, 2008).

4.9.1 Moisture content of dessert mixes

In developing countries, microbial growth is influenced by moisture, which is a major cause of food deterioration. Food dehydration or drying eliminates this issue by lowering the moisture content which promotes microbial development. Therefore, it is crucial for farmers to consider the moisture content of food supplies as it plays a major role in determining the quality of storage and minimizing post-harvest loss (Zambrano *et al.,* 2019). For analysing the moisture content, the products developed were packed in double laminated pouches with nitrogen filling and stored at ambient temperature. The initial moisture content of the product developed were noted down. The products were stored for two months, and the moisture content was noted down at one-month intervals of application.

Table No: 25 Moisture (%) of stored dessert mixes

Period of study	f_5v_1	f_5v_2
Initial	21.8%	22.7%
±SE(m)	0.777	
CV (%)	6.045	
After 1 month	19%	20.6%
±SE(m)	0.754	
CV (%)	6.595	
After 2 months	17.4%	18.2%
±SE(m)	0.408	
CV (%)	3.973	

For the dessert mix f_5v_1 the moisture percentage decreased from 21.8% from the initial value to 19% after a period of one month and 19% to 17.4 % after a period of two months. Similarly, for the dessert mix f_5v_2 the moisture gradually decreased from 22.7% to 20.6% after one month and 20.6% to 18.2 after 2 months of storage.

4.9.2 Microbial profile

To analyse the shelf life and quality of dessert mixes the microbial analysis was conducted. In order to determine the microbiological profile, the rate of contamination with bacterial colonies, fungal colonies, and coliforms were evaluated. The results are illustrated in the following table.

Table: 26 Total bacterial count of dessert mixes

Dessert mixes	Initial count (CFU/ gram of sample)	After one week (CFU/ gram of sample)
f_5v_1	25×10^4	38×10^4
f_5v_2	17×10^4	26×10^4

It was clear from the table 26 that after one week of storage period the bacterial colonies were observed in dessert mix f_5v_1 from initial stage (25×10^4) and after one week (38×10^4). The dessert mix f5v2 had also detected from initial stage (17×10^4) and after one week (26×10^4). Regardless of their presence, the bacterial colonies were however within the FSSAI limits.

Table: 27 Total fungal count of dessert mixes

Dessert mixes	Initial count (CFU/ gram of sample)	After one week (CFU/ gram of sample)
f_5v_1	TLTC	TLTC
f_5v_2	TLTC	TLTC

The table 27 given above depicts the result of fungal count in the two dessert mixes. From the result, it is clear that the fungal colonies were absent in the two dessert mixes during the storage period.

Table: 28 Total yeast and mold count of dessert mixes

Dessert mixes	Initial count (CFU/ gram of sample)	After one week (CFU/ gram of sample)
f_5v_1	TLTC	TLTC
f_5v_2	TLTC	TLTC

The table 28 depicts the result of yeast and mold count in the two dessert mixes. From the result, it is evident that there were no presence of yeast and mold colonies in the two dessert mixes during the storage period.

Table: 29 Total coliform count of dessert mixes

Dessert mixes	Initial count (CFU/ gram of sample)	After one week (CFU/ gram of sample)
f_5v_1	TLTC	TLTC
f_5v_2	TLTC	TLTC

The table 29 depicts the result of coliform count in the two dessert mixes. From the result, it is understandable that the coliform colonies were not present in the two dessert mixes during the storage period.

4.10 COST OF THE PRODUCTS

The expense of the two dessert mixes were conducted, taking into account the costs of different goods. This covers labor and fuel costs as well as the cost of the milk powder, sugar, banana and jackfruit seed.

Table: 30 Cost of the products developed and commercially available dessert mixes

Dessert mixes	Cost per 300g (1L)
f_5v_1	110/-
f_5v_2	100/-
Commercial product -1	95/-
Commercial product - 2	75/-

The cost of the production for dessert mixes can be observed in the above table. The table clearly demonstrates that the production of dessert mix f_5v_1 (Rs. 110/-) had the highest cost, whereas f_5v_2 (Rs. 100/-) had the lowest cost in comparison. When compared to dessert mixes that are sold commercially, the rate of dessert mixes was high. It was due to the market value of ingredients used for developing the product.

DISCUSSION

5. DISCUSSION

The results of the present study entitled **“Development of jackfruit seed based functional and instant ethnic dessert mix”** is discussed below, under the following heads:

5.1 Standardization of base ingredient for ethnic dessert base (*Ada*)

5.2 Processing of ethnic dessert base (*Ada*)

5.3 Selection of best dessert base (*Ada*)

5.4 Standardization and quality evaluation of jackfruit seed-based functional and instant ethnic dessert (*Ada Payasam*) mix

5.5 Development of instant ethnic dessert mix

5.6 Functional quality analysis of dessert mix

5.7 Sensory evaluation of ethnic dessert mix

5.8 Quality analysis of ethnic dessert mix

5.9 Storage stability of ethnic dessert mix

5.10 Cost of the products

One of the most valuable and popular fruits in India is jackfruit (*Artocarpus heterophyllus*). It is a member of the Moraceae family. Of all the edible fruits, it is the biggest. More than 50 genera and more than 800 species make up the Moraceae family, which is mostly found in tropical and subtropical areas. Although they are mostly trees and shrubs, the whole family includes latex (Sundarraj *et al.,* 2018). It is a crop with several uses, including food, fuel, fodder, lumber, medicine, and industry (Bose *et al.,* 2003). Since it is inexpensive and readily available in huge quantities throughout its fruiting season, jackfruit is a valuable but underused fruit that is sometimes referred to as the poor man's fruit. In the household garden, jackfruit trees are mostly cultivated without any special care techniques. The jackfruit plants consistently produce large amounts of fruit. Jackfruit has a very high production and can generate up to 300-500 kg of fruits per tree, depending mostly on the age and growing environment (Nath *et al.,* 2001).

The South Indian equivalent of kheer, the '*payasam'*, is a highly favored dessert that is typically served during festivals and special events. It has a semi-solid to fluid consistency. (Unnikrishnan *et al*., 2000). The traditional preparation of *palada payasam*, a traditional product from Kerala, involves combining sugar and milk with pre-gelatinized rice batter flakes known as "*ada*". The product has a restricted shelf life of 1-2 days due to physico-chemical and microbiological deterioration. (Changade *et al.,* 2012). Dessert mixes can become more nutritious by adding jackfruit seeds, which are particularly abundant in protein, calcium, and fiber and have been linked to reduced fat content. The current tendency is to consume foods high in nutrients that are safer to consume microbiologically and also more convenient. The goal of this study was to create an instant ethnic dessert mix that would be easier to produce, more nutrient-dense, more persistent on the market, and more practical for both manufacturers and consumers.

5.1 STANDARDIZATION OF BASE INGREDIENT FOR ETHNIC DESSERT BASE (*ADA*)

Jackfruit (*Artocarpus heterophyllus Lam*) is one of the biggest edible fruits grown all over the world. The capacity of the jackfruit tree to give more fruits than any other tree in the Moraceae family, between 70 and 200 kg of fruit per tree, depending on variety, cultural customs, and environmental factors, sets it apart from other trees. Fruits typically weigh between 3.5 to 10 kg, while they can occasionally weigh up to 25 kg (Kumar *et al.,* 1988). A popular vegetable that may be used to make pickles and soups is tender jack fruit. Papads and chips are also made from pulp, both ripe and unripe. Ripe fruit retains its luscious pulp and is either eaten fresh or preserved in syrup. This fruit may be used to produce jam, jelly, and other value-added products since it contains pectin (Singh *et al.,* 1991). Jackfruit seeds can be processed into flour in a number of methods, such as via autoclaving, drying, roasting, boiling, and germination (Eke-Ejiofor *et al.,* 2014). The rind, seeds, and succulent yellow fleshed bulbs make up jackfruit. The round, 1-1.5 cm in diameter, light brown to brown jackfruit seeds is encased in a thin white membrane and measure 2-3 cm in length (Menaka *et al.,* 2011). Succulent, aromatic, and delicious yellow sweet jackfruit bulbs contain between 100 and 500 seeds, or 8 to 15% of the fruit weight (Madruga *et al.*, 2014). Due to their insipid texture and taste, seeds are typically either ignored or discarded as waste (Kooh *et al.,* 2016). They are used much less constantly, just sometimes as dessert, as minor components in recipes, or as a snack after boiling, steaming, or roasting (Sy Mohamad *et al.,* 2019).

In the present study to obtain good quality seeds, the cultivars of jackfruit *koozha* and *varikka* were selected. The fruits were collected from Instructional farm, College of agriculture, Vellayani and local markets.

About 10 to 15 percent of a jackfruit's weight is comprised of its seeds. Usually, seeds are thrown away or roasted and eaten as a snack or in certain local dishes. Fresh seeds cannot be stored for an extended period of time. Their fleshy white cotyledon is bordered by a white aril and coated in a thin brown spermoderm. Research indicates that they contain a lot of carbohydrate and proteins (Ranasinghe *et al.,* 2018). Additionally, the resistant starch and fiber found in jackfruit seeds transit the body undigested and support the healthy bacteria in our digestive tracts (Cheri Bantilan *et al.* 2019). After the seeds were blanched and dried, inactive anti-nutritional components were exposed, leading to the preparation of jack fruit seed flour. Chapati was made by combining jack fruit seed flour with wheat flour (Sharma *et al.,* 2009).

Nuts and seeds are a good source of fiber, vitamins, minerals, lipids, and proteins. Mature ovules containing abundant proteins, fiber, healthy lipids, and minerals including calcium, iron, zinc, and magnesium are called seeds. Nuts are dry fruits that have edible kernels and a high calorific content. They also include proteins, dietary fiber, antioxidants, unsaturated fatty acids, vitamins, and minerals. Seeds offer a nutrient-dense alternative to meat, fish, and eggs, since they are high in fiber, protein, iron, zinc, and vitamins. Iron absorption is enhanced by vitamin C rich seed consumption. Edible seeds lower the risk of diabetes, heart disease, and controlling weight. When combined with cereal grains, flax seeds, turmeric, pumpkin seeds, and protein-rich oilseed meals can produce nutritionally balanced diets (Sarwar *et al.,* 2011). Low levels of digestible carbohydrates are present in oilseeds, despite their substantial fat, protein, and fiber content. These characteristics have been linked to lower insulin and glucose levels, a low glycemic index, and increased satiety (Kim *et al.,* 2017).

According to a study, chutney powder was made by incorporating flax seed. There is no trans-fat in flax seeds, which raises the risk of coronary heart disease. It is crucial for women to incorporate flax seeds into their diet on a daily basis to prevent malignancies of the breast, prostate, and ovary cancers. Lignan, which is present in flax seed, may have anti-carcinogenic effects (Westcott *et al.,* 2003). Omega 6 and omega 3 fatty acids are present in flax seeds, which are essential for normal growth and development, and it also enhances nutrient absorption, promotes weight loss, is gluten-free, and rich in antioxidants (Rubilar *et al.,* 2010). The study concluded that most people were comfortable adopting groundnut-based chutney powder. The chutney powder prepared with black gram was preferred by those over 35 years who required low-fat products. Therefore, it can be said that both chutney powders are equally important, but consumers can choose the product based on their nutritional needs (Mummaleti *et al.,* 2019).

5.1.1.1 *Collection of raw materials*

In this study, *koozha* and *varikka* jackfruit cultivars were selected for processing in order to get high-quality seeds for making dessert bases. The testa and seed coat were carefully separated from the seeds.

5.1.1.2 *Preparation of raw materials and processing Treatments*

The seeds from both varieties were cleaned manually; seed coat and testa were peeled off using a stainless-steel knife before processing. The base for the ethnic dessert mix was processed using three treatments. p_1 - Boiling and grinding, p_2 - Drying and powdering, p_3 – Flaking

For p_1, the pre-processed jackfruit seeds which were finely diced and size reduced, were boiled for five to ten minutes and ground into paste using sufficient amount of water. For p_2, the jackfruit seeds were gelatinized for 10 minutes in order to remove the anti-nutritional factors which will inhibit nutrient absorption and sensory parameters. After gelatinization, the excess water was drained out. The seeds were then finely diced and tray dried in cabinet driers at 70°C for 2 hours. The time and temperature were standardized. After tray drying, the seeds were allowed to cool and ground to fine powder. For p_3, the seeds were soaked for about 15 minutes, dried at 60°C for half an hour, roasted for 10 minutes in an open pan at low flame and then flaked using the flaker machine. Jackfruit seed flakes obtained was directly used with other ingredients instead of cooking for instant dessert mix.

Noodles made from jackfruit seed flour had been developed by Kumari *et al.* (2015), ensuring the inclusion of the functional qualities. When noodles were developed using a feeder speed of 16 rpm and a drying temperature of 60 °C, the addition of 10 and 20% jackfruit seed flour led to decreased calorie and carbohydrate contents but increased protein, fiber, and mineral contents as well as improved sensory quality.

After cleaning, the flax seeds were dry-roasted at 80°C for five minutes. Black Gram and groundnuts are roasted in different batches. Spices and red chilies are toasted with a tiny bit of oil. In one sample, flax seeds and groundnut are combined; in another, flax seeds and black gram are combined. The sample was mixed with roasted chiles, spices, and salt, then combined into a fine powder (Mummaleti *et al.,* 2019).

5.2 PROCESSING OF ETHNIC DESSERT BASE (*ADA*)

Jackfruit seed-based ethnic dessert was prepared using the bases (p_1 & p_2) obtained from processing treatments. The methods of cooking the base (*Ada*) were c_1 – Steaming, c_2 – Boiling.

For c_1 & c_2, the base material was blended with water to form the required consistency. The batter was then spread over thin aluminium foils/ butter paper, rolled and steamed/ boiled for 10 minutes respectively. After cooling, the *Ada* was separated from the butter paper, cut into small pieces of size (6mm) and dehydrated to constant and required moisture content. The time and temperature of dehydration was standardized. The *Adas* obtained from p_3 was directly used for preparing instant dessert mix.

Research has shown that heating weakens cell walls, increasing the number of carotenoids that are extracted (Rodriguez *et al.,* 1999). Cooking, however, has also been linked to a loss of important antioxidants and vitamins, mostly of the water-soluble and heat-labile varieties. The type of cooking procedure used determines how much is lost (Lin *et al.,* 2005). Vegetables that have been cooked can have significantly different phenolics and antioxidants than those that are raw. This is most likely the result of several actions, including the breakdown, release, and change of the phytochemicals. In most cases, cooking increased the antioxidant activity of the specified vegetables. When everything was taken into account, steaming was the most prevalent method to cook (Saikia *et al.,* 2013).

5.3 SELECTION OF BEST DESSERT BASE (*ADA*)

For selecting the best ethnic dessert base (*Ada*) standardized from the above treatments, the functional properties like rehydration ratio, yield ratio, solubility index and organoleptic evaluation of each combination was conducted and compared with the instant rice *ada* available in the market. The best ethnic dessert (*Ada*) formulated from each cultivar was selected for the next experiment.

5.3.1 Assessment of functional qualities of ethnic dessert base

A crucial component of manufacturing food products is utilizing their positive characteristics. In bread items, where hydration is sought to ease handling, and in meatballs, doughnuts, and pancakes, where oil absorption property is crucial, the functional qualities decide if the blends would be effective (Mepba *et al.,* 2007). The significant physicochemical characteristics that control the intricate relationship between molecule conformation, structure, and composition are known as functional properties (Kinsella *et al.* 1976).

5.3.1.1 Rehydration ratio

The capacity of the dried dessert base pieces to restore their original product attributes was used to examine the rehydration ratio. In the current study, rehydration ratio was observed to be highest for $v_1p_1c_1$ (1.173^a), $v_2p_1c_1$ (1.233^a), $v_1p_1c_2$ (1.127^{ab}) and $v_2p_1c_2$ (1.103^{ab}) treatments and lower ratios were observed in $v_1p_2c_1$(0.387^d), $v_2p_2c_1$(0.453^d) and control (0.377^d). Sreejaya and Krishnaja (2023) reported rehydration ratio of jackfruit seed flour as 0.364 (*koozha*) and 0.359 (*varikka*). The jackfruit seed-based dessert base had the highest rehydration ratio than jackfruit seed flour.

5.3.1.2 Yield ratio

The difference between the initial weight and the final weight divided by the initial weight was used to compute the yield in percentage terms. The $v_2p_1c_2$ (1.247^a), $v_1p_1c_2$ (1.230^a) and $v_2p_1c_1$ (1.210^a) had the highest yield ratio and v_1p_3 had the least yield ratio on dry basis.

The treatment $v_1p_1c_2$ (1.527^{ab}), $v_2p_1c_2$ (1.603^a) had the highest yield ratio and v_2p_3 (0.773^e) had the least yield ratio on wet basis. An output of 54.95% starch was obtained from jackfruit seeds. Still, the starch yield from jackfruit seeds in earlier studies ranged from 12 to 28% (Oates *et al*., 1996). The weight of the jack seeds slumped upon the removal of brown spermoderm, white arils, and processing loss (Islam *et al.,* 2015).

5.3.1.3 Solubility index

Solubility is a fundamental physicochemical feature that is more important in food than other properties. If the solubility of a product is higher, it is likely to be partially dissolved in the water (solvent medium) which leads to a negative impact on consumers. In the current study, control (0.9818[a]) had more solubility index than other treatments, followed by v_1p_3 (0.9575[ab]), v_1p_2c (0.9538[b]) and v_2p_3 (0.9499[bc]). A study conducted by Islam (2015) reported that the jackfruit seed-based flour had solubility of 2.31%. This variation in the solubility index must have been due to the various processing treatments in this study.

5.3.2 Sensory evaluation of dessert base from various treatments

The jackfruit seed-based dessert base developed from various treatments were analyzed using sensory parameters like color and appearance, taste, texture, flavour, and overall acceptability. The results obtained are discussed here.

5.3.2.1 Preparation of score card

The treatments were subjected to an organoleptic evaluation using a custom-made 9-point hedonic scale scorecard which ranges from 9 (Like extremely) to 1 (Dislike extremely). Sensory acceptability of the dessert base developed from various treatments was evaluated by 15 panelists from Department of Community Science, College of Agriculture, Vellayani.

5.3.2.1.1 Color and Appearance

A food's appearance, which is the first thing one notices through senses, which is an important factor affecting acceptance of food products. The treatment $v_2p_2c_1$ (8.4) from *koozha* cultivar and $v_1p_2c_1$ (7.9) from *varikka* cultivar obtained highest rank and these two treatments are on par with control (7.7).

5.3.2.1.2 Taste

The primary aspect guiding a product's approval is its taste. The treatment $v_2p_2c_1$(8.3) from *koozha* cultivar and $v_1p_2c_1$(7.6) from *varikka* cultivar had got the highest score for the attribute of taste.

5.3.2.1.3 Texture

The texture was associated to the product's external appearance, which signifies smoothness or roughness. The treatment $v_2p_2c_1$ (8.5) and $v_1p_2c_1$ (8.0) had the highest score among the 10 treatments.

5.3.2.1.4 Aroma

The Selection, acceptability, and consumption of food are all influenced by aroma. From the result it is evident that the treatments $v_2p_2c_1$(8.4) and $v_1p_2c_1$ (7.9) had got the highest score among the 10 treatments.

5.3.2.1.5 Mouthfeel

Apart from taste and smell, mouthfeel describes the physical experiences that foods or drinks elicit in the mouth and contributes to the overall flavor. The treatment $v_2p_2c_1$ (8.3) and $v_1p_2c_1$ (7.8) had got the highest score, they were on par with each other for the mouthfeel attribute.

5.3.2.1.6 Overall acceptability

Overall acceptability is a crucial criterion in the organoleptic evaluation process, which has many ramifications. In the current study, the treatment $v_2p_2c_1$ (8.4) from *koozha* cultivar and $v_1p_2c_1$ (7.9) from *varikka* cultivar exhibited a high standard of acceptability.

5.3.3 Selection of best treatment

In the current study, sensory evaluation of jackfruit seed-based dessert base was worked on to find out the best treatment among 10 treatments. From the results of statistical analysis of sensory evaluation, it is clear that the treatments $v_2p_2c_1$ from *koozha* cultivar and $v_1p_2c_1$ from *varikka* cultivar got higher scores in the attributes such appearance, texture, taste, aroma, mouthfeel and overall acceptability. It may be due to the reason that seeds of the cultivar *koozha* is better than *varikka* which has an astringency in mouth during sensory analysis. The processing treatment p_2 (Drying and powdering) and method c_1 (Steaming) had the highest score in sensory evaluation than p_1 (Boiling and grinding), c_2 (Boiling) and p_3 (Flaking). The jackfruit seed-based flakes resembled the rice flakes which are thin and dry, and get dissolved completely as diary substitutes. From the solubility of flakes, it didn’t have the stability of the traditional *ada* base.

5.3 STANDARDIZATION AND QUALITY EVALUATION OF JACKFRUIT SEED-BASED FUNCTIONAL AND INSTANT ETHNIC DESSERT (*ADA PAYASAM*) MIX

The selected dessert bases from *koozha* and *varikka* cultivar were combined with different ingredients to develop eight varieties of instant dessert mixes. Standard proportions of the ingredients were experimented for each combination of mixes after different trial and errors. The proportions were compared with commercially available dessert mixes.

Using raw jackfruit bulb flour and raw jackfruit seeds, Veena *et al.* (2015) developed noodles that were extruded and exposed seed flour and refined flour in varying proportions of 40:30:30, 50:25:25, 50:30:20, 50:40:10, 50:10:40, and 50;20;30.

The ingredients for five different *payasam* mixes developed by Divakar *et al.* (2014). with *nendran* banana cultivar were: fat, cashewnuts, raisins, cooked sago, coconut chips, and jaggery syrup. Bananas were allowed to ripen, cleaned, blanched, peeled, and then pureed into a paste. The last step was adding the flavor. After utilizing coconut milk to reconstitute the items, cashewnuts, raisins, and coconut chips were fried along with fat and was added into the mix.

Using raw jackfruit flour and jackfruit seed flour, Ajisha *et al.* (2018) developed an instant vermicelli *payasam* mix based on jackfruit. The organoleptic and nutritional properties of the jackfruit-based vermicelli, which was made with 60% raw jackfruit flour and 30% jackfruit seed flour, were found to be highly satisfactory.

5.4 DEVELOPMENT OF INSTANT ETHNIC DESSERT MIX

The dessert base obtained from the treatment $v_2p_2c_1$ from *koozha* cultivar and $v_1p_2c_1$ from *varikka* cultivar were selected as the best *ada* base for the development of the instant ethnic dessert mix. It was combined with eight different ingredients to develop dessert mixes.

Barela and Shelke (2017) did investigation on "Acceptability, chemical composition and cost structure of kheer prepared from cow milk blended with coconut milk". The study was taken up to utilize valuable, nutritious coconut milk with cow milk for preparation of kheer and to obtain value added products. The cost of kheer increased with increase in the levels of blending of coconut milk in cow milk. Hence it may be concluded that coconut milk could be successfully utilized for the preparation of kheer.

According to a study, the physical, chemical, and sensory characteristics of the pumpkin replacement baked products were noted. The substitution of pumpkin pulp in the sandwich, cake, and cookie recipes had a detrimental effect on the final products' physical texture and feel by more than 15%, compared to 20% in the butter and chiffon cake recipes. Pumpkin powder is the best source of minerals and antioxidants, whereas other uses such as pumpkin paste, bread mixes, and baked foods have many more calories and are fortified with vitamin A. Overall, those who took the survey said that they would purchase the products made from pumpkin and that they found them to be satisfactory (Aziz *et al.,* 2023).

5.3 FUNCTIONAL QUALITY ANALYSIS OF DESSERT MIX

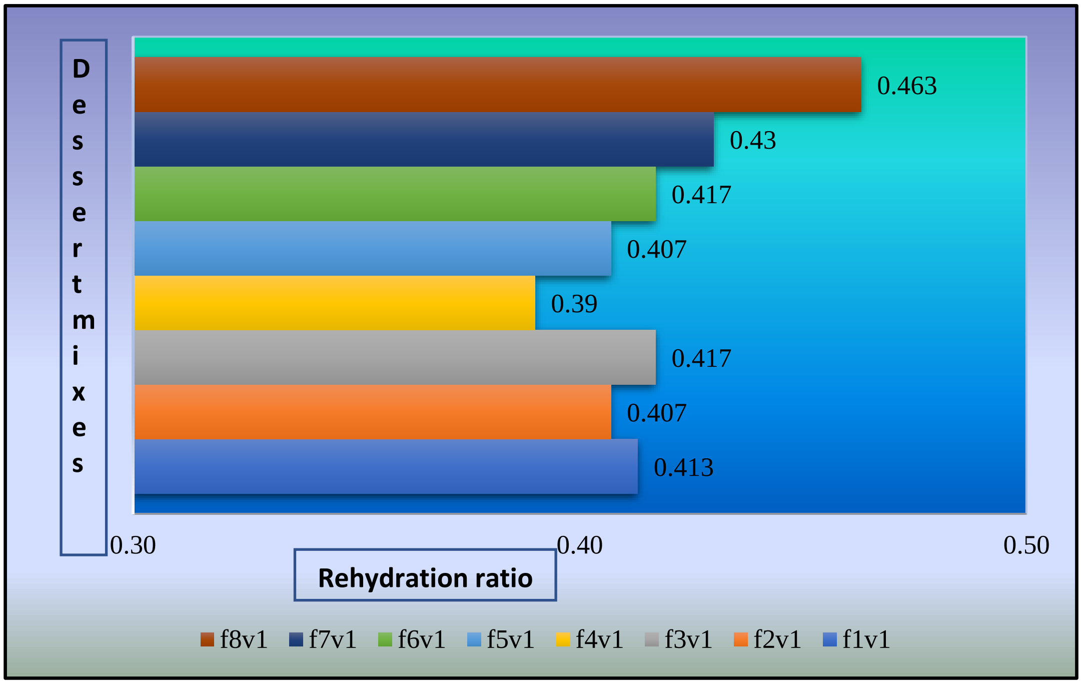
Functional qualities explain how ingredients act in food preparation and during cooking, as well as how they change the final product's appearance, flavor, and texture. The basic physical and chemical characteristics known as functional attributes represent the intricate relationship between the molecular conformity, composition, structure, physical and chemical characteristics of food ingredients as well as the environment in which these are related and assessed (Kaur *et al.,* 2006). To evaluate how proteins, lipids, fibers, and carbohydrates might behave in specific systems and to demonstrate whether or not such proteins can be used to replace convectional protein, functional characteristics must be determined (Siddiq *et al.,* 2009).

In the current study, the dessert mixes were analysed for its functional characteristics like rehydration ratio, swelling power, yield ratio, water absorption capacity, and solubility index.

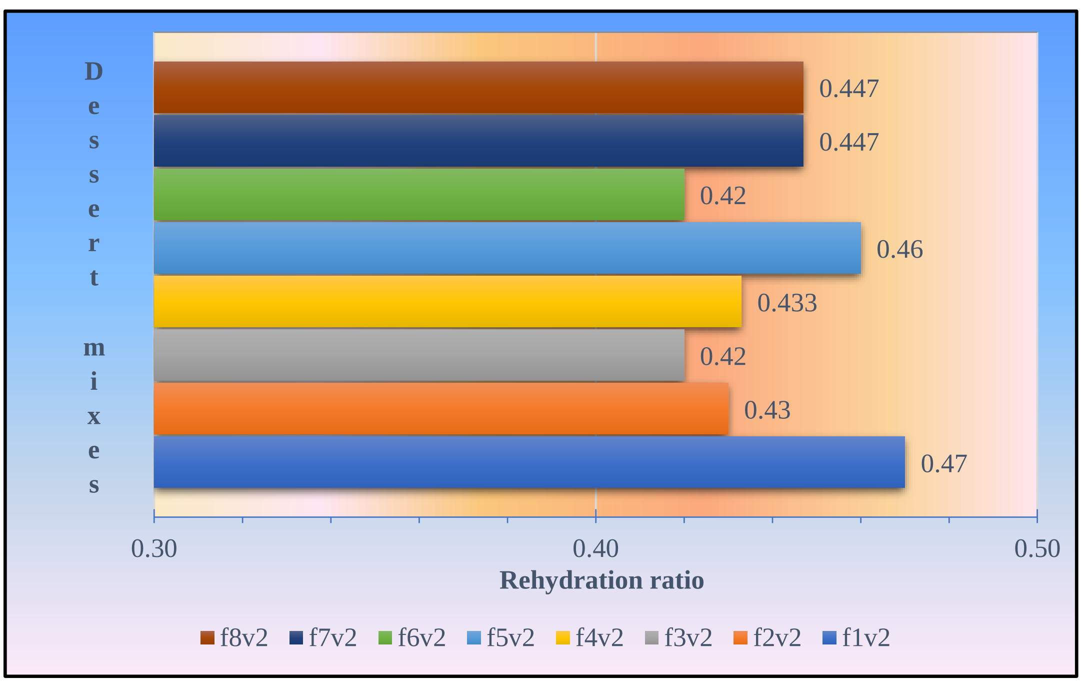
5.6.1 Rehydration ratio

Rehydration ratio is a measure of the ability of a material to absorb water after drying. In the current study, rehydration ratio was highest (0.463) for the dessert mix combination f_8v_1 from *varikka* cultivar and rehydration ratio was highest (0.470) for the dessert mix combination f_1v_2 from *koozha* cultivar.

Graph: 1 Rehydration ratio of *varikka* cultivar-based dessert mixes



Graph: 2 Rehydration ratio of *koozha* cultivar-based dessert mixes



5.6.2 Swelling power

High starch content, especially one that contains more amylopectin, increases the ability of foods and flours to swell (Chandra and Samsher, 2013). Swelling power was highest (1.920) for the dessert mix combination f_8v_1 from *varikka* cultivar and swelling power was highest (2.200) for the dessert mix combination f_1v_2 from *koozha* cultivar.

5.6.3 Yield ratio

The yield of dried products is directly correlated with the amount of water in the original product. Yield ratio was highest (1.393) for the dessert mix combination f_5v_1 and yield ratio was highest (3.866) for the dessert mix combination f_5v_1 on dry and wet basis from *varikka* cultivar. Yield ratio was highest (1.363) for the dessert mix combination f_5v_2. Yield ratio was highest (3.700) for the dessert mix combination f_5v_2 on dry and wet basis from *koozha* cultivar.

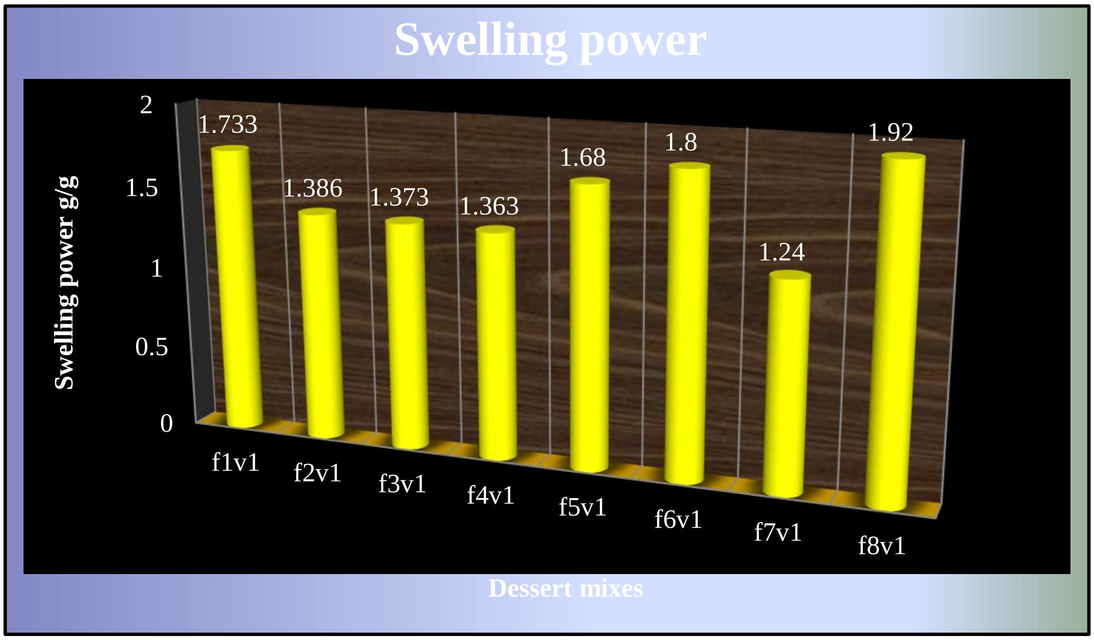
According to Veenakumari (2015), the yield ratio of an extruded product made from jackfruit ranged from 0.86 to 0.97 percent. A study conducted by Soumya (2021) found that *koozha* and *varikka* bulbs had varying range of percentage compositions for the jackfruit bulbs, which were 45.09 to 43.33, the seeds 25.88 to 36.12, the perigones 5.57 to 5.24, the testa was 1.12 to 1.97 percent, the rind was 12.93 to 11.77, and the core was 6.81 to 6.86, with jackfruit *koozha* having the highest composition due to increased flour content and yield compared to *varikka* jackfruit.

5.6.4 Water absorption capacity

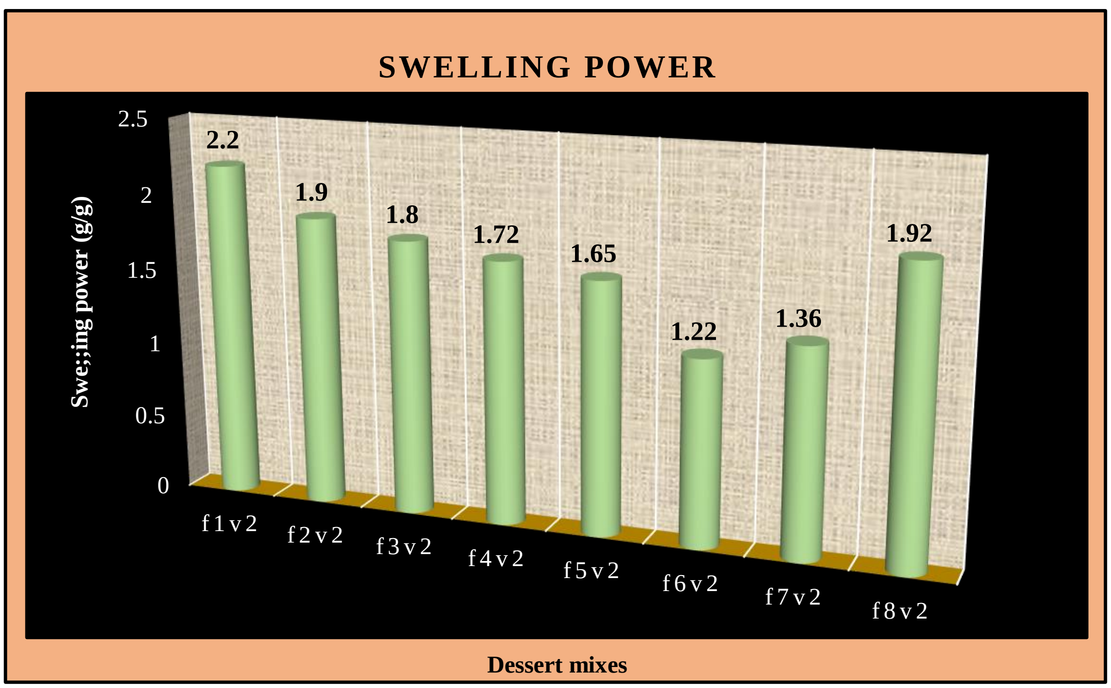
Water absorption capacity is a significant viscosity-affecting processing parameter. Furthermore, a material's capacity to absorb water is essential for baking applications as well as for the bulking and consistency of the final products (Niba *et al.,* 2001).

Water absorption capacity was highest (2.633) for the dessert mix combination f_1v_1 from *varikka* cultivar and water absorption capacity was highest (2.603) for the dessert mix combination f_3v_2 from *koozha* cultivar. According to a study by Tharani (2018), the rinds of *varikka* and *koozha* jackfruits had a water absorption capacity of 4.88% and 4.98%, respectively. Another study conducted by Soumya (2021), showed *varikka* jackfruit bulb flour (VJBF) surpassed *Koozha* jackfruit bulb flour (KJBF) (4.95%) and nutri flour (JNF) (4.36%) in terms of water absorption capacity (5.23%).

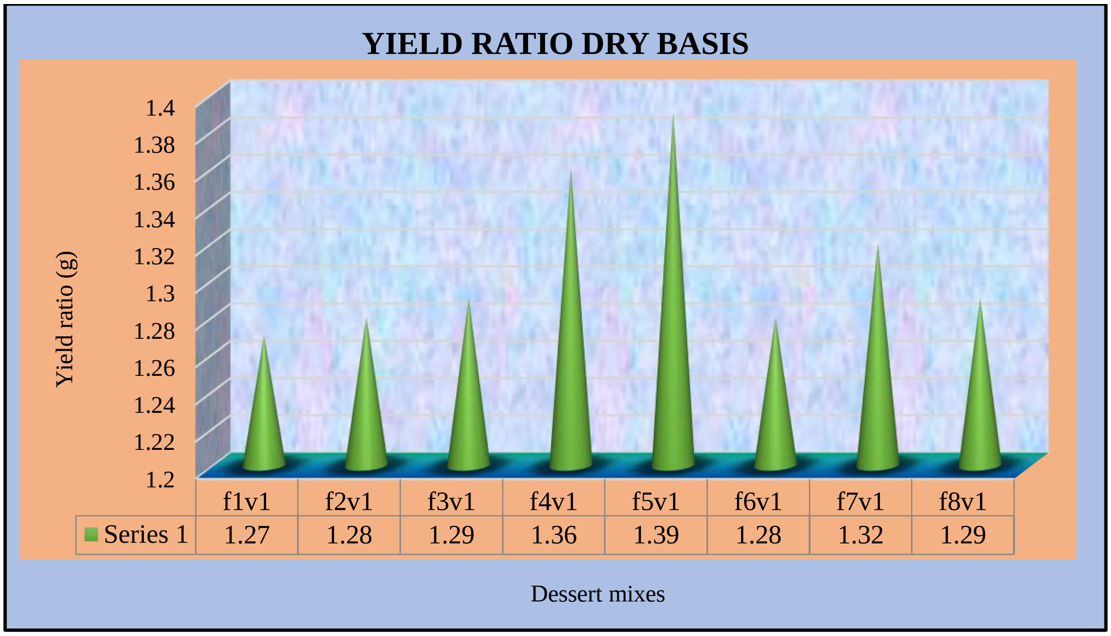
Graph: 3 Swelling power of *varikka* cultivar-based dessert mixes



Graph: 4 Swelling power of *koozha* cultivar-based dessert mixes

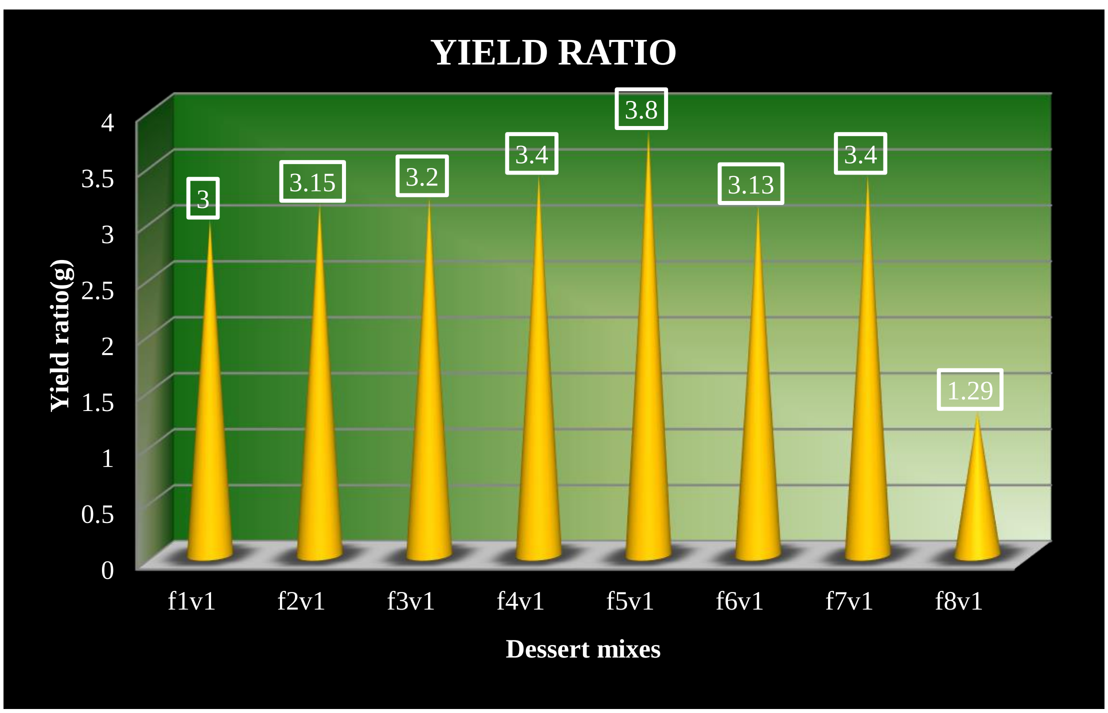


Graph: 5 Yield ratio of *varikka* cultivar-based dessert mixes (Dry basis)

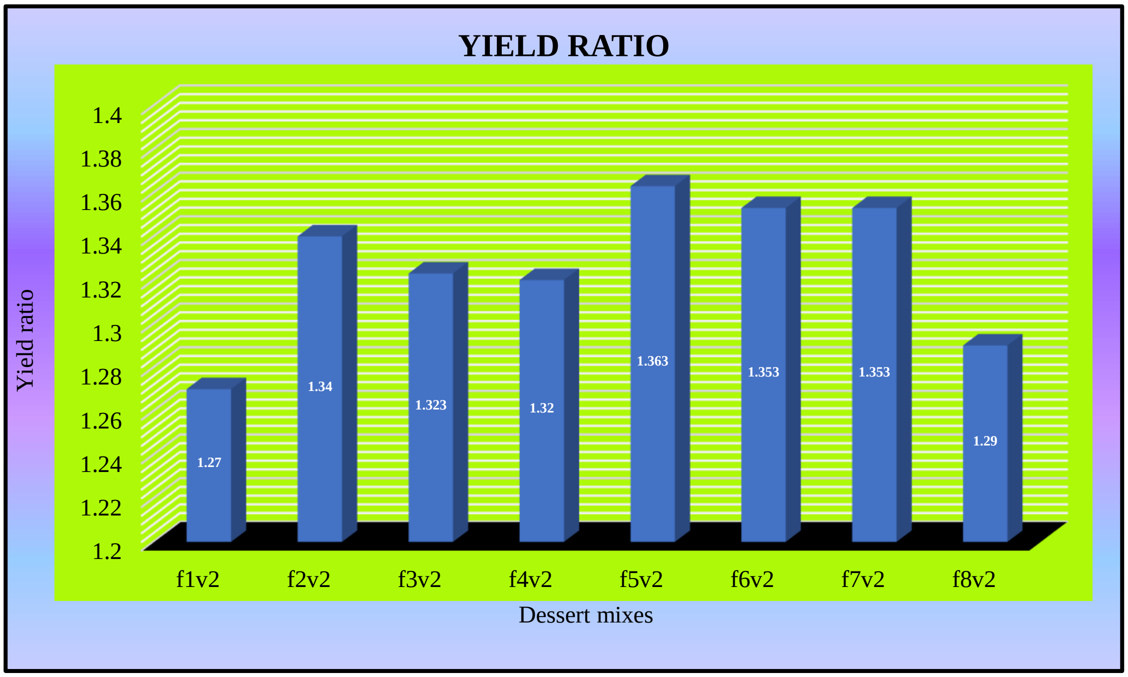


	f1v1	f2v1	f3v1	f4v1	f5v1	f6v1	f7v1	f8v1
Series 1	1.27	1.28	1.29	1.36	1.39	1.28	1.32	1.29

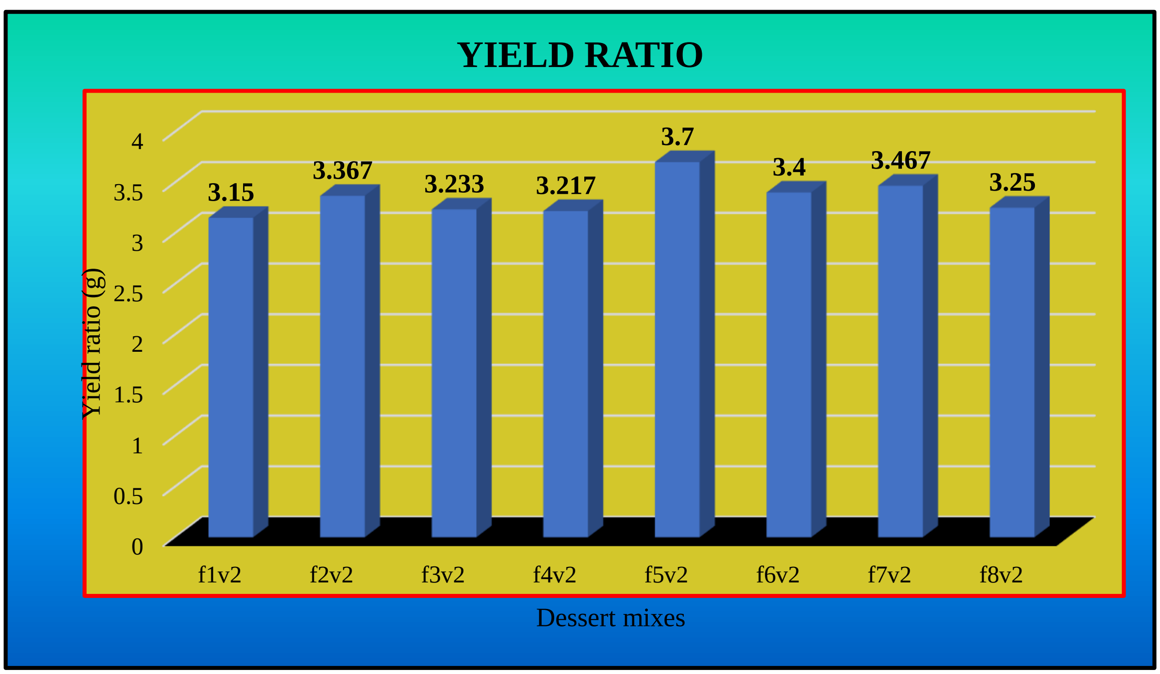
Graph: 6 Yield ratio of *koozha* cultivar-based dessert mixes (Wet basis)



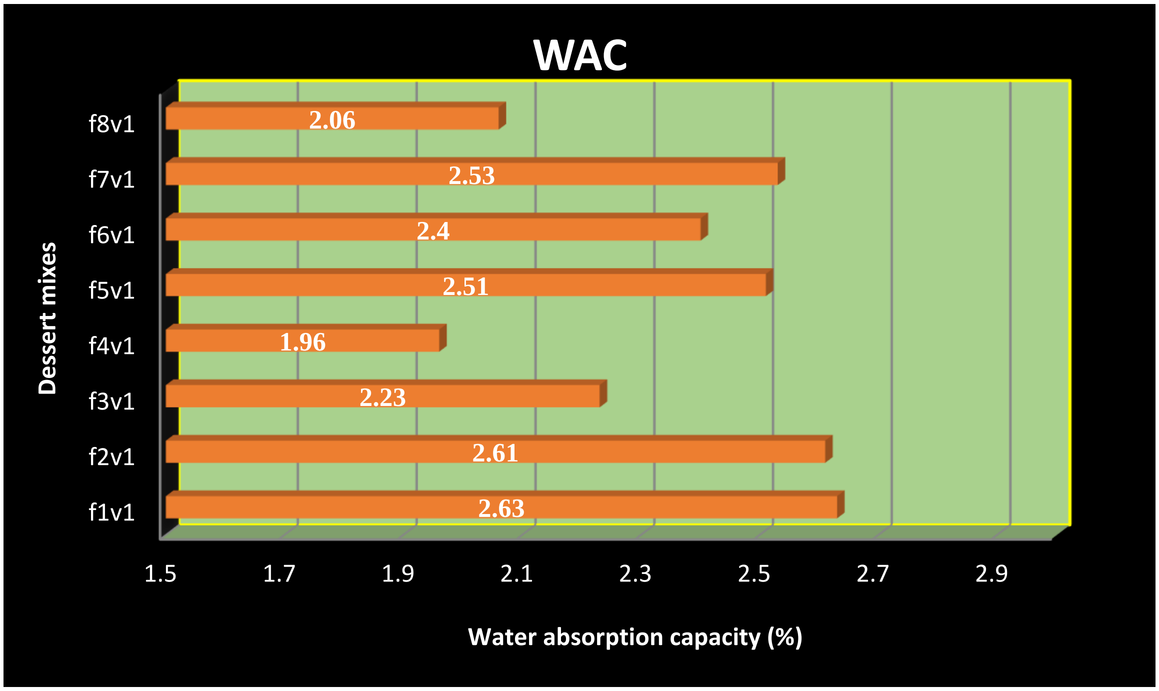
Graph: 7 Yield ratio of *koozha* cultivar-based dessert mixes (Dry basis)



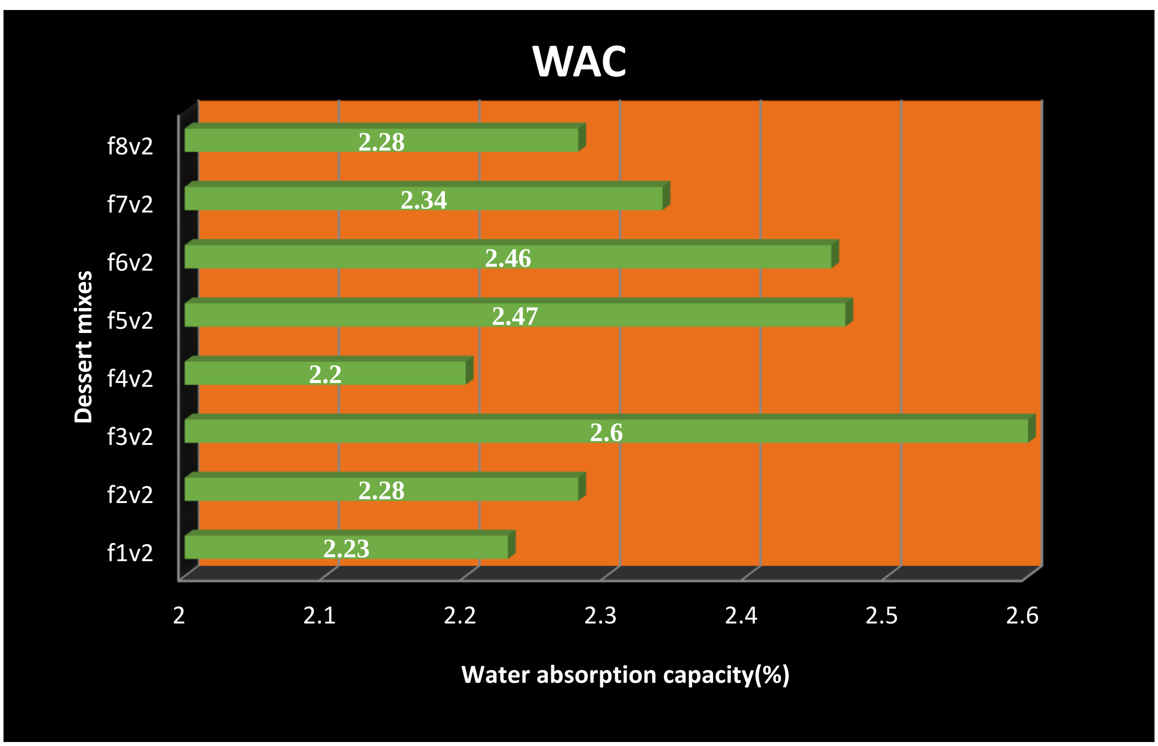
Graph: 8 Yield ratio of *koozha* cultivar-based dessert mixes (Wet basis)



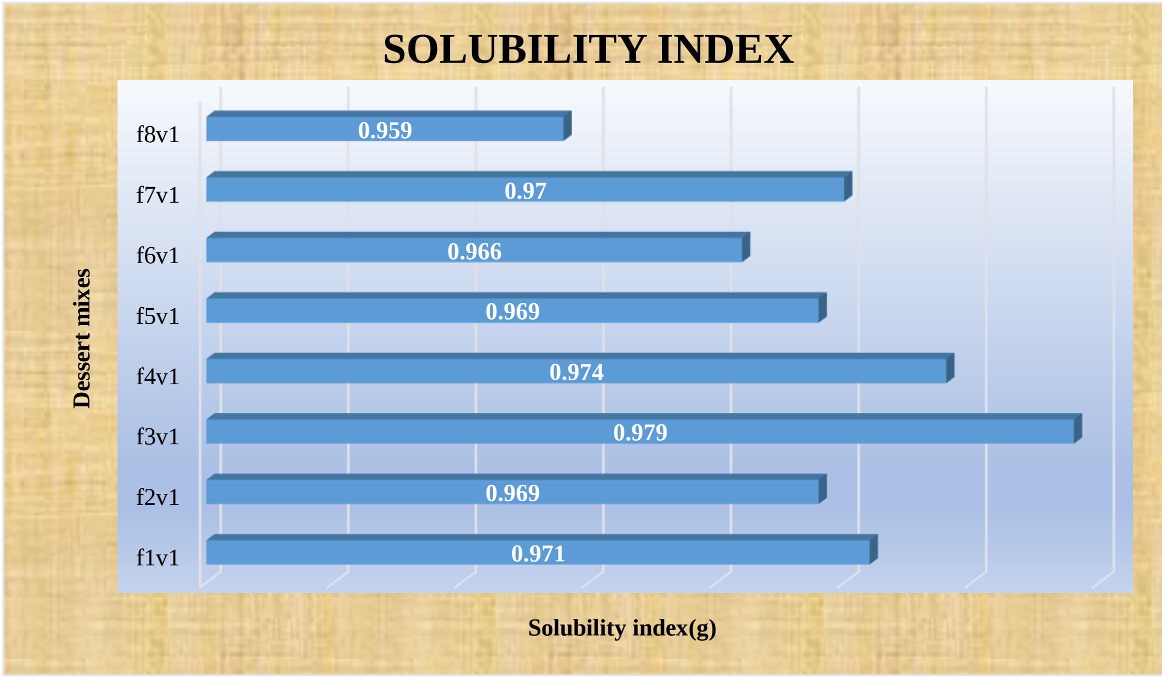
Graph: 9 Water absorption capacity of *varikka* cultivar-based dessert mixes



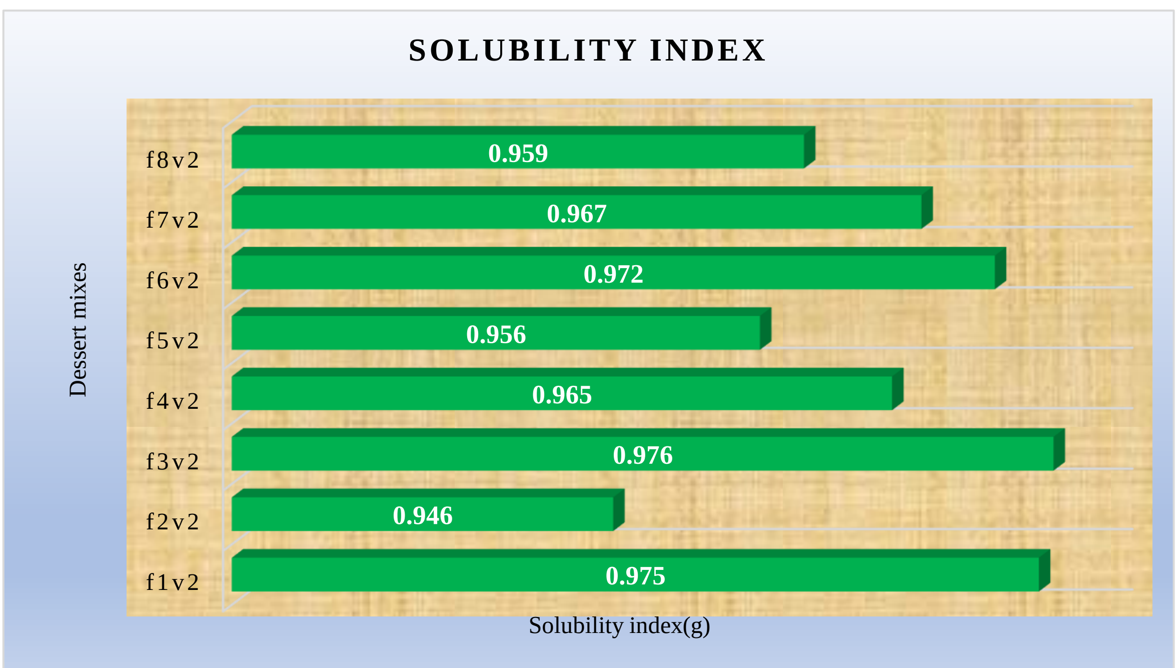
Graph:10 Water absorption capacity of koozha cultivar-based dessert mixes



Graph: 11 Solubility index of *varikka* cultivar-based dessert mixes



Graph: 12 Solubility index of *koozha* cultivar-based dessert mixes



5.6.5 Solubility index

The solubility index analyzes a food's tendency to dissolve in a solvent, usually water or oil. In the current study, solubility index was highest (0.979) for the dessert mix combination f_3v_1 from *varikka* cultivar and solubility index was highest (0.976) for the dessert mix combination f_3v_2 from *koozha* cultivar. The soulbility index of jackfruit seed flour was 1.80%, as reported by Akter and Haque (2018) while Islam *et al.* (2015) reported that, the jackfruit seed flour solubility index was 2.31%.

5.7 SENSORY EVALUATION OF ETHNIC DESSERT MIX

The evaluation, analysis, and interpretation of responses to food products as experienced by the tactile, gustatory, visual, olfactory, and aural senses are referred to as sensory evaluations. It can be thought of as a branch of science that looks at specific characteristics of a food ingredient or product by comparing and contrasting a range of products (Hossain, 2014).

The dessert base was standardized in eight different combinations such as f_1, f_2, f_3, f_4, f_5, f_6, f_7 and f_8 from each cultivar. Hedonic scale rating was used to conduct sensory evaluation to find out the best combination of dessert mix.

5.7.a Sensory evaluation of ethnic dessert mix from Varikka cultivar

5.7.a.1 Appearance

Appearance is an essential parameter that determines a consumer's acceptance of a food product. Sensory evaluation for the appearance attribute ranged from7- 8.3. The dessert mix combination f_5v_1 (8.3) had got the highest score for appearance among all the eight combinations.

5.7.a.2 Texture

Texture is an indicator of food quality and has great impact on how well a meal gets accepted. The value for texture was between 6.6 to 7.9. The maximum score for texture was noted for the combination f_5v_1 (7.9).

5.7.a.3 Taste

Food's taste is a complicated phenomenon that influences its acceptability, delight, and overall satisfaction. The primary source of taste is human perception, which includes salty, sweet, sour, and savory (umami) (Premavalli *et al.,* 2012). According to Stevenson *et al.* (1999), the smells associated with sweetness and sourness has an impact on how people perceive taste. The mean score for the attribute taste ranged between 6.2 and 8. The combination f_5v_1 (8) and f_1v_1 (8) got highest score for taste among all the eight combinations of mixes.

5.7.a.4 Aroma

Aroma is one of the most crucial sensory experiences, which typically influences the consumer's decision to choose and accept the product The mean score for aroma ranged between 6.8- 7.7. The combination f_5v_1 (7.7) had got the highest score for the attribute of aroma.

5.7.a.5 Mouthfeel

Mouthfeel is different from taste because it depicts the actual feelings that a food or beverages produce in the tongue. According to the sensory evaluation, the combination f_5v_1 (7.7) had got the highest score for the attribute of taste.

5.7.a.6 Overall acceptability

The subjective metric of acceptability is hedonic, or satisfaction, which is impacted by the food's sensory qualities. The dessert mix combination f_5v_1 (7.9) was most preferred than the other combinations.

5.7.b Sensory evaluation of ethnic dessert mix from Koozha cultivar

5.7.b.1 Appearance

Appearance defines people's initial perceptions of food products. It may also affect the selection and satisfaction of a product by a customer. The mean score for appearance ranged from 6.9 -8. The dessert mix combination f_5v_2 (8.0) had got the highest score for the attribute of appearance.

5.7.b.2 Texture

Texture is one of the primary senses. It is characterized by qualities like hard, soft, liquid, solid, and rough. The mean score for the attributes of texture ranged from 6.6- 7.8. The maximum score for texture was noted for the dessert mix combination f_5v_2 (7.8).

5.7.b.3 Taste

In sensory evaluation, taste is significant since it determines whether food is regarded as acceptable. The mean score for the attribute taste ranged from 5.6 - 8.2. The dessert mix combination f_1v_2 (8.2) got highest score for taste among all the eight combinations.

5.7.b.4 Aroma

A basic criterion for evaluating food is its aroma. The odor of volatile substances with the nose causes one to experience aroma. The mean score for aroma ranged from 5.8- 7.9. The dessert mix combination f_5v_2 (7.9) had got the highest score for aroma among all the eight combinations.

5.7.b.5 Mouthfeel

The sensation that food leaves on the mouth after consumption is called mouthfeel. The dessert mix combination f_5v_2 (7.6) had got the highest score for mouthfeel attribute.

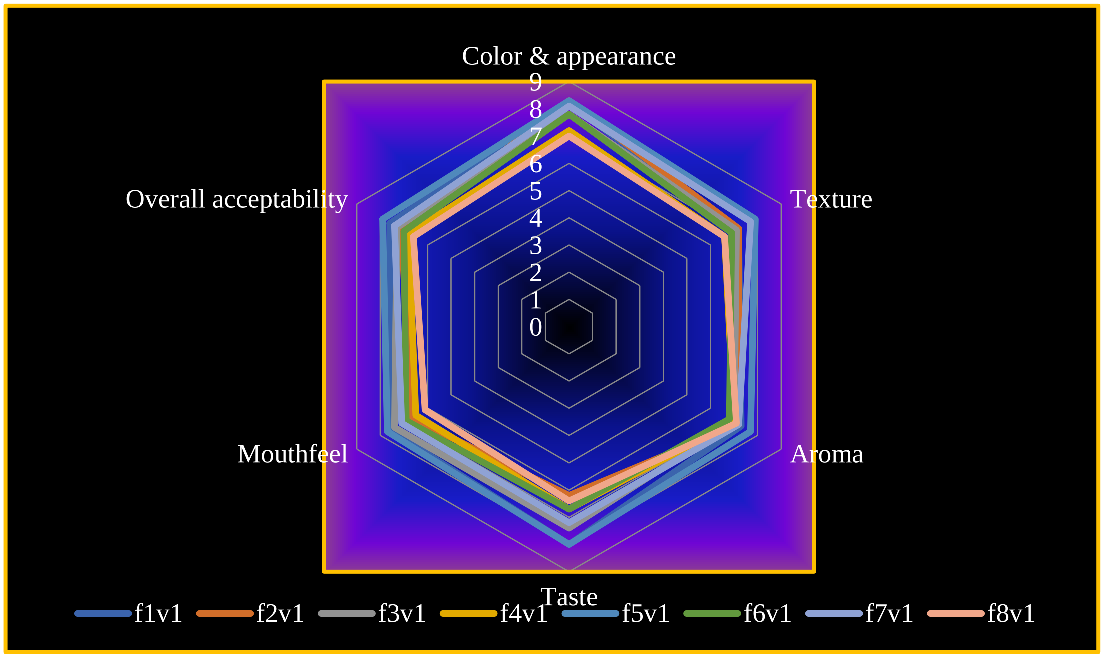
5.7.b.6 Overall acceptability

Overall acceptability is a subjective measure of acceptability and is influenced by the sensory aspects of food. From the statistical analysis of overall acceptability, the dessert mix combination f_5v_2 (7.8) was most preferred than the other combinations.

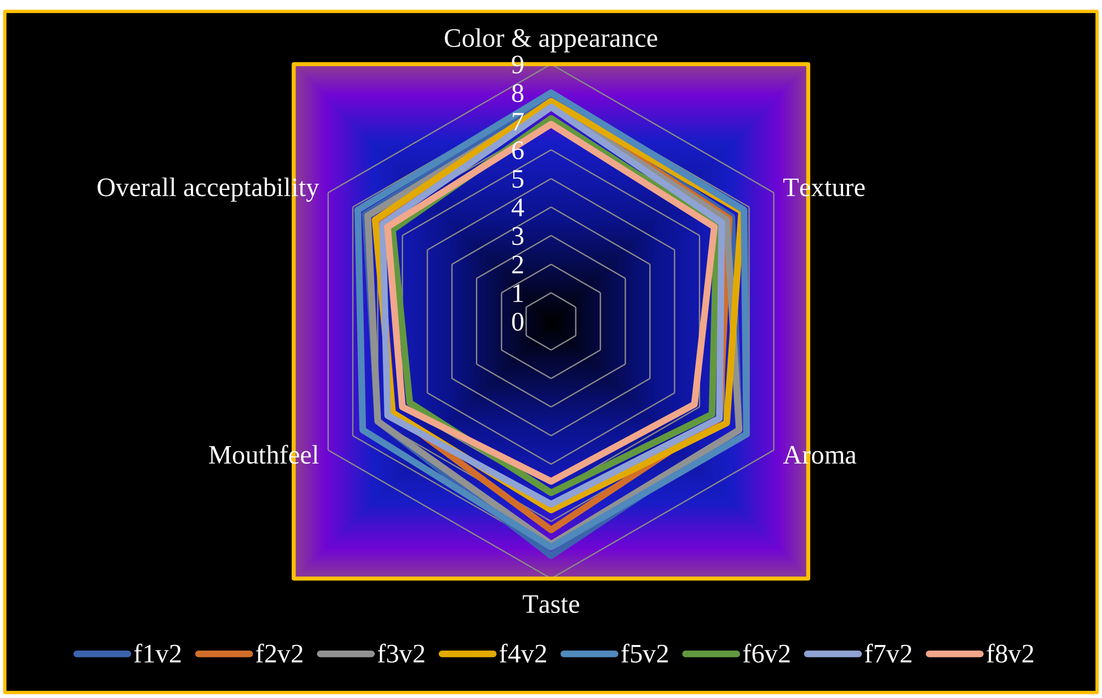
5.7.1 Selection of best treatment

The best dessert mix for the current study were determined to be f_5v_1 and f_5v_2. Based on the results of sensory evaluation and functional quality analysis these desserts mix combination were selected as the best. The dessert mix f_5v_1 tasted like the traditional *payasam*. While the dessert mix f_5v_2 was chewy and had a good consistency of *payasam*. Both the combinations of dessert mixes were banana flavoured since it was incorporated with dehydrated banana preserve pieces. The two combinations of dessert mixes were selected for quality analysis and storage studies.

Graph: 13 Sensory evaluation of *Varikka* cultivar-based dessert mix.



Graph: 14 Sensory evaluation of *koozha* cultivar-based dessert mix.



5.8 QUALITY ANALYSIS OF ETHNIC DESSERT MIX

The nutrients like carbohydrate, protein, fat, calcium, crude fiber and moisture content of the selected dessert mixes (f_5v_2 and f_5v_1) were analysed using standard techniques.

5.8.1 Carbohydrate

Food contains organic components called carbohydrates that include carbon, hydrogen, and oxygen. These compounds can be absorbed, digested, and broken down in the tissues to produce carbon dioxide and water. The majority of human meals worldwide are comprised of them; foods high in starch are the cheapest to manufacture and store. The carbohydrate content of dessert mix combination f_5v_2 was 57.11g/100g and dessert mix combination f_5v_1 was 56.19g/100g. According to Chrips *et al.* (2008), the percentage of carbohydrates in various jackfruit seed types ranged from 37.4% to 42.5%. Veenakumari (2015) states that the amount of carbohydrates was 81.46g in jackfruit seed flour. According to Islam (2015), the flour made from jackfruit seeds was composed of 71.46% of carbohydrates.

5.8.2 Fat

The body uses fats as nutrient from meals to make hormones, nerve tissue, including the brain, and cell membranes. Fat also serves as a fuel for the body. The body stores fat in fat cells if it is not utilized as fuel or as building blocks. The fat content in dessert mix f_5v_2 was 0.020g and dessert mix f_5v_1 was 0.011g. According to Gunasena (1993), jackfruit has modest fatty acid content (0.1–0.4%), while Sreeletha *et al.* (2018) also reported a similar fat content of 0.4 percent.

5.8.3 Protein

The building blocks of life are proteins. The human body is made up of protein in every cell. An amino acid chain makes up the basic building blocks of proteins. To aid in cell growth and repair, your diet must include protein. Additionally, children, teenagers, and pregnant women require protein for healthy growth and development. The protein content of dessert mix f_5v_2 was

10.6g/100g and dessert mix f_5v_1 was 9.9g/100g. According to Chrips *et al.* (2008), the protein content of jackfruit seeds can range from 5.3% to 6.8%.

5.8.4 Crude fiber

Crude fiber is the residual material from plants that is extracted using diluted acid and then diluted alkali. It is a measurement of the amount of indigestible cellulose, pentosans, lignin, and other similar components found non existing dietary sources. The dessert mix f_5v_1 contained 2.7g of crude fiber, whereas dessert mix f_5v_2 contained 1.2g. While Munishamanna (2012) showed that Jackfruit bulb flour contained 1.8g of fiber per 100g, Ocloo *et al.* (2010) claimed that Jackfruit seed flour contained 3.19g of fiber.

5.8.5 Moisture

Any sort of water that is present in a food product is considered to be part of its moisture content. The dessert mix f_5v_2 had moisture content of 22.73%, while dessert mix f_5v_1 had 21.81% of moisture. According to Jayamuthunagai (2014), the seed flour had a moisture level of 7.75 percent. Food product with reduced moisture content has higher quality and longer shelf life. The length of time that flour is dried usually determines how much moisture it contains.

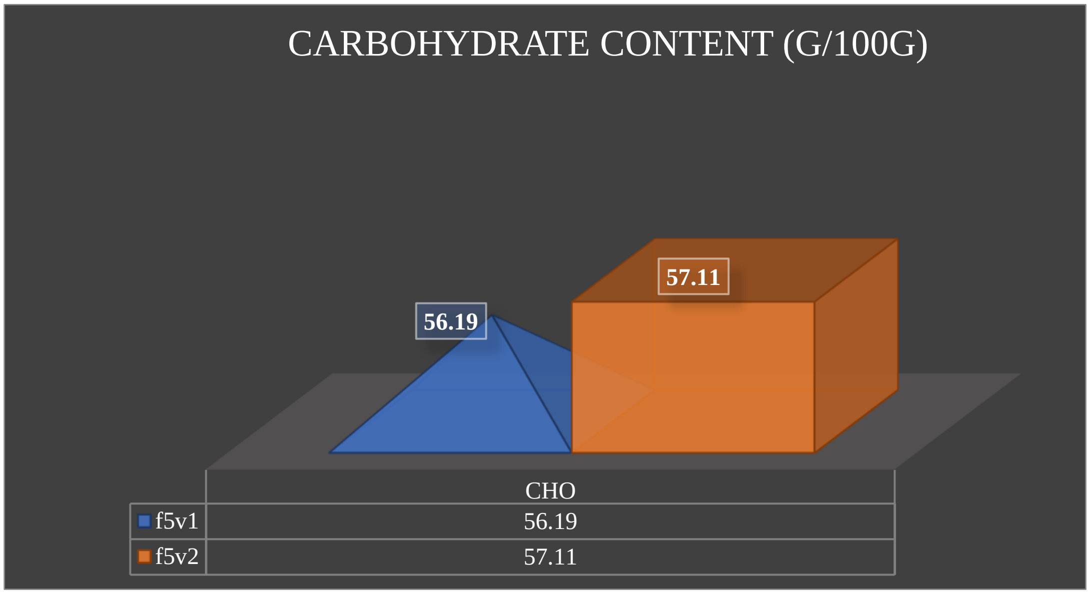
5.8.6 Calcium

The mineral calcium is necessary for the body to perform key essential functions, including the development and maintenance of healthy bones. Of all the minerals in the body, calcium is the most prevalent. Structure and hardness are derived from the nearly complete storage of calcium in teeth and bones. The dessert mix f_5v_2 had 70mg/100g and dessert mix f_5v_1 had 40mg/100g of calcium. According to Samaddar (1985), each 100g of ripe jackfruit flakes contains 30.0–73.2 mg of calcium. According to another investigation by Nisar *et al.* (2021), jackfruit seed flour had a calcium level of 41.20 mg/100g.

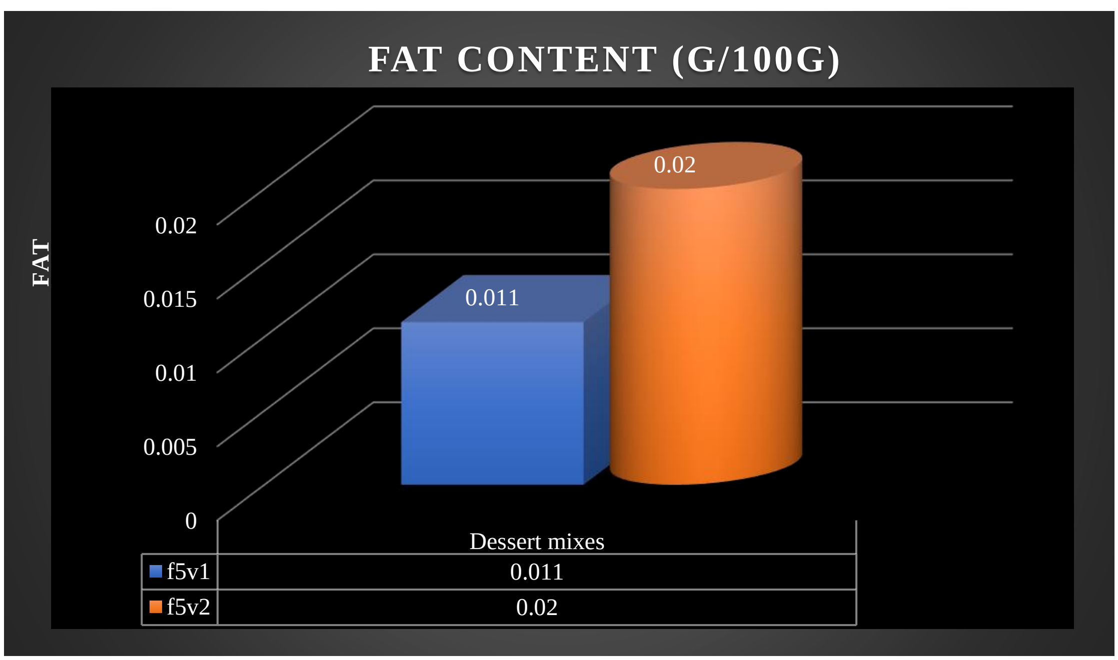
5.8.7 Beta-carotene

Plants have a pigment called beta-carotene that gives them their color. The Latin term for carrot is where the term beta-carotene originates. It imparts rich colors to fruits and vegetables that are yellow and orange. The dessert mix f_5v_2 had 0.002mg/100g and dessert mix f_5v_1 got 0.001mg/100g. According to Chandrika *et al*., 2005, the carotenoids found in jackfruit seeds

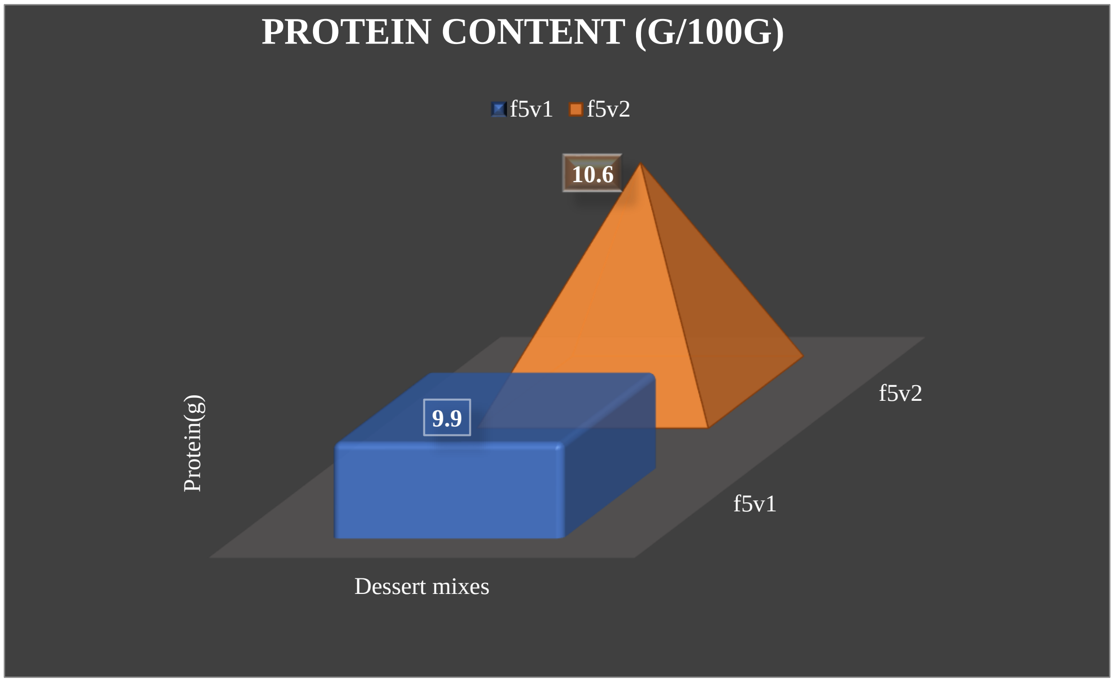
Graph: 15 Carbohydrate content of dessert mixes



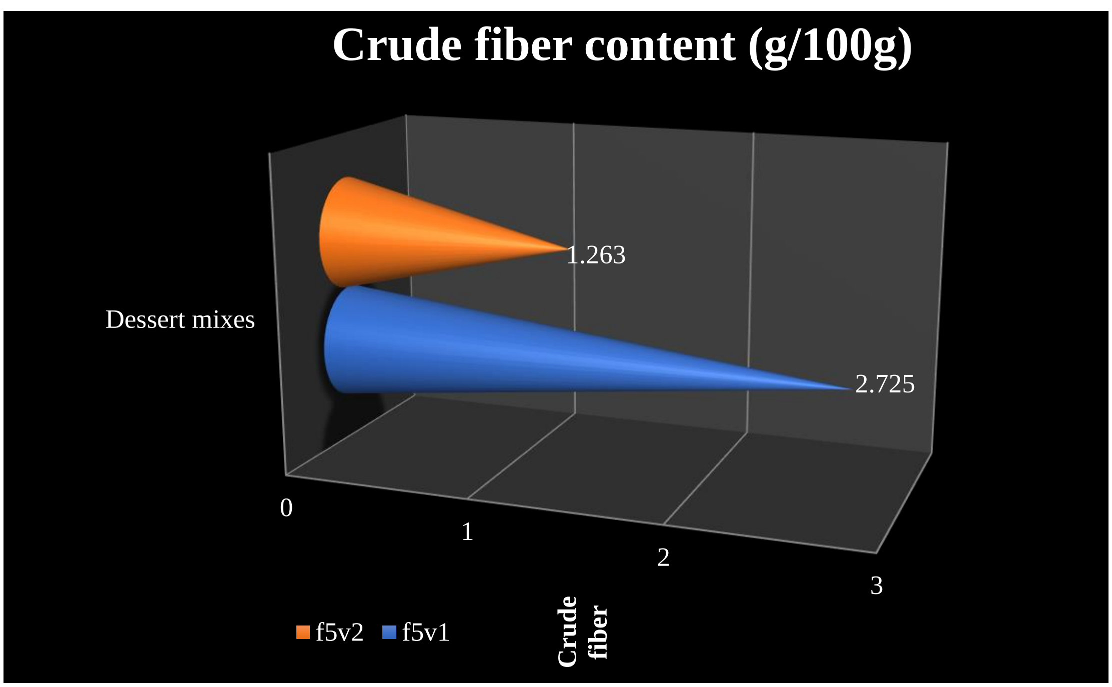
Graph: 16 Fat content of dessert mixes



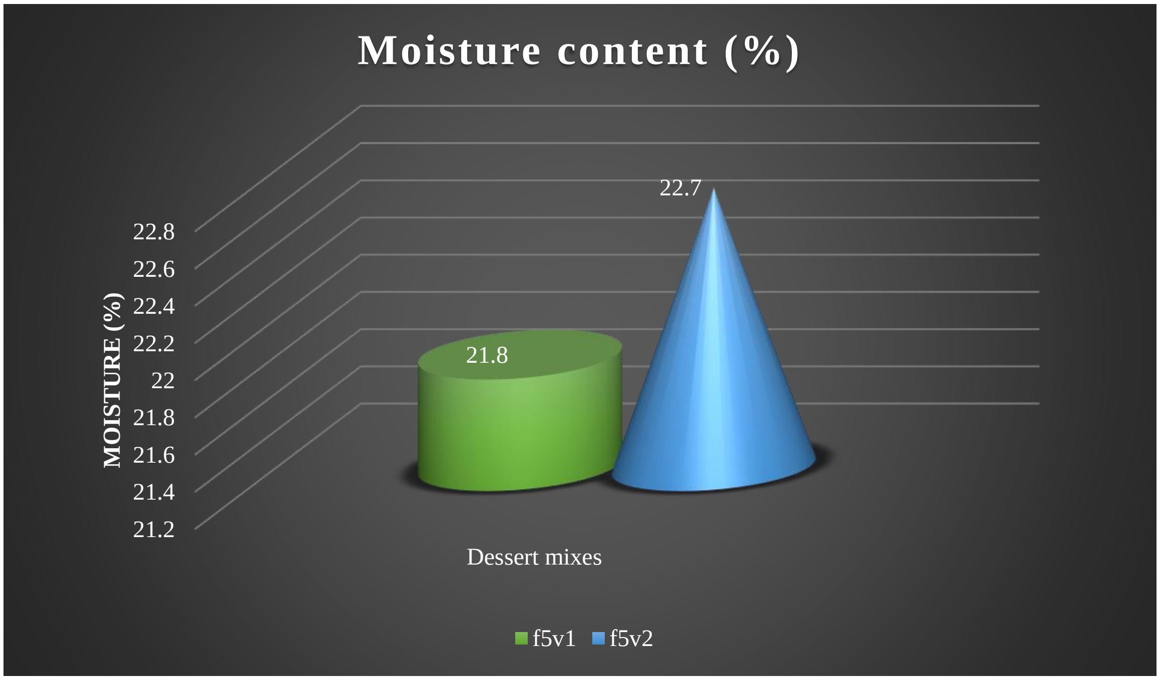
Graph: 17 Protein content of dessert mixes



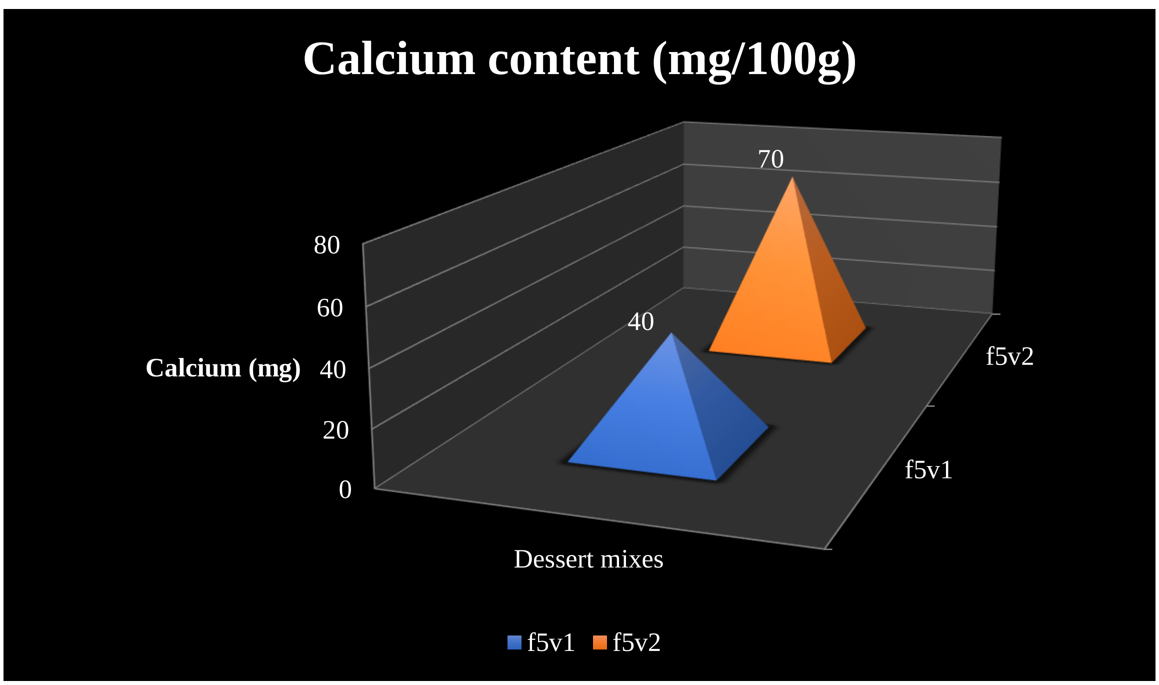
Graph: 18 Crude fiber content of dessert mixes



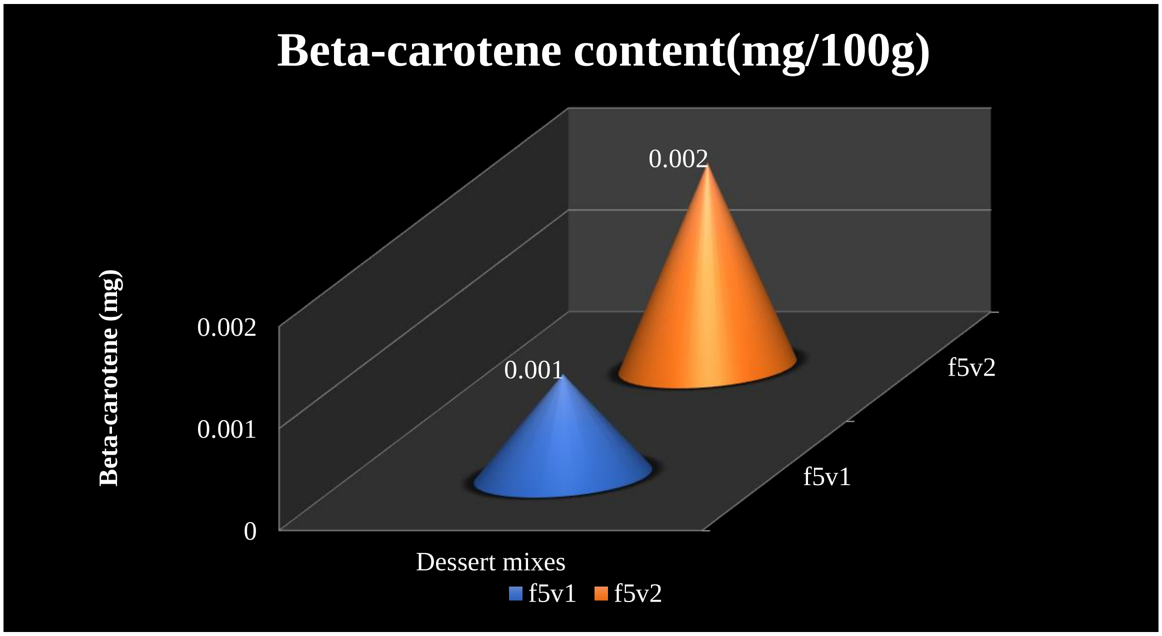
Graph: 19 Moisture content of dessert mixes



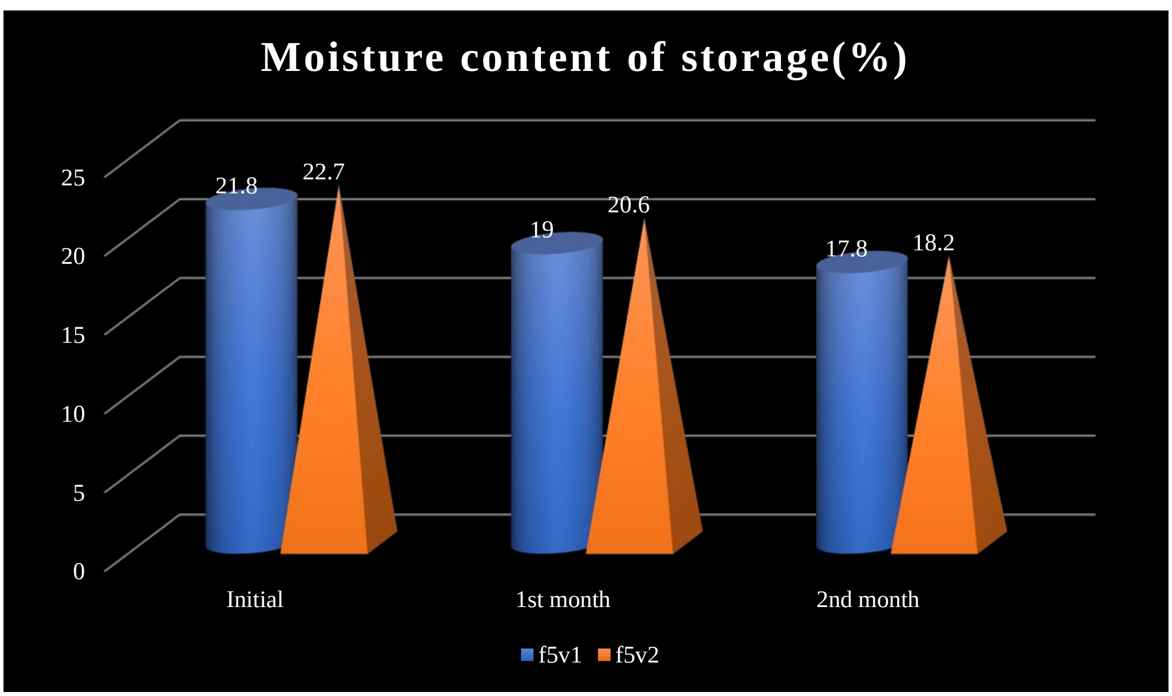
Graph: 20 Calcium content of dessert mixes



Graph: 21 Beta- carotene content of dessert mixes



Graph: 22 Moisture content of stored dessert mixes



include 9-cis-β-carotene (0.79), 15-cis-β-carotene (0.18), All-trans-β-carotene (29.55) All-trans-αcarotene (1.24), and 13-cis-β-carotene (2.45).

5.9 STORAGE STABILITY OF ETHNIC DESSERT MIX

The technique of preserving raw or processed food in sealed containers under extremely controlled circumstances is known as food storage. Food contamination and deterioration, which can result in potentially fatal food poisoning, can be avoided with proper food storage techniques. The shelf life of food items is determined by how long they can be kept without being stale or changing in flavor, taste, or other aspects. When food is stored for usual applications, noticeable alterations could happen. Both chemical and physical changes are possible.

5.9.1 Moisture content of dessert mixes

A food product's moisture content is the total amount of water it contains. It is often represented as a percentage of weight on a wet basis. For a longer shelf life of food product, minimized moisture content is crucial. The moisture content of developed dessert mixes initially ranged from 21.8 to 22.7 per cent. After one month of storage, it was observed that the moisture content of dessert mixes decreased, the value ranged from 20.6 to 19 per cent. After two months of storage, moisture of dessert mixes was noted between 18.2 to 17.4 per cent. The dessert mix f_5v_2 (18.2%) had the highest moisture compared to f_5v_1 (17.4%) dessert mix combination.

5.9.2 Microbial profile

The quality and safety of food items are determined by the analysis of microbial growth in developed food products. Achieving the absence of harmful microorganisms and preventing their proliferation by whatever means necessary ensures food safety. To determine the products' shelf life, microbiological analysis has been carried out on stored goods. Both the initial and one-week storage microbiological examinations were conducted.

In the current study, the presence of bacterial colonies was observed in dessert mix f_5v_1 and f_5v_2, initially count ranged from 17×10^4 to 25×10^4 and, 26×10^4 to 38×10^4 after one week of storage. Despite the presence of bacterial colonies, the count was within the FSSAI-recommended limit. There was no presence of fungal, coliform, yeast and mold count in the dessert mixes f_5v_1 and f_5v_2. Morshed *et al.* (2019) reported that throughout the first 96 days of storage, jackfruit seed flour was free of microbes.

5.10 COST OF THE PRODUCTS

The market worth of the commodities used to develop the dessert mixes was used to determine the cost of product. The cost of 300 gm of dessert mix are: dessert mix f_5v_1- (Rs.110/-) and for f_5v_2- (Rs.100/-). The rate of dessert mixes was higher than the commercially available dessert mixes due to the market value of ingredients used for developing the dessert mix especially diary substitute.

The jackfruit seed-based functional and instant ethnic dessert mixes are rich in protein, calcium and low in fat which is a healthy choice for dessert lovers. It takes little effort to get prepared. Therefore, it is admissible as a novel product.

SUMMARY

SUMMARY

The study entitled **“Development of jackfruit seed-based functional and instant ethnic dessert mix”** was carried out with the objective to develop jackfruit seed-based functional and instant ethnic dessert mix and evaluation of its quality. The study entailed of standardization of jackfruit seed-based ethnic dessert (*Ada*), processing of ethnic dessert, selection of best ethnic dessert base, standardization and quality evaluation of jackfruit seed-based dessert (*Ada payasam*) mix, development of dessert mix, functional quality analysis, sensory evaluation, quality analysis and storage stability of ethnic dessert mix.

Mature jackfruits (*varikka* and *koozha*) were collected from the instructional farm, College of Agriculture, Vellayani and also from the local markets. After the jackfruit had been knifed open, the seeds were taken out of the bulb. The jackfruit seeds were cleaned manually using a stainless-steel knife. The seed coat and testa were peeled off before processing. The seeds from both cultivars were subjected to various processing treatment including p_1 (Boiling and Grinding), p_2 (Drying and Powdering) and p_3 (Flaking). For p_1, the seeds were boiled for 10 minutes and ground into paste with enough water to form batter. For p_2, the seeds were sliced into fine pieces, gelatinized at 60°C for 5 minutes and tray dried at 70°C for 120 minutes then ground into powder (sieved with 150-micron fine wire mesh). For p_3, the seeds were cut into thin slices, tray dried at 60°C, roasted for 15 minutes at 60°C, and then flaked with a flaker machine (2mm diameter).

The two cooking methods used for further processing the base materials were c_1 (Steaming) and c_2 (Boiling). For c_1, the batter for the dessert base was spread onto butter paper and steamed with a steamer. *Ada* sheets thus obtained were sliced and dehydrated at 60°C. For the treatment c_2, the base batter was spread onto butter paper and immersed in boiling water until cooked. *Ada* sheets obtained in this manner were sliced into desirable size (6mm) and dehydrated at 60°C. The dessert base developed from *varikka* and *koozha* cultivar were stored and subjected to further analysis. Functional qualities and sensory parameters of jackfruit seed-based dessert base were evaluated. $v_1p_2c_1$ (*varikka*) and $v_2p_2c_1$ (*koozha*) was chosen as the best treatment according to the study findings.

The dessert mix were developed using $v_1p_2c_1$ and $v_2p_2c_1$ treatments in eight different permutations such as sugar/ jaggery, milk powder/ coconut milk powder and jackfruit preserve/ banana preserve in varying combination. The functional quality analysis showed that the dessert mixes f_8v_1 (0.463) and f_1v_2 (0.470) had the highest rehydration ratio. Swelling power was highest for the dessert mix f_8v_1 (1.920) and f_1v_2 (2.200). Yield ratio was highest for the dessert mix f_5v_1(1.393) and f_5v_1(3.866) on dry and wet basis from *varikka* cultivar. Yield ratio was highest for the dessert mix f_5v_2 (1.363) and f_5v_2 (3.700) on dry and wet basis from *koozha* cultivar. For water absorption capacity, the dessert mixes f_1v_1(2.633) from *varikka* cultivar and f_3v_2 (2.603) from *koozha* cultivar were found to highest among the eight combinations. Solubility index of dessert mixes from *varikka* cultivar ranged between 0.959 -0.979 % and the values of dessert mixes of *koozha* culitivar were 0.946-0.976%. No significant difference was observed among the dessert mix with respect to rehydration ratio and solubility index. There was no significant difference between water absorption capacity of *koozha* cultivar, yield ratio on dry basis and wet basis of *koozha* cultivar. The sensory evaluation of the eight distinct mixes from each cultivar were conducted with 10 semi trained panelist, the difference in the scores were analysed by using Kruskal wallis, a non-parametric test. There was no significant difference between the eight different mixes from *varikka* cultivar with respect to various attributes like texture, aroma, mouthfeel and overall acceptability. There was no significant difference between the dessert mixes from *koozha* cultivar for the sensory parameters except taste.

The best dessert mixes were selected on the basis of results of functional quality analysis and sensory evaluation. The combination f_5v_1 and f_5v_2 were selected as the best dessert mix from each cultivar. Selected dessert mixes were subjected to quality analysis and shelf-life study. The carbohydrate content of dessert mix combination f_5v_2 was (57.11g/100g) and dessert mix combination f_5v_1 was (56.19g/100g). The fat content in dessert mix f_5v_2 was (0.020%) and dessert mix f_5v_1 was (0.011%). The protein content of dessert mix f_5v_2 was (10.6g/100g) and dessert mix f_5v_1 was (9.9g/100g). The dessert mix f_5v_1 contained 2.725% of crude fiber, whereas dessert mix f_5v_2 contained 1.263%. The dessert mix f_5v_2 had moisture content of 22.73%, while dessert mix f_5v_1 had 21.81% of moisture. The dessert mix f_5v_2 had 70mg/100g and dessert mix f_5v_1 had 40mg/100g for calcium. The dessert mix f_5v_2 had 0.002mg/100g and dessert mix f_5v_1 had 0.001mg/100g for beta-carotene.

The moisture content of developed dessert mixes f_5v_1 ana f_5v_2 initially ranged from 21.8 to 22.7 per cent. After one month of storage, the value ranged from 19 to 20.6 per cent. After two months of storage, the moisture of dessert mixes was noted between 17.4 to 18.2 per cent. Microbial analysis of stored products was done to ascertain the shelf life of the products. The presence of bacterial colonies was observed in dessert mix f_5v_1 and f_5v_2, initially count ranged from 17×10^4 to 25×10^4 and, 26×10^4 to 38×10^4 after one week of storage. Despite the presence of bacterial colonies, the count was within the FSSAI-recommended limit. There was no presence of fungal, coliform, yeast and mold count in the dessert mixes f_5v_1 and f_5v_2. after one week of storage.

Cost of the developed products were calculated. The cost estimate of the dessert mixes ranged from Rs. 100/- to 110/-. The rate of the premixes was high compared to commercially available dessert mixes. It was due to the market value of ingredient used for developing the dessert mix namely milk powder which is generally absent in commercially available dessert mixes.

The study concludes that the jackfruit seed based functional and instant ethnic dessert mixes are rich in nutrients and quick to put together. Compared to other dessert mixes that are commercially available, the developed dessert mixes are a good source of nutrients. Therefore, the functional and instant ethnic dessert mixes made from jackfruit seeds can be regarded as a novel product. The ability to create innovative, healthful, and ready-to-eat food items is expanding in tandem with consumer awareness of sustainable living. Customers may now implement a credible food strategy since they are aware of the causal relationship between food, health and nature. Fruit byproduct development for value-added products has drawn a lot of scientific interest. The development of instant ethnic dessert mix will make dessert (*payasam*) preparation, handling, storage, and packaging more convenient for both home and entrepreneurs. As a result, the current study has shed light on fresh ideas for developing enriched goods from disregarded plant portions that are nutritionally significant.

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APPENDICES

APPENDICES I

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI, THIRUVANANTHAPURAM
DEPARTMENT OF COMMUNITY SCIENCE

Score card for sensory evaluation of jackfruit seed-based functional and instant ethnic dessert base.

Name: Date:

Signature:

Treatment	Appearance	Texture	Aroma	Taste	Mouthfeel	Overall acceptability
$v_1p_1c_1$						
$v_2p_1c_1$						
$v_1p_1c_2$						
$v_2p_1c_2$						
$v_1p_2c_1$						
$v_2p_2c_1$						
$v_1p_2c_2$						
$v_2p_2c_2$						
v_1p_3						
v_2p_3						
c						

Score values assigned:

Dislike extremely: 1 Dislike very much: 2 Like extremely: 9

Dislike moderately: 3 Dislike slightly: 4

Neither like nor dislike: 5 Like slightly: 6

Like moderately: 7 Like very much: 8

APPENDICES II

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI, THIRUVANANTHAPURAM
DEPARTMENT OF COMMUNITY SCIENCE

Score card for sensory evaluation of *varikka* cultivar-based functional and instant ethnic dessert mix.

Name: Date:

Signature:

Treatments	Appearance	Texture	Aroma	Taste	Mouthfeel	Overall acceptability
f_1v_1						
f_2v_1						
f_3v_1						
f_4v_1						
f_5v_1						
f_6v_1						
f_7v_1						
f_8v_1						

Score values assigned:

Dislike extremely: 1 Dislike very much: 2

Dislike moderately: 3 Dislike slightly: 4

Neither like nor dislike: 5 Like slightly: 6

Like moderately: 7 Like very much: 8

Like extremely: 9

APPENDICES III

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI, THIRUVANANTHAPURAM
DEPARTMENT OF COMMUNITY SCIENCE

Score card for sensory evaluation of *koozha* cultivar-based functional and instant ethnic dessert mix.

Name: Date:

Signature:

Treatments	Appearance	Texture	Aroma	Taste	Mouthfeel	Overall acceptabilty
f_1v_2						
f_2v_2						
f_3v_2						
f_4v_2						
f_5v_2						
f_6v_2						
f_7v_2						
f_8v_2						

Score values assigned:

Dislike extremely: 1 Dislike very much: 2

Dislike moderately: 3 Dislike slightly: 4

Neither like nor dislike: 5 Like slightly: 6

Like moderately: 7 Like very much: 8

Like extremely: 9

APPENDICES IV

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI, THIRUVANANTHAPURAM
DEPARTMENT OF COMMUNITY SCIENCE

COMPOSITION OF MEDIA USED FOR MICROBIAL ANALYSIS

NUTRIENT AGAR (1 L)

Peptone – 5g

Meat extract – 3g

Agar – 20g

Distilled water – 1000ml

EOSIN METHYLENE BLUE AGAR (1 L)

EMB – 36g

Agar – 15g

Distilled water – 1000ml

ROSE BENGAL AGAR (1 L)

Glucose – 10g

Peptone – 5g

$MgSO_4$. $7H_2O$ –0.5g

Agar – 15g

Rose Bengal – 35mg

Distilled water –1000ml

YEAST EXTRACT PEPTONE DETROSE (1L)

YEPD – 65g

Agar – 15g

Distilled water – 1000ml

ABSTRACT

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The study entitled "Development of jackfruit seed- based functional and instant ethnic dessert mix" was conducted at the department of Community Science, College of Agriculture, Vellayani, during the period 2021-2023. The objective of the study was to develop jackfruit seed based functional and instant ethnic dessert mix and to evaluate its quality.

Jackfruit seeds from cultivars *varikka* and *koozha* were selected for the study. The jackfruit seeds were cleaned manually using a stainless-steel knife. The seed coat and testa were peeled off before processing. The processing treatment of developing dessert base were p_1 (Boiling and Grinding), p_2 (Drying and Powdering) and p_3 (Flaking). For p_1 the seeds were boiled for 10 minutes and ground into paste with enough water to form batter. For p_2, the seeds were sliced into fine pieces, gelatinized at 60°C for 5 minutes and tray dried at 70°C for 120 minutes then ground into powder (sieved with 150-micron fine wire mesh). For p_3, the seeds were cut into thin slices, tray dried at 60°C, roasted for 15 minutes at 60°C, and then flaked with a flaker machine (2mm diameter). c_1 (Steaming) and c_2 (Boiling) were the two methods used for further processing the base. For c_1, the batter for the dessert base was spread onto butter paper and steamed with a steamer. *Ada* sheets thus obtained were sliced and dehydrated at 60°C. For the treatment c_2, the base batter was spread onto butter paper and immersed in boiling water until cooked. *Ada* sheets obtained in this manner were sliced into desirable size and dehydrated at 60°C.

Time and temperature for each treatment were standardized as 60°C (10 minutes) for Boiling and grinding; 70°C (120 minutes) for Drying and powdering; Drying (30 minutes), roasting (15 minutes) at 60°C for flaking. Sensory evaluation was conducted for the 10 samples. Treatment: (2×2×2) +2 = 10, replication: 3

Functional components like rehydration ratio, yield ratio, and solubility index of the 10 samples were also analysed to select the best treatment for obtaining the *Ada* base. Considering statistical analysis of functional components and sensory evaluation of 10 samples, $v_1p_2c_1$ and $v_2p_2c_1$ were opted as the best treatment from each cultivar and it was used for further analysis.

As a second part of the study, the developed dessert base from each cultivar were infused with sugar/ jaggery, milk powder/ coconut milk powder and jackfruit preserve/ banana preserve in

varying combination to obtain 8 distinct dessert mixtures. Functional characteristics with respect to each cultivar of the eight dessert mixes, including their Rehydration ratio, Yield ratio, Solubility index, Swelling power, and Water Absorption Capacity, were tested. Eight distinct permutations of the jackfruit seed-based dessert mix were made, and it was then put through a sensory evaluation procedure. Scores were kept for a variety of factors, such as color and appearance, flavor, texture, taste, and overall acceptability. Of the eight dessert mix combinations, two (f_5v_1 and f_5v_2) were selected for further study based on the functional characteristics and sensory evaluations. Treatment: 2×8 = 16, replication: 3.

On subjecting the selected treatment to quality analysis, it depicted that the dessert mix f_5v_1 had more crude fibre (2.73%) than f_5v_2 and commercially available dessert (*ada*) mixes. The dessert mix f_5v_2 had more protein (10.6g/100g), calcium (70mg/100mg) than f_5v_1 and commercially available dessert mixes. The developed dessert mixes were less in fat and carbohydrate than commercially available dessert mixes. Although nitrogen was flushed and the dessert ingredients were packaged in laminated pouches, the pack was not fully filled with nitrogen gas, since this method is more suited for packaging chips and other snacks. Microbiological methodologies were used to measure Total Bacterial Count (TBC), Total Fungal Count (TFC), Total Yeast and Mold Count (TYMC) and Total Coliform Count (TCC). The presence of bacterial colonies was observed in dessert mix f_5v_1, count was 38×10^4 after one week of storage period. While the f_5v_2 dessert mix observed with 26×10^4 after 1 week of storage. The TYMC, TFC and TCC of the two samples f_5v_1 and f_5v_2 was TLTC. Treatment: 2×2=4, replication: 4.

There's a growing need for nutrient-dense, tasty food that's also easy to prepare and consume. People are opting for foods that are high in nutrients due to diet-disease relationship. Since the developed dessert mix was rich in protein, fiber, calcium and has negligible amount of fat, it is a healthy choice for dessert lovers. However, the standardized product needs to be further scaled up for commercialization and marketing. In order to appeal to a wider range of consumers, jackfruit seed-based dessert mixes are an excellent option for natural and organic ingredients, free of artificial sweeteners and preservatives.

സംഗ്രഹം

2021-2023 കാലയളവിൽ വെള്ളായണി കാർഷിക കോളേജിലെ കമ്മ്യൂണിറ്റി സയൻസ് വിഭാഗത്തിൽ "ചക്ക വിത്ത് അടിസ്ഥാനമാക്കിയുള്ള പ്രവർത്തനപരവും തൽക്ഷണ വംശീയ മധുരപലഹാര മിശ്രിതത്തിന്റെ വികസനം" എന്ന തലക്കെട്ടിൽ പഠനം നടത്തി. ചക്ക വിത്ത് അടിസ്ഥാനമാക്കിയുള്ള പ്രവർത്തനപരവും തൽക്ഷണ വംശീയ മധുരപലഹാര മിശ്രിതവും വികസിപ്പിക്കുകയും അതിന്റെ ഗുണനിലവാരം വിലയിരുത്തുകയും ചെയ്യുക എന്നതായിരുന്നു പഠനത്തിന്റെ ലക്ഷ്യം.

വരിക്ക, കൂഴ എന്നീ ഇനങ്ങളിൽ നിന്നുള്ള ചക്ക വിത്തുകളാണ് പഠനത്തിനായി തിരഞ്ഞെടുത്തത്. ചക്ക വിത്തുകൾ കത്തി ഉപയോഗിച്ച് വൃത്തിയാക്കി. സംസ്ക്കരിക്കുന്നതിന് മുമ്പ് വിത്തിന്റെ തവിട്ടുനിറത്തിലുള്ള തൊലികൾ കളഞ്ഞു. ഡെസേർട്ട് ബേസ് വികസിപ്പിക്കുന്നതിനുള്ള പ്രോസസ്സിംഗ് ട്രീറ്റ്മെന്റ് p_1 (തിളപ്പിക്കലും പൊടിക്കലും), p_2 (ഉണക്കലും പൊടിക്കലും), p_3 (ഫ്ലേക്കിംഗ്) എന്നിവയായിരുന്നു.

പി$_1$-ന് വിത്തുകൾ 10 മിനിറ്റ് തിളപ്പിച്ച് മാവുണ്ടാക്കാൻ ആവശ്യമായ വെള്ളം ഉപയോഗിച്ച് പേസ്റ്റ് ആക്കി. p_2-ന് വേണ്ടി, വിത്തുകൾ നല്ല കഷണങ്ങളാക്കി, 60 ഡിഗ്രി സെൽഷ്യസിൽ 5 മിനിറ്റ് ജെലാറ്റിനൈസ് ചെയ്തു, ട്രേ 70 ഡിഗ്രിയിൽ 120 മിനിറ്റ് ഉണക്കി പൊടിയാക്കി (150-മൈക്രോൺ ഫൈൻ വയർ മെഷ് ഉപയോഗിച്ച് അരിച്ചെടുത്തു). പി$_3$ -യ്ക്ക് വേണ്ടി, വിത്തുകൾ നേർത്ത കഷ്ണങ്ങളാക്കി മുറിച്ച്, ട്രേ 60 ഡിഗ്രി സെൽഷ്യസിൽ ഉണക്കി, 15 മിനിറ്റ് 60 ഡിഗ്രി സെൽഷ്യസിൽ വറുത്ത്, തുടർന്ന് ഒരു ഫ്ലേക്കർ മെഷീൻ (2 എംഎം വ്യാസം) ഉപയോഗിച്ച് അടർത്തിയെടുത്തു. c_1 (ആവിയിൽ വേവിക്കുന്നു), c_2 (തിളപ്പിക്കൽ) എന്നിവ അടിസ്ഥാനം കൂടുതൽ പ്രോസസ്സ് ചെയ്യുന്നതിന് ഉപയോഗിച്ച രണ്ട് രീതികളാണ്. c_1 ന്, ഡെസേർട്ട് ബേസിനുള്ള ബാറ്റർ ബട്ടർ പേപ്പറിൽ വിരിച്ച് ഒരു സ്റ്റീമർ ഉപയോഗിച്ച് ആവിയിൽ വേവിച്ചു. ഇങ്ങനെ ലഭിച്ച അഡാ ഷീറ്റുകൾ 60 ഡിഗ്രി സെൽഷ്യസിൽ നിർജ്ജലീകരണം ചെയ്തു. c_2 ചികിത്സയ്ക്കായി, അടിസ്ഥാന ബാറ്റർ ബട്ടർ പേപ്പറിൽ പരത്തി പാകം ചെയ്യുന്നതുവരെ തിളച്ച വെള്ളത്തിൽ മുക്കി. ഈ രീതിയിൽ ലഭിച്ച അഡാ ഷീറ്റുകൾ ആവശ്യമുള്ള വലുപ്പത്തിൽ മുറിച്ച് 60 ഡിഗ്രി സെൽഷ്യസിൽ നിർജ്ജലീകരണം ചെയ്തു.

ഓരോ ട്രീട്മെന്റിന്റെയും സമയവും താപനിലയും തിളപ്പിക്കുന്നതിനും പൊടിക്കുന്നതിനുമായി 60°C (10 മിനിറ്റ്) ആയി കണക്കാക്കി; 70°C (120 മിനിറ്റ്) ഉണക്കുന്നതിനും പൊടിക്കുന്നതിനും; ഉണങ്ങുമ്പോൾ (30 മിനിറ്റ്), വറുത്ത് (15 മിനിറ്റ്) 60 ഡിഗ്രി സെൽഷ്യസിൽ ഫ്ലേക്കിംഗിനായി. 10 സാമ്പിളുകൾക്കായി സെൻസറി മൂല്യനിർണയം നടത്തി. ട്രീട്മെന്റുകൾ: (2×2×2) +2 = 10, പകർപ്പ്: 3

പത്ത് സാമ്പിളുകളുടെ റീഹൈഡ്രേഷൻ റേഷ്യോ, യീൽഡ് റേഷ്യോ, സോളബിലിറ്റി ഇൻഡക്സ് തുടങ്ങിയ പ്രവർത്തന ഘടകങ്ങളും അഡാ ബേസ് ലഭിക്കുന്നതിനുള്ള മികച്ച ട്രീട്മെന്റു തിരഞ്ഞെടുക്കുന്നതിന് വിശകലനം ചെയ്തു. ഫങ്ഷണൽ ഘടകങ്ങളുടെ സ്റ്റാറ്റിസ്റ്റിക്കൽ വിശകലനവും പത്ത് സാമ്പിളുകളുടെ സെൻസറി മൂല്യനിർണ്ണയവും പരിഗണിച്ച്, ഓരോ ഇനത്തിൽ നിന്നും ഏറ്റവും മികച്ച ചികിത്സയായി വി$_1$പി$_2$സി$_1$, വി$_2$പി$_2$സി$_1$ എന്നിവ തിരഞ്ഞെടുത്തു, അത് കൂടുതൽ വിശകലനത്തിനായി ഉപയോഗിച്ചു.

പഠനത്തിന്റെ രണ്ടാം ഭാഗമായി, ഓരോ ഇനത്തിൽ നിന്നും വികസിപ്പിച്ച മധുരപലഹാര അടയിൽ പഞ്ചസാര / ശർക്കര, പാൽപ്പൊടി / തേങ്ങാപ്പാൽ പൊടി, ചക്ക പ്രിസർവ് / വാഴപ്പഴം എന്നിവ ചേർത്ത് 8 വ്യത്യസ്ത പലഹാര മിശ്രിതങ്ങൾ വികസിപ്പിക്കാൻ ഉപയോഗിച്ചു. എട്ട് ഡെസേർട്ട് മിക്സുകളുടെ ഓരോ ഇനങ്ങളുടേയും പുനർ ജലാംശം, വിളവ് അനുപാതം, ലയിക്കുന്ന സൂചകം, നീർവീക്കം, ജലം ആഗിരണം ചെയ്യാനുള്ള ശേഷി എന്നിവ ഉൾപ്പെടെയുള്ള പ്രവർത്തന സവിശേഷതകൾ പരീക്ഷിച്ചു. ചക്ക വിത്ത് അടിസ്ഥാനമാക്കിയുള്ള മധുരപലഹാര മിശ്രിതത്തിന്റെ എട്ട് വ്യത്യസ്ത ക്രമമാറ്റങ്ങൾ ഉണ്ടാക്കി, തുടർന്ന് അത് ഒരു സെൻസറി മൂല്യനിർണ്ണയത്തിനു വിധേയമാക്കി. നിറവും രൂപവും, രുചി, ഘടന, രുചി, മൊത്തത്തിലുള്ള സ്വീകാര്യത എന്നിങ്ങനെ വിവിധ ഘടകങ്ങൾക്കായി സ്കോറുകൾ രേഖപ്പെടുത്തി. എട്ട് ഡെസേർട്ട് മിക്സ് കോമ്പിനേഷനുകളിൽ രണ്ടെണ്ണം (ഫ്$_5$വി$_1$, ഫ്$_5$വി$_2$) പ്രവർത്തന സവിശേഷതകളും സെൻസറി വിലയിരുത്തലുകളും അടിസ്ഥാനമാക്കി കൂടുതൽ പഠനത്തിനായി തിരഞ്ഞെടുത്തു. ട്രീട്മെന്റുകൾ: 2×8 = 16, പകർപ്പ്: 3.

തിരഞ്ഞെടുത്ത ട്രീട്മെന്റിൽ ഗുണമേന്മയുള്ള വിശകലനത്തിന് വിധേയമാക്കുമ്പോൾ, ഫ്$_5$വി$_2$, വാണിജ്യപരമായി ലഭ്യമായ ഡെസേർട്ട് (അട) മിക്സുകളേക്കാൾ കൂടുതൽ അസംസ്കൃത ഫൈബർ (2.73%) ഡെസേർട്ട് മിശ്രിതം ഫ്$_5$വി$_1$-ൽ ഉണ്ടെന്ന് അത് ചിത്രീകരിച്ചു. ഡെസേർട്ട് മിക്സ് ഫ്$_5$വി$_2$-

ൽ ഫ്$_5$വി$_1$-നേക്കാൾ കൂടുതൽ പ്രോട്ടീൻ (10.6g/100 ഗ്രാം), കാൽസ്യം (70mg/100 ഗ്രാം), വാണിജ്യപരമായി ലഭ്യമായ ഡെസേർട്ട് മിക്സുകൾ എന്നിവ ഉണ്ടായിരുന്നു. വികസിപ്പിച്ച ഡെസേർട്ട് മിശ്രിതങ്ങളിൽ വാണിജ്യപരമായി ലഭ്യമായ ഡെസേർട്ട് മിശ്രിതങ്ങളേക്കാൾ കൊഴുപ്പും കാർബോഹൈഡ്രേറ്റും കുറവാണ്. നൈട്രജൻ ഫ്ലഷ് ചെയ്യുകയും ഡെസേർട്ട് ചേരുവകൾ ലാമിനേറ്റഡ് പൗച്ചുകളിൽ പാക്ക് ചെയ്യുകയും ചെയ്തെങ്കിലും, പായ്ക്ക് പൂർണ്ണമായും നൈട്രജൻ വാതകം കൊണ്ട് നിറയ്ക്കാൻ കഴിഞ്ഞില്ല, കാരണം ഈ രീതി ചിപ്സിനും മറ്റ് സ്നാക്സിനുമാണ് കൂടുതൽ അനുയോജ്യം. ടോട്ടൽ ബാക്ടീരിയ കൗണ്ട് (ടിബിസി), ടോട്ടൽ ഫംഗൽ കൗണ്ട് (ടിഎഫ്സി), ടോട്ടൽ യീസ്റ്റ് ആൻഡ് മോൾഡ് കൗണ്ട് (ടിവൈഎംസി), ടോട്ടൽ കോളിഫോം കൗണ്ട് (ടിസിസി) എന്നിവ അളക്കാൻ മൈക്രോബയോളജിക്കൽ മെത്തഡോളജികൾ ഉപയോഗിച്ചു. ഡെസേർട്ട് മിക്സ് ഫ്$_5$വി$_1$-ൽ ബാക്ടീരിയ കോളനികളുടെ സാന്നിധ്യം നിരീക്ഷിക്കപ്പെട്ടു, സംഭരണ കാലയളവിന്റെ ഒരാഴ്ചയ്ക്ക് ശേഷം എണ്ണം 38×10^4 ആയിരുന്നു. 1 ആഴ്ച സംഭരണത്തിന് ശേഷം ഫ്$_5$വി$_2$ ഡെസേർട്ട് മിക്സ് 26×10^4 ആയി നിരീക്ഷിച്ചു. ഫ്$_5$വി$_1$, ഫ്$_5$വി$_2$ എന്നീ രണ്ട് സാമ്പിളുകളുടെ ടിവൈഎംസി, ടിഎഫ്സി, ടിസിസി എന്നിവ ടിൽടിസി ആയിരുന്നു. ട്രീട്മെന്റുകൾ: 2×2=4, പകർപ്പ്: 4.

തയ്യാറാക്കാനും ഉപയോഗിക്കാനും എളുപ്പമുള്ള പോഷക സാന്ദ്രമായ, രുചികരമായ ഭക്ഷണത്തിന്റെ ആവശ്യകത വർദ്ധിച്ചുകൊണ്ടിരിക്കുകയാണ്. ഭക്ഷണ-രോഗ ബന്ധം കാരണം ആളുകൾ ഉയർന്ന പോഷകങ്ങൾ അടങ്ങിയ ഭക്ഷണങ്ങൾ തിരഞ്ഞെടുക്കുന്നു. പ്രോട്ടീൻ, നാരുകൾ, കാൽസ്യം എന്നിവയാൽ സമ്പുഷ്ടമായതും കൊഴുപ്പ് കുറഞ്ഞ അളവിലുള്ളതുമായതിനാൽ, ഡെസേർട്ട് പ്രേമികൾക്ക് ഇത് ആരോഗ്യകരമായ തിരഞ്ഞെടുപ്പാണ്. എന്നിരുന്നാലും, വാണിജ്യവൽക്കരണത്തിനും വിപണനത്തിനുമായി സ്റ്റാൻഡേർഡ് ഉൽപ്പന്നം കൂടുതൽ സ്കെയിൽ ചെയ്യേണ്ടതുണ്ട്. വൈവിധ്യമാർന്ന ഉപഭോക്താക്കളെ ആകർഷിക്കുന്നതിനായി, കൃത്രിമ മധുരവും പ്രിസർവേറ്റീവുകളും ഇല്ലാത്ത പ്രകൃതിദത്തവും ജൈവികവുമായ ചേരുവകൾ ഉൾപ്പെടുത്തിയ മികച്ച ഉല്പന്നമാണ് ചക്ക വിത്ത് അടിസ്ഥാനമാക്കിയുള്ള മധുരപലഹാര മിശ്രിതങ്ങൾ.