DEVELOPMENT OF NOODLES WITH THE INDIGENOUS INDIAN RICE

By

THAHMINA KN

(20PFD029)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore – 641 043

In partial Fulfillment of the Requirements for the

Degree of Master of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

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Signature of the Supervisor

Signature of the Head of the Department

CERTIFICATE

This is to certify that the thesis entitled, **"Development of Noodles with the Indigenous Indian Rice"** submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore in Partial fulfilment of the requirements for the award of the degree of Master of Science in Food Service Management and Dietetics, is a record of original research work done by **Ms. K. N. Thahmina** with Register Number 20PFD029 during the period of this study under the Supervision and Guidance of **Dr. S. Thilagamani,** Assistant Professor (SG), Department of Food Service Management and Dietetics, Avinashilingam Institute For Home Science and Higher Education For Women, Coimbatore- 641 043, Tamil Nadu, India.

Signature of the Supervisor

Signature of the Candidate

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

LIST OF ANNEXURES

I. INTRODUCTION

Food is considered as a fuel to the human body and it is needed for the physiological function of the body. Food gives us different nutrients which are needed for the various activities to be carried out. Each food is unique in the amount and type of nutrient content from the six classes of nutrients in them. These nutrients are required for the growth and development of the human body. These nutrients are required by every phase of human growth such as the pregnancy, lactation and catch-up growth in children **(Millward, 2012)**. The food is also defined as "any substance consumed to provide nutritional support for an organism" **(WHO)**.

Food is divided into different categories according to their properties. It is divided into food groups such as the Fruits, Vegetables, Grains, Protein Foods and Dairy **(Chang and Koegel, 2017)**. Every food group is unique in the way of contributing nutrients to the human upon consumption of the particular food groups. Whole grains have been a part of the human diet for about 10,000 years and it has high concentration of Vitamin B, minerals, elevated levels of basic amino acids, elevated tocol levels in the lipids and other major nutrients **(Slavin, 2004)**. Pulses are largely produced by Asian countries and a valuable source of energy which are derived from the carbohydrate, high protein content and fat available in the pulses **(Ofuya and Akhidue, 2005)**. Vegetables and Fruits are known for their high concentration in vitamins, minerals and antioxidants apart from other basic nutrients. They have a wide variety of divisions in which each group is rich in specific nutrients **(Millward, 2012).** Dairy are polyvalent compounds containing the essential nutrients and it is mainly rich in calcium **(Heaney, 2000).**

Food is consumed not only as a part of nutrition but also contributes to human tradition and culture. Around the world the people consume foods based on their geographical regions, culture, religion, economy and traditional habits **(*Zhang and Ma, 2016*).** People also consume their foods according to their social classes and economic balance. People in rich countries eat more compared than those in poor countries. The consumption of fat also increases according to the increase in income. The consumption of the food patterns also closely relates to the production and availability of the local products **(Olugbire *et al*., 2021).**

Millets are ancient nutritional crops and were consumed as staples by the people mostly by low-income people in Asia and Africa. Millets are considered as an ideal food to the human beings as it contains high levels of nutrient content such as the protein, minerals, vitamins, antioxidants, non-glutinous and non-acid forming diets. Millets are traditionally cultivated and consumed as human feeds and animal feeds by both the Asian and the African countries **(Padulosi *et al*., 2015).**

In India there are some millets which are commonly cultivated and consumed. India is the world's leading producer of millet production. India is also home to various types of millets and it was consumed by many of the people. The millets were used traditionally which is again regaining its market due to the nutritional awareness by the people **(Gowri, 2020).** In India the millets can be easily grown due to the weather and the trait for rain-fed farming and the millets mature quickly leading to a faster yield of the crops. These millets are very farmer friendly as they grow even in poor soil conditions and can offer other benefits in nutritional, ecological and socioeconomic areas **(Padulosi *et al*., 2015).**

Millet consumption has decreased by nearly 1per cent globally, although it is anticipated to increase between 2019 and 2024. Millet's importance as staple food has declined in India and globally during the last two decades due to demand and supply variables such as rising incomes, urbanization, and government policies **(*Gowri, 2020*).** The discovery of nutrients in millets gave rise to the term "nutria-cereals" Some of the most common millets consumed in India are finger millet (ragi), italian millet, proso millet, kodo millet, barnyard millet, tiny millet, job's tears, and teff.

For the last 3000 to 4000 years cereals have taken dominance and it is consumed by most of the world's population. These have been a major part of daily diet. In America, the grain varieties such as wheat, oats, barley, and rye are some of the major parts of their diet **(Slavin, 2004).** Most people in most developing nations rely on cereals for around 60 per cent of their daily calories, with little protein to supplement it, whereas those in rich countries rely on it for only 30 per cent of their daily calories **(Gil *et al*., 2011).**

Rice is one of the major crops which is consumed by the Asian countries and it is grown by almost two billion people and consumed more than four **(FAO, 2016)**.

The Asian countries are countries with a large produce of rice about 89 per cent of world's production, and 55 per cent of the production is from India and China. Harvesting of the rice accounts for 144 million hectors around the continent in which India and China dominate half of the total area **(Milovanovic & Smutka, 2017).** In countries such as China, Vietnam, Bangladesh, India, and Cambodia generally consume large amounts of rice.

India is the world's second largest rice producer and it is in the way of overtaking China - the world's most populous nation. **(Milovanovic and Smutka, 2017)**. It has about 30,000 traditional varieties before the era of high-yielding varieties. Each of the states had its own varieties of rice which has evolved over centuries. these traditional rice varieties include coarse, fine, scented and non-scented types **(*Ahuja et, al., 2008*)**

Rice grains are highly nutritious and possess various properties. Whole grain cereals also have a number of health benefits, including lowering the risk of Hypertension, Type 2 Diabetes Mellitus (DM2), Cardiovascular diseases, and certain types of cancer, as well as a number of gastrointestinal disorders. Wholegrain cereals, which contain all layers of the grain (bran, germ, and endosperm), are high in nutrients and phytochemical components that have been linked to health benefits, including dietary fibre, antioxidants, phenolic compounds, phytoestrogens such as lignans, vitamins, and minerals. **(Gil *et al*., 2011).**

Until recent years, the rice was thought to be nutritionally inadequate due to it being high in carbohydrates and low in protein but these proteins were high in quality. India is gifted with the wealth of medicinal plants, which are traditional rice varieties used in ayurveda for years. The traditional rice varieties of India have different colours such as the black. brown and red **(Umadevi *et al*., 2019).**

With over 100,000 native landraces of the indica group, South Asia is a rich reservoir of rice genetic variation. Thousands of rice landraces (Oryza sativa L. ssp. indica) exist in India, with different natural hues of black, purple, red, brown, and white grains. The colour content varies depending on the secondary metabolite profile. **(Ray *et al*., 2021).** Currently India has 6000 varieties of traditional rice varieties out of which originally had about 110,000 varieties. Most of the traditional

varieties of rice were lost due to the green revolution which led to the increased amount of high yielding hybrid varieties **(Priya *et al*., 2019).**

There was disappearance of the traditional foods due to the colonization and green revolution leading to collapse in crop diversity. This led to various concerns such as the nutritional deficiencies, hinders ecological systems and transition of diet which caused various diseases. The traditional foods are significant in nutrition and also can improve the food security and economic advancement for small household farmers. Traditional foods can be brought again by agricultural technologies supported by globalization and also with the globalized market of increasing trade, migration and communication trends **(Trolio *et al*., 2016).**

Traditional variety of rice has tasted the hinch of demise as a result of the proliferation of high-yielding variants The prominent reason for the disappearance of the traditional landraces is due to the introduction of the high yielding varieties in the 1960s. The farmers and the people were fascinated by the miracle seeds which were the high yielding varieties and were drawn to them leaving the traditional varieties unnoticed. These factors contributed to the loss of several well-adapted rice varieties native to India, including those that are drought-tolerant, flood-tolerant, and suited to poorly drained and lowland agriculture **(Ashraf and Lokanadan, 2017).**

To revive the traditional landraces of rice and to increase the production of these rice varieties various actions on both the people's side and governmental side were taken. One of such actions taken by the government are Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPVFR Act) and the Geographical Indications of Goods (Registration and Protection) Act, 1999 (GIs Act). Even though the government has taken such actions the farmers are either unaware of these legislations or its actions making again the revival of these landraces to a query **(Blankeney *et al*., 2020).**

These traditional foods were then transferred to a convenience form so that people could use them. Convenience foods are which aids in convenience in cooking time, transportation, buying and processing before consumption. The convenience foods are of many types such as the Ready-To-Eat (RTE), Ready-To-Serve (RTS), Ready-To-Cook (RTC) which does their work according to their name specified. The

traditional foods over the years were converted to these convenient forms so that it may reach all the people any matter of distance or economic status. These convenient foods also play a very important part in reaching out to the traditional foods to the community. Over the past two decades before the 2000s, these convenient foods took a very slow rise and the cereal-based traditional foods also needed attention **(Premavalli, 2000).**

India is the world's second-largest food producer, and its production is projected to rise in the period following 2010. Large investments in the food processing sectors, such as canning, specialised processing, dairy and food processing, frozen food/refrigeration, packaging, and thermal processing, may be made to enhance the production of convenience foods. This is also a technique to cut down on food waste and keep seasonal crops from becoming obsolete. There has been increasing growth in the food processing sector and India has set a target of 20 per cent growth by 2015. There is a vast opportunity for the food processing sector in India compared to the fact that developed countries process food about 80 per cent, whereas India processes about 1.3 per cent **(Gupta, 2009).**

There are also various brands which have set their benchmarks in the Ready-To-Eat foods. These have verily been welcomed between the Non-resident Indians but they are in a cheering phase between the resident Indians. Various factors are also included in the buying behavior of the Ready-To-Eat foods which in turn also leads to the acceptability of the Ready-To-Eat foods. People have accepted Ready-To-Eat foods due to the convenience factor and taste factor **(Sarathy and Gopal, 2011)**.

Convenience foods first set their bench mark in the developed countries and then they were likely to move to the developed countries. These foods are a part of daily diet in the United States and other countries. There not only single factors that affect the consumption patterns of these foods. They are driven by various factors and this was also changed for different countries. The changing trends and the variables change with the trends of the country and leads to a potential market to the convenience foods **(Sheely, 2008).**

The people are now turning their tables to eat healthy foods in order to maintain a healthy lifestyle and to make their body to a peaceful state. The healthy

Ready-To-Eat foods are now gaining attention towards many of the people. Most of these consumers are health-conscious people who are illiterate and want a convenient way to eat those foods. These people buy these products due to various factors considering the ingredients, brand name, packaging, calories content and package styling. The people who are migrating need their taste of traditional foods but in an easier way and so, probably choosing these Ready-To-Eat foods as their go to foods **(Vijayabaskar and Sundaram, 2012).**

India is a country which has a diversity of religion, culture and food. Indians traditionally, likes to consume foods which are homemade which were also had some religious concerns. These food consumption patterns were shifted in the Indian families due to the increasing awareness and influence of the western cultures. These were started from the early 1900's when there was a change in the consumption of food such as when people tasted the foods outside of their homes. The domestic women are eager to try out new convenience foods to produce foods for their families. They are now tending to ease their cooking process by eliminating the first few steps of food preparation and shifting to convenience foods **(Srinivasan and Shende, 2016).**

The demand for convenience food in India is growing every day due to a variety of factors. The rise of the Ready-To-Eat convenience industry has been attributed to factors such as the migration of people from rural to urban areas, an increase in the working population, an increase in health consciousness, and advancements in wellness. The proportion of ready-to-eat foods in total foods increased from 28.7 per cent to 61.7 per cent. As a result, these stores have been a huge success for convenience foods **(Dhir and Singla, 2020).**

As we are moving into a more technology prone world, people love to ease out their work and to have the work to be done promptly. This also shifted the people of India to have convenience foods. Many companies have entered India and also set their trade mark in the country. The marketing strategies have also aided in the selling of the convenience foods in the country. These foods have reduced the stress for working people by reducing their time in the kitchen, which also led to great success

with convenience foods. These foods are now in an emerging state, which can be brought into higher sales by future research **(Verma and Chawla, 2020).**

Hence the presented study titled **"Development of Noodles with the Indigenous Indian Rice"** was undertaken with the following objectives. To develop novel and convenience food products which is packed of nutraceuticals like the antioxidants, phytochemicals, polyphenols and dietary fibre. To process the Indigenous rice varieties into convenient food products. To evaluate the sensory attributes and nutritional properties of the develop product.

2. REVIEW OF LITERATURE

The Literature pertaining to the study titled "**Development of Noodles with the Indigenous Indian Rice"** is reviewed under the following headings:

A. Availability and Use of Traditional Foods- Indian Scenario.
B. Nutritional Important and Significance of Traditional Rice.
C. Importance and Need of Traditional Ready-To-Eat and Ready -To-Serve Foods in the Indian Food Market.

A. Availability and Use of Traditional Foods- Indian Scenario:

Nelson *et al*., (2019), reported the impact of green revolution on the indigenous crops of India. Due to green revolution many high yielding crops were introduced which were suitable for tropical conditions of south Asia by the IRRL in 1960s. they increased the growth rate of the food-grain output. This led to the loss of the landraces which were indigenous to the country. As the farmers shifted to mono-cropping after the green revolution, the consumption of traditional rice varieties in the Indian diet which were resistant to the drought, salinity and the floods were reduced These were also high in nutrition compared with hybrid varieties. The revival of these traditional varieties is done by initiating the purchase and management of the germplasm of indigenous varieties by the Indian government, knowledge of the benefits of these crops, availability, passion of the farmers, and adaptation of geological indication (GI) for the traditional products.

Triolo *et al*., (2016), analysed on exploiting globalization to revive traditional foods. There was disappearance of the traditional foods due to the colonization and green revolution leading to collapse in crop diversity. This led to various concerns such as the nutritional deficiencies, hinders ecological systems and transition of diet which caused various diseases. The traditional foods are significant in the nutrition and also can improve the food security and economical advancement for small household farmers. Traditional foods can be brought again by agricultural technologies supported by globalization and also with the globalized market of increasing trade, migration and communication trends. The modern agricultural

techniques used for the traditional foods can be more efficient, provide quality, increase shelf life and the traditional foods can be spread world-wide.

Jerath *et al*., (2016), reported the contribution of indigenous foods towards the nutritional status of the tribal region of Jharkhand, a place in India. It was a cross-sectional study covering four villages with qualitative data collection methods. The tribal women consumed the indigenous varieties of green leafy vegetables, meats, tubers, during the season and throughout the year by following a proper storage method. It was found that they were relatively eaten low during the rainy season. Their major staple food was rice with daily intake of green leafy vegetables and other vegetables once a week.

Sivakumar *et al*., (2021), discussed the traditional rice varieties in order to see the scope for future sustainable production. Traditional rice varieties are rich in nutritional properties. Different rice varieties have different properties which are a good donor for the high yielding rice varieties with low glycemic index. The traditional rice varieties of rice were put into physiological stress such as drought, salt stress in which they showed resistant to theses stress compared to the high yielding varieties. The traditional landraces possess unique genetic rice germ plasm and backgrounds providing genetic reservoir for rice improvement. These play as a potential door for the high yielding varieties for the development. This provides a future scope of providing nutritious rice varieties.

According to Nongdam and Tikendra (2014), nutritional facts and the usage of the traditional foods, bamboo shoots of northeast India. Bamboo shoots are considered as a nutritionally rich with various health benefits. They are high in proteins, amino acids, carbohydrates, minerals, vitamins, dietary fibres, phytosterols, less cholesterol content. The bamboo shoots are done into different food items and they are consumed by the northeast India. They are from the integral part of the popular traditional cuisines either consumed fresh or fermented. The traditional dish made from the bamboo shoot is named as kupe. The bamboo shoot also has good market potential about ten billion dollars. The usefulness of the bamboo shoots is not well known by the common people, which is mainly concerned with the ignorance of

the high nutritional values but they play an important role in everyday life of te indigenous people of Asiatic countries.

Sarkar *et al*., (2015), explored about the traditional and ayurvedic foods of India. The traditional Indian foods dates back to Indian civilization and Indian old literature. Ayurveda is considered as traditional system of medicine which is mainly based on food and body and includes various treatments. There are various traditional foods in India which is based on grains such as idli, dosa, ambali, ragi hurihittu, enduri pitha, dhokla, hawaijar; based on fruits such as banana, bale dandu palya. Banana stem juice, vazhai poo poriyal, jackfruit, monkey jack, bael fruit, mango, mango pachadi, mango peel chutney, jamun fruit, papaya, papaya salad, bitter gourd, green leafy vegetable, spinach roti, basle soppu palya, saag, batua paratha, mulai keerai masiyal; based on mik such as dahi, rabdi, ginna, Sandesh, lassi, buttermilk. These foods are used by the Indian house-holds on the daily basis and also for various therapeutic uses.

Jerath *et al*., (2016), stated the potential of the indigenous foods to address the hunger. A cross-sectional study was done by selecting four villages in the Santhal tribal community, Jharkhand, India. Participatory rapid assessment and focus group discussion methods were used to collect the data from the communities. To attain the nutritional needs of the indigenous population, diversifying and maximizing the utilization of the indigenous foods are a good strategic approach. A tota of 103 types of indigenous foods were analysed in which they showed a high levels of micronutrients like calcium, beta carotene, folate in most of them. The some of the vegetables can full fil the recommended dietary allowances of nutrients up-to 30 per cent of vitamin A and 40 per cent of calcium. These foods are identified as a rich source of micronutrients and transferring knowledge of these indigenous foods along with their nutritional importance in the diet could lead to a sustainable community.

Patel *et al*., (2020), reviewed on the traditional agricultural practices in India a susceptive for environmental sustainability and food security. The traditional agricultural practices were nearly over 4000 years old, provide financial resilience to the marginal farmer. These also helps to enrich the diet and nutritional security of the global population. The aspects include social equality, economic profitability and

environmental health for traditional agriculture. These aids many features such as environmental feature, economical feature, social feature. These practices are the store hose of the intergenerational knowledge of the community. These practices also help in the availability of the traditional foods to the community. For the future climatic change, efforts are needed to develop farming systems and select suitable crops and so, sufficient supplies of food and economic security, conservation of traditional crop wealth, sustainability of production systems and environmental conservation can be attained.

Mobolate *et al*., (2019), evinced the methods involving in the storage of the food grains preservation in India and Nigeria. The most of the crop waste are due to the improper post-harvest handling. The storage of the food grains plays an important role in the economies of the developed and developing countries. The storage of the grain attributes to the quality, demand and seasonal prices. Traditionally these grains are stored using various methods which includes solarization, open fire place, open air/ aerial storage, storage with diatomized earth, gourds, palmyra leaf (*broassus labellifer L.)* bin, crib, straw bin, earthen bins, bamboo bin, storage bags, earthen pot-pile, storage with table salt, platform storage, underground pit, mud house storage, silo, mud silo, thatch silo, metal silo, plastic silo, bamboo house, mud rhombus, obeh, warehouse. These type of traditional storage practices are cheap and are constructed with the readily available materials locally providing a high shelf life to the grains and ensuring the availability of the food grains to the people.

Pradhan *et al*., (2019), explained the contribution of finger millet, increase in the availability of nutritious food at the household. Agriculture is affected due to the varying climatic conditions and this can be overcome by increasing the yield of traditional crops. Usually, the yield of traditional crops is low when it is done using the traditional way of agriculture. The study area was selected and the status of the agriculture and nutrition of the people were noted. The less availability of the crop was due to the low-productivity and practicing traditional crop yielding leading to dense crops with unevenly spread nutrients was found in the base line survey and a high yielding finger millet was farmed. This increased the yield of the finger millet under the controlled conditions and they also needed 35 per cent less women labour for the production. There was also increase in the consumption of the finger millet

about 13 per cent in average and more households were also adapted to the finger millet.

Sudha *et al*., (2013), reported the acceptance of the brown rice by the Indians at the region of Chennai and the experiment was conducted including the participants of 82 consumers with nine samples containing BPT rice and brown rice of various per cent of polishness and a questionnaire was used. It showed that most men and about half of the women came forward to substitute brown rice or 2.3 per cent polished rice in their diet instead of white rice when education on their nutritional benefits were given.

Blankeney *et al*., (2020), stated the use and awareness of the two laws such as "The Protection of Plant Varieties and Farmers' Rights Act, 2001" and "The Geographical Indication of Goods (Registration and Protection) act 1999" which was implemented by the government of India for the protection of traditional rice varieties. The Protection of Plant Varieties and Farmers' Rights Act (PPVFR) was associated with Seed Care which extended the area of cultivation of the traditional rice varieties. The Geographical Indication of Goods Act (GIS) provided the geographical indications of various indigenous crop varieties which makes the farmers to cultivate the traditional rice of the region.

B. Nutritional Important and Significance of Traditional Rice:

Umadevi *et al*., (2012), rice is a staple food for the most of the world's population which has a good content of nutritional components and medicinal properties. Different countries have various rice varieties embedded with nutritional and therapeutic values. These rice varieties have different functional properties such as prevention of diseases like brown rice, a traditional variety of rice which aids in the protecting the body against cancerous cells, contains high levels of neurotransmitter nutrients, preventing chronic constipation.

Priya *et al*., (2019), reviewed the nutritional and functional properties of coloured rice varieties of south India, which showed that red coloured rice varieties are rich in iron and zinc. Maappillai samba which is a red-coloured rice variety of Tamil Nadu has, protein (8.16±0.45), fat (0.918±0.13), crude fibre (2.5±0.28), carbohydrates (75.86±2.31). Black coloured rice varieties have a high amount of

protein, fat and crude fibre and brown rice varieties has a high amount of fibre and a good source of other nutrients such as the magnesium, phosphorous (0.17-0.43), selenium, thiamine (0.29-0.61), niacin (3.5-5.3), vitamin B6 and manganese. The brown rice has its bran layer, which contains higher amount of calcium (10.0-50.0), zinc (0.6-2.8) and iron (0.2-5.2). The coloured rice varieties has phytochemical compositions than the white rice. The red and black rice varieties contain anthocyanins which can be broken by the digestive enzymes and gut microflora. They also possess inhibition of reductase enzyme and anti-diabetic activities. Mapillai Samba, has a total phenolic compounds and anthocyanin content than other varieties and have β-sitosterol which has hypocholesterolemic effect, improves fertility and also heals colon cancer.

Rajendran *et al*., (2018), analysed the phytonutrients in the ten traditional rice varieties in which eight of them were from southern parts and two of them were from northern parts of India. The solvent of these rice was extracted by the addition of methanol and were centrifuged. The vitamin-E content was reported high in the pigmented rice varieties than the white rice, in which mapillai samba had the highest vitamin-E content (26.73±0.49 µg/g). The phenolics content of mapillai samba was 39.61±0.75 mg/100g, Poongar was 10.23±1.22 mg/100g. The difference in the phenolic compounds is due to the dark pigments of the pericarp such as the red and black colour. Flavonoids have many health benefits such as counteracting Cancer, promote antioxidant, anti-inflammatory activities which are higher in the red and black varieties. The flavonoid content of the poongar was 2.20±0.11 mg/100g. The total anthocyanin content was highest in the coloured rice, prominently in black rice. The total anthocyanin content of mapillai samba is 42.21±0.28 mg/100g.

Upadhyay and karn (2018), discussed about the nutritional composition and health benefits of the brown rice. It is an un milled rice with the bran layer which is high in vitamins like thiamine, niacin, pyridoxine, and minerals such as manganese, phosphorous, and iron. It also contains the antioxidative components such as the vitamin-E, phytosterols, phytic acid, phenols, γ-0ryzanols and tricin. The milling leads to significant loss of components like fiber lipids, minerals, B-vitamins about the range of 60-90 per cent. The dietary fibre present in the brown rice prevents the carcinogens actions in the mucosa, aids in the normal colonic microflora growth,

lower risk of Type-II diabetes, reduces serum cholesterol, low-density lipoprotein, blood pressure, serum Low Density Lipoprotein-cholesterol, triacylglycerol levels, improve glycaemia, insulin sensitivity. It prevents the diseases associated with vitamin deficiency. It also has high amount of iron content. The protein content ranges between 4.3-18.2 per cent and has several antioxidants, phenolic compounds such as tricin associated with Pulvative Cancer chemo preventive properties.

Lee *et al*., (2019), discussed that one cup of cooked brown rice (195 g) had an average of 216.4 calories of energy, 1.76 g fat, 0.64 g monounsaturated fat, 0.63 g polyunsaturated fat, 0.35 g saturated fat, 44.8 g carbohydrate, 5.03 g protein, 0.66 g fibre, 0.19 mg thiamine, 0.05 mg riboflavin, 2.98 mg nicotinic acid, 0.28 mg pantothenic acid, 0.28 mg vitamin B6, 7.80 mg folic acid, 19.50 mg calcium, 0.82 mg iron and 1.23 mg zinc. The components in the brown rice prevents colon cancer, type II diabetes, asthma and also reduces the damage to lipid membranes. The γ-0ryzanols present in the rice bran inhibits Low Density Lipoprotein-cholesterol synthesis. There was an increase in nutrients level about two to four times of niacin, thiamine, and riboflavin when the rice is milled, parboiled by when the starch is gelatinized it may reduce the glycemic index.

Yang *et al*., (2021), analyzed quantitively and qualitatively about the nutritional content in the bamboo (moongil) rice. The different types of bamboo species, rice and wheat were used for the study. The bamboo seeds had a longer in the size with thin and slender shape compared with the rice and wheat. The bamboo rice had starch content next to rice and lowest soluble sugar and proteins. It also had higher amount of potassium, manganese, iron, zinc and copper and calcium.

Kalaivani *et al*., (2018), studied the medicinal and nutraceutical properties of the karung (black) kavuni rice. The study involved collection of the rice from thanjavur super market and formed a product with the combination of karung kavuni with the other ingredients. The highest protein content was found in the product with karung kavuni, chenna and carrot extract whereas it was less in the product containing karung kavuni, bean and beet root extract. The study revealed that the products formulated with kavuni rice showed that considerable amount of nutrients, like the

carbohydrates and protein. The pigmented rice has properties such as the protection against the cytotoxicity, antioxidant and scavenging activities than the white rices.

Hemamalini *et al*., (2021), stated about the nutritional and therapeutic potential about the karuppu kavuni rice. The rice was purchased and the extract was prepared, it was then analysed for various properties. The study proved that it can be used in the prevention of disorders like the diabetes, arthritis, stress disorders. The phytochemical screening and gas chromatography analysis showed the presence of anthocyanin, flavonoids, coumarins, phenols, carbohydrates, amino acids, glycocides. It showed, it is a potent antioxidant which increases with its concentration. The reducing power assay gives the per cent of inhibition of kavuni extract was 88.54 per cent (1000µg/ml) and so can reduce oxidative stress. The extract inhibited the protein (87.13 per cent) which showed the anti-arthritic activity of karuppu kavuni. It lowers the postprandial blood glucose levels in the blood after the consumption of the meal with the inhibition of α-glucosidase (71.20 per cent). It also inhibits the amylase (80.37 per cent) which prevents the dietary starch to utilize by the body exhibiting its anti-diabetic activity.

Valarmathi *et al*., (2014), reported on black kavuni which is known for its anti-diabetic property with commonly eaten white rice varieties of Tamil Nadu. Four varieties of rice were Cultivated, powdered, stored and various analysis were done. Kavuni possessed lower levels of components when compared to the other white rice varieties such as total soluble sugars (29-35 per cent), starch (8-35 per cent) ash content (0.54 per cent) and crude lipid. It had higher level of total dietary fiber about (21-52 per cent), protein (7-24 per cent), iron (20-30 per cent), calcium (33-45 per cent), copper (9.5-14.7 per cent), sodium (21-38 per cent), potassium (7-15 per cent) and magnesium (8.9-26 per cent). The Gas Chromatography-Mass Spectrometry analysis revealed presence of 15 phenolic acids, sugar molecules, flavonoids, fatty acids and carotenoids in kavuni. It had higher amounts of β-carotene (26-65per cent) and lutein (95-96 per cent). The extracts of kavuni showed the Nitrous Oxide scavenging activity. It has inhibitory action against the α-glucosidase and α-amylase.

Joseph *et al*., (2007), assessed the variability of the black rice Navara - the traditional medicinal rice of kerala. The seven different types of navara rice were

collected and used for the study. They recorded about seventeen quantitative characters from seven type of Navara rice. They studied about the various aspects of Navara rice including plant height (86.57 to 101.5 cm), productive tillers (1.5 to 1.3 cm), maturity duration (87 to 101 days), panicle length (18.65 to 21.42 cm), size of grain (0.814 cm to 0.769 cm), grain yield per plant (7.8 g to 35.53 g). These helps in the better understanding of different types of Navara rice.

Joseph *et al*., (2007), also stated the characterization of the Navara rice. The study was held on the regional research station with the collection of study samples from the various parts of Kerala. Each type of entry out of thirty entries, was different in their qualitative traits. Every entry was different from each other. They were grouped together into three groups by leaf and basal leaf sheath. They also observed the Navara rice had loose and panicle particle types. They had also different grain colour with strelielema being straw in colour with seed coat varying from light brown to red which determines the colour of the Navara rice. It was grouped together by the gerplasm colour as golden yellow glumed and black glumed. They also had different genotypes which determines its characteristics.

Deepa *et al*., (2007), studied the nutrient and medicinal properties of Navara rice. It is a rice variety in which its colour varies from the golden yellow to brownish black. The Navara rice along with other two commonly used rice was used for the estimation of the amylose content, proximate analysis, mineral analysis, fatty acid analysis, triglyceride analysis and statistical analysis. The analysis showed the proximate composition of Navara are, moisture per cent (13.10 ± 0.15), total carbohydrate (73.5±13.21), protein (9.52±0.34), crude lipid (2.48±0.5), Ash (1.42±0.06), fiber (8.08 ±0.03) which was for g per 100 g, energy value (1630 ±76.2) KJ per 100 g. The vitamin content of the Navara rice were folic acid (0.05 ± 0.001), thiamine (0.52 ± 0.01a,b), Riboflavin (0.071 ± 0.001a,b), Niacin (7.32 ± 0.81b). the mineral content were Iron (1.93 ± 0.01), Calcium (11.6 ± 0.08a,b), Sodium (30.9 ± 0.14a,b), Magnesium (216 ±0.10a,b), Potassium (304 ± 0.48a,b), Phosphorus (354 ± 15.42a,b) mg per 100g.

Rajagopalan *et al*., (2022), analyzed the metabolomic which showed the nutritional and therapeutic potential of the red coloured rice mapillai samba. It is a

long duration rice with bold and red grain genotype. The metabolomic profiling exhibited the presence of a total 113 metabolites belonging to 21 different metabolites such as the carboxylic acids (29 compounds), amino acids (27 compounds), fatty acids (16 compounds), and phenylpropanoids (10 compounds). It also showed antihypercholesterolemic, anti-infertility, antioxidant, and anticancer properties which were due to a total of 43 significant metabolites (VIP score > 1) belonging tophenylpropanoids and phytosterols identified by Partial Least Squares - Discriminant Analysis. The mapillai samba is a nutritious rice and can be replaced for a healthy diet. The Heat map and fold change analyses also confirmed the abundance of phenylpropanoids, steroids, and a few other therapeutic metabolites.

Krishnanunni *et al*., (2014), reported the chemical composition and volatile compounds along with the in-vitro assay. Two variety of rice was used which are karungkuravai and mapillai samba. They were analysed for various aspects, the gas chromatography identified nine compounds in which the mapillai samba had several phytochemicals which is also responsible for the medicinal properties of the rice. The sistestrol in this rice exhibited inflammatory; antineoplastic, antipyretic, and immuno modulating activities. The volatile compounds were identified by head space analysis showed curlone, 2H-1,4-Benzodiazepin-2-one, 7-chloro-1,3-dihydro-5-phenyl-1-(trimethylsilyl). It is also used as nathuratherapist as a cure to diseases of central nervous system. It also showed the antioxidant activity and free radical scavenging capacity.

C. Importance and Need of Traditional Ready-To-Eat and Ready-To-Serve Foods in the Indian Food Market

Food and Drug Administration (2009) defined, “the Ready-To-Foods (RTE) foods are a group of food products that are pre-cleaned, precooked, mostly packaged and ready for consumption without prior preparation or cooking”. It should be also in an edible form without an additional preparation step to achieve food safety.

Pathel and Rathod, (2017), discussed about the consumers perception and preferences of the ready-to-eat foods. India is country of young consumers with busy lifestyle, so opting for easy cooking over traditional cooking is evident aiding to the transition of food consumption patterns. Various study was held to determine the

perception of Ready-To-Eat foods which led to know about the factors such as awareness, availability, certification, ingredients and packaging.

Chaudhury, (2010), determined the factors influencing the importance of consumers buying behaviour of Ready-To-Eat foods. The exploration of new technologies has set a great sale of Ready-To-Eat s in India. The Ready-To-Eat cereal have been purchased due to its convenience over the diet and nutrition. Easy preparations, healthy foods, convenience, safety and cleanliness, taste, affordability and familiarity are some of the motives to ingest Ready-To-Eat cereals. Statistical data with questionnaire including all those concerning factors showed that Ready-To-Eat foods have been attained a notable growth in the recent times and the determinants of buying these foods included convenience, appeal, mood and price.

Vijayabaskar and Sundaram (2012), studied on the purchasing behavior of Ready-To-Eat's and Ready-To-Cook by the health-conscious people in the southern India by the survey method. The consumers intend to by a product mainly considering the ingredients, brand awareness, calorie content and package styling. The 80 per cent of Indians choice of food depends on the health considerations as there are rise in obesity, diabetes and heart diseases. The 38 per cent of the rural house-holds opted for cereal and cereal substitutes. The product containing high level of nutritional benefits are also given importance while buying.

Rahman (2013), explored the Ready-To-Eat and Ready-To-Cook foods with reference to the MTR, which is a popular Ready-To-Eat brand in India. The Indian Ready-To-Eat has now emerged from a pioneer to well-versed industry. This is initially due to the introduction of retorting technology and technological advancements in packaging and flavour science. The urban people are more prone in experimenting the Ready-To-Eat and Ready-To-Cook foods as that saves time and has a good taste. The market is also expanding due to the infrastructure provided by the Indian government and other projects that benefit both the government and the processing industry.

Rahman (2015), stated that Indian ethnic Ready-To-Eat's states that, double income family of middle class in India mostly opt for the Ready-To-Eat foods. The Indians also consume more foods related to Indian reginal Ready-To-Eat's. The

demand for these includes due to various changes in the life-style, socio economic status, increased working bachelor, convenience foods, generation pertaining not to cook the traditional foods. There are various brands such as “Haldirams, MTR, Priya, Kohinoor, Tasty bite, Veekay, Asoka” which has set their strong foundation in the Indian kitchens producing various Ready to Eat foods. The Indian traditional foods have a great demand on the Indian industry and also among the other states abroad.

Raj and Mishra (2020), reported the socio-demographic factors and selected buying behavioral attributes of purchasing of the convenience foods. The sociological factors are the main factors which influences the food choices. There are various factors including the expression of culture, religion, influence from family members and peers. The students going to college such as the undergraduate and post graduate students are very much preferred due to the taste, variation, low price point, accessible and affordable. The business class people less preferred the convenience foods and their factors included healthiness, strong brand image, food safety norms and food labelling. The nuclear family preferred shelf-life of the product. The high-class peoples did not compromise in health and preferred low sugar and fat packaged items.

Premavalli (2000), reviewed on the convenience foods which are given for the defence forces developed based on the traditional Indian foods. The traditional foods dates back to the Aryan civilization and it is then mixed with the culture and habits of the country. About 250 traditional foods are in use based on the staple cereals are in use and in which 15 per cent are in use commonly around the India. The products of Ready-To-Eat with traditional nature have become a necessity for economical and seasonal agricultural produce. For the defence personnel there are different specifications for the food such as it should be Ready-To-Eat, satisfy the Indian palate, stable from 45 to -40˚Celcius, suitable packaging, one-man compo-pack, nutritionally adequate. Over the years traditional foods are converted into convenience foods under Ready-To-Eat foods. These foods have a stable shelf-life preserving over months and also provides nutritional benefits. There are lot of future scope to develop the traditional Ready-To-Eat foods

Dhir *et al*., (2020), evinced on the consumption of the convenience foods and their health status of the working women. The new trends and also the migration of

the people has led to the increase consumption of the convenience foods. The study was held in the region of India, Punjab. The total participants were about 60 working and 60 non-working women. The questionnaire was prepared and factors and the attributes affecting the buying behaviour of the convenience foods. This study revealed that 58.3 per cent of the working women bought these convenience foods along with their groceries and 15 per cent of them consumed daily and 56.7 per cent of the non-working women bought them only when needed. The working women consumed Ready-To-Eat snacks weekly about 28.3 per cent and daily about 20 per cent. The Indian women coping both the home and work it is inevitable to not consume the convenience foods and there is a steady increase in the consumption of these convenience foods.

Banerjee (2021), stated the economic status of the global convenience food industry. As people are in a shifting phase of adopting the trends, the working people of the world is partly dependent on the Ready-To-Eat foods. The market of convenience foods in India showed that $262 million in 2017 and is expected to rise at a CAGR of around 16 per cent-18 per cent reaching $650 million by 2023. The popularly consumed convenience foods in India were based on the single or a combination of recipes in vegetarian styles. There is also an ongoing demand and growth for the Ready-To-Eat foods and it is critical to avoid from the diet of the people.

Kumari *et al*, (2019), developed a Ready-to-Eat product using the pearl millet which is one of the traditional crops of India. The pearl millet was popped and other processing was done, to produce a breakfast cereal which has a potential market with additional nutritional benefits, than the other cereal breakfast available in the market. They were high in dietary fiber, acting as a functional food and so had a hyperglycemic effect and also had high protein. Using these traditional crops to produce Ready-To-Eat's, also increases the income and the employment in the rural areas.

3. METHODOLOGY

The methodology pertaining to the study on the "**Development of Noodles with the Indigenous Indian Rice"** is presented under the following headings:

A. Selection of the Ingredients.
B. Developing a Process to Produce Noodles with the Indigenous Indian Rice Varieties.
C. Organoleptic Evaluation and Standardization of the Developed Product.
D. Nutrient, Physiochemical and Shelf-Life Analysis of the Developed Product.
E. Acceptability of Indigenous Indian Rice Noodles among the Adults aged 20-69 year**.**

A. Selection of the Ingredients:

In order to develop a noodle using the traditional Indian rice varieties, some of the indigenous crops of India were selected. The traditional rice varieties of India are of three colour which includes red, black and brown. They include a wide range of rice varieties, in which from each colour two varieties of rice were chosen and are depicted in Figure 1. These were selected considering their nutritional and functional properties. The rice (oryza *sativa*) selected from are Kavuni (black) and Navara(black), Mapillai samba (red), Poongar (red), Matta (brown), Moongil rice (brown).

Rice Is a major source of carbohydrates and has a well-balanced lysine content. The traditional rice varieties are higher in nutritional qualities when compared the white rice varieties. This is mainly due to the outer bran covering of the rice grains. These also are rich in antioxidants, volatile compounds, phytochemicals making it rich in nutrients. The black rice such as Kavuni rice have high number of antioxidants which is found to be in the bran layer of the rice containing anthocyanin, high amount of protein, iron, calcium **(Valarmathi *et al*., 2014)**. Navara rice has more resistant starch and is a better source of dietary fibre **(Deepa *et al*., 2010)**. The red pigmented rice such as the Mapillai samba possessed total of 113 metabolites and has got the highest total phenols, antioxidant activity followed by anthocyanins and flavonoids. Poongar rice has a good amount of total phenol, anthocyanin and

flavonoid content **(Devraj *et al.*, 2019)**. The brown pigmented rice varieties such as the Matta rice contains vitamin-E, phytic acid, phytosterols, phytic acid and tricin **(Rajendran *et al.*, 2016)**. Bamboo rice contains lowest soluble sugars and proteins along with higher amount of minerals **(Yang *et al.*, 2021).** These rice varieties were selected to develop a product which is packed of nutraceuticals and to convert them to a convenient food product.

The other ingredients selected include soya bean flour, corn flour, groundnut oil and salt. The soya bean flour was selected in order to increase the protein content of the noodles. The soya bean has the highest amount of protein about 28.20 per cent and highest amount of ash, vitamins, minerals, isoflaviones and lecithin ***(*Etiosa *et al.*, 2017)**. They also have a good binding property. The ground nut oil was added, one of the traditionally used oils in south India, along with providing additional nutritional value. The corn flour was added to bind the ingredients together and to extrude the product. The salt is added for the taste and sodium content.

Ethical cleareance for the study as obtained from Institutional Human Ethics Committee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore with Approval number AUW/IHEC/FSMD-21-22/XPD-25 is given in Appendix-I.

Image of selected ingredients			
Botanical name	*Oryza sativa L. indica*	*Oryza sativa L. indica*	*Oryza sativa L. indica*
Common name	Karuppu Kavuni	Navara	Poongar
Other names	• Forbidden rice • Emperor's rice	• Rice that cures • Shashtikashali	• Women's rice
Bran colour	Black	Black	Red
Origin	India	India- Kerala	India - Tamil Nadu

Duration in days	160	90	100
Average height of crop	127 cm	108 cm	75 cm
Maximum height of the crop	148 cm	115 cm	81 cm
Yield of grain per acre	1350 kgs	700 kgs	600 kgs
Health benefits	Antidiabetic Anticancer Antiarthritic activity Reduce oxidative stress Boost heart health Anticholesterolemic	Nathuratherapist Antidiabetic Improves aches and pains Cures gastrointestinal problems	Antidiabetic Anticholesterolemic Immune boosting Antianemia Good for pregnant women

Image of selected ingredients			
Botanical name	*Oryza sativa L. indica*	*Oryza sativa L. indica*	*Oryza sativa L. indica*
Common name	Mapillai samba	Matta	Moongil
Other names	• Bridegroom rice • Red rice	• Palakkadan • Kerala matta rice • Kaje rice	• Mulayari
Bran colour	Red	Brown	Brown
Origin	India- Tamil Nadu, Thiruvannamali	India- Kerala, Palakkad	India
Duration in days	160	100	40 years
Average height of crop	137 cm	60	15 cm

Maximum height of the crop	147 cm	71	40 meters
Yield of grain per acre	750 kgs	1500 kgs	74 tonnes
Health benefits	Antihypercholesterolemic Antifertility Antipyretic Immune modulating activities Antineoplastic Improves colon cancer	Reduces serum cholesterol Antidiabetic Treats pulvative cancer Insulin sensitivity	Enhances fertility Anticholesterolemic Reduces joint pains

Figure 1: Properties of Selected Ingredients

B. Developing a Process to Produce Noodles with the Indigenous Indian Rice Varieties.

The development of the noodles with the indigenous rice varieties undergoes various steps from the preliminary procedure till the extrusion of the noodles. The rice noodle process is different from the refined wheat / whole wheat flour noodles as the wheat flour contains gluten which helps in the stretchability and flexibility of the noodles. The rice flour noodles are based on the gelatinization of the rice starch which helps in the stretchability of the rice noodles.

a. Preliminary Preparation Procedure for the Development of the Noodles:

i. ***Washing:***

All the six varieties of the rice were spread in a completely dry and clean flat plates respectively and removed any dust or stone particle present. They were then submerged in a bowl containing water and then washed, it was repeated for three times to ensure there is complete removal of any dirt present. They were then kept on a clean cloth to remove the excess water present in the rice varieties before the actual drying process.

ii. ***Drying the Rice:***

Sun Drying:

All the rice was then placed on the plates separately and then covered using a clean cotton cloth to avoid any dust and insects intruding. The plates were kept outside were there is direct contact with the sunlight. They were sundried for about 12 hours till there is no moisture surrounded by them. These were then transferred to a clean air tight container respectively.

Dry Roasting:

The rice was dry-roasted using a wide iron pan which can spread the heat evenly at the temperature of 150˚ Celcius. Each rice was added separately and was roasted for about four minutes till they slightly change in colour. Another indication was splattering of the rice, this shows the rice is crisp and there is reduction in moisture content.

iii. ***Grinding into Flour:***

The rice varieties were ground using the mixer. Each rice has different timing usually, but grinds within six minutes. These rices were grinded to a fine powder. They were ground separately and then transferred to a clean air-tight container.

iv. ***Sieving:***

The ground rice was then sieved using a sieve of the pore 2mm. Rice was shifted for three times. This ensures to obtain fine particles and remove any big size particles. Sieving also helps to obtain a smooth consistency to the noodles and also results in fine particles of rice flour.

v. ***Mixing of the Ingredients:***

It is the first step in the making of noodles. The proper mixing of the ingredients together is necessary for the uniform distribution of the ingredients and also for the hydration of the flour. All the six-rice flour was added to a container and then they were mixed together using a whisk. This will make even distribution of the rice flour **(Ahmed *et al*.,2016)**.

vi. ***Dough Formation:***

To the rice flour needed salt, and water was added and was mixed together. The water was boiled at a temperature of 96.3˚ Celsius. In a container, all the six varieties of rice flour, soya bean flour and salt were added and mixed together using a whisk. This was then added to the boiling water and then they were mixed together. The flour was cooked with mixing for three minutes. It was then closed with lid for a minute. These were then added to another bowl, and they were kneaded together while it is still hot. It should be kneaded till they become into a dough consistency. The proportion of the water to form a dough consistency was 30 per cent. When the water is added to the rice flour and it is heated in which gelatinization takes place which helps in the formation of the dough. The heat treatment such as the boiling or the steaming of the rice flour gelatinizes the starch with the following retrogradation which helps in holding the structure of the noodles **(Hui Lu and Collado, 2010).**

vii. ***Steaming:***

The dough formed is then separated into small equal balls. These are then placed in a steamer and steamed for about four minutes. They were then taken out in a bowl and kneaded for at least two minutes and form a dough.

viii. ***Extruding the Dough into Noodles:***

The dough formed is extruded into noodles using the noodle extruder. The dough is separated into batch and then it is sent through an extruder. It is pressed and the noodle is obtained which was laid on a flat plate. It is then sprinkled with some rice flour to reduce the stickiness of the dough.

b. Production Process of the Noodles:

For the formulation of the method, firstly all the six flours of the traditional rice varieties such as the kavuni, navara, poongar, mapillai Samba, Matta, moongil were taken. All these flours were taken in an equal amount of 10g each and then they were mixed together. Soya bean flour and salt were added to it. The soya bean flour was added in different proportion to find out the proportion of ingredients which gives long noodles. They include soya bean flour of different proportion of 25 per cent, 50 per cent, 75 per cent, 100 per cent which are 15g, 30g, 45g, 60g were added

respectively. In the trial, different proportion of soya bean flour and different method were used to find an effective method and proportion for developing the noodles.

The variations are done by taking equal proportions of rice with changing the proportions of the soya bean flour, to determine the quantity of ingredients to be added. The composition of the ingredients used is shown in the table-1.

TABLE I

Composition of Ingredients used in Trial Production

Ingredients	Composition				
	Trial-1	**Trial-2**	**Trial-3**	**Trial-4**	**Trial-5**
	25%	**25%**	**50%**	**75%**	**100%**
Kavuni rice	10g	10g	10g	10g	10g
Navara rice	10g	10g	10g	10g	10g
Poongar rice	10g	10g	10g	10g	10g
Mapillai samba	10g	10g	10g	10g	10g
Matta rice	10g	10g	10g	10g	10g
Moongil rice	10g	10g	10g	10g	10g
Soya bean flour	15g	15g	30g	45g	60g
Groundnut oil	5ml	5ml	5ml	5ml	5ml
Salt	1.5g	1.5g	2.5g	3.5g	5g

Method-1:

The dough was prepared by mixing all the ingredients together and then they were mixed using the hot water. The flours were kneaded into a dough using the hot water. The hot water helps the dough to stay together. These were then sent through an extruder, dried and packed.

Method-2:

In this method, all the flours were mixed together and then they were added to the hot water of temperature 93.6˚Celsius while they were still on the stove. The flour was mixed using a spatula and cooked in the stove for two minutes. The flour was cooked for another one minute by closing the flour with the lid in a simmering temperature, this makes the flour to cook through and the flour becomes fluffy. This was then taken out of the heat and the was kneaded into a dough. The dough was then

separated into small balls and then they were steamed for three minutes. These steamed balls were kneaded together and then was made into dough. These was then extruded and was dried and packed.

Method-3:

In this method the same technique followed but, with the addition of corn starch. The corn starch was added, as it can give stretchability to the noodles and helps in attaining a longer noodle. To the selected variety, 30g of corn flour was added along with the other ingredients and then the other preparation process was carried out, extruded, dried and packed.

Sensory Evaluation of the Products:

The sensory attributes which were appearance, texture, flavour, taste, overall acceptability was evaluated for the developed products. It was done to choose a product to continue the further process to develop into noodles. The sensory evaluation was done against each method and also within the methods. The products were evaluated for at both the dried state and cooked state. The sensory evaluation of the products was done to find out the appropriate cooking method and for the quantity of ingredients. For the determination of preparation method, sensory evaluation was done against method-1 coded OOO and method-2 coded AAA as shown in Figure 2, both with the same amount of ingredients but with the different cooking method. For the determination of the quantity of ingredients the sensory evaluation was done within the method-2, where the products coded AAA, ABA, ACA, ADA was evaluated against each other as shown in Figure 3, in which each products had a different quantity of ingredient (soyabean flour). Each of the trial in this method had different proportion of soyabean flour which proceeding from 25 per cent to 100 per cent.

Figure 2: Sensory evaluation of dried and cooked product prepared using method-1 and method-2, for the determination of preparation process.

Figure 3: Sensory evaluation of dried and cooked product prepared with method-2, for the determination of quantity of ingredients.

c. Variations:

The noodles were prepared using two different variations which were with and without the addition of corn flour. The selected variety with the accepted proportion from the trial. These was then prepared as a variation as these were the most accepted by the panel. The variation-1 was done using, 100 per cent of soya bean flour which is 60g of soya bean flour along with the other ingredients such as the kavuni, Navara, mapillai samba, poongar, matta and moongil rice of each 10g, salt and ground nut oil were used to prepare the noodles. For the variation-2, the same amount of ingredients was used along with the addition of 30g of corn flour. The quantity of ingredients used in variation-1 and variation-2 is shown in the Table II.

TABLE II

Quantity of Ingredients used in Variations

Ingredients	Variation-1	Variation-2
Black rice:		
Kavuni rice	10g	10g
Navara rice	10g	10g
Red rice:		
Poongar rice	10g	10g
Mapillai samba	10g	10g
Brown rice:		
Matta rice	10g	10g
Moongil rice	10g	10g
Other ingredients:		
Soyabean flour	60g	60g
Salt	5g	5g
Groundnut oil	5g	5g
Corn flour	0g	30g

C. Organoleptic Evaluation and Standardization of the Developed Product

The developed product was subjected to sensory evaluation using five-point hedonic scale and the product which has the highest value of acceptability was standardized. The process of sensory evaluation and standardization is discussed as follows:

I. Organoleptic Evaluation of the Developed Variations:

The sensory evaluation by the five-point hedonic scale was used to evaluate the noodles with 50 semi trained panel members. The sensory namely which are appearance, texture, flavour, taste, overall acceptability was evaluated. The sensory attributes of the product were evaluated by using questionnaire for both states as shown in Annexure I and II. The scores were recorded according to the response of the panel members. For each level of likeness, it was given a score from the scale of 5 to 1 in which, there is a gradual decrease of the likeness. The hedonic scale values were evaluated for each sensory attribute at their both states. The sensory scale for the dried product of various criteria were analysed. For appearance rating scale was, 5-very long, 4-moderately long, 3- neither long nor short, 2-moderately short, 1-very short. The scale for texture was ranging from 5-very crisp, -moderately crisp, 3-neither or nor crisp, 2-moderately soggy, 1-very soggy. The scale for flavour and taste were 5-excellent, 4-good, 3-fair, 2- poor, 1-very poor and for the overall acceptability, the scales were, 5- likes very much, 4 -liked moderately, 3- Neither liked nor disliked, 2- dislike moderately and 1-dislike very much. The sensory attributes for the cooked product varied for the texture which were 5-very soft; 4- moderately soft; 3-neither or nor soft; 2-moderately hard;1-very hard. Panel member was provided with water before and after testing the product to evaluate the sensory characteristics of the developed products in the laboratory. This is to ensure that the taste of the one product does not affect the taste of the other products.

The product was developed with two variations coded AAD and ADA in which both the variation has a same amount of ingredients with the addition of corn flour in the variation-2. In Variation-1, AAD with 10g of kavuni, 10g of navara, 10g of poongar, 10g of mapillai Samba, 10g of Matta, and 10g of moongil rice were used along with salt, ground nut oil and soya bean four. Varaition-2, ADA with 10g of kavuni, 10g of navara, 10g of poongar, 10g of mapillai Samba, 10g of Matta, and 10g

of moongil rice along with salt, ground nut oil, soya bean flour and corn flour. The two variations were kept for analysis on the both the dried and cooked state as shown in Figure 4. The score was obtained for both the dried and cooked state were then calculated and evaluated. This would reveal the acceptability of the both forms. The mean value of the score was calculated for each product and evaluated.

Figure 4: Sensory evaluation of variations for both the cooked and dried state

II. Standardization of Noodles:

According to Food Safety and Standards Authority of India "The objective of standardization is to set up a standard for a procedure or a product specification, to which every stakeholder adheres, in order to ease logistical procedures, facilitate trade and possibly improve quality if the requirements of the standard involve an improvement compared to common practices". For the standardization of the noodles, it was gone through the various stages of the standardization. Firstly, the recipe for the development of the noodles should be reviewed which includes listing of all ingredients, amounts and the proper order. Then, the recipe should be prepared in a small amount and weigh the number of products. The yield of the product should be determined. After the product is done once it is then checked for all the attributes and it is adjusted according to the need. It is then retested to assure all the information and the amounts in the production of the noodles is correct and complete. The variation

which is most accepted is selected and the same procedure is tried, tested and evaluated. The procedure is repeated to get a product which is similar in taste and other attributes of the food can be achieved when it is done.

The variation-1 and variation-2 has ingredients such as 10g of each rice variety including kavuni, Navara, mapillai samba, poongar, matta and moongil rice. Along with this main ingredients 60g of soyabean flour, 5g of salt and 5g of oil was added. For the variation-2 along with the same ingredients 30g of corn starch and 200ml of water for the preparation of the dough. These were prepared according to the process of production of the rice noodles. The recipe was adjusted until they achieved their needed acceptance. Then, the recipe was repeated until they were correct and complete with doneness, texture, flavour, appearance and taste.

III. Drying:

The noodles were extruded using one of the traditional methods of drying which is sun drying. Sun drying is an efficient method of drying and it is used widely for the drying of rice noodles. This type of drying is also used in the drying of vermicelli, which is a rice stick noodles traditionally consumed by Indians. The noodles are dehydrated to increase their shelf life and to adds more flavour. The noodles which were extruded was laid on the flat plates. The plates were first applied with the ground nut oil, which was used in the recipe to prevent the dried noodles from sticking on the plates. The noodles were then covered using a clean muslin cloth to prevent them from any dust or other particles from interrupting. The noodles were dried about 6 hours at a temperature of 32˚ Celsius to 35˚ Celsius. The noodles were prepared at sunny weather period of the year and so, they were dried straight after they were extruded. The noodles were flipped in the mid-way of drying to ensure there is even drying in the both the side of the noodles.

IV. Packaging and labelling of the Product:

a. Packaging:

The noodles which were dried was packed using food grade polythene packets. Each pack contains 120g of noodles yielding two serving sizes. The noodles were packed inside the polyethylene cover and then they were sealed. The package was ensured with no dirt before the product was packed.

b. Labelling of the product:

The product which was packed also contained labelling details. The food labelling requirements were done according to Indian regulations, food safety and standards (packaging and labelling) regulations, 2011. The labelling requirements such as the, Name of the food product, List of ingredients, Nutritional information, Declaration regarding Veg or Non-veg, Declaration regarding Food Additives, Net quantity, Batch identification, Date of packaging. Along with these requirements other additional information such as the recipes were added which can be accessed by scanning the QR code.

c. Food cost:

The food cost of the product was calculated by obtaining the prices from the product purchased from the nearby local market. The price of each product was calculated for each variety of rice, soya bean flour, corn flour, ground nut oil and salt according to the amount used to prepare a particular quantity of the product.

d. Recipes:

The rice noodles developed were subjected to different recipes which will go along the developed rice noodles. The recipes followed had different main ingredients which were categorized into chicken, egg, vegetables, paneer and mushroom. These are some of the recipes which are commonly prepared and so these were tried out with the developed product. These recipes which were developed were included in the packets of the product. These recipes were tried out and then these were displayed to assess the acceptability of the product.

TABLE III

Recipes Incorporating the Developed Noodles

Category	Recipes	Category of Food
Main Dish	Chicken Noodles	Non-vegetarian
	Vegetable Noodles	Vegetarian
	Paneer Noodles	Vegetarian
	Mushroom Noodles	Vegetarian
	Egg Noodles	Non-vegetarian

D. Nutrient, Physiochemical and Shelf-Life Analysis of the Developed Product:

The developed product was analysed for various aspects such as the nutrient, texture, antioxidant and the pH. These analyses of the develop product was done by various methods pertaining to the type of analyses done. Each analyses have a different but a suitable method used for the developed product. These analyses are one in order to find the properties of the developed product and so the value of the product can be obtained.

I. Nutrient Analysis:

The developed product was given for the nutrient analysis and the nutrient content of major nutrients such as the energy, carbohydrates, protein, fat which are the major nutrients. The minerals such as the calcium was analyzed as the red rice and the black rice are a rich source of calcium content. These rice varieties are rich in dietary fiber compared to the normal white rice and so they were also analyzed for the dietary fiber content. The procedure adopted for the analysis of nutrients is given in Appendix VI.

II. Antioxidant Analysis:

The rice such as the kavuni rice, Navara rice, poongar rice, mapillai samba rice, matta rice, moongil rice are a rich source of antioxidants and these are mostly present in the bran layer of the rice crop. As, the rice was used along with the bran layer for the production of the product it was analysed for the antioxidant capacity. The total antioxidant capacity of the product was analysed by UV-VIS spectrophometer as procedure shown in Appendix VII. The total antioxidant capacity of the Methanol extract of the sample was evaluated by the phosphomolybdenum method. 5 to 10gm of sample was taken and extraction was done using methanol solvent.0.3 ml of extract was combined with 3 ml of reagent solution. The tubes containing the reaction solution were incubated at 95° Celcius for 90 minutes. Then, the absorbance of the solution was measured at 695 nm using a UV-VIS spectrophotometer against blank after cooling to room temperature. Methanol (0.3 ml) in the place of extract was used as the blank. The total antioxidant activity is expressed as the number of gram equivalent of ascorbic acid.

III. Texture Analysis:

The product was subjected to analyse the texture. The texture of the noodles was analysed by compression method which is a popular method of instrumental texture measurement. A strand of noodles was placed on a flat plate shape surface and a flat probe was lowered to the product at a speed 1mm/sec. The sample was deformed and the extend of the deformation or the resistance offered by the sample is recorded. This gave various properties of texture of noodles such as the hardness, adhesiveness and break force.

IV. pH Analysis:

The pH of the product is a measure of concentration of Hydrogen ions in a solution. The pH of the food was measured using a pH meter as procedure given in Appendix VIII. The pH electrode is used to measure the pH of a product which can be analysed for both the liquid or food homogenate. Three grams of the product was taken, and then it was blended into powder form. This was then diluted using distilled water till all of the powdered product was dissolved. It was then placed in a pH meter, which was neutralized, and the electrode which was cleaned, standardized was inserted into the blended mixture and the Ph of the developed product was measured **(Vijayakumar, 2017).** The pH meter then read the pH of the product placed and the calibration in the machine was noted which was taken as the pH of the developed product.

IV. Shelf-Life Analysis:

The developed and dried product was analysed for shelf life. The 30g of the developed product which was fully developed was kept in an air-tight packaging. The packets were first washed thoroughly and then they were dried without leaving any moisture content. The packets were wiped with clean white cotton cloth to prevent any dust and moisture as these may be invade as a cause for the spoilage of the product. Then the product was added in the dried form and it was made sure that the packets was closed properly. The container was then kept in a dry place in room temperature. The product was kept for thirty days and was checked for the shelf life of the product. The shelf-life of the product was analyzed for 30 days. Each day the

packet was opened and checked for the spoilage. Any changes in the colour, flavour, and smell were noted. The growth of the mould or microbes were also noted to analyze the shelf-life of the product.

Variation – 1 *Variation – 2*

Figure 5: Shelf-Life Analysis of the Developed Products

E. Acceptability of Indigenous Indian Rice Noodles among selected the Adults

Selected variations incorporating the developed product were given among the adults aged (20-69 years) in a nearby residential area. Both the variations were given to study the acceptability of the products for the attributes such as the appearance, texture, flavour and taste among the selected adults. The products were cooked and they were displayed to the adults. The population of the acceptability study was ten people and included of male and female. The two variations of the noodles were cooked side by side. While cooking the noodles only salt was added and no other extra ingredients such as the vegetables and other seasoning were not added so that people can taste the authentic taste of the noodles.

The people were educated about the sensory attributes and then they were told to give score for the product according to the sensory attributes. The sensory evaluation by the five-point hedonic scale was used to evaluate the noodles as show in Appendix V. The sensory namely which are appearance, texture, flavour, taste, overall acceptability was evaluated. These scores were then recorded according to the response by the adults. The hedonic scale values are, 5- likes very much, 4 -liked

moderately, 3- Neither liked nor disliked, 2- dislike moderately and 1-dislike very much.

Both the products were given simultaneously so that they can find the difference in both. The sensory evaluation by the respondents was noted and then they were evaluated. The people were also asked some of the questions about indigenous Indian rice varieties and also hey were educated about the nutritional and health benefits of the rice and also the developed product.

Flow Chart of the Study on Development of Noodles with the Indigenous Indian Rice

Phase- I

Selection of Ingredients for the Development of Noodles with Indian Indigenous Rice Varieties

- Rice flour:
  - Black rice- Kavuni, Navara
  - Red rice- Poongar, Mapilai samba
  - Brown rice- Matta, Moongil rice
- Soya bean flour
- Corn flour
- Ground nut oil
- Salt

Phase- II

Development of Noodles with the Indigenous Indian Rice

↓ Washing of rice
↓ Drying
↓ Dry roasting
↓ Grinding into flour
↓ Mixing the ingredients
↓ Dough formation
↓ Extrusion
↓ Drying

Phase- III

Organoleptic Evaluation and Standardisation of the Product

- **Trial run for the products**- different proportion of the soya bean flour was used and different method of cooking was done.
- **Variations** - done with and without the addition of corn flour from the selected trial.
- **Organoleptic evaluation**- The noodles were subjected to sensory evaluation for appearance, texture, flavour, taste and overall acceptability.
- **Standardisation** - The variations was standardised.

Phase- IV

Nutrient and Shelf-Life Analysis of the Product

The standardised product was analysed and calculated for nutrients such as energy, carbohydrate, protein, fat, fibre, calcium, total antioxidant capacity and texture. It was then kept for shelf-life analysis.

Phase- V

Acceptability of the Developed Product

The product developed was assessed by giving the cooked samples to the adult age 20-69 years and the sensory attributes of their likeliness was noted.

4. RESULTS AND DISCUSSION

The result of the study entitled **"Development of Noodles with the Indigenous Indian Rice"** is presented under the following headings:

A. Development of Noodles with the Indigenous Indian Rice Varieties:

B. Nutrient, Physiochemical and Texture Analysis of the Sun-Dried Traditional Rice Noodles.

C. Organoleptic Evaluation and Standardization of Indigenous Indian Rice Noodles

D. Observation of the Shelf Life of the product

E. Acceptability of Indigenous Indian Rice Noodles among the selected Adults

A. Development of Noodles with the Indigenous Indian Rice Varieties:

The ingredients were selected considering the nutritional properties and also the various colour varieties of rice. India is a country which is a home to various Indigenous rice varieties. These rice varieties come in three different colours of bran layer which are red, brown and black rice. Along with these ingredients other ingredients were selected considering their binding properties and other nutritional properties.

1. Kavuni Rice
2. Matta Rice
3. Poongar Rice
4. Corn Flour
5. Navara Rice
6. Moongil Rice
7. Mapillai samba Rice
8. Soya bean flour
9. Salt
10. Ground nut Oil

Figure 6: Selection of ingredients

The other main ingredient apart from the traditional rice includes soya bean flour. This was selected to add more protein to the product and also as a major binding material for the noodles. Another binding material was corn flour which is

majorly used in the production of the rice noodles and so to hold the structure of the noodles. To add taste for the noodles salt was added in the needed amount. The groundnut oil was added to prevent the dough from sticking and also to hold the dough together. These selected ingredients were used to develop the noodles and is in Figure 6.

i. Development of Noodles:

For the development of the noodles with the Indigenous Indian rice various steps were handled out including all the preliminary steps till the extrusion of the noodles. These steps were done with the needed precautions. For the development of the noodles five trials along with two variations were done. These two variations were then standardised, and then evaluated.

The trials were done to find a method to develop the noodles with the Indigenous Indian rice. There were two methods to select the cooking method and also the quantity of the ingredients. There was a difference in the cooking method of method-1 and method-2.

Method-1:

In method-1 the dough was prepared by adding the hot water at 96.3° Celsius, then the flour was kneaded together to hold them together. These were then extruded using the extruder and then they were dried. The ingredients used in trial-1 are listed in the Table IV and the pictorial process of the method of preparation of the noodles, using the method-1 is represented in the Figure 7.

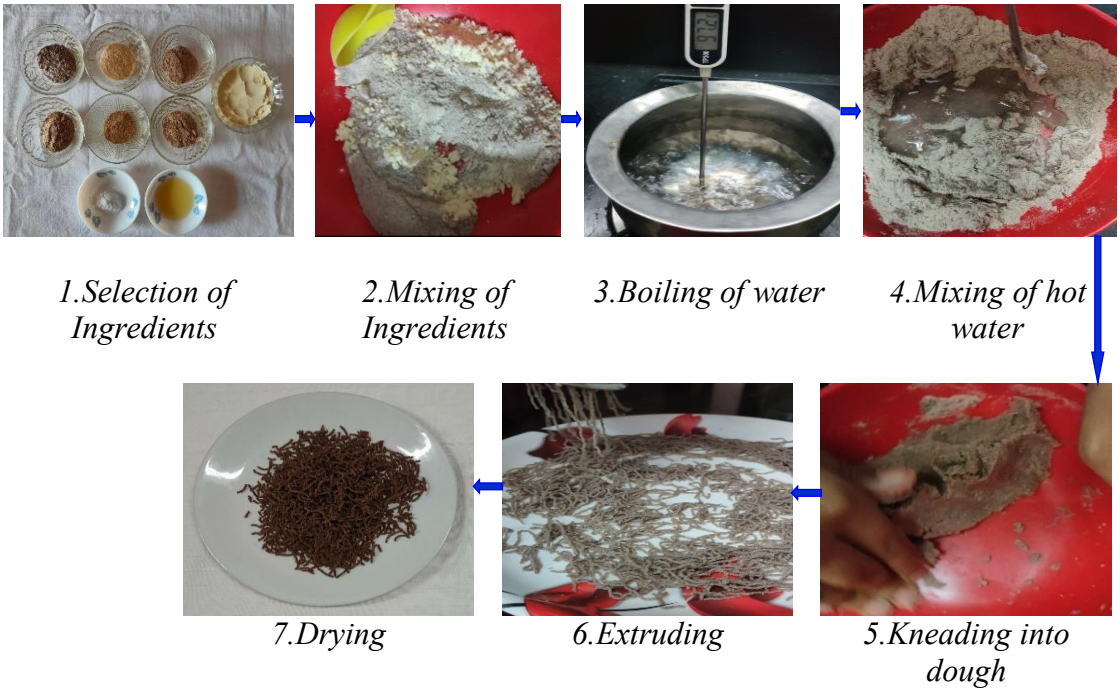

Figure 7: Pictorial representation of process of method-1

TABLE IV

Quantity of Ingredients used in the Trial using Method-2 of Preparation

Ingredients	Quantity
	Trial-1
Kavuni rice	10g
Navara rice	10g
Poongar rice	10g
Mapillai samba rice	10g
Matta rice	10g
Moongil rice	10g
Soya bean flour	15g
Groundnut oil	5ml
Salt	5g

The product developed using this method resulted in very short extruded noodles as the dough was not holding together for a long time. When they were extruded, they delivered very short length noodles which were about an approximate length of 2.5 cm. The length of the noodles was measured using measuring tape. They also were very thin in the circumference which were not very likely of the noodles. In this method, there was not enough time for gelatinisation of the rice flour, which resulted in the very short noodles.

Method-2:

In method-2 the dough was prepared using a method where the dough is cooked twice. Firstly, all the ingredients which is shown in Table V, were mixed together and then they were cooked on the stove using hot water of 96.3° Celsius. These were then kneaded for two minutes while they were still hot and then they were made into small balls, which were then steamed for about three minutes. These balls were kneaded again for two minutes to form a dough. This dough was then extruded and dried while the dough was still hot. In this method there were various trials were done to find out the quantity of the ingredients and also a method of cooking process. Pictorial process of the method of preparation of the noodles, using the method-2 is represented in the Figure 8.

Figure 8: Pictorial Representation of Process of Method-2

TABLE V

Quantity of Ingredients used in the Trial using Method-2 of Preparation

Ingredients	Quantity			
	Trial-2	**Trial-3**	**Trial-4**	**Trial-5**
Kavuni rice	10g	10g	10g	10g
Navara rice	10g	10g	10g	10g
Poongar rice	10g	10g	10g	10g
Mapillai samba rice	10g	10g	10g	10g
Matta rice	10g	10g	10g	10g
Moongil rice	10g	10g	10g	10g
Soya bean flour	15g	30g	45g	60g
Groundnut oil	5ml	5ml	5ml	5ml
Salt	1.5g	2.5g	3.5g	5g

In the developed product using the method-2, four trials were done in which the quantity of the soybean flour was changed for each one. From the four trials (trial-2, trial-3, trial-4, trial-5), trial four had the longest length among them. The length of each trial was approximately about, trial-2: 5 cm, trial-3: 9 cm, trial-4: 10 cm and trial-5: 11 cm. Increase in the length of the noodles compared to method-1 was due to the gelatinisation process of the rice. As in this method, the dough was cooked for two times, one when the dough was mixed with the hot water and another one when the dough was steamed. These two heating processes allowed the rice particles to gelatinize and to form long noodles compared with method-1.

The cooking time of the noodles also varied for each trial. The cooking time of noodles increased gradually for each type of trial in which each trial had an increase in the amount of soya bean flour added to it. As like the cooking time, the yield of the noodles also increased as there is an additional amount of soy bean flour in each of trials are shown in the Table VI and the difference in the appearance of the noodles when it is dried and cooked is shown in Figure 9.

TABLE VI

Physical Properties of Developed Indigenous Indian Rice Noodles

Method	Trial product	Weight/ Yield	Cooking Time (minutes)	Length of the noodles (cm)
Method-1	Trial-1	44g	1.47	2.5
Method-2	Trial-2	66g	2.10	5
	Trial-3	6 g	2.38	9
	Trial-4	75g	3.14	10
	Trial-5/ variation-1	107g	3.20	11
Method-3	Variation-2	122g	3.22	21

Variation-1 *Variation-2*

Figure 9: Dried and Cooked State of Developed Product

ii. Drying of the Noodles:

The developed product was dried using the sun light and then time taken to dry the product was noted. For drying of the noodles completely, it took about 12 hours including the time of both with and without sun light. The product was kept in the sunlight of temperature ranging between 33˚ Celsius to 24˚ Celsius for a day, with attaining a peak temperature of 33˚ Celsius for 2 hours. The drying of the product was recorded every two hours as shown in Figure 10 and Figure 11 to see the progress of drying for developed product.

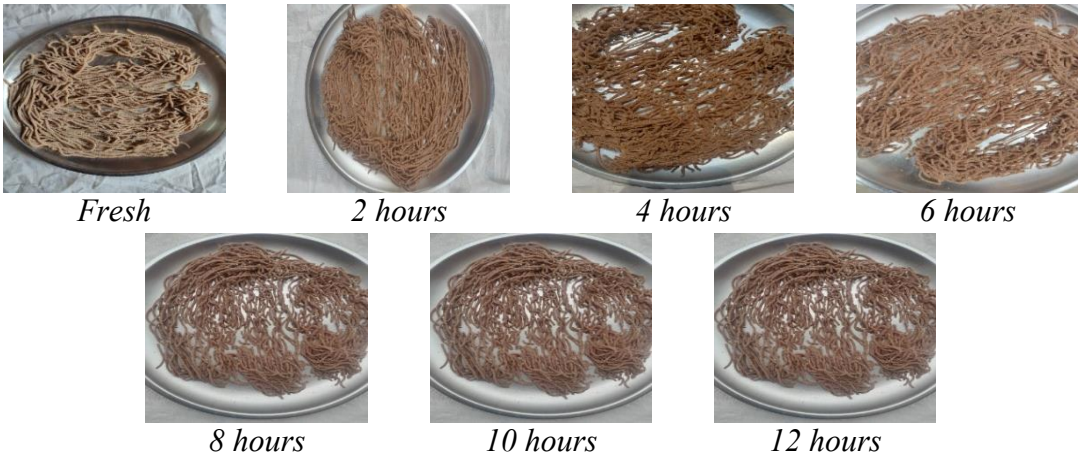

Figure 10: Drying of Noodles (Variation-1) at Two Hour Interval

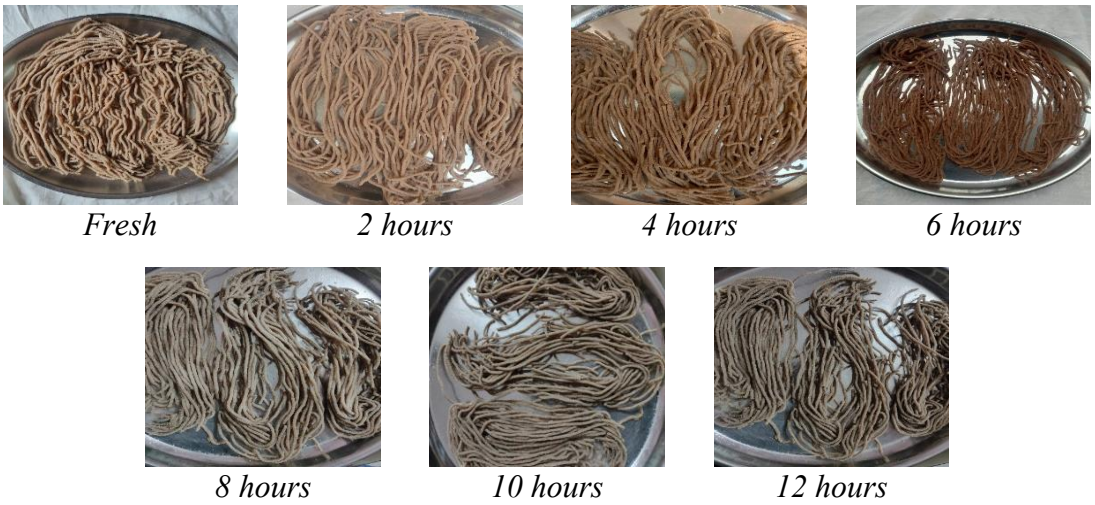

Figure 11: Drying of Noodles (Variation-2) at Two Hour Interval

ii. Food Cost:

The food cost of the product is calculated by considering all the ingredients used for the purchased amount which was then converted to one serving. The product was packed for two serving and so the maximum retail price of the product was calculated for two serving. Quantity of the ingredients and the prize for the quantity used as shown in Table VII was considered while calculating the food cost.

TABLE VII

Food Cost Calculation of the Developed Product

S. No	Ingredients	Quantity for 50 serving	Cost for 50 serving (Rs)	Quantity for 2 serving	Cost for 2 serving
1.	Kavuni rice	500g	85	10g	3.4
2.	Navara rice	500g	50	10g	2
3.	Poongar rice	500g	50	10g	2
4.	Mapillai Samba rice	500g	40	10g	1.6
5.	Moongil rice	500g	150	10g	6
6.	Matta rice	500g	25	10g	1
7.	Soya bean flour	3kg	297	60g	11.88
8.	Corn flour	1.5kg	78	30g	3.12
9.	Ground nut oil	250ml	35	5ml	1.4
10.	Salt	250g	3.75	5g	0.15
Total					**Rs. 32.55**

Calculation:

Yield - 120 g

Weight per portion - 60 g

No of serving - 2

Cost of 2 portion - 32.55 RS

Cost per portion - 32.55/2 = 16.27 RS × 1.66 =27.01 Rs.

Cost for 1 serving = 27 Rs.

In each packet, the product was packed for 2 serving. So, the maximum retail price for the product was calculated for two serving. For variation-1 and variation-2 there is a difference in the ingredients. For variation-1, there is no corn flour and so the cost of corn flour was deducted in the calculation.

The cost of variation-1 for 2 servings- Rs. 54

The cost of variation-2 for 2 servings- Rs. 34

iii. Packaging and labelling of the Noodles:

The noodles made were packed and then food labelling was done. The labelling contained of all the needed information for the food product developed. The labeling contains of the name of the product, nutritional fats, ingredients, cooking instructions, manufacture date, expiry date, maximum retail price of the product and batch number and the design is shown in the Figure 12 and Figure 13. The developed product was packed using the bio degradable packaging and the labeling was also inserted in the packets as shown in Figure 14.

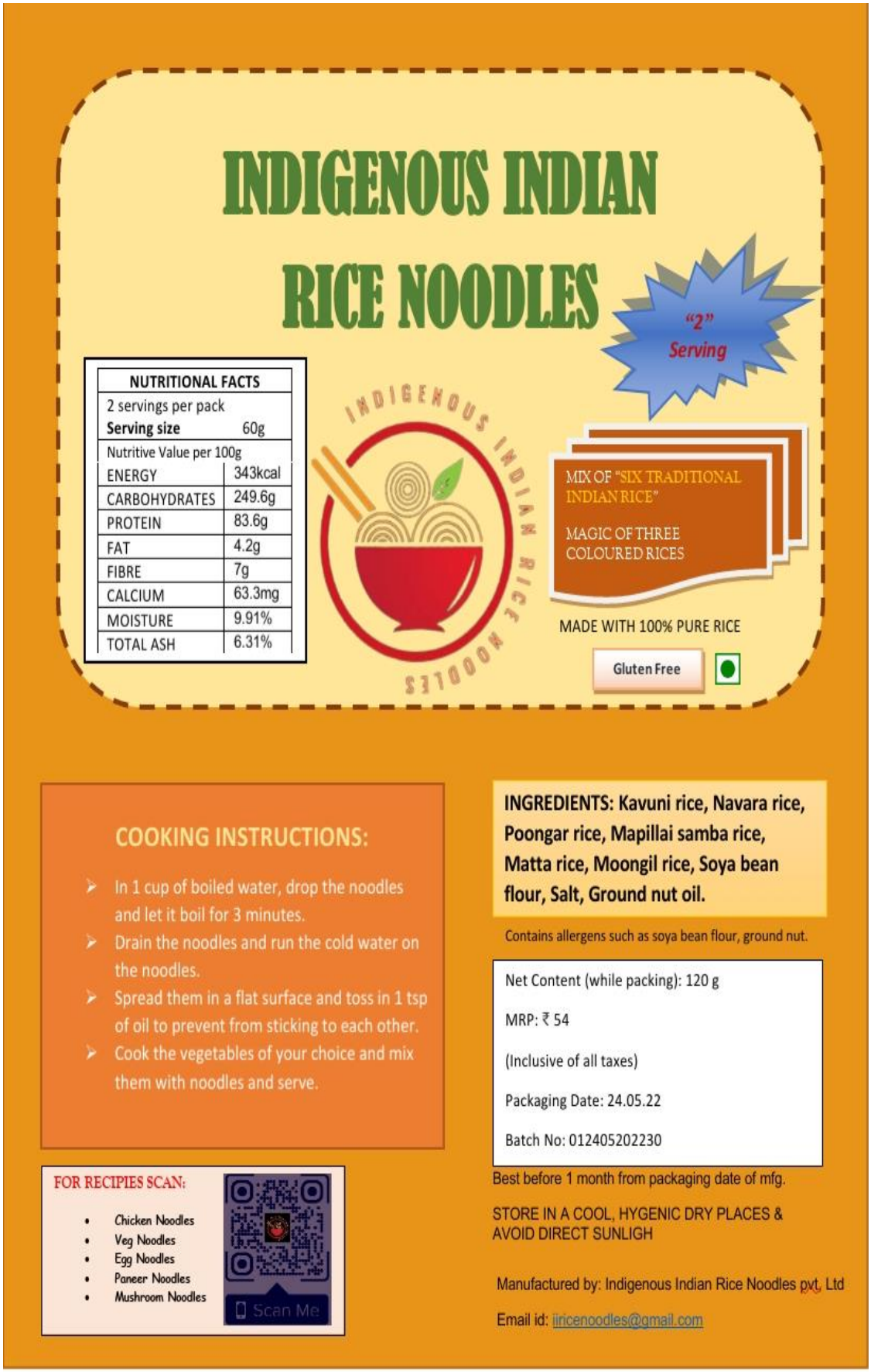

Figure 12: Packaging design of the developed product for variation-1

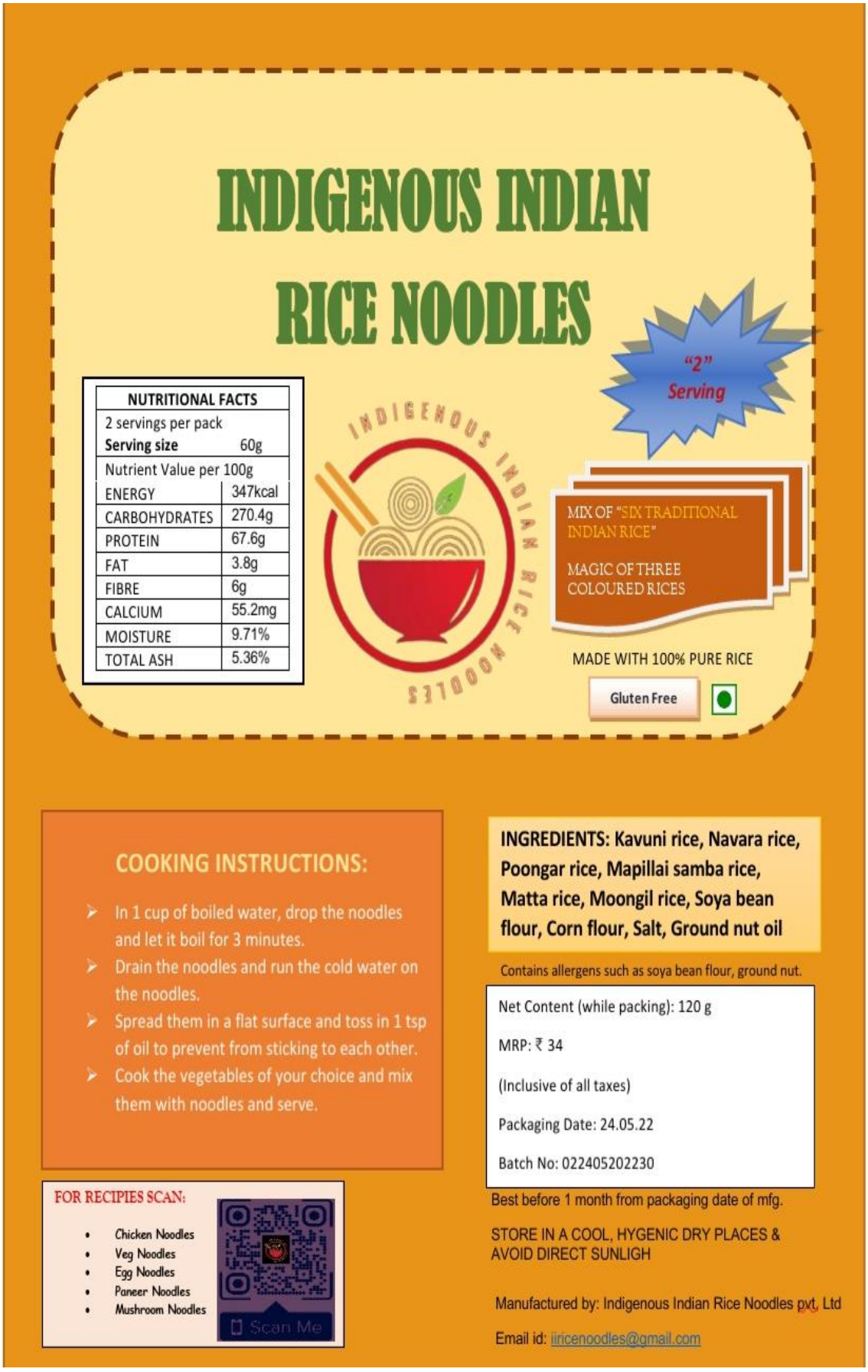

Figure 13: Packaging design of the developed product for variation-2

(Front View) (Back View)

Figure 14: Packaging of the Developed Products

B. Nutrient, Physiochemical and Texture Analysis of the Sun-Dried Traditional Rice Noodles:

The developed product was subjected to various analysis which included nutrient, total antioxidant capacity, texture and pH to acknowledge the characteristics of the product. These products were analysed so that more understanding of the product is obtained as well as the acceptability of the product can be analysed.

a. Nutrient Content:

The nutrient analysis for both the variations were done. The major nutrients such as the Energy, carbohydrate, protein, fat, fiber was analysed. The minor nutrient such as the calcium were calculated as they were found high in the rice varieties. The amount of the nutrients present in both the variations is given in the Table VII

TABLE VIII

Nutrient Content of the Indigenous Indian Rice Noodles

Nutrients	Variation-1 (Without corn flour)	Variation-2 (With corn flour)
Energy (Kcal)	343	347
Carbohydrate (g)	249.6	270.4
Protein (g)	83.6	67.6
Fat (g)	4.2	3.8
Fiber (g)	7	6
Calcium (mg)	63.4	55.2
Moisture (%)	9.91	9.71
Total Ash (%)	6.31	5.36

The nutrient analysed for both the variation was slightly differed. The variation-2 had a slightly high energy compared with the variation-1 as displayed in the Chart 1. The major difference of nutrients was found in protein, in which variation-1 as highest about 83.6g per 100g and calcium in which variation-1 had 63.37mg per 100g. The difference in the nutrients from the variation-1 to variation-2 is mainly due the addition of corn flour. Even though both the product was made with the same processing steps, in variation-2 there was an additional ingredient namely corn flour. So, the addition of this ingredient changed the proportion of the other ingredients per 100g which has resulted in the changes in the nutrient content of the developed products.

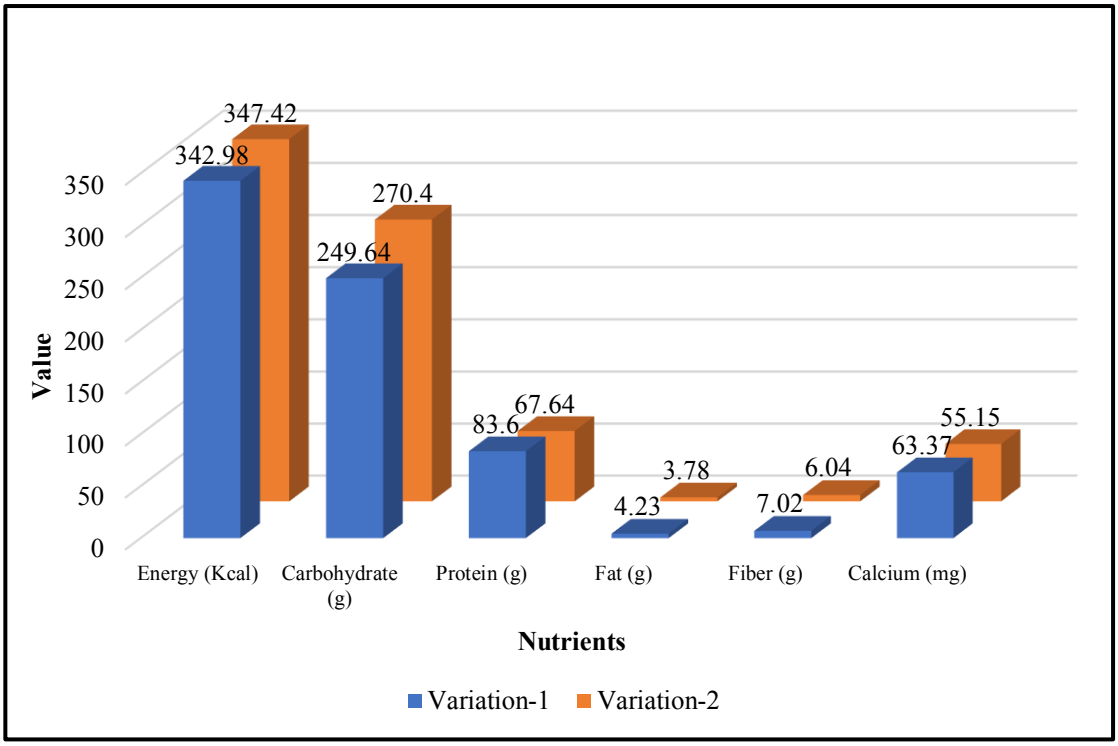

Chart 1: Comparison of Nutrients from Variation-1 and Variation-2

b. Antioxidant Capacity:

The traditional rice was a rich source of antioxidants due to their coloured bran layer. In assessing the total antioxidant capacity of the products, the variation-1 was higher antioxidant capacity than variation-2. The total antioxidant capacity was assessed using UV-VIS Spectrophotometry method. The variation-1 had total antioxidant capacity of 10.5µg/g Ascorbic acid and the variation-2 had 8.6µg/g Ascorbic acid as exhibited in Table IX.

TABLE IX

Total Antioxidant Capacity of the Indigenous Indian Rice Noodles

Variations	**Total Antioxidant capacity**
Variation-1	10.5µg/g Ascorbic acid
Variation-2	8.6µg/g Ascorbic acid

c. Texture Analysis of the Product:

The noodles have different textures as they are of different forms such as dried or fresh and may happen to have thick or thin structures. To analyse the texture of the product, the noodles was subjected to compression method of texture analysing with a speed of 1mm/sec. The hardness of the noodles indicates the noodles bite in which the variation-2 had a greater value than the variation-1, as shown in Table X. The Chart 2 and Chart 3 indicates the difference in the hardness of the noodles from variation-1 and variation-2.

TABLE X

Parameters of Texture Analysis of the Indigenous Indian Rice Noodles

Name	Hardness-Force	Adhesiveness	Adhesive Force	Break Force
Parameters	Calc. at Entire Areas	2th Node-Next Node	2th Time	Sensitivity:10
Unit	N	J	N	N
Variation-1	1.55520	0.00000	0.01160	-
Variation-2	14.7784	0.00000	0.01121	14.7784

Test type: Compression Shape: Plate Speed: 1mm/sec

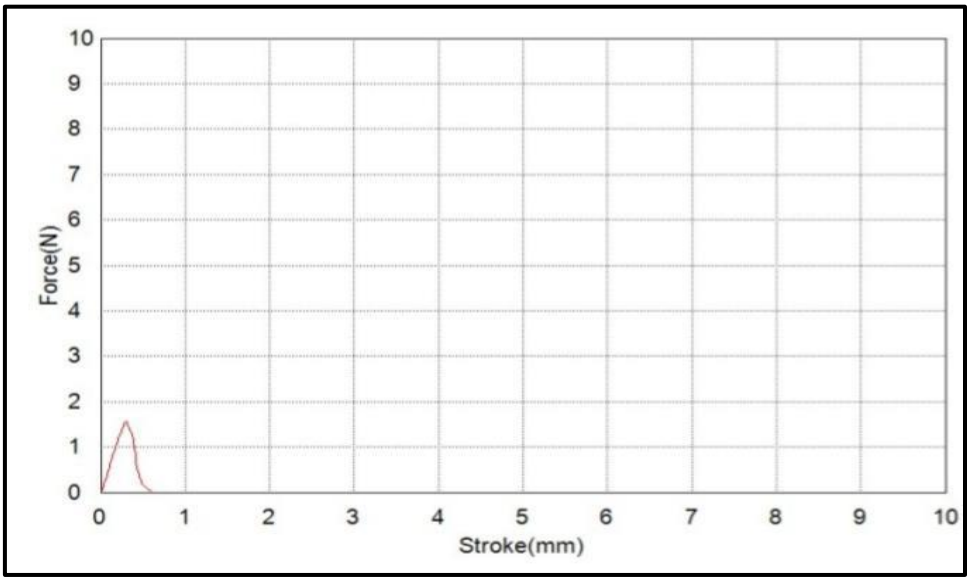

Chart 2: Hardness of Variation-1 of the Developed Product

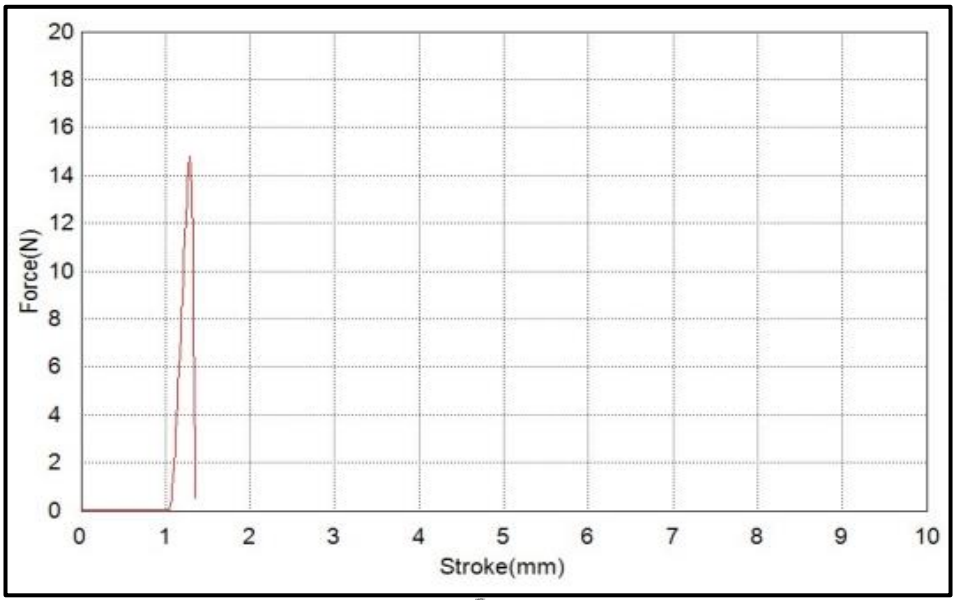

Chart 3: Hardness of the Variation-2 of the Developed Product

d. pH Analysis:

The pH of the product determines the free acidity produced by the product**.** The rice variety usually have a pH pertaining to a range of six to seven which is a slightly acidic nature. The pH of the developed product as analysed by the use of pH meter and readings shown is exhibited in the Figure 15. The results of the pH analysed from the developed product as shown in Table XI, showed that the pH of variation-1 as 5.57 and pH of variation-2 as 5.35. The both the variation had a slightly acidic pH. The study pertinning to analyses of the cooked rice (*Oryza sativa* L. *indica*) also shows that pH decreases along with the duration of the storage (**Nugrahanto *et al*., 2018).** The pH of the developed product not only is influenced by the traditional rice varieties added to the product but also by the other ingredients added to the developed product namely soya bean flour which is added as an equal amount of rice, corn flour, ground nut oil and salt.

TABLE XI

pH of the Developed Products

Variations	pH value	Medium
Variation-1	5.57	Acidic
Variation-2	5.35	Acidic

(Variation-1) *(Variation-2)*

Figure 15: Readings of pH taken during analyses of developed products using Ph meter

C. Organoleptic Evaluation and Standardization of Indigenous Indian Rice Noodles:

The organoleptic evaluation was done using five-point hedonic scale rating to find out the best variation of the developed product. The products were evaluated for both the raw and cooked product. The products were evaluated and the mean scores for the sensory attributes like appearance, texture, flavour, taste and overall acceptability of all the variations were done by 50 semi-trained panel members. The organoleptic evaluation was done for both the trials and also for the standardized variations. The mean sensory acceptability Score of the Traditional Rice Noodles Raw are given in the Table.

TABLE XII

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Trial - Raw

Trial	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
T1	2.4±0.69	3.2±0.63	3.2±0.78	3.4±0.69	2.4±0.51	2.92±0.35
T2	2.7±0.48	3.3±0.48	3.7±0.48	3.5±0.52	2.7±0.48	3.18±0.33

The sensory for the trial-1 vs trial-2 was done to find out the suitable cooking method for the development of the noodles. The mean scores from these two showed that trial-2 had more acceptability than trial-1 as shown in the Table XII. The appearance of the noodles had a very low acceptance, but trial-2 had slightly more appearance than trial-1. The trial-2 had a point difference in the texture and taste. The trial-2, had a slightly more value than the trial-1 in the traits such as flavour 3.7 and overall acceptability 2.7. This as depicted in Chart 4, the cooking method from trial-2 is more acceptable and the trials were done using this method.

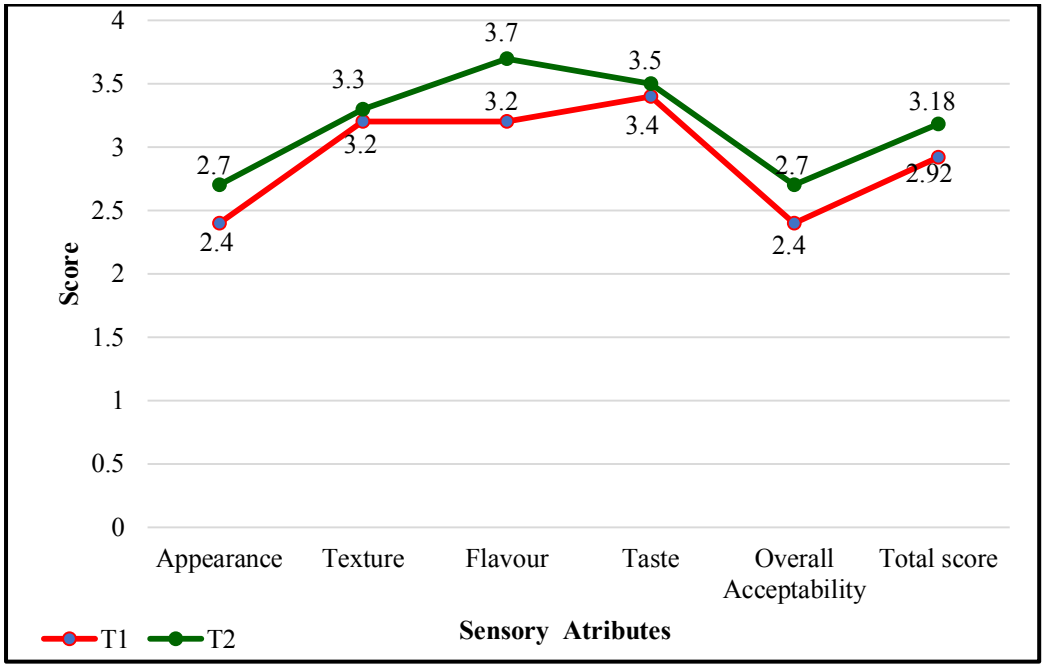

Chart 4: Acceptability Evaluation of Trial for the Indigenous Indian Rice Noodles (Raw) for Preparation Method

TABLE XIII

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Trial - Cooked

Trial	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
T1	1.8±0.78	2.9±0.73	2.8±0.63	3.1±0.73	2.1±0.56	2.5±0.40
T2	2.2±0.63	2.9±0.56	3.4±0.51	3.1±0.73	2.4±0.51	2.8±0.35

The sensory for the trial-1 vs trial-2 was done to find out the suitable cooking method for the development of the noodles. These trials were cooked and then they were evaluated. The mean scores from these two trials shows us that trial-2 is more accepted in all the sensory attributes than the trial-1 as shown in Table XIII. The mean score of the taste and texture were 3.1 and 2.9 respectively, which were same for the two trials. Apart from those the trial-2 obtained highest score in appearance-2.2, flavour-3.4, overall acceptability 2.4. This mean score of the trials as displayed in Chart 5, conveyed that the cooking method used for trial-2 were carried out.

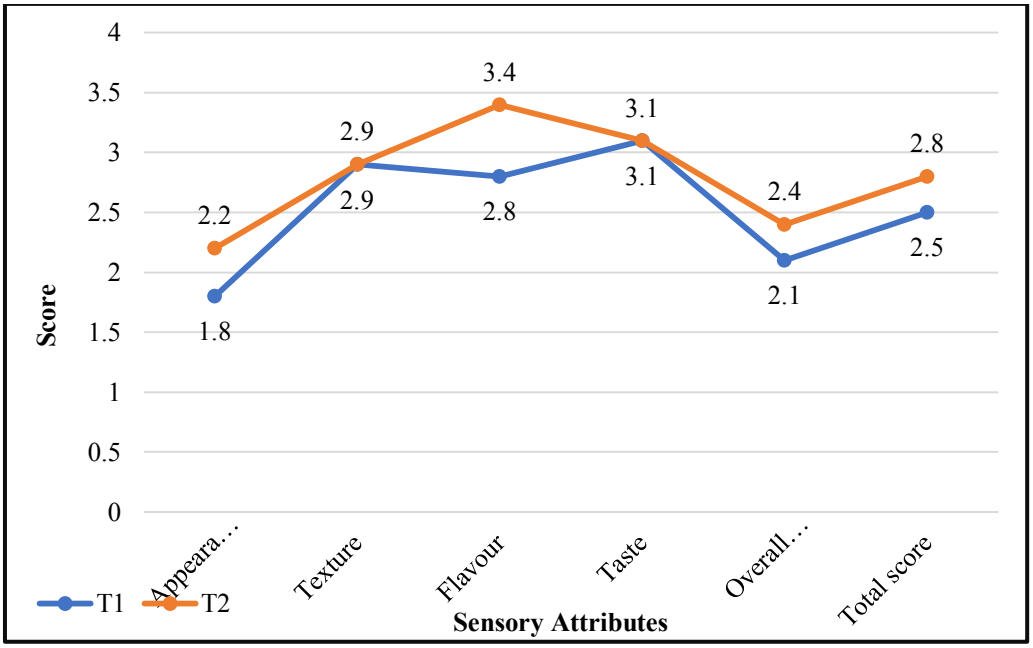

Chart 5: Acceptability Evaluation of Trial for the Indigenous Indian Rice Noodles (Cooked) for Preparation Method

TABLE XIV

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Trial - Raw

Trial	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
T2	2.7±0.48	3.3±0.48	3.7±0.48	3.5±0.52	2.7±0.48	3.18±0.33
T3	3.1±0.73	3.6±0.51	3.6±0.51	3.7±0.48	3.3±0.48	3.46±0.34
T4	3.3±0.48	3.7±0.48	3.7±0.48	3.8±0.42	3.4±0.51	3.5±0.23
T5	4.3±0.48	4.2±0.42	4.1±0.56	4.1±0.31	4.0±0.66	4.2±0.26

The sensory for the trial-2, trial-3, trial-4 and trial-5 was done to find out the suitable cooking method for the development of the noodles. The highest mean scores of these four trials were obtained by the trial-5. The trial-5 obtained scores such as the appearance-4.3, texture-4.2, flavour-4.1, taste-4.1 and overall acceptability-4.0 as shown in Table XIV. From the other trials were also obtained almost equivalent values. The scores gradually increased from the trial-2 to trial-5. Trial-4 had a greater acceptability and so the quantity on the ingredients from the trial-5 was selected as shown in Chart 6.

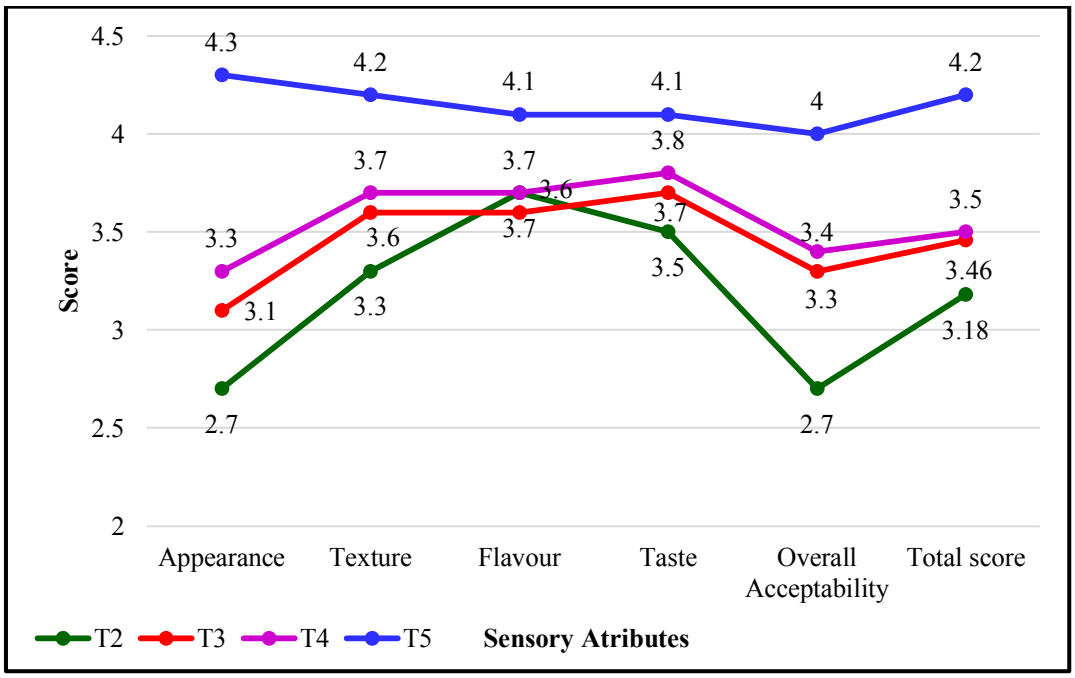

Chart 6: Acceptability Evaluation of Trial for the Indigenous Indian Rice Noodles (Raw) for Quantity of Ingredients

TABLE XV

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Trial - Cooked

Trial	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
T2	2.7±0.48	3.3±0.48	3.7±0.48	3.5±0.52	2.7±0.48	3.18±0.33
T3	2.5±0.52	3.4±0.84	3.1±0.73	3.1±0.56	2.9±0.56	3.0±0.47
T4	2.8±0.63	3.6±0.51	3.7±0.48	3.8±0.42	3.4±0.51	3.5±0.25
T5	3.9±0.56	4.0±0.47	4.1±0.56	3.9±0.31	4.1±0.73	4.0±0.26

The sensory for the trial-2, trial-3, trial-4 and trial-5 was done to find out the suitable cooking method for the development of the noodles. The highest score was obtained in the trial-5. The trial-5 obtained scores such as apperance-3.9, texture-4.0, flavour-3.9 and overall acceptability-4.1 as shown in Table XV. The mean sensory score from the raw and cooked were differed. The cooked products obtained slightly a lesser score as exhibited in Chart 7.

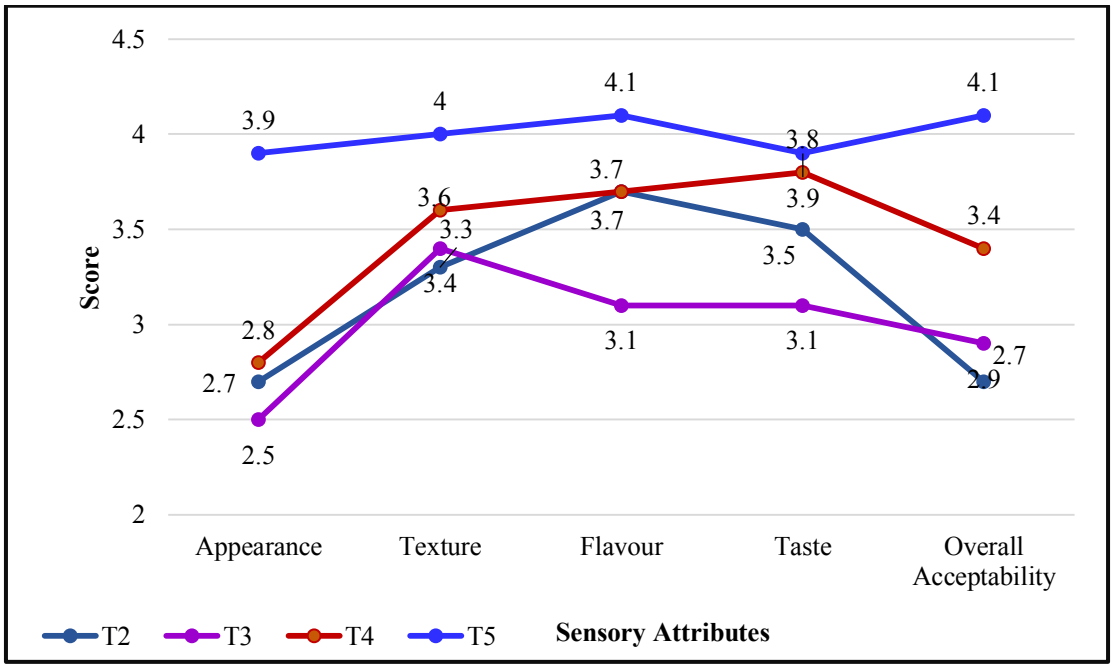

Chart 7: Acceptability Evaluation of Trial for the Indigenous Indian Rice Noodles (Cooked) for Quantity of Ingredients

TABLE XVI

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Variations - Raw

Variations	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
V1	3.9 ± 0.56	4.3 ± 0.67	4.2 ± 0.63	4.4 ± 0.69	4.2 ± 0.42	3.85
V2	4.5 ± 0.52	4.4 ± 0.51	4.3 ± 0.67	4.1 ± 0.73	4.4 ± 0.51	3.98

The highest score was recorded in variation 2, where there was an addition of corn flour of 5 g. There was not a great difference in the two variations in the total score but the variation 2 obtained the highest score. The mean scores of the taste were high in the overall acceptability of taste which is 4.4 as shown in Table XVI. The mean scores which were high in the variation 2 are appearance 4.5, texture 4.3, Flavour 4.3, overall acceptability 4.4 and total score 3.98187. This is also represented by the graph as shown in Chart 8.

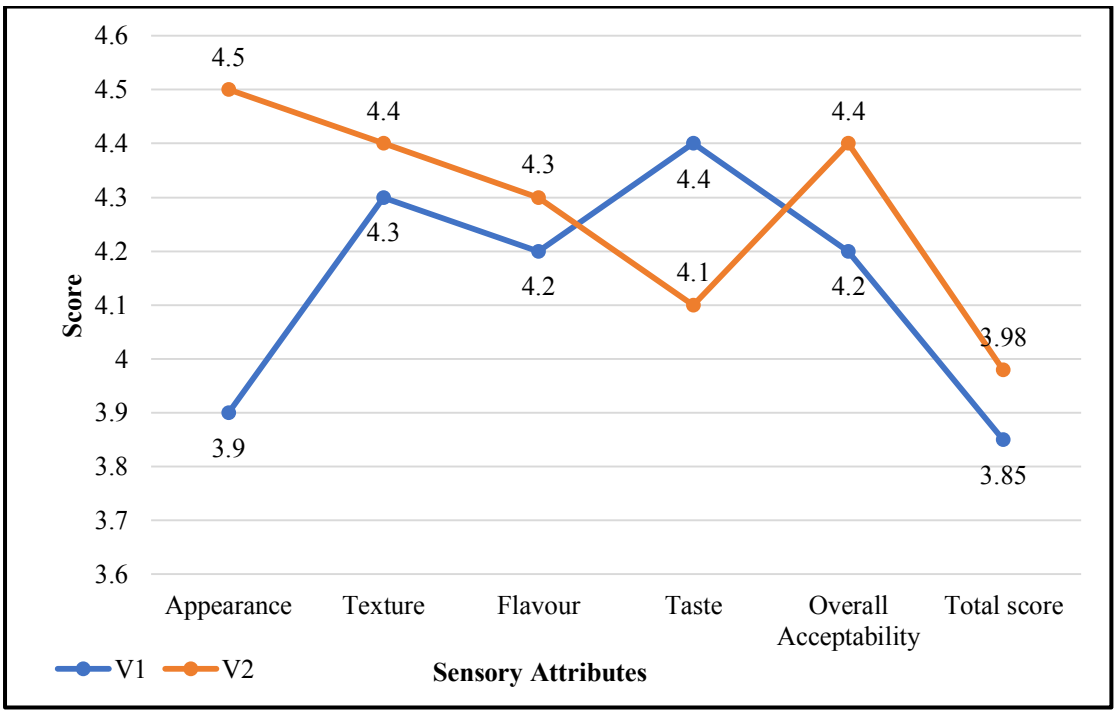

Chart 8: Acceptability Evaluation of Variations for the Indigenous Indian Rice Noodles (Raw)

TABLE XVII

Mean Sensory Acceptability Score of the Traditional Rice Noodles for Variations - Cooked

Variations	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
V1	3.3 ± 1.05	3.4 ± 0.96	3.5 ± 0.97	3.6 ± 0.96	3.5 ± 0.97	3.22
V2	4.4 ± 0.69	4.2 ± 0.78	4.3 ± 0.67	4.4 ± 0.69	4.4 ± 0.66	4.34

The highest score was recorded in variation 2, and the mean of the total score was 4.34. When the product was cooked there is a highest difference in mean score in which the variation 2 was high in all the categories as shown in Table XVII. The variation 2 got the mean score were appearance 4.4, texture 4.2, flavour 4.3, taste 4.4, overall acceptability 4.444444 and a total score of 4.34. There was a difference of total score about 1.11 which was not observed in the raw product. This is also represented by the graph which is given below in Chart 9.

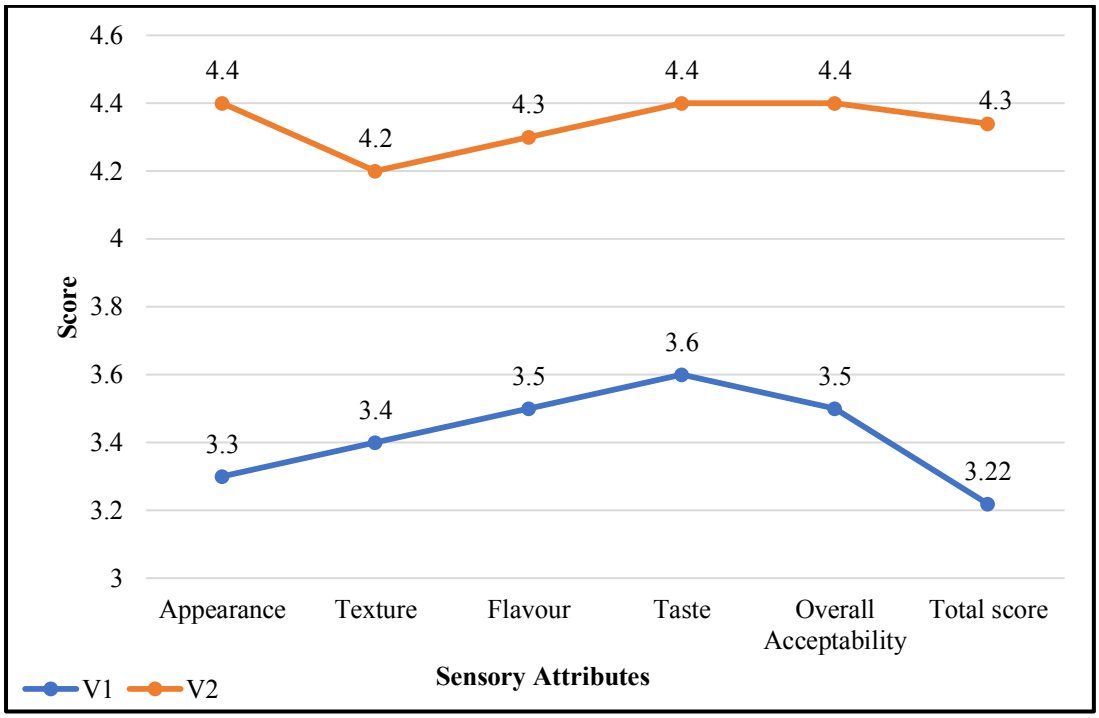

Chart 9: Acceptability Evaluation of Variations for the Indigenous Indian Rice Noodles (Cooked)

The noodles were standardised going through various stages of processing for the noodles. The variation-1 and variation-2 were both standardised. They both have undergone same processing technique with the change in the addition of ingredients. The both had the same amount of ingredients such as the 10g of kavuni rice, 10g of navara rice, 10g of mapillai Samba rice, 10g of poongar rice, 10g of Matta rice, 10g of moongil rice, 60g of soya bean flour, 5ml of ground nut oil and 5g of salt. For the Variation-2, there was an addition of ingredients which include 30g of corn flour. For the preparation of dough, the temperature of the water was 96.3^0 Celsius, in which the dough was cooked for two minutes and then this was kneaded for about 2 minutes. Then, this dough was steamed for four minutes which was again kneaded for two minutes. Then they were extruded and dried. This process was repeated for three times for each variation so that it is achieved its standard method of preparation of noodles.

Recipes:

The rice noodles developed were subjected to different recipes which will go along the developed rice noodles. The recipes followed had different ingredients which were categorized into chicken, egg, vegetables, paneer and mushroom. These recipes were cooked and then they were displayed. The recipes were cooked for both the variation. The same recipes were done for both the variations simultaneously and these were then tasted. The recipes cooked and displayed is show in the Figure 16. In all those recipes tried mushroom noodles was a very different recipe as there was no addition of vegetables instead a recipe containing of mushroom and sauces. The other recipes included vegetables along with the main ingredients. These noodles were good in taste, flavour and colour. The texture of the noodles was very different from the usual noodles which is mostly prepared using durum wheat, as this noodle is prepared from the rice flours. The colour of the noodles were a purplish brown colour as this selected rice had antioxidant rich bran layers which was grinded and made into noodles.

1.Chickennoodles

2.Vegetable noodles

3.Paneer noodles

4. Egg noodles

5. Mushroom noodles

Figure 16: Recipes Cooked with the Developed Product

1. CHICKEN NOODLES

Category: Main Dish Portion size: 01 serving

Cooking time: 35 minutes

Ingredients:

Ingredients	Quantity
Chicken	150 g
Rice Noodles	60 g
Garlic	2 cloves
Bell pepper	¼ cup
Carrots	¼ cup
Cabbage	¼ cup
Spring onion	2 tbsp
Chilli sauce	1 ½ tsp
Soya sauce	1 ½ tbsp
Garam masala	½ tsp
Pepper powder	½ tsp
Oil	2 ½ tbsp
Salt	to taste

Method:

- Marinate the chicken with pepper, salt, soya sauce and garam masala. Keep it for at least 10 minutes.
- In a pan, add water about ½ liters and bring them to boil.
- Add salt and 1 tsp of oil to it and add the noodles to it. Cook for 3 minutes, strain them using colander and add cool water and rinse.
- In a pan, add 1 tbsp of oil. Add chopped garlic and fry for 30 seconds.
- Add the marinated chicken and saute it on a medium heat until it is completely cooked.
- Then add spring onions and saute them for a minute.
- Now, add the chopped vegetables such as carrot, capsicum, cabbage and saute for 2 minutes.
- Then, add soya sauce chilli sauce, and salt and saute.
- Now add the cooked noodles to this mixture and saute together.
- Transfer to the serving plate and serve hot.

2.VEG NOODLES

Category: Main Dish Portion size:01 serving

Cooking time: 15 minutes

Ingredients:

Ingredients	Quantity
Noodles	60g
Garlic	1/2 tbsp
Green chilli	2 no's
Onion	1 no
Cabbage	100g
Carrot	100g
Bell Pepper	100g
Green beans	100g
Oil	2 tbsp
Soy sauce	1 tbsp
Vinegar	1 tsp
Chilli sauce	1 tbsp
Salt	to taste

Method:

- In a pan, add water, 1 tsp of oil, 1 tsp of salt and bring to boil. Then add the noodles to it. Cook for 3 minutes, strain them using colander and add cool water and rinse.
- Pour oil to a pan and heat it
- Add the chopped garlic and green chilies and stir fry for 30 seconds.
- Then, add onions and fry till it become translucent.
- Add all the vegetables and toss them for 3 minutes.
- Add pepper and salt and saute.
- Now add the noodles and toss till they are completely mixed.
- Transfer them to a serving plate and serve

3.PANEER NOODLES

Category: Main Dish Portion size:01 serving

Cooking time:15 minutes

Ingredients:

Ingredients	Quantity
Noodles	60g
Paneer	50g
Onion	½ no
Carrot	15g
Beans	15g
Cabbage	30g
Garlic	2g
Chilli sauce	1 tsp
Spring onions	15g
Roasted cashew	10g
Pepper powder	1 tsp
Oil	1 tbsp
Salt	to taste

Method:

- In a pan, add water, 1 tsp of oil, 1 tsp of salt and bring to boil. Then add the noodles to it. Cook them for 3 minutes, strain them using colander and add cool water and rinse.
- Chop the paneer to small cubes and fry them using oil to golden brown and set aside.
- In the same pan, chopped green chillies, garlic and saute.
- Then, add onion and fry well.
- Add chopped vegetables and saute for 3 minutes.
- Add chilli sauce, pepper powder and saute.
- Add the cooked noodles and combine till they are well mixed.
- Garnish them with roasted cashew and coriander leaves.

4. EGG NOODLES

Category: Main Dish Portion size:01 serving

Cooking time:15 minutes

Ingredients:

Ingredients	Quantity
Noodles	60g
Egg	1 no
Carrot	15g
Capsicum	15g
Onion	15g
Vinegar	½ tsp
Soya sauce	¼ tsp
Tomato sauce	¼ tsp
Chilli sauce	½ tsp
Salt	To taste
Pepper powder	as required
Spring onions	1 tsp

Method:

- In a pan, add water, 1 tsp of oil, 1 tsp of salt and bring to boil. Then add the noodles to it. Cook for 3 minutes, strain using colander and add cool water and rinse.
- Break the eggs in a bowl. Add salt and black pepper powder. Mix it well.
- In a pan, add 1 tsp of oil, 1 tsp of salt and bring to boil. Then add the noodles to it. Cook for 3 minutes, strain them using colander and add cool water and rinse.
- Make an omelette and cut it into small pieces. You can also make scrambled eggs in the same wok you would use to make noodles.
- To make noodles, add oil in a wok along with all the vegetables and stir fry on high flame for 2-3 minutes.
- Add boiled noodles, vinegar, soya sauce, salt, black pepper, ketchup and chilli sauce to it. Mix everything and cook for about 2 minutes.
- Now add the cooked egg and spring onions. Stir it well and cook for another minute. Serve hot.

5. MUSHROOM NOODLES

Category: Main Dish Portion size:01 serving

Cooking time: 20 minutes

Ingredients:

Ingredients	Quantity
Noodles	60g
Garlic	4 cloves
Mushrooms	1 cup
Soy sauce	1 tbsp
Chilli flakes	¼ tsp
Rice vinegar	½ tbsp
Chilli sauce	1 tsp
Sesame oil	½ tbsp
Oil	1 tbsp
Spring onions	¼ cup

Method:

- In a pan, add water, 1 tsp of oil, 1 tsp of salt and bring to boil. Then add the noodles to it. Cook them for 3 minutes, strain using colander and add cool water and rinse.
- Whisk together soy sauce, chilli flakes, vinegar, sweet chilli sauce and sesame oil and set aside.
- In a pan, add oil and garlic. Stir fry the garlic till they are golden brown and add mushrooms. On a high heat, saute the mushrooms for two minutes. Add the cooked noodles, along with the sauce and toss well on high heat.
- Sprinkle with chopped green scallions and serve hot.

Nutritional value of the recipes:

The nutritive value of each recipe was calculated. For, the nutrients of the developed noodles, it was calculated by the values obtained by the nutrient analysed. For, the other ingredients used in the recipes the values were calculated using the Indian Food Composition Tables, ***(NIN, 2017)***. The nutrients calculated were energy, carbohydrate, protein, fat, fibre and calcium for both the variations as depicted in the Table XVIII and Table XIX.

TABLE XVIII

Calculated Nutritive Content of the Recipes Cooked with Developed Indigenous Indian Rice Noodles - Variation-1

Nutrients	Chicken Noodles	Vegetable Noodles	Paneer Noodles	Egg Noodles	Mushroom Noodles
Energy (kcal)	898	429	585	302	380
Carbohydrates (g)	159.8	164.7	169.0	154.9	157.0
Protein (g)	80.4	54.8	64.2	56.8	55.5
Fat (g)	61.8	18.2	29.7	7.8	15.6
Fibre (g)	9.5	12.8	10.5	7.5	11.0
Calcium (mg)	122.0	129.8	344.5	73.2	75.3

TABLE XIX

Calculated Nutritive Content of the Recipes Cooked with Developed Indigenous Indian Rice Noodles - Variation - 2

Nutrients	Chicken Noodles	Vegetable Noodles	Paneer Noodles	Egg Noodles	Mushroom Noodles
Energy (kcal)	901	432	588	305	382
Carbohydrates (g)	172.2	177.2	181.5	167.4	169.4
Protein (g)	70.8	45.1	54.6	47.2	46.0
Fat (g)	61.5	17.9	29.5	7.6	15.4
Fibre (g)	9	12.2	9.9	6.9	10.4
Calcium (g)	117.1	124.9	339.5	68.3	70.4

D. Observation of Shelf Life of the product:

The shelf-life qualities of the developed rice noodles were assessed for a period of thirty days. The products which were developed with two variations were stored at a room temperature of 32° Celsius. These products were individually packed and the packets were sealed so that no air or moisture cannot invade them. The products were packed in 30 packets each of which weighed five grams. These were stored in a clean area with less moisture.

The packets were opened every day to check the shelf life of the product and the attributes such as the appearance, texture, flavour, taste, and overall acceptability of the product. The changes in these attributes were checked and noted and the shelf life of the product was established.

TABLE XX

Shelf-Life Study on Traditional Rice Noodles (Sun Dried)

Dates of Observation of Shelf-life	Appearance		Texture		Flavour		Taste		Overall acceptability	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
1 to 5	X	X	X	X	X	X	X	X	X	X
6 to 10	X	X	X	X	X	X	X	X	X	X
11 to 15	X	X	X	X	X	X	X	X	X	X
16 to 20	X	X	X	X	X	X	X	X	X	X
21 to 25	X	X	X	X	X	X	X	X	X	X
26 to 30	X	X	X	X	X	X	X	X	X	X

V1- Variation-1 **V2-** Variation-2
X- The product was acceptable with the absence of Spoilage.
Y- The product was not acceptable with the presence of Spoilage.

The products were assessed and evaluated. The shelf-life of the products for the period of thirty days as shown in Table XX, the product was stable and had no changes in their sensory attributes. Both the products had the same shelf life and there were no changes in between the period of analysis. In the period of thirty days, there was no microbial contamination and no molds or fungus formation found. The products did not have any change in their attributes and holds the shelf-life.

E. Acceptability of Indigenous Indian Rice Noodles among the selected Adults:

The acceptability of the product was assessed by giving the cooked product to 25 untrained panel members at a residential area of Coimbatore. These untrained panel members were taken as a small group of representation of the public in order to obtain the acceptability of the product. The panel members were in the age group among the adults. Both the variation of the noodles was given, so that, the acceptable product for both the variations can be analysed and the product with highest acceptability can also be obtained. The panel members analysed the product as shown in Figure 17 and gave scores to the product from five to one according to the sensory evaluation, five-point hedonic scale.

As the respondents were public and they were untrained panel members who are not familiar with the sensory evaluation, they were first taught about the scoring criteria's which varied for every attribute. For appearance rating scale was, 5-very long, 4-moderately long, 3- neither long nor short, 2-moderately short, 1-very short. The scale for texture ranged from 5-very soft, -moderately soft, 3-neither or nor soft, 2-moderately hard, 1-very hard. The scale for flavour and taste were 5-excellent, 4-good, 3-fair, 2-very poor, 1-very poor and for the overall acceptability, the scales were, 5- likes very much, 4 -liked moderately, 3- Neither liked nor disliked, 2- dislike moderately and 1-dislike very much. such as 5- likes very much, 4 -liked moderately, 3- Neither liked nor disliked, 2- dislike moderately and 1-dislike very much.

They were then displayed with products with two variations without being named and without indicating difference between the two sample products. The panel members were also indicated to drink the water in between each product they consume, in avoidance that one product is influenced by other. The panel members then tasted and analysed the attributes of the products displayed. The scores were given according to their likeliness towards the product.

Figure 17: Sensory Evaluation by the Untrained-Panel Members

The mean sensory scores of the products by the ten untrained panel members as shown in the Table XXI reveals the acceptability of the product among the public. These respondents act as a representation of the public and so, the acceptability among the public can be assessed. When compared with the mean of the variation-1 with variation-2, variation-2 obtained a higher level of scores in all aspects. There was a greater difference in the mean scores such as taste 4.2, texture 4.4, flavor 4.1 and the overall acceptability was 4.6.

TABLE XXI

Mean Sensory Assessment of Acceptability of the Developed Product Among Adults Aged 20-69 Years

Variations	Appearance	Texture	Flavour	Taste	Overall Acceptability	Total score
V1	2.8±0.63	2.3±0.67	3.1±1.10	4.2±0.91	3.1±0.56	3.1
V2	4.2±0.78	4.4±0.84	4.1±0.87	4.6±0.51	4.6±0.51	4.38

Among the both of the variation, variation-2 had the highest total score which also shows that it had a higher level of acceptability among the public. The variation-2 had an acceptability of 59 per cent and the variation-2 had an acceptability of 41 per cent as shown in Chart 10. This clearly shows that the variation-2, was mostly accepted by the people. The main reason behind the variation-2 being most acceptable was due to the appearance as variation-2 had a long strand of noodle compared with the variation-1. The taste of the noodles also slightly varied from variation-1 to variation-2, due to the addition of the corn flour which also added a starchy taste to the noodles giving it to a taste of the rice noodles.

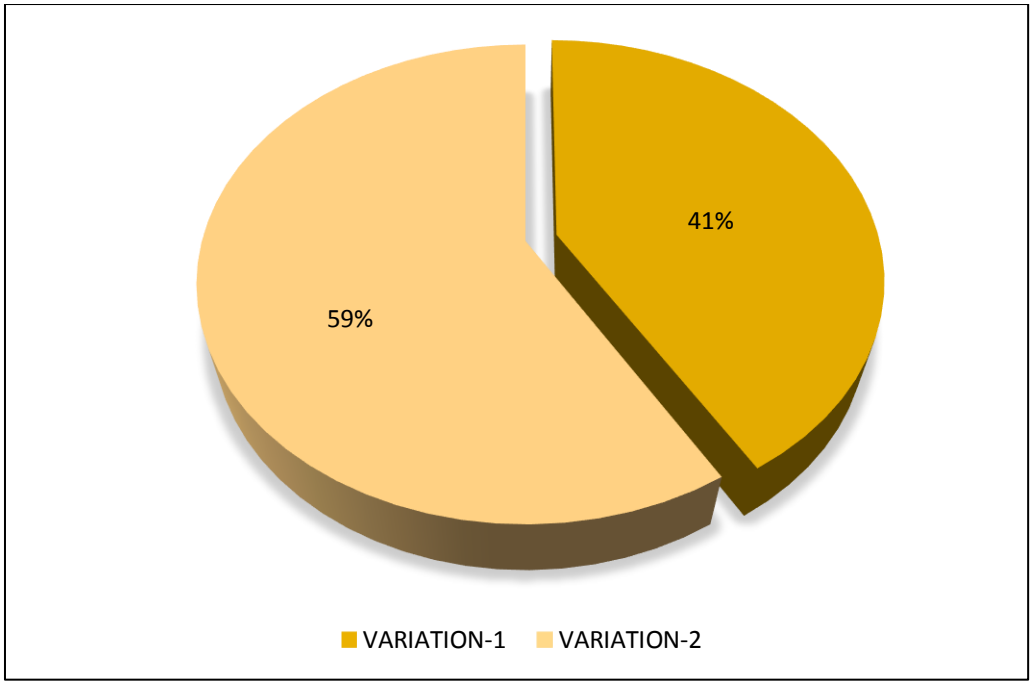

Chart 10: Total Score of Acceptability of the Products

Most of the people were un aware of the rice noodles but were certainly was very familiar with a traditional dish which was a similar dish of rice noodles. The respondents were also asked verbally some of the questions, to make understand them more about the product. The most of the people when asked about the knowledge of traditional rice varieties they were aware of rice such as the kavuni, matta, and some were aware of the poongar rice. Matta rice being one of the commonly used rice in kerala, the study population were also aware of this rice. When the people were asked about the consumption of the developed product in their diet, they were all certain that they could include this in their diet. When compared to having these rice varieties separately, the respondents felt that having them in a noodle form was more convenient form and the cooking process of this noodles was also very easy.

The respondents felt that noodles are one of the foods which they consume in their part of diet, which is a convenient food and takes very less time to prepare. But most of the noodles available in the market were unhealthy and due to the addition of refined wheat flour and other additives. Noodles with the health benefits of antioxidants and other nutrient rich food made the respondents to accept the product and they were all certain that they could include this in their daily diet for themselves and their family.

V. SUMMARY AND CONCLUSION

For about 3000 to 4000 years of human history, rice has been one of the major crops which is consumed in many of the countries. They are largely produced in India and China and have become a part of their daily diet. India is the second largest producer of rice varieties and it has became home to various traditional rice landraces. These Indigenous rice varieties have a higher nutritional property than the polished white rice varieties. They also have various health benefits such as anti-diabetic, hypocholesterolemic, reduces serum cholesterol, controls blood pressure. People are not well aware of these nutritiously rich traditional rice landraces and even if they are, most of the people are not using them in their daily diet as it takes a long time for the preparation. The study titled **"Development of Noodles with the Indigenous Indian Rice"** was carried out with the objectives to develop novel and convenience food products which are packed with nutraceuticals like the antioxidants, phytochemicals, polyphenols and dietary fibre and to process the Indigenous Indian rice into a convenient form so that these rice varieties reach more people and can be benefitted by these.

From among almost 10,000 traditional Indian rice, six of the rice varieties selected by considering various such as the nutritional properties, colour of the bran such as black, red, brown and the availability. These rice pertaining to black, are Kavuni, Navara; red are Mapillai samba, Poongar; and brown includes Matta and Moongil rice were used. The noodles were prepared by mixing all these rice flours with the other ingredients such as the soya bean flour, salt and ground nut oil for variation-1 and an additional ingredient, corn flour was added in the variation-2. They were processed, extruded and dried. The product was standardised and analysed for nutrients, total antioxidant capacity, pH and texture. Organoleptic evaluation of the developed product was done by the semi-trained panel members, using five-point hedonic scale. The developed product was packaged with labelling instructions. In order to study the acceptability of the developed noodles, 25 adults from residential area of Coimbatore evaluated the products and rated with five point hedonic rating scale.

The salient findings of the study are:

- From the trials made to find a suitable preparation method, trial-2 was more acceptable and this method was used to prepare the developed noodles. This was due to the method used to developed the trial-2, had more time for gelatinization and so the product had more stretchability and a longer noodle compared with trail-1 as obtained. So, this method was carried out in the development of the noodles.
- Even though the noodle were long than the trail-1, it was not long enough for an ideal noodle to develop. So, more trails with different proportion of soyabean flour was carried out. In this, trail-2 to trail-5, each trial had soya bean flour with the proportion of 25 per cent to 100 per cent to the 60g of total rice flour added.
- Trial-5 had the highest acceptability as this noodle was longer compared to all the five trials. This was due to the soya bean flour and its binding properties along with the gelatinsation of the starch.
- The trial preparation showed that, increase in soya bean flour, increases the binding nature of the ingredients.
- Variations were done with the same amount of ingredients along with same method of preparation but variation-2 had an addition of corn flour. Among the both variations, variation-2, had very long noodles of length 21 cm whereas variation-1 had a length of 11 cm. This was due to the additional ingredient corn flour, which increased the gelatinization of the starch.
- The nutrient properties of the sun dried Indigenous Indian rice noodles were analysed for both the variation. The nutrient analysed for the variation-1 shows that the developed product contains, 206kcal of energy, 149.8g of carbohydrates, 50.2g of protein, 2.5g of fat, 4g of fibre, 38mg of calcium per serving.
- The nutrient content of the variation-2 includes, 208kcal of energy, 162.2g of carbohydrates, 40.6g of protein, 2.3g of fat, 3.6g of fibre, 33.1mg of calcium per serving.
- Total antioxidant activity of the developed products was analysed using UV-VIS spectrophotometer, which showed variation-1 had 10.5µg/g Ascorbic acid and variation-2 had 8.6µg/g Ascorbic acid.

- Variation-1 had high amount of total antioxidant capacity compared with the variation-2 for per gram of sample analysed.
- The texture analyses exhibited the hardness of the developed product. Variation-2 had a higher break force of 14.7784 N and variation-2 had break force of 1.55520 N. this exhibited that Variation-2 had a high hardness which in turn shows the crispiness of the developed product.
- The pH of the developed product was acidic ranging between the range of 5.57 for variation-1 and 5.35 for variation-2.
- The sensory evaluation of the trial-1 and trial-2 revealed that the trial-2 was more accepted in both the dried and cooked state. From the sensory evaluation of trial-2 to trial-5, the more accepted one was trial-5 in both the dried and cooked form which had a 60g of soya bean flour. The sensory evaluation of the variations reveled that variation-2 had a higher acceptability in both the dried and cooked state.
- The variation-2 had ingredients such as each 10g of all six rice along with 60g of soya bean flour, 30g of corn flour which is an additional ingredient from variation-1 and other ingredients.
- The product was subjected to development of recipes, in which the recipes included Chicken noodles, veg noodles, paneer noodles, mushroom noodles and egg noodles.
- QR code was inserted as an additional feature in packaging, which upon scanning shows a pdf with the recipes developed for the indigenous Indian rice noodles. It also contains details such as, an image of the recipe, cooking time, potion size, ingredients, method and the calculated nutritional value each of the recipes.
- The product was stable for the period of shelf life analysed (30 days) for both the variation which was dried using sunlight and when kept in a clean airtight container in room temperature. No microbial spoilage was seen, and there was no change in the sensory attributes of the developed product.
- The developed product when analysed among the selected adults, variation-2 had a higher acceptability among them. Variation-2 had 59 per cent of acceptability of the product whereas variation-1 had 41 per cent of acceptability.

- The selected adults who represented as a population of people for public were willing to use the developed product with the indigenous Indian rice as this noodle is high in nutrient content compared with the other noodles which are made of refined wheat four.
- The developed product with the indigenous Indian rice noodles of variation-2 was found as the most acceptable due to its appearance, length of the noodles, stability and taste and so it can be produced commercially as a Ready-To-Eat Indigenous Indian rice noodles.

Conclusion:

The developed Noodles with the indigenous Indian rice was a way of promoting convenient form of products to obtain the nutritional and health benefits of the rice varieties of the developed product. Such products could be certainly useful for all health conscious population groups to include Indigenous rice in the daily diets. Use of traditional rice in place of refined flour will be an alternate as gluten free product and can be used in conditions excluding gluten in diet. Convenience foods as noodles will be easier, healthier, tastier and a different option as healthy choice for the consumers. Such products in the food industry will aid to facilitate the health and well being of the consumers.

Scope for Future Research Work:

- Development of various Ready-To-Eat products with incorporation of indigenous rice and millet varieties.
- Promotion of products such as Ready-To-Serve and Ready-To-Use with indigenous food commodities at food service operations.
- Awareness on production and consumption of traditional rice varieties among young population groups.

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ANNEXURE I

Questionnaire on Sensory Evaluation Score Card for Evaluation of Developed Product (Raw)

Name : Contact Number :

Date : Address :

State of the product : Raw Email id :

Sensory evaluation :

The sensory evaluation is done using five-point hedonic scale, for all the varieties developed.

Code	Appearance	Texture	Flavour	Taste	Overall acceptability	Total score

Grade:

Appearance	5-very long; 4-moderately long; 3- neither long nor short; 2-moderately short. 1-very short
Texture	5-very crisp; 4- moderately crisp; 3-neither or nor crisp; 2-moderately soggy;1-very soggy
Flavour	5-excellent; 4-good; 3-fair; 2-poor; 1-very poor
Taste	5-excellent; 4-good; 3-fair; 2-poor; 1-very poor
Overall Acceptability	5-liked very much; 4-liked moderately; 3-neither liked nor disliked; 2-disliked moderately; 1-disliked very much

Signature of Participant

ANNEXURE II

Questionnaire on Sensory Evaluation Score Card for Evaluation of Developed Product (Cooked)

Name : Contact Number :

Date : Address :

State of the product : Cooked Email id :

Sensory evaluation :

The sensory evaluation is done using five-point hedonic scale, for all the varieties developed.

Code	Appearance	Texture	Flavour	Taste	Overall acceptability	Total score

Grade:

Appearance	5-very long; 4-moderately long; 3- neither long nor short; 2-moderately short. 1-very short
Texture	5-very soft; 4- moderately soft; 3-neither or nor soft; 2-moderately hard;1-very hard
Flavour	5-excellent; 4-good; 3-fair; 2-poor; 1-very poor
Taste	5-excellent; 4-good; 3-fair; 2-poor; 1-very poor
Overall Acceptability	5-liked very much; 4-liked moderately; 3-neither liked nor disliked; 2-disliked moderately; 1-disliked very much

Signature of Participant

APPENDIX I

HUMAN ETHICAL COMMITTEE CERTIFICATE

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

24th March 2022

To
Ms.Thahmina.K.N
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Thahmina.K.N,

Ref: Your proposal No. IHEC/21-22/FSMD-25 entitled "Development of Noodles with the Indigenous Indian Rice" resubmitted for approval to IHEC on 18.03.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/ FSMD-25 entitled "Development of Noodles with the Indigenous Indian Rice"resubmitted by you. The Approval number for the same is AUW/IHEC/FSMD-21-22/XPD-25.

We wish you all the best in your research endeavours.

Regards,

V. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee

APPENDIX II

Plagiarism Report

Introduction

ORIGINALITY REPORT

6%	4%	3%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.tarj.in Internet Source	<1%
2	Angel Gil, Rosa M Ortega, José Maldonado. "Wholegrain cereals and bread: a duet of the Mediterranean diet for the prevention of chronic diseases", Public Health Nutrition, 2011 Publication	<1%
3	www.slideshare.net Internet Source	<1%
4	nopr.niscair.res.in Internet Source	<1%
5	ace.acadiau.ca Internet Source	<1%
6	krishikosh.egranth.ac.in Internet Source	<1%
7	"Brown Rice", Springer Science and Business Media LLC, 2017 Publication	<1%

APPENDIX III

Nutrition Analysis Test Reports

1. Indigenous Indian Rice Noodles-Variation-1

ALPHA
LABS & TECHNOLOGIES
FOOD / WATER / SOIL TESTING

281-C, Thadagam Road, Amutha Surabi Upstairs,
Opp Avila Convent, Venkittapuram, Coimbatore-641025.
Tel : 0422 - 2441499 Mobile: 96294 40642
E-mail : alphalabtech@gmail.com www.alphalabtech.in

TEST REPORT

REPORT NO:	ALT/17239/2022	REPORT DATE:	04.05.2022

Customer Details :	Ms. THAHMINA.K.N AVINASHILINGAM UNIVERSITY		
Sample Description:	RICE NOODLES - I		
Sample Code no:	ALT/MAR/22/17239	Sample Received Date	28.04.2022
Sample Analysis Date	28.04.2022	Sample Completed Date	04.05.2022

RESULTS OF THE ANALYSIS

S.NO	TEST PARAMETERS	UNIT	TEST PROTOCOL	RESULT
1.	Moisture	%	AOAC 21ST EDITION 925.10	**9.91**
2.	Total Ash	%	AOAC 21ST EDITION 923.03	**6.31**
3.	Fat	%	AOAC 21ST EDITION 920.85	**0.47**
4.	Total Protein	%	IS 7219:1973	**20.9**
5.	Carbohydrate	%	AOAC 21ST EDITION 986.25	**62.41**
6.	Energy	KCals/100g	ALT/SOP/03/01:2016	**342.98**
7.	Iron	mg/100g	AOAC 21st EDITION 944.02:	**BDL**
8.	Calcium	mg/100g	AOAC 21st EDITION - 944.03	**63.37**
9.	Fibre	%	AOAC 20th edition,920.86	**3.51**

BDL- Below Detection Limit

*****End of Report*****

Approved by: S.S. Gr

ALPHA LABS & TECHNOLOGIES ISO 9001 CERTIFIED

Checked by: C

2. Indigenous Indian Rice Noodles-Variation-2

ALPHA
LABS & TECHNOLOGIES
FOOD / WATER / SOIL TESTING

281-C, Thadagam Road, Amutha Surabi Upstairs,
Opp. Avila Convent, Venkittapuram, Coimbatore-641025.
Tel : 0422 - 2441499 Mobile: 96294 40642
E-mail : alphalabtech@gmail.com www.alphalabtech.in

TEST REPORT

REPORT NO:	ALT/17240/2022

REPORT DATE:	04.05.2022

Customer Details :	Ms. THAHMINA.K.N AVINASHILINGAM UNIVERSITY		
Sample Description:	RICE NOODLES - II		
Sample Code no:	ALT/MAR/22/17240	Sample Received Date	28.04.2022
Sample Analysis Date	28.04.2022	Sample Completed Date	04.05.2022

RESULTS OF THE ANALYSIS

S.NO	TEST PARAMETERS	UNIT	TEST PROTOCOL	RESULT
1.	Moisture	%	AOAC 21ST EDITION 925.10	9.71
2.	Total Ash	%	AOAC 21ST EDITION 923.03	5.36
3.	Fat	%	AOAC 21ST EDITION 920.85	0.42
4.	Total Protein	%	IS 7219:1973	16.91
5.	Carbohydrate	%	AOAC 21ST EDITION 986.25	67.60
6.	Energy	KCals/100g	ALT/SOP/03/01:2016	347.42
7.	Iron	mg/100g	AOAC 21st EDITION 944.02:	BDL
8.	Calcium	mg/100g	AOAC 21st EDITION - 944.03	55.15
9.	Fibre	%	AOAC 20th edition,920.86	3.02

BDL- Below Detection Limit

*****End of Report*****

Approved by: S.S. G

ALPHA LABS & TECHNOLOGIES ISO 9001 CERTIFIED

Checked by: C. B

APPENDIX IV

Total Antioxidant Assay Test Report

SPECIALIZED TESTING SERVICES
(AN ISO 9001 CERTIFIED MULTI DISCIPLINARY TESTING LABORATORY)
No.14, Amburose Street, MTP Road, Kavundampalayam, Coimbatore - 641 030.
Phone : +91 422 4980402, E-mail : stslabcbe@gmail.com, Web : www.stslab.in

REPORT NUMBER: STS/RE/2022-23/0267

DATE: 30.04.2022

TEST REPORT

Issued To	:	**MS.THAHMINA.K.N,** M.SC, FSMD, AVINASHILINGAM UNIVERSITY, COIMBATORE.
Sample Description	:	**INDEGENOUS INDIAN RICE NOODLES**
Sample Quantity Received	:	50g (approx.) (each one sample)
Date of Receipt of Sample	:	28.04.2022
Date of Start of Analysis	:	28.04.2022
Date of Completion of Analysis	:	30.04.2022
Sampling Done by	:	Customer

ANTIOXIDANT ASSAY

S.NO	NAME OF THE SAMPLE	TOTAL ANTIOXIDANT CAPACITY	TEST METHOD
1.	Variation - 1	10.5µg/g Ascorbic acid	By UV-VIS Spectrophotometric
2.	Variation - 2	8.6µg/g Ascorbic acid	

Analyzed By: Abirami.A

Important Note:
**The given results reflect our findings of the submitted sample only. Reports shall not be reproduced except in full without the written permission from the laboratory.*
**The report/results should not be used as evidence in the court cases and also forbidden to use for any kind of advertisements.*
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For SPECIALIZED TESTING SERVICES

Authorized Signatory

APPENDIX V

Texture Analysis Test Reports

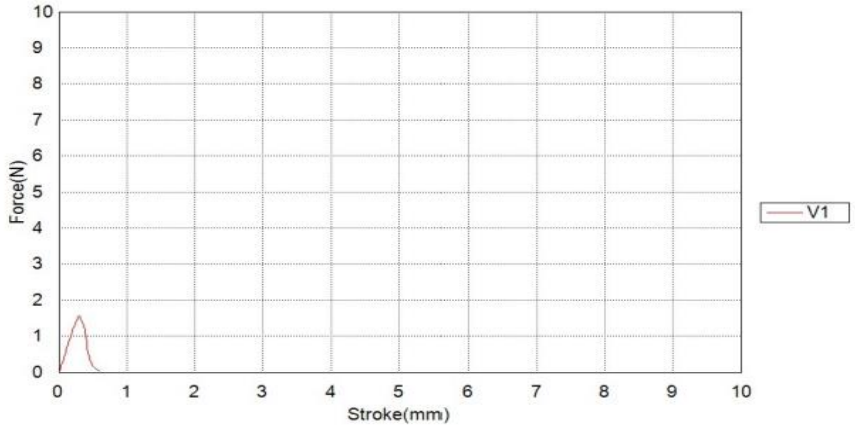
1. Indigenous Indian Rice Noodles-Variation-1

V1

Key Word		Product Name	Lays chips
Test File Name		Method File Name	Chips.xmel
Report Date	5/4/2022	Test Date	5/4/2022
Test Mode	Texture	Test Type	Compression
Speed	1mm/sec	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name	Hardness_Force	Peak_Max. 1_Force	Brittleness	Cohesiveness
Parameters	Calc. at Entire Areas	1th Node - Sensitivity: 10(%FS)1th		
Unit	N	N	N	
V1	1.55520	-.-	-.-	-.-
Average	1.55520	-.-	-.-	-.-
Standard Deviation	-.-	-.-	-.-	-.-
Range	0.00000	-.-	-.-	-.-

Name	Adhesiveness	Adhesive_Force_Force	Break_Force	Chewiness
Parameters	2th Node- Next Node	2th Time	Sensitivity: 10	
Unit	J	N	N	N
V1	0.00000	0.01160	-.-	-.-
Average	0.00000	0.01160	-.-	-.-
Standard Deviation	-.-	-.-	-.-	-.-
Range	0.00000	0.00000	-.-	-.-



Comment

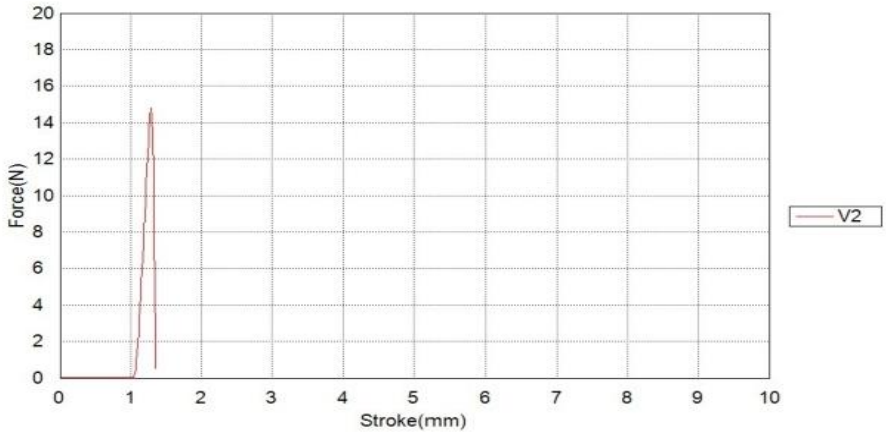
2. Indigenous Indian Rice Noodles-Variation-1

V2

Key Word		Product Name	Lays chips
Test File Name		Method File Name	Chips.xmel
Report Date	5/4/2022	Test Date	5/4/2022
Test Mode	Texture	Test Type	Compression
Speed	1mm/sec	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name	Hardness_Force	Peak_Max. 1_Force	Brittleness	Cohesiveness
Parameters	Calc. at Entire Areas	1th Node - Sensitivity: 10(%FS)1th		
Unit	N	N	N	
V2	14.7784	-.-	-.-	-.-
Average	14.7784	-.-	-.-	-.-
Standard Deviation	-.-	-.-	-.-	-.-
Range	0.00000	-.-	-.-	-.-

Name	Adhesiveness	Adhesive_Force_Force	Break_Force	Chewiness
Parameters	2th Node- Next Node	2th Time	Sensitivity: 10	
Unit	J	N	N	N
V2	0.00000	0.01121	14.7784	-.-
Average	0.00000	0.01121	14.7784	-.-
Standard Deviation	-.-	-.-	-.-	-.-
Range	0.00000	0.00000	0.00000	-.-



Comment

APPENDIX VI

Procedure for Nutrient Analysis

1. Estimation of Energy:

Scope:

The SOP provides the method for determination of Energy value I the products.

Method:

The energy of the food product is analysed by calculation method

Calculation:

Food energy values in both kilocalories (kcal) and kilojoules use the same factors. Energy (kcal/100g) = (Carbohydrate X 4) + (Protein X 4) + (Fat X 9)

2. Estimation of Carbohydrate:

The carbohydrate of the developed product can be estimated by calculation method.

Calculation method:

100 minus the value of the moisture, total ash, total fat, total protein. Calculate the result for carbohydrates.

Formula:

Carbohydrate (g/100)=100- (Moisture+ Ash+ Protein+ Fat)

3. Protein Estimation by Lowry's method

Protein can be estimated by the methods as given by Lowry and also by estimating the total nitrogen content. No method is 100% sensitive. Hydrolysing the protein and estimating the amino acids alone will give the exact quantification.. The method developed by Lowry et al., (2010), is sensitive enough to give a moderately constant value and hence largerly followed. Protein content of enzyme extracts is usually determined by this method.

Principle:

The blue colour developed by the reduction of the phosphomolybdic - phosphotungastic components in the Folin-ciocalteau reagent by the amino acids tyrosine and tryptophan present in the protein plus the colour developed by the biuret reaction of the protein with the alkaline cupric tartrate are measured in the Lowry's method.

Materials:

- 2% sodium Carbonate in 0.1 N Sodium Hydroxide (Reagent)
- 0.5% Copper Sulphate, (CUSO4 5H20) in 1% potassium sodium tartrate (Reagent B)
- Alkaline copper solution: Mix 50 mL of A and 1 mL of B prior to use (Reagent C)
- Folin-ciocalteau reagent (reagent D); Reflux gently for 10 hours a mixture consisting of 100 g sodium tungstate (Na2WoO4 2H20), 25 g sodium molybdate (Na2MoO4 2H20)
- 700 mL water, 50 mL of 85% phosphoric acid, and 100 mL of concentrated hydrochloric acid in a 1.5 L flask. Add 150 g llithium sulphate, 50 mL water and a few drops of bromine water. Boil the mixture for 15 min without condenser to remove excess bromine cool, dilute to 1 L and filter. The reagent should have no greenish tint. (determine the acid concentration of the reagent by titration with 1 N NAOH to a phenolphthalein end point)
- Protein solution (Stock standard) Weigh accurately 50 mg of bovine serum albumin (Fraction V) and dissolve in distilled water and make up to 50 mL in a standard flask.

Working standard

Dilute 10 mL of the stock solution to 50 mL with distillued water in a standard flask. One mL of this solution contains 200 µg protein.

Procedure

- Extraction of protein from sample Extraction is usually carried out with buffers used for the enzyme assay.
- Weigh 500mg of the sample and grind well with a pestle and mortar in 5 - 10 ml of the buffer. Centrifuge and use the supernatant for protein estimation.

- Pipette out 0.2, 0.4, 0.6,0.8 and 1ml of the working standard into a series of test tubes.
- Pipette out 0.1ml and 0.2 ml of the sample extract in two other test tubes.
- Make up the volume to 1ml in all the test tubes. A tube with 1ml of water
- serves as the blank.
- Add 5 ml of reagent C to each tube including the blank. Mix well and allow to stand for 10min.
- Then add 0.5ml of reagent D, mix well and incubated at room temperature in
- the dark for 30 min. Blue colour is developed.
- Take the reading at 660nm.
- Draw a standard graph and calculate the amount of protein in the sample.

Calculation

Express the amount of protein mg/g or 100g sample.

4. Estimation of Fat:

To determine the amount of Fat in the product.

Procedure:

- First of all, rinse all the glass apparatus by petroleum ether and dry it in the oven at 102°c and after removing it keep in the desiccator.
- Weigh 5 gram of grounded and dried sample and place it in the thimble.
- Place the thimble in the soxhlet extractor.
- Take a 150ml round bottom flask and clean it and fill the flask with 90 ml petroleum ether.
- Place the whole setting on a heating mantle and allow the petroleum ether to boil.
- Continue the extraction process for several hours, almost 6 hours.
- Remove the condensing unit from extraction unit and allow the sample to cool down. Finally, it removes all the lipid.
- Collect almost all the solvent after distillation.
- Place the sample in the oven and after removing it place in the desiccator.
- Take the weight of the sample.

- As a result, we get a defat sample.

Calculation : Fat percentage = (w2-w1)/p × 100

5. Estimation of Crude Fibre

Crude fibre consists largely of cellulose and lignin (97%) plus some mineral matter. It presents only 60-80% of the cellulose and 406% of the lignin. The crude fibre content is commonly used as a measure of the nutritive value of poultry and live stock feeds and also in the analysis of various foods and food products to detect adulteration, quality and quantity.

Principle:

During the acid and subsequent alkali treatment, oxidative hydrolytic degradation of the native cellulose and considerable degradation of lignin occur. The residue obtained after final filtration is weighed, incinerated, cooled and weighed again. The loss in weight gives the crude fibre control.

Materials

Sulphuric acid solution (0.255± 0.005 N): 1.25g concentrated sulphuric acid diluted to 100mL (Concentration must be checked by titration)

Sodium hydroxide solution (0.313± 0.005N): 1.25g sodium hydroxide in 100mL distilled water (Concentration must be checked by titration with standard acid)

Procedure

- Extract 2g of ground material with ether or petroleum ether to remove fat (Initial boiling temperature 35-38 ºC and final temperature 52ºC) If fat content is below 1% extraction may be omitted.
- After extraction with ether boil 2g of dried material with 200mL of sulphuric acid for 30min with bumping chips.
- Filter through muslin and wash with boiling water until washings are no longer acidic
- Boil with 200mL of sodium hydroxide solution for 30 min.
- Filter through muslin cloth again and wash with 250 mL of boiling 1.25% H2SO4 there 50mL of portions of water and 25mL alcohol.

- Remove the residue and transfer to ashing dish (Preweighed dish W1)Dry the residue for 2 h at 130± 2º C. Cool the dish in a desicator and weigh (W2).
- Ignite for 30 min at 600± 15ºC.
- Cool in a desiccators and reweigh (W3).

Calculation

% crude fibre in ground sample

= Loss in weight on ignition (W2-W1) - (W3-W1) / weight of sample x 100

6. Estimation of Calcium

Titrimetric method

Principle

Calcium is precipitated as oxalate and is titrated with standard potassium permanganate.

Reagents

a. 4% ammonium oxalate solution
b. Dilute ammonia solution: 2 ml of liquor ammonia with 98 ml water.
c. 1N H_2SO_4
d. 0.01 N Potassium permanganate solution
e. 0.01 N oxalic acid: Sodium oxalate is dried in an oven at 100-105ºC for 12 h. exactly 0.67 g is dissolved in redistilled water. Five ml of concentrated H_2SO_4 is added and solution made up to 1 L after it has cooled down. Standardisation of potassium permanganate solution: 25 ml of 0.01 N oxalic acid is transferred to an Erlenmeyer flask. One ml of concentrated H_2SO_4 is added, warmed to about 70ºC and titrated against $KMnO_4$ solution, till the pale pink colour remains. The normality of $KMnO_4$ solution = (25 x 0.01)/ Titre value (ml)

Procedure

Two ml of sample is taken into a 15 ml centrifuge tube. Add 2 ml of distilled water and 1 ml of ammonium oxalate solution and mix thoroughly and leave overnight. Again the contents are mixed and centrifuged for 5 min at 1500 rpm. The supernatant

liquid is poured off and the centrifuge tube drained by inverting the tube for 5 min on a rack (care should be taken not to disturb the precipitate). The mouth of the centrifuge tube is wiped with a piece of filter paper. The precipitate is stirred and the sides of the tubes are washed with 3 ml of dilute ammonia. It is centrifuged again and drained as before. The precipitate is washed once more with dilute ammonia to ensure the complete removal of ammonium oxalate. The precipitate is dissolved in 2 ml of 1N H_2SO_4. The tube is heated by placing it in a boiling water bath for 1 min and titrated against 0.01 N $KMnO_4$ solution to a define pink colour persisting for at least 1 min.

Calculation

1 ml of 0.01 N $KMnO_4$ is equivalent to 0.2004 mg of calcium.

mg of calcium/ 100 ml serum = [(X-b) x 0.2004 x 100]/ 2

where, X = Volume in ml of 0.01 N $KMnO_4$ required to titrate the sample, b = Volume in ml of 0.01 N $KMnO_4$ required to titrate 2 ml of H_2SO_4 (blank). If the normality of $KMnO_4$ is 'a', the value obtained in the above formula should be multiplied by the factor, a/ 0.01.

APPENDIX VII

Procedure for Total Antioxidant Assay

Total Antioxidant Capacity assay:

Procedure:

- The total antioxidant capacity of the Methanol extract of the sample was evaluated by the phosphomolybdenum method according to the procedure.
- 5 to 10gm of sample was taken and extraction was done using methanol solvent.
- 0.3 mL of extract was combined with 3 mL of reagent solution.
- (0.6 M sulfuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate).
- The tubes containing the reaction solution were incubated at 95°C for 90 min.
- Then, the absorbance of the solution was measured at 695 nm using a **UV-VIS spectrophotometer** against blank after cooling to room temperature.
- Methanol (0.3 mL) in the place of extract was used as the blank.
- The total antioxidant activity is expressed as the number of gram equivalent of ascorbic acid.
- The calibration curve was prepared by mixing ascorbic (1000, 500, 250, 125, 62.5 and 31.25 µg/mL) with methanol.

APPENDIX VIII

Procedure for pH Analysis

Standard Operating Procedure pH Meter:

- Connect the plug ton 230 V AC 50 Hz single phase.
- Put ON the power to the pH meter using the rocker switch provides in the back panel of the pH meter.
- Press the piano CHECK / READ switch to CHECK position.
- Observe the digital display. It should read 7.00 + 0.01.
- Wash the pH electrode (and the pt-100 probe) thoroughly with distilled water.
- Prepare pH 7.00, pH 4.00 and pH 9.2 buffers using the buffer power.
- Place the buffer 7.00 below the electrode and immersed in the buffer.
- Press CHECK / READ switch so that the display takes CHECK value of 7.00 and disconnects the electrode signal.
- The buffer 7.00 pH or 4.00 is placed. The display is automatically reads correct values within +0.01, then the pH meter is ready for perfect operation.
- The equipment can be linearised between 7.00 and 4.00 or 7.00 and 9.2 at any one time.
- Press the piano switch, CHECK / READ to leave the display at CHECK position.