VALUE ADDED BAKED PRODUCTS FROM RAW JACKFRUIT

by

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(2014-16-107)

THESIS

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN HOME SCIENCE

(Food Science and Nutrition)

Faculty of Agriculture

Kerala Agricultural University

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE

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KERALA, INDIA

2016

DECLARATION

I, hereby declare that this thesis entitled **"VALUE ADDED BAKED PRODUCTS FROM RAW JACKFRUIT"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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DEDICATED TO MY FAMILY

Acknowledgement

I therefore chose to place on record, my sincere gratitude to all the following individuals without whom this thesis wouldn't have materialised.

At the foremost my deepest gratitude to my major advisor, Dr. Suma Divakar, Assistant Professor (S.S), Department of Home Science, for her inspiring guidance, timely advice and constant encouragement throughout the course of my study without which this work would not have seen the light of the day. Her unbound motherly affection and understanding helped me to overcome many situations of crisis and recover when my steps faltered. Her advice in my career as well as in my personal life has been priceless.

It is with immense gratitude, I acknowledge Dr. Mary Ukkuru, former Professor and Head, Department of Home Science, for her scientific advice, , constructive support during the course of work. My deep appreciation goes to Dr. P.V Nandini, Professor and Head of Department of Home Science for timely advice for successful completion of my thesis.

No words can truly represent my deep sense of gratitude to Dr.Mini C, Professor and Head, Department of Processing Technology for her wholehearted help, valuable suggestions, critical scrutiny constant encouragement and suggestions at various stages of the study.

I cordially offer my sincere thanks to Dr. Prassana Kumari, Dr.C. Nirmala, Dr. Soffi Cheriyan, Dr. Rari John and Dr. Anitha of the Department of Home Science, for their immense help and cooperation rendered throughout this research endeavour. It was my great privilege and pleasure to have the best help and cooperation from Binu chetta,Priya chichi, and Manju chechi, the staff members of Department of Home Science

I sincerely express my profound gratitude to Asian Bakery for the help and unstinted co-operation rendered in the completion of work.

I account my sincere thanks to Dr. Elsamma Job, Professor, Department of Ag. Economics, for inspiring and motivating me with suggestions regarding work which made me to look at her with awe and respect. I remember with gratitude the co-operation Dr.Vijaya Raghaban, Professor and head Department of Agricultural statistics for his help in the completing the statistical analysis of the data.I avail this opportunity to Dr. B. Aparna, Assisstant Professor, Department of Soil Science for her wholehearted help .

I express my gracious thanks to Kerala Agricultural University for providing me the KAU fellowship.I deem it my privilege in expressing my obligation to Dr.Chitra Devadarshini and Dr. Diptimayee Jena Associate Professor, Odisha University of Agriculture and Technilogy for their encouragement. My acknowledgement will be incomplete if I don't mention my gratitude to Balchandran, Rajagopal, , Leena and Sindhu, hostel staff for their parenting care and wholehearted support to complete this dissertation against all odds.

From the depth of my heart I thank my seniors Krishnendu,Krisnashri Saima, Lakshmi,Veena,Neethu, pritam, suma and Preetin and express my love and affection to my loving juniors Aiswrya,Gayatri , Taslima and Meghna for their help and support at the different stages of this study.

I submit oceans of thanks to my dearest friends, Anjali, Shilpa, Salini and Athira for helping me to stay focused and overcome the setbacks during my research, and sincere regards to my classmates Priya, Aswathy, and Siji or their help.

No words in this mortal world can suffice to express my feelings towards my father Rama Chandra Sahoo, mother Kanaklata Sahoo, Sister Romy and Liza, brother Rakesh for their unconditional love, blessings and patience.

I also place on record, my sense of gratitude to one and all, who directly or indirectly, have lent their hand in this venture.

Above all I bow my head before Almighty for the blessings showered on me during the course of my study and also at all other times when I needed it most for ramifying the paths of thick and thin of my efforts.

Ambika Sahoo

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LIST OF ABBREVIATIONS AND SYMBOLS USED

WAI	Water absorption index
OAI	Oil absorption index
FC	Foaming capacity
SP	Swelling Power
Cfu/g	Colony forming unit per gram
Fig	Figure
OVA	Overall Acceptability
et al.	And others
i.e.	That is
IU	International unit
Rpm	Rotation per minute
RDA	Recommended dietary allowances
T_1	Treatment 1
T_2	Treatment 2
T_3	Treatment 3
T_4	Treatment 4
T_5	Treatment 5
T_6	Treatment 6
T_7	Treatment 7
pH	Potential of hydrogen
HTST	High temperature short time

KMS	Potassium meta bi-sulphite
NS	Not significant
CD	Critical difference
ND	Not detected
cc	centimeter cube
RF	Refined flour
RJBF	Raw jackfruit bulb flour
g	Gram
Kcal	Kilo Calories
Mg	Milligram
m	Meter
cm	Centimeter
mm	Millimeter
ml	Milliliter
min	Minutes
hrs	Hours
^{0}C	Degree Celsius
^{0}F	Degree Fahrenheit
@	At the rate of
%	Percentage

INTRODUCTION

1. INTRODUCTION

Bakery industry is a rapidly growing industry in our country. This industry in India is the largest of the food industries with an annual turnover of about Rs. 3,000 crore. India is the second largest producer of biscuits in the world. The industry comprises of individual bakers and Industrial bakers. Individual bakers form a tiny sector catering to the requirements of the local market and the Industrial bakers focus on the fast moving consumer goods (FMCG), with market operations in many parts of the country.

Bakery products are gaining popularity day by day. Young generations mostly prefer the bakery products to other food stuffs. Women's employment has generated an added need among nuclear families to depend on ready-to eat food items like baked products. The growth of the bakery products has reduced the responsibilities in the kitchen as well. Besides, people going out of home, can easily satisfy their food needs. Thus the bakery products have solved the refreshment problems of many families. The bakery products have reduced the dependence on house wives to satisfy family food requirements.

Increased demand for the bakery products has also helped the primary sector of the country i.e. agriculture. Almost all the bakery products are made from wheat and dairy products. There is a great demand of these agricultural items all over the world. Thus farming has now become more commercial. Farmers grow the crops and sell their produce at competitive prices in the national as well as international market. These bakery products have thus brought prosperity to the farmers all over the country. Bakery products have globalized the markets facilitating the producers to sell their products profitably.

In India bakery products are in common use and have become very popular in the society. In today's fast life, bakery products are becoming one of the most essential food items in human diet, due to its readymade availability and high nutritive value.

1.1 SCOPE AND IMPORTANCE

The outcome of the work would benefit small scale processing units and also farm women to bring value addition to this under exploited fruit, growing in abundance in the state.

Now a days consumers are also increasingly conscious about their health, they demand taste along with nutritive quality. There is an increasing realization that though bakery products processed from refined flour are tasty, they cause various harmful effects to the body, owing to the harmful additives .Thus there is a need felt to substitute refined flour with safe and healthy ingredients. Products from composite flours have thus become a trend in the market.

In the present scenario of Kerala, every year large amounts of jackfruit are produced, out of which a significant portion goes waste due to their perishable nature and seasonal glut. Value addition through processing and preservation has to be considered as an important alternative for reducing the post harvest losses of this nutritious fruit and also for serving it in off season

There have been innumerable efforts to bring about value addition to ripe jack fruit. The standardized products range from candies, jams, jellies, beverages to table dishes. It is evident from literature that many efforts have not been undertaken to exploit the market potential of raw jackfruit.

Jack fruit, especially in the raw form is not easy to handle, owing to the difficulty experienced in separating the edible bulbs from the rind. The difficulty has its origin in the morphological and biological hindrances associated with the fruit. Therefore, it is urged that this indigenous or underutilized fruit which is not marketable in the fresh form be processed to acceptable products.

It has become all the more necessary to open new avenues, for better utilization of raw jack fruit, as traditional uses have already become stabilized. Therefore, there lies great opportunity for non-traditional uses of jackfruit in the form of baked products.

1.1 OBJECTIVE

Keeping in view the above facts and also the market prospects of the jackfruit based baked products, this study was planned with the objective to develop raw jackfruit flour based baked products viz., bread, bun, rusk and pizza base and assess their quality characteristics.

1.2 LIMITATIONS

The study is conducted with locally available raw materials at retail prices. There are no additives added to the products so as to bring out 'healthy' products. Hence the commercial viability will be less compared to market brands.

1.3 ORGANISATION OF THESIS

The thesis is organized five chapters. The first chapter is the introduction, which includes the scope and importance of the study, objectives and limitations. Second chapter on materials and methods comprises selection of raw material, identifying variables, measurement of variables and statistical analysis. Fourth chapter comprises of results of the study which deals with specific findings of the study. Discussion chapter follows which justifies the findings of the study with related literature. The sixth chapter on summary summarizes the salient features of the study with future line of work.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The literature of the present study entitled "Development of value added baked products from raw jackfruit" is presented under the following subheads:-

2.1 Jackfruit and its importance

2.2 Need to utilize jackfruit in Kerala

2.3 Importance of baked products

2.4 Need for improving the quality of flour used in baking

2.5 Scope of composite flour

2.1 JACKFRUIT AND ITS IMPORTANCE

India is the second biggest producer of fruit in the world and is considered as the motherland of jackfruit. "Chakka", its Malayalam name, according to some, has given birth to the English name jackfruit. In India, it has wide distribution in Assam, Tripura, Bihar, Uttar Pradesh, the foothills of the Himalayas and the South Indian States of Kerala, Tamil Nadu and Karnataka. Jackfruit plays a significant role in Indian agriculture and culture. (Sidhu, 2012)

Singh (2012) reported that Jackfruit is widely grown as an important tree in Kerala's homesteads and also as a shade crop in coffee plantations. It is popularly known as the poor man's fruit in the eastern and southern parts of India. The tender fruits of the tree are used as vegetables and the ripe ones as table fruits. The traditional varieties bear fruits once in a year. The tender fruits come to market from March onwards and continue till August. The fruits begin to ripen in the month of June. However, the late varieties may ripen in October.

Jackfruit is a multi-purpose tree providing food, timber, fuel, and fodder with medicinal and industrial products. However the primary economic product of jackfruit is the fruit which is used both when mature and immature. When in the unripe green stage, it is remarkably similar in texture to chicken, making jackfruit

an excellent vegetarian substitute for meat. In fact, canned jackfruit in brine is sometimes referred to as “vegetable meat”. Jackfruit seeds can be roasted like chestnuts, or boiled. The fruit pulp is sweet and tasty and used as dessert or preserved in syrup. (Amrik, 2012)

2.1.1 Medicinal Benefit of Jackfruits

The whole tree has a valued place in research due to its medicinal and nutritive properties. All parts of the tree are said to have medicinal properties. The young fruits are acrid, astringent, and carminative. The ripe fruits are sweet, cooling, and laxative and have aphrodisiac compounds including flavonoids, stilbenoids, arylbenzofurons and jacalin, a lectin which is used as a brain tonic. The seeds are diuretic and constipating.

The extracts and metabolites of *Artocarpus* particularly those from leaves, bark, stem and fruit possess several useful bioactive compounds. Several pharmacological studies of the natural products from *Artocarpus* have conclusively established their mode of action in the treatment of various diseases and other health benefits. Jackfruit is regarded as a species worthy of research because of its wider potential in medical and dental field. The *Artocarpus* species are also rich in phenolics (Kalpana*et al*., 2014).

The latex is useful in various diseased conditions like dyspepsia, ophthalmic disorders and pharyngitis and is also used as an antibacterial agent. The ash of jackfruit leaves is used in treating ulcers. The dried latex yields artostenone, convertible to artosterone a compound with marked androgenic action. Mixed with vinegar, the latex promotes healing of abscesses, snakebites and glandular swellings. The root is a remedy for skin diseases and asthma. An extract of the root is taken during fevers and diarrhoea. (Jitendra*et al.,* 2014).

2.1.2 Nutritional Benefit of Jackfruits

The fruit is made of soft, easily digestible flesh (bulbs) with simple sugars like fructose and sucrose. The flesh of the jackfruit is starchy and fibrous, and is a source of dietary fiber which makes it a good bulk laxative.

The fresh fruit is a good source of potassium, magnesium, manganese, and iron. Potassium is an important component of the human cell and also body fluids which helps to control heart rate and blood pressure. Jackfruit has small amounts of pro vitamin A and flavonoid pigments such as carotene-ß, xanthin, lutein and cryproxanthin-ß. Jackfruit is also a good source of vitamin C (13.7 mg /100g or 23 per cent of recommended daily allowance, RDA).

It is one of the rare fruits that is rich in the B-complex group of vitamins. It contains very good amounts of vitamin B-6 (pyridoxine), niacin, riboflavin, and folic acid. There may be nutraceutical or pharmaceutical opportunities in jackfruit given its widespread usage in traditional Chinese and Indian medicine. (Airani, 2007).

The seeds are good sources of carbohydrates, protein and energy. Jackfruit seeds have been trialed for nutrient enhancement and functional properties such as water and oil absorption capacity (Odoemelam, 2005),so as to establish their value as an additive for convenience foods products. Latex from the skin of the fruit (and leaves) is used for topical treatment in a number of cultures. The wood of the tree also yields ‘morin’, a yellow food dye. (Amrik, 2012).

2.1.3 Value Addition of Jackfruit Flour

As jackfruits are soft and delicate, they are more prone to damage and spoilage during handling and storage. Due to their high perishability, postharvest management required is also high. Every year a large amount of jackfruit is produced, out of which a significant portion goes waste, due to its perishable nature and seasonal glut.

Value addition through processing and preservatives has to be considered as an important alternative for the reducing the post harvest losses of this nutritious fruit and for serving it in off season. (Haq, 2006).

It has become all the more necessary to open new avenues, for better utilization of raw jack fruit, as the traditional uses have already become stabilized. Therefore, there lies great opportunity for non-traditional uses of jackfruit in the form of baked products.

Results from the study by Mukprasirt and Sajjaanantakul (2004) suggest that, the native starch from jackfruit seed could be used as an alternative for modified starches in a system needing starch with high thermal or mechanical shear stability. Ocloo *et al*. (2010) concluded from their study that, jack fruit seed flour has a lot of potential in the food industry, especially as a thickener and binding agent Ukkuru and and Shruthy (2011) standardized shelf stable and consumer acceptable jackfruit seed flour based health mixes and confectionery products.

Abraham and Jayamuthunagai (2014) reported that**,** the addition of jack fruit seed flour (JSF) in different proportions (5%, 10%, 15% and 20%) to pasta increased the nutrient content and textural properties, 10 per cent JSF substituted pasta got the maximum consumer acceptability.

A study by Sultana *et al.* (2014) concluded that, chapatti containing 80 per cent atta, 5 per cent white jackfruit seed flour, 10 per cent brown seed flour and 5 per cent bengal gram flour was the best among the three types of samples because of its higher calorific value and sensory acceptability. Furthermore seeds can also be used to prepare bread or dry foods in supplementation with other flours like wheat (Goswami*et al.,* 2010).

Priyadarshini *et al.* (2013), utilized jackfruit seed flour along with de-fatted soy flour which is a protein rich material, in the formulation of four sets of extruded breakfast cereals.

2.2 NEED TO UTILIZE JACKFRUITS IN KERALA

Kerala is blessed with a natural wealth of jack trees. They are found abundantly in several parts of Kerala. It forms a part of the backyard garden and is an inevitable component of the traditional gardens inherited from generation to generations but not seen as a main crop. The trees are also naturally found as a component in natural vegetation.

Different varieties such as 'Nattuchembarthi', 'Malyasian honey','Sindhooram Varrika', 'Pancham Varrika', 'Koozha', seedless and Chempikalom varrika jack trees are available in Kerala. The fruit size varies from mere 3 kg to 20 kg. There are light green, yellow and even black fruited trees. The bulb size varies from 4 cm to 10 cm in length, light cream to deep orange colour; insipid to very sweet with varying ranges of acidity in the flakes.

Sontakke (2006) reported that, in Kerala, Jackfruit cultivation area is present in 72,000 acres with a production of 8, 9800 ton per year.

Jack fruit, especially in the raw form is not easy to handle, owing to the difficulty experienced in separating the edible bulbs from the rind. The difficulty has its origin in the morphological and biological hindrances associated with the fruit. Therefore, it is urged that, this indigenous or underutilized fruit which is not marketable in the fresh form be processed to acceptable products (Jagdeesh *et al.,* 2007

The huge post harvest loss of the fruits paves way for loss of nutrients in the fruit that would otherwise nourish the consumers. Thus, jack fruit is a commercially unexploited fruit because there exist no awareness among the farmers about its potential. Jack fruit trees naturally exist in farm lands and in secondary forest regions. They produce fruits only with the blessings of nature and there is no human intervention.

2.3 IMPORTANCE OF BAKED PRODUCTS

People of all ages prefer bakery products, because of their taste, color and ease in indigestion. They eat and serve different bakery products in parties and

festivals. Celebrating any moment of happiness is incomplete without bakery products.

Bakery products are becoming prominent day by day. They are very popular because of their taste and easy digestabilities. Bakery items are usually loved by all. Nowadays individuals have virtually no time to invest in making breakfast; it is the breads, buns or biscuits which have replaced the conventional breakfast dishes. Honoring any occasion of pleasure is incomplete without bakery items. They take a good share of snacks and are therefore are abundantly available. (Stevenrio, 2012).

Bakery products have the advantage of being ready to serve and ready to eat. Their durability, taste, and eye-catching appeal make the products popular.

Bakery products, once considered as a sickman's diet have now become essential food items of the vast majority of people in India. Breads, buns and biscuits have become popular among all sections of the population, irrespective of age groups and economic conditions. The cause for rise in popularity of baked products is mainly due to urbanization. This has called for an increased demand for convenience products, at reasonable costs, with greater nutritional qualities and variety with different textural and taste profiles (Saurabh, 2013).

Baking industry offers a large variety of products. However its stability faces great challenges due to the heavy competition among the producers.

2.3.1 Classification of Baked Products

Bakery products are the easy, readymade food items which are easily available on demand. These are available since decades, but now the liking for these items is increasing rapidly. In the present era, there are large varieties of bakery products available in the market. The popular bakery products are classified as discussed below.

Bread

Bread is a very old bakery product. The history of bread starts with the Neolithic age and marches through time, according to the availability of ingredients, advances in technology, economic conditions, socio cultural influences, procedures and food standard tastes. The earliest breads were unleavened. Variations in grain, thickness, shape and texture varied from culture to culture.

In modern days bread is becoming one of the most essential food items in the human diet due to its ready availability and high nutritive value. It is the most consumable wheat based bakery product. It is the most popular breakfast item in almost every family. It is also easy to manufacture and also cheap compared to other bakery products. Mainly wheat flour is used in its preparation.

Since the consumption of Bread is increasing rapidly day by day, the demand is also increasing enormously. The production of bread is estimated at 11.5 lakh tones per annum. In this sector 25-30% of the production is from the organized sector units. There is a lot of scope for introducing anti-diabetic bread or breads of high/low calories and so on. (Rosell *et al*., 2011)

Biscuits

Biscuits are important products in the bakery industry. It has now become a common item of consumption among all classes of the community. It makes a tasty nutritious snack with tea or coffee. This highly nutritious and easy to digest products, that can be preserved for a long time. It is within the reach of even lower economic class of people. It is available in small shops at all places. It is also the most common snack used by all the people. Biscuit is made mostly of simple wheat flour, sugar etc. By varying the ingredients and flavors it is possible to produce a variety of biscuits.

It is liked by people of all age-groups. It is available at a variety of forms being cheap as well as costly. Its demand is continuously seen to be growing. These are easily digestible items of food and the plant and machinery used in making biscuits is not heavy and expensive. Biscuits are found in both sweet and salty tastes.

Biscuits also have a very old history, but these are not however as old as bread. Biscuits are found in all shapes such as squares, circles, rectangles etc. Due to their increasing demand, there is a bright scope for marketing amongst new entrepreneurs as well as for existing manufacturers. (Oyewole *et al.,*1996)

Cakes

Cake is a new bakery product compared to the other bakery products. It was earlier famous in the Western countries but now it is becoming popular in other parts of the world too. In olden times it was considered the food of rich homesteads and was mostly popular among Christians. But with modernization, it is gaining popularity among all the communities. It is a perishable product made for wheat flour, cream, gel, sugar and milk. It is of two types viz., egg cakes and fruit cakes.

Egg is mostly used in this to make it fluffy. Egg cakes are more perishable than fruit cakes. Cakes are used in parties and on all happy occasions. Mostly the young generations have developed the taste for this item. But the use of cakes is mostly confined to urban areas. These are not very popular in rural areas due to its low accessibility, as it is not available everywhere, except in big bakeries. Plant and machinery used in preparing cakes is expensive and needs good investment. Its scope is increasing in India also. (Karaoglu *et al.,* 2009)

Pizza

Pizza is a round shaped bakery product. It is salty in taste. It is the most common fast food popular these days among people especially the youth and the children. It is made in many flavors such as cheese pizza, onion pizza, capsicum pizza, mushroom pizza etc.

It needs various raw materials for its preparation. It is prepared as a base, pasting cream on it and adding vegetables, cheese, mushroom, spices, sauce etc. It has a bland taste and has high calorific value. It is also baked in ovens at a high temperature. Pizza is a highly perishable product and is preserved very carefully. It is a new bakery product in India which was earlier popular only in foreign countries. Due to the advent of western culture, pizza is also becoming the preference of youth and the children. It is comparatively tough to manufacture.

Unlike the other bakery products, pizza is an expensive bakery product. Middle class people cannot easily afford them regularly. Pizza is a new product in our country. Its demand is tremendously increasing in India. It is totally confined to consumers of urban areas and many rural consumers are unaware about this fast food. But due to the growing demand, its future prospects are bright. (Dorina *et al.,* 2014)

Rusk

Rusk is a very old product in our country. It is a bakery product which is made of wheat flour and suji. It is slight sweet in taste and is consumed as a snack with tea and milk. Its preparation process is very simple. It can be preserved for a long period of time i.e. up to 2 to 3 months. They have very low storage cost. This is a very cheap bakery product and even common man can afford it easily. These are popular in urban as well as rural areas.(Ahmad *et al* .,2012)

Namkeen

As its name suggests 'namkeens' are salty in taste and are found in different flavors. Some namkeens are also salty as well as sweet or sour in taste. These are comparatively very old bakery products and are consumed on a large scale all over the country. It is not very much perishable and can be preserved for 2 to 3 months. It is simple to prepare and is a mixture of many different items.

The more items added to the dough mixture, the more its taste increases. Its taste depends upon the quality and the freshness of the materials used in it. That is why the branded namkeens have superior taste than the non-branded namkeens because the raw materials used by the big brands are of very good quality and these companies to maintain the quality norms. (Rampersad *et al*., 2003)

Sandwich

Sandwich is a new bakery product in our country. Earlier it was famous only in foreign countries. It is a very simple food item with high calorific value. Only few spices are used in preparing sandwiches. It is a good accessible item in urban areas and can satisfy hunger to a large extent. It is salty in taste.

It is a readymade product which can be prepared in very less time and not much appliances are needed to manufacture it. Sandwich is a perishable product and becomes very quickly stale due to the presence of cream in it. It is mostly triangle in shape. Bread, cream, butter and vegetables are needed to manufacture it. It is packed in thin plastic, transparent sheets and is consumed in all types of weather. It needs a moisture free place for its storage.

Sandwich is gaining popularity among children, youth, adults and even the old-age people as it is not very spicy. It is a moderately priced product and can be consumed by middle class families too. Being a highly perishable food item it is not available in rural areas and so is very uncommon in the villages. But it has a bright future and its manufacturers can hope to earn good profit from the increasing sale of this product in any region.

Bakery Industry is an important part of the society's economic and social structure .As the population grows, its food habits keep changing largely consumers are focusing towards low calorie and fiber rich diets. Bakery industry is also gaining growing in the country.

This Industry is thus having many products in itself such as- Biscuits, cakes, breads, pastries, pizza, sandwiches etc. These are items, which are liked by the young generations to point out. But there are many problems and challenges before this Industry in our country. Firstly, it is found that the procedures which are being used for the processing of such items are very much traditional because of which, the promotions remain high and the quality inferior. Secondly, this industry is not organized in nature because of which, the tastes differ from bakery to bakery.

It is also found that the marketing practices adopted are defective which results in the increase of marketing costs to a large extent. If we go into depth of this, we find that the profits of the manufacturers seem to be very low, so by adulteration with inferior quality goods they earn heavy profits. (Albus *et al.,* 2000).

2.4 NEED FOR IMPROVING QUALITY OF FLOUR USED IN BAKING

In this fast age of busy work schedules; people are consuming more processed food items to suit their tight time schedules. As a generation endowed with advanced technology and greater conveniences, people are eating more processed and fast foods than ever. These unhealthy eating habits have resulted in the increase of non communicable diseases (NCDs) like diabetes, obesity and some types of cancer. (Sharma *et al.,* 2012).

The number of diabetic and hypertensive patients in India is expected to increase to 69.9 and 213 million respectively by 2020. Cardio vascular diseases (CVD) will be the largest cause of disability and deaths in India. Kerala is emerging as the "capital" of life style diseases in India with high prevalence of hypertension, diabetes, obesity and risk factors for heart diseases reaching levels comparable to those in western countries. (Reddy *et al*., 2006).

People are becoming aware of this serious issue of life style diseases since the last few decades. Thus functional foods have become an essential component of human diet to prevent and cure such life style disorders (Jisha *et al.,* 2008).

Recently, consumer awareness of the need to eat high quality and healthy foods – known as functional foods has increased. Functional foods are foods which contain ingredients that provide additional health benefits beyond the basic nutritional requirements.

Health consciousness of consumers has increased over the years. Functional foods have attracted all sections of the population, which have been proved to prevent and control degenerative diseases.

There is a trend to produce specialty breads from whole grain flour and other functional ingredients which are known as health breads or functional foods 'Iron calla' the bread made from refined flour does not possess any of these qualities and in fact is found to be harmful in the long run. (Ndife *et al.*, 2011).

Supplementing staple foods with legumes rich in lysine have been suggested to improve the nutritional status of children in developing countries. (FAO/WHO, 2003).

2.4.1Processing of Maida

Maida or refined flour is the processed endosperm of wheat. It is further refined and bleached with aloxanes and benzyl peroxides for finer quality.

In earlier days maida was mixed with hot water to use as gum to stick wall posters. May be, this is the reason to name Maida as the all purpose flour (Rahiman, 2012).

Aloxanes predispose humans to diabetes, as this chemical is found to affect the normal functioning of beta cells of pancreas. Besides refined flour has a high GI, it releases sugar into the bloodstream quickly. To counter this, the pancreas responds with a sharp insulin spike, with prolonged consumption of processed and refined foods (over a period of time), inflammation is caused leading to insulin resistance and eventually type II diabetes. (Ankur and Shahjad, 2012).

2.4.2 Impact of Refined Flour on Health

. Besides this, aloxane causes adverse effects to our body and leads to diseased conditions like acidity, digestive problems, weight gain, and cardio vascular diseases (CVD). (Federiuk *et al.,* 2004) explains the effect of maida as follows.

Constipation

Since maida is refined flour, there are no fibers in it. This causes problems in digestion, causing constipation and also weight gain.

Acidification of blood

Maida is acidic in nature and therefore has low mineral content. This makes the blood acidic and can cause related health complications.

Obesity

High glycemic index (GI) implies excess of glucose in blood after food consumption. The body will store the excess glucose as fats. Therefore regular consumption of food with high GI leads to obesity and high triglyceride count in blood.

Heart Diseases

High triglyceride counts in blood, after continuous consumption of maida leads to heart diseases, like hypertension, high blood pressure, atherosclerosis, myocardial infarction and rheumatic diseases.

Other harmful effects

Maida is not only low in nutrients, but also deficient in moisture and fiber content. This affects the peristalsis of the gastro intestinal tract leading to grave situations. (Mark, 2008)**.**

2.4.3 Maida an Inevitable Ingredient of Bakery Products.

Bakery industry survives on maida as the base material for most of its priced products. Therefore it is difficult to avoid it all together.

Maida flour was banned in many European countries. But due to political lobbying and manufacturer's pressure the ban was withdrawn. Refined flour is still the globally available raw material for baking industry.

Therefore supplementation of refined flour with inexpensive staples, such as cereals and pulses is proved to help improve the nutritional quality of refined products (Paucean and Man 2013).

Changing trends

In developing countries, bakery and convenience foods are being prepared with fortified or composite flour to increase their nutritive value.

2.5 SCOPE OF COMPOSITE FLOUR

Composite flour can be incorporated in bakery and confectionary products, extruded products, chapathies, breakfast items, health mixes and many more popular food items.

Composite flour is a blend of various ingredients which is mostly intended to replace wheat flour totally or partially in food products.The extent to which wheat flour could be replaced by other vegetable flours naturally depended on the nature of the products to be baked.

Incorporating locally available flours into food products would help to reduce the import of wheat in developing countries. Hence these governments are giving more focus on this aspect Food and Agricultural Organization (FAO) initiated this ‘composite technology ‘in 1964, by promoting indigenous crops like cassava, yam, maize, and many others for substituting wheat flour. The sensory qualities of the composite flour based bakery products were found to be on par with the conventional products. Moreover, this concept has brought in immense variety in baked products.

Mostly the processed foods are prepared from refined wheat flour which is not healthy reported from scientific studies. More cereals and less protective foods in the diet, negatively affects nutritional status. Cereal based foods are deficient in micro nutrients. Nutrient rich materials have to be blended with nutrient deficient materials. Also this improves the functional quality of the products.

Cereal based foods are deficient in micro nutrients. The deficiency of lysine and threonine in wheat flour can be made of by the composite flours. For

example; the protein quality of both the cassava-soya and the cassava-groundnut breads is higher than that of common wheat bread (Ojure and Quadri, 2012).

Nutrient rich materials have to be blended with nutrient deficient materials. This also improves the functional quality of the product.

The ingredients that can be used for preparation of composite flour are ,cassava, sweet potato, taro, maize, rice, sorghum, ,yam, ragi, oats, barley, buck wheat, pulses ,chick-pea, cowpea, mung bean, vegetables like pumpkin, bread fruit and fruits like papaya and jackfruits, as seen reported in literature.

2.5.1 Baked Products from Different Composite Flour

Breads

Consumption of bread has invariably increased in developing countries over the years. This is mainly attributed to urbanization, increase in population and higher incomes. Besides it is a convenient food. Hence in the role of composite flour is felt essential to improve the nutritional status of the population. Including corn, barley, cassava and chick pea in breads have been evaluated for quality and acceptability.(Seibel, 2011)

Maize-sweet potato bread

Maize sweet potato bread was standardized with 20 per cent orange fleshed sweet potato, 20 percent yellow maize and 60 percent refined wheat flour. This combination yielded it higher carbohydrate, fiber, fat, ash, beta carotene and vitamin B complex. (Julius, 2014)

Barley-soy bread

Nutritionally improved bread were obtained with the incorporation of 15 per cent barley and defatted soya flour into wheat flour. They were organoleptically also acceptable. Beta glucan content along with fiber and amino acid profile got improved through this blending. Soya flour accounted for

improvement in protein quality. (Basmanand Koksel, 2003). Specific volume, body and shelf life of bread also improved with this addition.

However incorporation of 15 per cent and above of soya flour caused a beany flavor which was not acceptable. Thermal treatment and L. ascorbic acid treatment could be an answer to this problem. (Dhingra and Jood, 2002)

Malted rice bread

Incorporation of malted rice flour up to 35 per cent to wheat flour improved the consumer acceptability of bread along with its nutritive value. This flour improved the gas production in the dough along with better colour of crust, moisture retention and enhanced flavor. Addition of hydroxyl propyl methyl cellulose (HPMC) at 4 per cent improved the specific volume. This could also be served as a gluten free bread. (Vellupillai*et al*., 2010).

Pumpkin bread

Twenty per cent incorporation of pumpkin flour into refined flour improved the loaf volume and water absorption capacity. (Mansour *et al.* 1999).

Mixed flour bread

The viability of using by products like mango seed kernel into leavened bread has been established. The bread comprised of 85:5:5:5 ratio of refined wheat flour, sprouted moong bean flour, sugar and mango kernel flour, which was comparable in qualities to refined wheat flour bread. (Menon *et al*., 2014).

Biscuits/Cookies

They are the most popular ready to eat snacks characterized by relatively long shelf life, convenience and good eating quality. Composite flour can be successfully incorporated to this product to improve its nutritional qualities. (Pratima and Yadava, 2000).

Sorghum-soya biscuit

A biscuit with 12-14 per cent protein was developed with sorghum and soya flour in the ratio 80:20. The product was less costly and had high biological value. (Krishnan *et al*., 2011).

Buck wheat Biscuit

A therapeutic biscuit was developed with the addition of 20-30 per cent buck wheat flour which was found to obtain high acceptability scores. Rutin, catechins and polyphenols account for the health benefits like reduction in blood pressure, cholesterol, blood sugar and even cancer (Baljeet *et al*.,2014).

Sweet potato cookies

Fiber rich cookies were developed with sweet potato flour incorporated into refined flour at 10%. The product resulted in better texture and flavour (Saeed *et al*., 2012).

Ragi biscuit

'Gluco type' biscuits were developed with the incorporation of 60 per cent ragi flour. Spread ratio of this product was not affected with this addition (Saha *et al.,* 2011).

Fenugreek biscuit

Up to 10 per cent incorporation of fenugreek did not cause any change in the sensory qualities of the refined flour based biscuits. However spread ratio was seen to decrease with increase in fenugreek flour. (Hooda and Jood, 2005).

2.5.2 Other Food Products with Composite Flour. .

Pasta

Pasta is a staple food product that is produced mainly by mixing durum wheat and semolina. In recent years, pasta has become recognized as a healthy food, with allow fat content, no cholesterol and a low glycaemic index. In pasta processing, gluten is considered to be the most significant factor related to cooking quality (Dexter and Matsuo 1978). Gluten consists of gliadin and glutenin and is responsible for elasticity and chew ability of pasta, which is highly appreciated by consumers (Cleary and Brennan, 2006).

Cassava- peanut pasta

Pasta made from 60 per cent cassava flour,15 per cent peanut flour and 25 per cent wheat flour gave higher protein content, complex carbohydrate and improved colour (Wood,2009).

Maize-soya pasta

Pasta was made from 30 per cent maize flour, 40 per cent soy flour and 30 per cent wheat flour. It was rich in protein, beta carotene and had better colour, higher water absorption and cooked weight (Dexter and Matsuo 1978).

Rice -semolina pasta

Dough with 50 per cent pre gelatinized rice and 50 percent semolina produced excellent gluten free pasta. Gelatinization improved the binding capacity of the flour. Guar gum and protein mixture was also effective in stabilizing the flour along with gelatinized rice. (Marti *et al.,* 2010).

Soya pasta

Protein content was raised by 5 times when defatted soya flour or soya protein was incorporated to alkaline sweet potato flour at the rate of 15 per cent. The functional qualities like cohesiveness and springiness also improved with this addition.(Cleary and Brennan,2006).

Chapathi

Chapathies are Indian breads that are prepared in almost all Indian houses on a regular basis, which is made with whole grain especially wheat. Chapatti is a healthy and staple Indian dish. If made with whole grain composite flour, it is really healthy for the body as it gets enriched with soluble fiber and proteins and other nutrients.

Astudy was conducted by (Ankita and Maya, 2014) to evaluate quality of composite flour in chapathies fed to diabetic patients. The chapathies were comprised of different types of composite flours .The various ingredients included bajra, barley, Bengal gram, maize and foxtail in different combinations. Among the different combinations, the combination of bajra and bengal gram in the ratio 40:60 was found to have lower glycemic index.

Ragi - bengal gram chapathi

This chapathi comprised of 20 percent ragi flour, 10 percent bengal gram flour and 70 percent wheat flour. It had high sensory quality and was higher in calcium, fiber and protein content.

Health mixes

Another important group of products in modern market that is suitable for all age groups are the health mixes. It is also used in the convalescing stage, to recoup to normal health. The health mix combination comprising of wheat, rice, semolina, groundnut, Bengal gram, green gram, soya, maize, cardamom was found to be most acceptable than other combinations.(Eggum and Beame2003).

Breakfast items

Besides, it is also possible to add composite flour in our day to day food products like ‘iddli’, ‘dosa’, ‘upma’, ‘puttu’, ‘idiyappam’ as seen in the supermarkets today. It improves the quality of these food products.

Conclusion

The research interest in composite flour has been on the rise in the recent past, with the aim of finding non-wheat alternatives and, thus reducing the non-wheat producing country’s dependence on imported wheat (Bugusu *et al*., 2001).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present study entitled, "Value added baked products from raw jackfruit flour" was aimed at developing value added baked products from the bulbs of raw jackfruit(c v *koozha*). The developed products viz. fruit bread, bun, rusk and pizza base were studied in depth for their physico-chemical properties, functional qualities and nutritional profile. The organoleptic and shelf life qualities were also ascertained. The methodology of the present study is presented under the following heads.

3.1 Selection and collection of jackfruit

3.2 Processing of flour

3.3 Functional quality analysis of flours

3.4 Preparation of Composite flour

3.5 Processing of candy

3.6 Standardization of baked products

3.7 Quality analysis of baked products

3.8 Selection of the best combinations

3.9 Storage stability of baked products

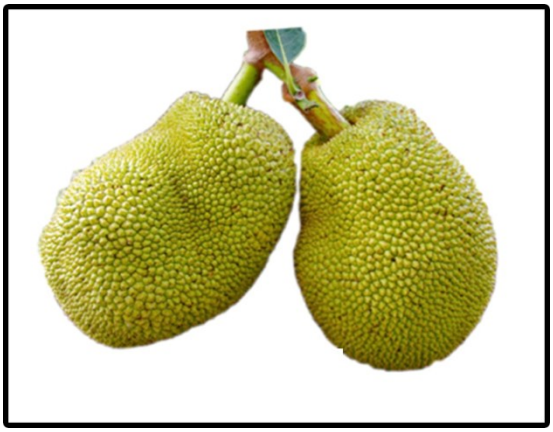
3.10 Cost of the products

3.1 SELECTION AND COLLECTION OF JACKFRUIT

Jack fruit is the most under exploited fruit in the state owing to its typical inaccessibility, fruiting nature and fruit characteristics. Moreover it is difficult to handle due to its large size and exuding latex.

Jackfruit type *koozha* was selected for the study.The matured jackfruits were procured from the Instructional Farm, College of Agriculture,Vellayani.

Plate: 1- Jackfruit –the raw material



Whole Jackfruit

Whole bulbs

sliced bulbs

Raw mature jackfruits 90-105 days after fruit set with optimum visible maturity indices were selected. Maturity indices selected were distance between spines per unit area, hollow sound on tapping and green colour of spines. The other ingredients namely refined flour, vegetable oil, sugar, yeast and iodised salt were purchased from the Super market

3.2 PROCESSING OF FLOUR

Jack bulb flour was processed according to the method standardized by Veena (2015). (Fig-1)

3.3 FUNCTIONAL QUALITY ANALYSIS OF FLOUR

Functional qualities such as water absorption index, oil absorption index, foaming capacity, swelling power and solubility of the jackfruit bulb flour were ascertained.

3.3.1 Water Absorption Index (WAI)

Known volume of sample (1g) and water (10ml) were mixed in a centrifuged tube. The suspension was allowed to stand at room temperature. It was centrifuged for 30 minutes. The volume of drained water and sediment was measured. Beuchat (1977).Water absorption index was calculated by the formula

Water absorption Index =

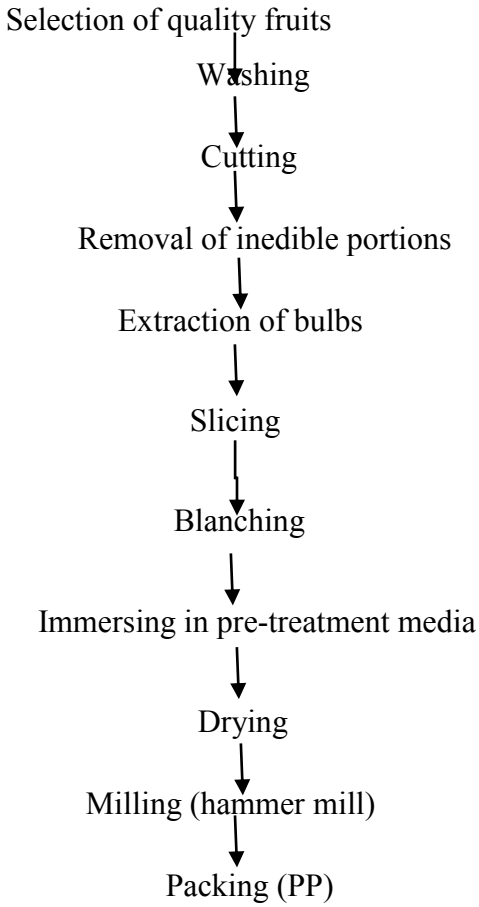
$$\frac{\text{Weight of water absorbed (g) x 100}}{\text{Weight of dry flour (g)}}$$

3.3.2 Oil Absorption Index (OAI)

Here in the same procedure was adopted but water was replaced by oil. The oil absorption index was calculated similarly. Beuchat (1977).

Fig-1

Flow diagram for preparation of raw jackfruit flour (RJF)flour



3.3.3 Foaming capacity (FC)

The volume of foam formed due to whipping of a known quantity of flour (1gm) with a known quantity of distilled water (50 ml) at room temperature was noted. (Narayana and Narasinga ,1982). The formula used was

$$\text{Foaming capacity} = \frac{\text{Volume of AW - Volume of foam BW}}{\text{Volume of BW}} \times 100$$

Where, AW = Foam volume after whipping,

BW= Foam volume before whipping.

Plate: 2- Jack fruit bulb flour

Flour

Flour packed in PP cover

3.3.4 Swelling Power (SP)

The known volume of flour (1gm) and distilled water (10 ml) was heated at 80^0 C. The resulting product was centrifuged and weight of paste was noted after the supernatant was decanted. (Leach *et al.,* 1959)

Formula used for calculation was

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

3.3.5 Solubility

Similar procedure was adopted for determination of solubility but here the supernatant was evaporated and the weight of dried sample was noted (Oladele and Aina, 2011). The formula used for calculation was

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

3.4 PREPARATION OF COMPOSITE FLOUR

Composite flour was prepared by substituting refined flour with jackfruit bulb flour up to a maximum of 60 percent in different proportions. The treatments selected for the study are presented in Table 1

Table-1 Treatments selected for the formulation of baked products

Treatment	**Proportion**
T_1	60% jackfruit flour+ 40%refined flour
T_2	55% jackfruit flour+45%refined flour
T_3	50% jackfruit flour+ 50%refined flour
T_4	40% jackfruit flour+ 60%refined flour
T_5	30% jackfruit flour+ 70%refined flour
T_6	20%jackfruit flour+ 80%refined flour
T_7(control)	100%refined flour

3.5 PROCESSING OF JACKFRUIT CANDY

Selected semi ripe jackfruit bulbs were cut into slices (1x1cm). They were subjected to osmotic treatments in two spells (60^0 and 70^0 brix). The drained fruit cubes were dehydrated at 65^0Ctill crisp. They were cooled and packed. (Poornima, 2014)

3.6 STANDARDIZATION OF BAKED PRODUCTS

Four products were standardized for the study, i.e. fruit bread, rusk, bun and pizza base. These were processed with the composite flour prepared by substituting refined flour(RF) with raw jack fruit flour(RJF) in the following proportions of (RF:JF) 40:60 , 45:55 ,50:50 ,60:40,70:30, 80:20(Table-1).Standardized recipes were used to process the products. All the four products were processed at the Asian bread Factory, Kaniyapuram.

Plate: 3- Jack fruit candy processing

Candy during Osmotic dehydration **Candy after drying**

Candy packed in PP covers

3.6.1 Ingredients Used for the Preparation of Baked Products

Wheat flour is generally the base for all baked products; water is used for blending, salt is added to bring out the taste and improve flavour, it also improves the texture. Yeast is added to make the dough rise and also impart softening to baked products. Sugar is incorporated to improve yeast activity. It also imparts colour to bread by delaying gelatinisation of starch.

The ingredients used for the preparation of fruit bread , rusk, bun and pizza base were composite flour, vegetable oil, sugar, dried yeast and salt. Composite flour acted as a base material. The quantity and proportion of ingredients are given in the table that follows. All the ingredients in the right proportions were taken for mixing and kneading.(Table 2).

Table – 2Ingredients for Fruit bread

Ingredients	**Treatments(100g)**						
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7 (control)**
Refined wheat flour(g)	40	45	50	60	70	80	100
Jack fruit bulb flour(g)	60	55	50	40	30	20	0
Salt(g)	1	1	1	1	1	1	1
Dry east(g)	1	1	1	1	1	1	1
Fat(g)	2	2	2	2	2	2	2
Sugar(g)	20	20	20	20	20	20	20
Water(ml)	65	65	65	65	6 5	65	65
Jackfruit candy(g)	5	5	5	5	5	5	5

Table - 3 Ingredients for Bun

Ingredients	Treatments(100g)						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7 (control)
Refined wheat flour(g)	40	45	50	60	70	80	100
Jack fruit bulb flour(g)	60	55	50	40	30	20	0
Salt(g)	1	1	1	1	1	1	1
Yeast(g)	1	1	1	1	1	1	1
Fat(g)	2	2	2	2	2	2	2
Sugar(g)	20	20	20	20	20	20	20
Water(ml)	45	45	45	45	45	45	45
Jackfruit candy(g)	5	5	5	5	5	5	5

Table - 4 Ingredients for Rusk

Ingredients	Treatments(100g)						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7 (control)
Refined wheat flour(g)	40	45	50	60	70	80	100
Jack fruit bulb flour(g)	60	55	50	40	30	20	0
Salt(g)	1	1	1	1	1	1	1
Yeast(g)	1	1	1	1	1	1	1
Cardamom powder	2	2	2	2	2	2	2
Fat(g)	2	2	2	2	2	2	2
Sugar(g)	20	20	20	20	20	20	20
Jackfruit candy(g)	5	5	5	5	5	5	5

Table – 5 Ingredients for pizza base

Ingredients		**Treatments(100g)**					
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7 (control)**
Refined wheat flour(g)	40	45	50	60	70	80	100
Jack fruit bulb flour(g)	60	55	50	40	30	20	0
Salt(g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Yeast(g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Olive oil(ml)	2	2	2	2	2	2	2
Sugar(g)	5	5	5	5	5	5	5
Water(ml)	65	65	65	65	6 5	65	65

3.6.2 Method Adopted for Processing of Baked Products

Straight dough method, the most accepted method was followed here also. All the ingredients were mixed together at slow speed till the dough reached the complete mixing stage. The appropriate temperature range of the mixed dough is between 26^0C and 28°C (78.8 and 82.4°F), fermentation temperature is 27°C (80.6°F), relative humidity is 75%, and fermentation time is between 1 to $1^1/_2$ hours. (Joel, 2011)

3.7 QUALITY ANALYSIS OF BAKED PRODUCTS

Quality is a very important parameter for judging the edible nature of any food product. It is the ultimate criterion for the desirability of a food product. The qualities of the baked products were assessed with respect to physical and sensory parameters, chemical constituents, nutrient composition and shelf life stability.

Plate: 4- Developments of products

Asian cakes bakery

Mixing of dough

Fig-2

Flow chart for processing of Fruit bread

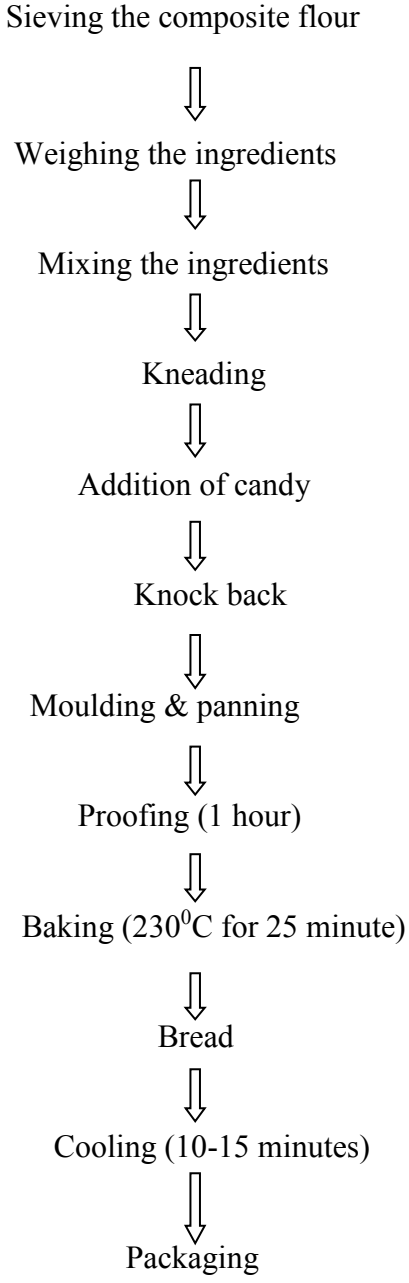
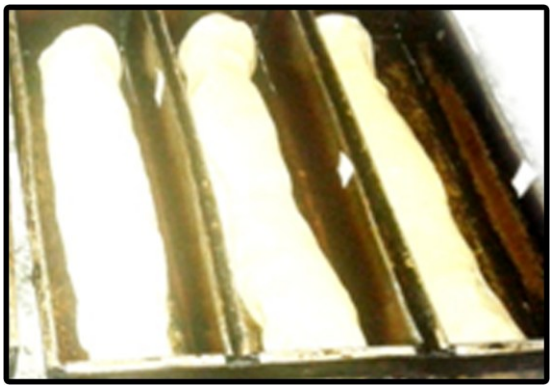


Plate: 5- Stages of baking Fruit bread



Panning of dough

Rotary diesel oven **Baked bread**

Fig-3

Flow chart for processing of bun

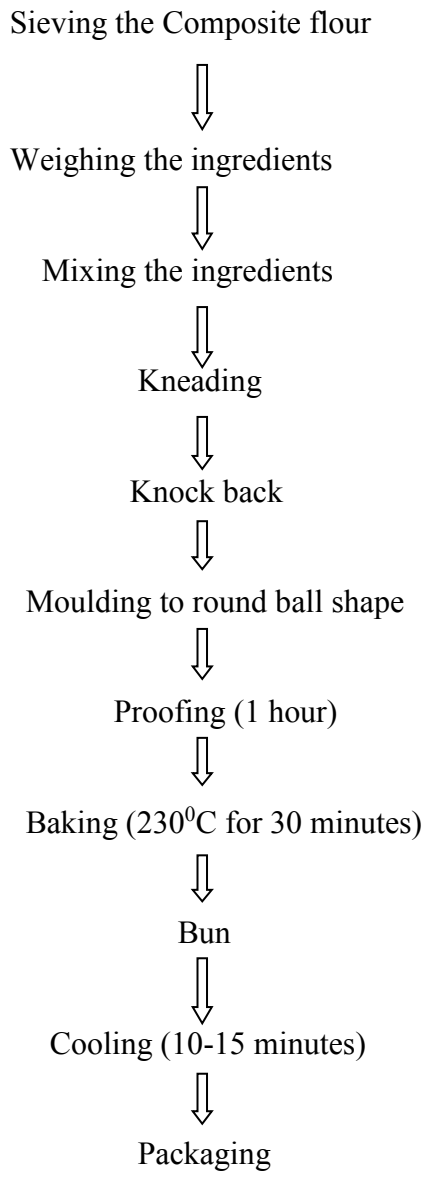


Plate: 6- Stages of baking Bun

Panning of dough

Baked buns

Fig-4

Flow chart for processing of Rusk

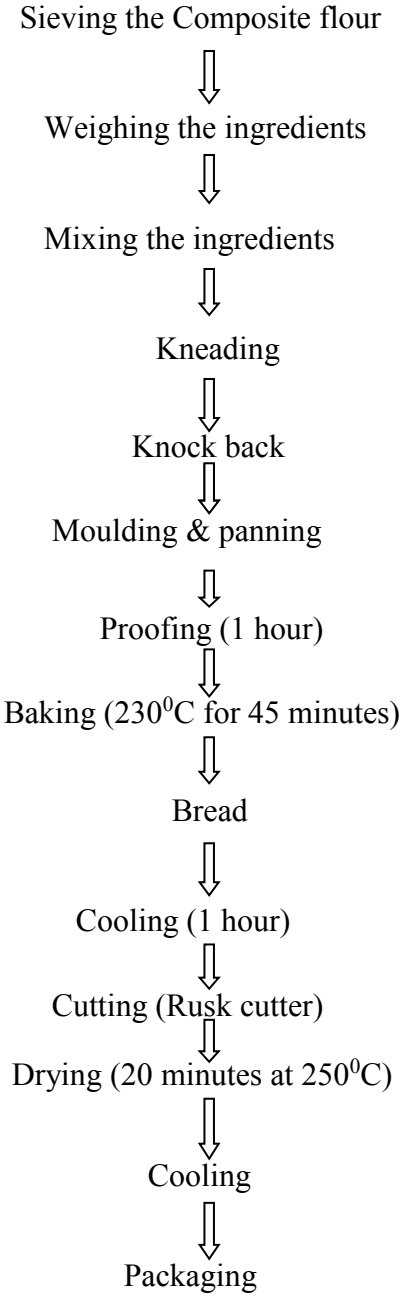


Plate: 7- Baked Rusk

T_1

T_2

T_3

T_4

T_5

T_6

T_7

Fig-5

Flow chart for processing Pizza base

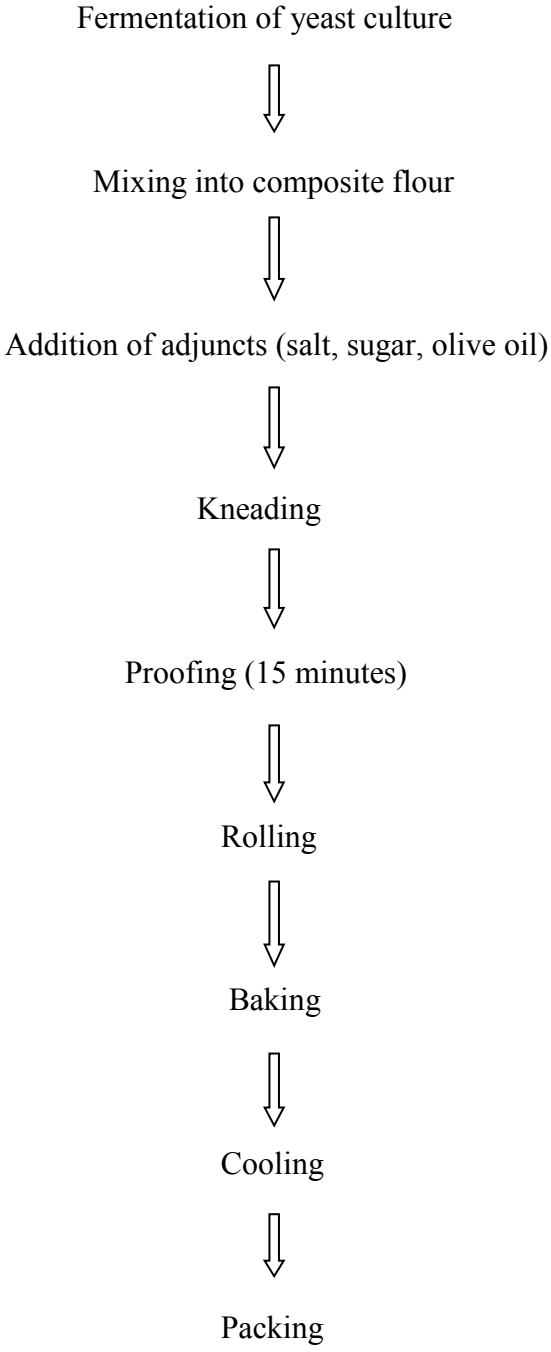


Plate: 8- Baked Pizza base

T_1

T_2

T_3

T_4

T_5

T_6

T7

3.7.1 Physical Properties of Baked Products

3.7.1.1*Physical properties of Fruit bread and bun*

Raw weight

After all the ingredients were mixed in the sequence prescribed in the recipe weight of the fruit bread and bun at dough stage was taken using an electronic weighing machine.

Baked weight

Baked weight of the fruit bread and bun were calculated by taking the weight of the product after baking.

Raw depth

Before baking a thin and fine wooden stick was pierced in the middle of the fruit bread and bun, till it touched the base, then the length of pierced portion was measured with a measuring scale.

Baked depth

A fine wooden stick was used again to pierce at the middle of the fruit bread and bun, till it reached the base, this pierced length of rod was measured by a measuring scale in cm.

Baking time

Uniform time was set for baking the four products as per the conventional practice.

3.7.1.2*Physical properties of rusk*

Yield percent

The yield ratio of the baked product was calculated using the formula

$$\text{Yield percent} = \frac{\text{Baked weight of the product}}{\text{Weight before baking}} \times 100$$

Volume

The volume of the rusk was calculated by "seed displacement method". A box of known dimensions and grains of known weight were used. The volume of container with and without the grain was noted. Then the product was placed into the filled in box and the overspill of grains gave the indication of the volume of the product.

The volume of loaf was calculated as

$$\text{Volume of loaf} = \frac{\text{L x Volume of the box}}{\text{C}}$$

Where L= Weight of spilled over seed and

C= Measurement of seeds used to fill the empty container

Raw weight

The ingredients were mixed properly and weight of the dough was recorded by using an electronic weighing machine.

Baked weight

Baked weight of the rusk was calculated by taking the weight of the product after baking.

Baking time

Uniform time for baking was taken for control and treatments

3.7.1.3 Physical Properties of Pizza base

The physical properties of the pizza base were scored based on the Limongi *et al*'s scale (2012), the parameters being wooden appearance, softness, taste, colour of edge, aroma, porosity and crispiness of edge.

3.7.2 Chemical and Nutrient Composition

The chemical and nutrient composition namely moisture, acidity, fat, protein, fibre, and energy were ascertained as per the following standard procedures. (Table-6)

Table-6

Analysis of chemical and nutritional constituents of baked products

Constituents	Method adopted
Moisture (%)	AOAC (2005)
Acidity (%)	
Fibre (g)	
Carbohydrate (g)	
Protein (g)	

Fat

The fat content was estimated using the soxhlet extraction method using petroleum ether as solvent. (AOAC, 2000).

Calorie

Calorific value was calculated by computing the energy factors with the amount of carbohydrate, protein and fat contained in the products.

3.7.3 Sensory Evaluation of Baked Products

Sensory evaluation was performed by semi trained panellists after considering their performance test in recognition of basic tastes and aroma. The panel comprised of members aged between 20-30 years.

Sensory quality is one of the most important criteria that determines the acceptability of any food product by the consumer- The organoleptic properties of the baked products includedappearance, colour, flavour, texture, taste and after taste which were assessed by a 10-memberpanel who were familiar with such products. A five point scale was used to rate each treatment. The differences in scores were analyzed using Kruskal Wallis test. The most acceptable product was identified using the hedonic rating scale

Preparation of score card

Score cards were prepared on a 5 point rating and 9 point hedonic rating. The5 point score card for sensory evaluation comprised of the sensory attributes-appearance, colour, flavour, taste, texture and after taste. These were rated as scores ranging from 1-5 as described by Sudha *et al*. (2007).

A 9 point score card was also prepared for evaluating the most acceptable product from the four products; 9 representing “like extremely” and 1 representing “dislike extremely”.(hedonic rating scale)

The score card for evaluating Pizza base comprised of seven parameters namely wooden brown appearance, colour of edge, porosity, aroma, taste, softness and crispness of edge, which were evaluated on a nine point scale. (Limongi *et a*l., 2012).

3.8. SELECTION OF THE BEST COMBINATION

The best treatment was selected by analyzing the scores of various sensory attributes. Among the sensory characteristics, appearance, colour flavour, taste, texture and after tastes of baked products were assessed.

3.9 STORAGE STABILITY OF BAKED PRODUCTS

Storage stability is of utmost important for a product to become successful commercially. A shelf stable product with respect to sensory quality and microbial attack is safe for consumption.

To observe the keeping quality, the baked products were stored separately in heat sealed PP pouches in ambient conditions. One unit of each baked product, identified as the best treatment was stored in PP pouches. One pouch from each product was picked randomly every day for 4 days, excepting rusk. Rusk was analyzed on a monthly basis. The values were analysed in triplicates. Moisture and microbial profile were analyzed periodically for 3 months.

3.9.1 Moisture

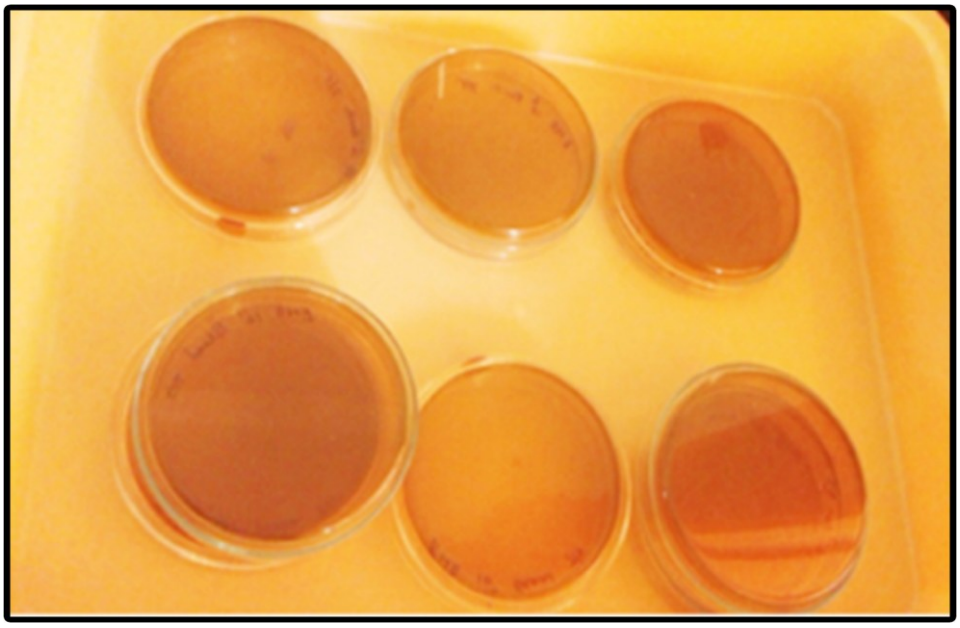
Moisture content of all the experimental samples was determined by thermo-statically controlled electric oven dry method. Empty crucibles were taken, washed, dried, cooled and weighed. Then a definite quantity of sample was taken in the crucible and weighed. The crucibles were placed in the oven and were dried at temperature of 250^0C. After drying the crucibles were removed from the oven and cooled in desiccators. It was then weighed. The crucibles were placed again in the oven, dried and taken out of the drier, cooled in desiccators and weighed. Drying, cooling and weighing were repeatedly done until a constant weight was obtained. For accuracy, at least four samples were dried in the oven and percentages of moisture content were then calculated. .

3.9.2 Microbial Profile

Baked foods which are stored and consumed after a period of storage require certain microbial criteria to be employed to ensure their quality and safety. According to Shankaran (2000), several factors such as quality of raw material, storage temperature, storage containers, processing methods and the environment in which it is processed will affect the microbiological quality of processed foods. Since baked foods provide ample scope for contamination by spoilage from pathogenic microorganisms, the microbial quality was assessed.

Plate: 9- Microbial profile

Pour plating for bacteria count



Pour plating for fungal count

The stored product samples were assessed for the presence of various microorganisms viz. bacteria, fungi, and coli forms up to three months.(On a daily basis for bread, bun and pizza base, and monthly intervals for rusk).The serial dilution of the samples followed by pour plating was employed to estimate the population of viable microorganisms in developed products.

3.10 COST OF THE PRODUCT

Cost of the developed baked products were calculated based on input cost i.e. cost of different ingredients used for the processing of the product, cost of packaging materials and output cost(10 percent of the cost of products were added as overhead charge for fuel and labour to the total input cost).

Analysis of Data

In order to obtain suitable interpretation, the generated data was subjected to statistical analysis like one way analyses of variance (ANOVA) at 0.05% significance level and Kruskal Wallis test. These tests mainly assessed the significant difference in the treatment means.

RESULT

4. RESULTS

The results of the present study entitled "Value added baked products from raw jackfruit" are detailed in this chapter under the following headings:

4.1Selection and collection of jackfruit

4.2 Processing of flour

4.3 Functional quality analysis of flours

4.4 Preparation of Composite flour

4.5 Processing of candy

4.6 Standardization of baked products

4.7Quality analysis of baked products

4.8 Selection of the best combination

4.9 Storage stability of selected products

4.10 Cost of the products

4.1SELECTION AND COLLECTION OF JACKFRUIT

Jackfruit is a dicotyledonous compound fruit of the jack tree (*Artocarpus heterophyllus* L.) and belongs to the family *Moraceae* which is commonly seen in many of the tropical countries.

Jackfruit is a common sight in the home steads of Kerala. Jackfruit has more protein, calcium, thiamine, riboflavin and carotene than fruits like banana. The main highlight of the fruit is its high fiber content. Beta carotene, flavonoid pigments (xanthin, lutein and cryptoxanthin-ß) and vitamin C are present in fair amounts. B complex vitamins like B_6, riboflavin, niacin and folic acid are also found in good proportions.

The fruit is rich in dietary fiber, which makes it a good bulk laxative. The fiber content helps to protect the mucous membrane of the colon by decreasing exposure time as well as binding to cancer-causing chemicals in the colon. Fresh fruits have small amounts of β-carotene and flavonoid pigments such as. Jackfruit is a good source of antioxidants of which vit-C itself constitutes 13.7mg or 23 per cent of RDA. It contains good amount of vit-B_6 (Pyridoxine) niacin, riboflavin and folic acid.

For the conduct of this study, fruits of *koozha* type were collected after 90-110 days of fruit set. They were more or less cylindrical in shape and had slight green colour with light green spines. On an average a single fruit had a weight of more than 10 kg. The fruits did not have any strong smell. Tree to tree variation was observed with respect to physical characteristics like size of bulb and seed, colour. The fruits were collected from the College of Agriculture, Vellayani.

Fresh firm and uniform seed jackfruits with optimum harvest maturity were harvested and washed under running potable water and transported to laboratory for further processing.

4.2PROCESSING OF FLOUR

Normally refined wheat flour is used as major ingredient in baking and confectionary industries. The demand of wheat flour is increasing day by day even though people are aware about its detrimental effects to health. Considering the high nutritive value and low price of Jackfruit flour, raw jackfruit can be tested as an alternative ingredient in bakery products, for bread preparation in particular (Hasidah and Noor Aziah, 2003).

Fruits were cleaned after harvesting under running water. It was then cleaned with distilled water. As the fruits are big in size, it was cut into big pieces, bulbs and the seeds were then separated out. Weight of the whole jackfruit, bulbs and seeds were noted separately

4.2.1 Preliminary Processing

To process jackfruit bulb flour, bulbs were subjected to several preliminary processing methods. Preliminary processing helps to preserve quality, appearance and acceptability of products by suppressing oxidative changes and microbial contamination during processing, storage and consumption.

Blanching is a pre-treatment done with hot water with steam on firm vegetables and fruits that helps to improve the quality of the products.

Here jackfruit bulbs were blanched for 2 minutes. In order to prevent browning of bulbs and also to preserve the colour of developed product, pre-treatment media comprising of 0.2%potassium meta-bisulphite (KMS) was used. (Veena, 2015)

Drying is basically used for decreasing moisture content and preventing enzymatic and microbial activity, thus consequently preserving the product for extended shelf life.Pre-treated bulbs were kept separately for drying at 60^0c. Drying helps to reduce the moisture content and also prepare materials for dry grinding. Jackfruit bulb (JFB) flour took 14 hrs for optimum drying to reach the breaking stage (Veena, 2015).

Dehydrated bulbs were milled separately into flour and sieved. The mesh size for sieving the flours was 0.05 mm. Residue, leftover after sieving was removed to get uniform fine powder. There was a loss of about 0.5 per cent in weight of product on processing of flour.

The processed jackfruit bulb flours were packed in PP covers. (Veena, 2015).

4.3 FUNCTIONAL QUALITY ANALYSIS OF FLOUR

The flour prepared from dehydrated bulbs were analyzed for various functional properties such as water absorption index, oil absorption index, foaming index, swelling power and solubility.

Functional properties are reflected from the complex interactions between the physical and chemical components of food along with their association with the environment. These characteristics are required to ascertain the activities of food components in specific conditions. Typical functional properties include emulsification, hydration (water binding), viscosity, foaming, solubility, gelation, cohesion and adhesion. (Siddiq *et al*., 2009).

In this study the functional properties of the flour were analyzed and these were compared with refined wheat flour.(Table-7)

Table -7Functional quality of Jackfruit bulb flour

Functional qualities (%)	**Bulb flour**	**Refined wheat flour**	**'t'values**
Water absorption index	2.95	1.50	6.835*
Oil absorption index	1.61	3.40	-253.142**
Foaming capacity	13.20	20.12	-48.317*
Swelling power	16.35	12.75	159.652**
Solubility	12.11	11.50	10.773**

(Values represent mean of four replications)

4.3.1. Water Absorption Index

The analysis revealed that jackfruit bulb flour had higher (2.95%) water absorption capacity than wheat flour (1.50%). Water absorption capacity represents the ability of the products to associate with water when processing into dough and paste. The result suggested that jackfruit bulb flour would be useful in foods such as bakery products which require hydration to improve handling features.

4.3.2. Oil Absorption Index

Oil absorption capacity is attributed mainly to the physical entrapment of oils. It is an indication of the rate at which the protein binds to fat in food formulations. The oil absorption capacity of jackfruit bulb flour in this study was lower than that of refined wheat flour (1.61% and 3.40% respectively). The lower oil absorption capacity of jackfruit flour could be due to the hydrophobic proteins. The relatively low oil absorption capacity of JFB flour suggests that it could absorb low fat in cooking procedure, which is a healthier attribute.

4.3.3 Foaming Capacity

Foaming capacity is the ability of a substance in a solution to produce foam after shaking vigorously. Proteins foam when whipped because they have higher surface activity. The foaming property is used as an index of the whipping feature of protein isolates. This explains why jackfruit flour had lower foaming capacity, since it is recorded with lower crude protein content. Here the foaming capacity of refined wheat flour was 20.12 per cent higher than the jackfruit bulb flour (13.20%).

4.3.4 Swelling Power

The swelling power of the flours were 16.35 per cent and 12.75 per cent for jackfruit bulb flour and refined wheat flour respectively. The gelatinization and swelling power provides suitable predictive methods for identifying baking quality of flour. Formation of protein amylase complexes in native starches and flours may be the cause of the higher swelling power. The extent of swelling depends on the temperature and availability of water. As per literature, increase in water absorption increases the swelling power. The high swelling power suggests that jackfruit bulb flour could be useful in food systems where swelling property is required.

4.3.5 Solubility

` Solubility value of jackfruit bulb flour was 12.11 per cent while for the refined flour it was 11.50 per cent. The high solubility of jackfruit bulb flour suggests that it is more digestible and assimilable than refined wheat flour and therefore it could be suitable for different food products qualitatively.

4.4 PREPARATION OF COMPOSITE FLOUR

Milligan *et al*. (1981) defined Composite flour is a mixture of flours, starches and other ingredients intended to replace wheat flour totally or partially in bakery products. Shittu *et al.* (2007) also agreed that the composite flours are either binary or tertiary mixtures of flours from some other crops with or without wheat flour.

The use of composite flours has a many advantages in developing countries by mainly saving on the currency; promotion of high-yielding native plant species, better supply of protein for human nutrition and better overall use of domestic agriculture production (Akubor and Badifu 2004).

Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown crops as flour (Hasmadi *et al*., 2014). Local raw material substitution for wheat flour is increasing due to the growing market for confectioneries (Noor Aziah and Komathi, 2009). Thus, several developing countries have encouraged the initiation of programmes to evaluate the feasibility of incorporating alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al*., 2011). For this study Jackfruit bulb flour was taken as the substitute in refined wheat flour.

Over the past decades, changing food habits has increased the demand in developing countries for wheat-based convenient foods such as bread and other baked products. These products are processed mainly with refined wheat flour as the main raw material because of the superior baking properties. Along with this, nutritional value is also extremely important, because refined flour is lacking in so

many nutrients. Different studies revealed that incorporation of different fruits, vegetables, pulses and tubers into the refined wheat flour increases the nutritional quality of baked products. In the present study as jackfruit bulb flour lacks gluten, it is unsuitable as the sole material for preparation of baked products. Hence there is need for addition of refined wheat flour in various proportions.

In this study, refined wheat flour (RF) and jackfruit bulb flour (JFB) were the basic materials used for the development of composite flour. The different combinations attempted for the Composite flour formulations of the baked products are presented in Table 1.

4.5 PROCESSING OF JACKFRUIT CANDY

Jack fruit based candy was processed to enhance the sensory quality of the product. Selected semi ripe jackfruit bulbs were cut into slices (1x1cm). They were subjected to osmotic dehydration in two spells (60^0 and 70^0 brix). The drained fruit cubes were dehydrated at 65^0C till crisp. They were cooled and packed. (Poornima, 2014).

Table- 8

Specification of jackfruit candy processing

Bulb dimension	End point	Temperature
1x1cm	60-70^0 Brix	65^0C

The candy processed was crispy in texture and sweet in the taste. The colour of the candy was yellow.

4.6 STANDARDIZATION OF BAKED PRODUCTS

India's bakery market is the third largest in Asia pacific after Japan and Australia. The per capita consumption of bakery products in India is roughly 1to 2 kg. Out of the 85000 bakery units in the country, 75000 units operate in the unorganized small scale sector, occupying 65 percent of the market share (Shraddha

et al., 2008). The major products in demand in market are breads, biscuits, cookies and pizzas.

Four acceptable baked products were processed. *viz.,* fruit bread, rusk,bun and pizza bases. The formulations were based on standardized recipes. The products were developed at the Asian Bread factory Kaniyapuram.

4.6.1 Standardization of Fruit bread

Bread is a product of high nutritional value and is consumed in most parts of the world. Bread can be considered to be the major bakery product as these account for 82 percent of all bakery productions. The organized sector in bread industry consists of around 1800 small scale bread manufacturers, 25 medium scale manufactures and two large scale industries. The unorganized sector accounts for 85 percent of the total bread production.

Bread may be described as a fermented confectionary product, produced mainly from wheat flour, water, yeast and salt made by a series of processes involving mixing, kneading, proofing, shaping and baking . Bread is an important staple food in both the developing and developed countries and is considered as one of the most important sources of nutrients like carbohydrate, protein, fibre, vitamins and minerals in the diets of many people all around the world. However, the product is endowed with very low fibre content as it is usually processed from refined wheat flour.

Now a days, since consumers are more concerned about their health, they focus on consuming products which boost up their immune system. Foods with high protein and fibre content are now mostly preferred by consumers to maintain their health and to keep away from many diseases like cardiovascular diseases, diabetes and weight gain. So there is a new trend in the market to develop products that have health benefits along with good sensory properties.

Recently studies revealed that unripe jackfruit helps to fight diabetes. In the present study for the processing of bread, composite flour was prepared using

refined flour and jackfruit flour in different proportion, (Table-1). Processed candy was also incorporated in the prescribed ratio.

4.6.1.1*Bread preparation by Straight-dough method*

.After proper kneading for 10-12 minutes, the dough was manually punched and left for 10-15 min in bench;(bench rest)for fermentation to take place.

In-between the fermentation the dough was knock backed to expel the excess gas and to redistribute the food for the yeast. Usually the knock-back is done when two third of the fermentation time is over. Then the dough was transferred to previously oiled molds so that dough does not stick to molds. This was placed in the proofer at a temperature range of 35-36^{0}Cfor 1 hour (since multi-grains need more time for proofing) and 85percent relative humidity. Then the proofed dough was placed in a preheated deck oven towards baking for 25 minutes. After baking, the breads were cooled and packed in PP covers. Then the physical characteristics of fruit breads were evaluated.

4.6.2 Standardization of Bun

A bun is a small and sometimes sweet, bread, or bread roll. Though they come in many shapes and sizes, they are most commonly hand-sized or smaller, with a round top and flat bottom.

Buns are usually made from flour, sugar, milk, yeast and butter. Common varieties contain small fruits or nuts, which may be topped with icing or caramel, or filled with jam or cream. Some types of buns are filled with various meats.

Bun may also refer to particular types of filled dumplings, such as Chinese ‘baozi’. Some of these types of dumplings may be bread-like in texture.

Conventionally a bun is normally made from dough that has been enriched with sugar and butter and even sometimes egg. Without any of these, the dough remains to be the 'bread dough' rather than 'bun dough' and the resultant product will be called a roll, rather than a bun

In this study bun was processed in 7 treatments following the procedures mentioned in chapter 3.6.2.

4.6.3 Standardization of Rusk

Rusk is a hard, dry biscuit or twice-baked bread. Firstly bread is baked and then the bread is sliced into the desired shape and size and baked again at low temperature so that they become really dry and crisp and have negligible amounts of moisture content. It is very crisp and light and the colour varies from golden brown to dark brown. It is different from a biscuit in terms of moisture content and in terms of the texture, since it a dried bread and therefore very light and has an open sponge like look (with lot of small air voids in between). The rusk can be made from plain breads and fruit cakes.

It is sometimes used as a baby teething food in United Kingdom. In India and Pakistan, rusk (or toast biscuit) is a traditional dried bread (also known as *'khasta'* in Hindi, '*rusk'* or '*cake rusk'* in Urdu, '*kattitoos'* in Bengali), that is eaten after having been dipped in coffee or tea. Therefore rusk is the anglicized term for the product, In Africa it is a traditional breakfast meal or snack. Called "*beskuit"*

Rusk was processed following the same procedure as bread, after that, it was again baked for 20 minutes at 250^{θ} C.

4.6.4 Standardization of Pizza base

Pizza is a flat, open-faced baked pie of Italian origin, consisting of a thin layer of bread dough topped with spiced tomato sauce and cheese, often garnished with anchovies, sausage slices and mushrooms.

Pizza base was processed as 7 treatments following the procedures mentioned in 3.6.2 and it was rated based on Limongi *et al'*s scale (2012).

4.7 QUALITY ANALYSIS OF THE BAKED PRODUCTS

The quality of food product is of utmost importance to consumers. Food products must first of all be safe and be without danger to common health. They must also fulfill consumer requirements both sensory and nutritional.

Now the baking industry, having a good *m*arket share, is focusing on higher *quality* products, particularly towards more nutritive and freshly baked products.

This baking industry is characterized with a variety of different products that daily find their place in the market. They attract all possible generations of consumers. In order to be in the fore front, it has become essential to make maximum efforts to maintain the quality of product.

In the present study, the physical, chemical, nutritional, sensory quality and storage stability was assessed.

4.7.1 Physical Properties of Baked Products

A physical property is any property that is measurable, whose value describes a state of a physical system. The changes in the physical properties of a system can be used to describe its transformations or evolutions between its momentary states. Physical properties are often referred to as observables. They are not modal properties. Quantifiable physical property is called physical quantity (Table-9).

.4.7.1.1 *Physical properties of Fruit bread*

The parameters studied under physical properties of fruit bread were raw weight, baked weight, raw depth, baked depth and baking time. The values obtained from these 6 treatments are compared with the control (T_7) which has processed from 100 per cent refined flour.

4.7.1.1.1 *Raw weight*

Raw weight of the baked product can be described as the key factor to be assessed, before processing. Here the raw weight meant the recording of weight of dough after mixing, kneading and proofing was performed. The weight was identical for all the 7 treatments (300g) from which the baked weight was measured

.

Table-9 Physical properties of Fruit bread

Treatments	Raw weight (g)	Baked weight (g)	Raw depth (cm)	Baked depth (cm)	Mean Difference (cm)	Baking time (min)
T_1	300	282.00	3.05	3.40	0.35	25
T_2	300	280.66	3.15	3.30	0.15	25
T_3	300	275.33	3.35	3.43	0.03	25
T_4	300	264.33	3.22	3.50	0.28	25
T_5	300	271.00	3.00	3.60	0.60	25
T_6	300	263.00	3.01	3.80	0.80	25
T_7(Control)	300	252.33	3.00	4.00	1.0	25
CD (0.5)	-	6.423	0.11	0.35	0.017	-

(Results are expressed as mean values of four replicates)

4.7.1.1.2 ***Baked weight***

Baked weight indicates the absorption of moisture, expansion of dough and evolution of gas. In the present study baked weight of fruit bread was taken after baking of the bread. The data here revealed that baked weight of the fruit bread ranged between 252.33g to 282.00 g. From the study it was found that T_6 (263.00) obtained the lowest weight after control which was on par with T_4 (264.33g).T_1 (282.00gm) obtained the highest weight among the 7treatments and was on par with T_2 (280g).Data analysis revealed that T_2 was on par with T_3 (275.33g). So from the values it can be concluded that addition of jackfruit flour produced an increase in weight of the product.

4.7.1.1.3 ***Raw depth***

Raw depth of fruit bread indicates the height of the dough before baking. In this study the raw depth of the 7 treatments was taken before baking. It was found

to be varying between 3cm (T_5) to 3.35cm (T_3) among the 7 treatments. The other observed values were 3.05cm (T_1), 3.15cm (T_2), 3.22cm (T_4) and 3.01cm (T6).

4.7.1.1.4 *Baked depth*

Baked depth indicates the increase or decrease in height and expansion of the bread. The baked *depth* was measured with a thin stick inserted inside into the pan from the top of the bread after baking. From the study it was observed that the baked depth varied between 3.30cm (T_2) to 4 cm (T_7) among the 7 treatments. It was shown that there was an increase in the baked depth with decrease in composition of JFB flour. The expansion was more with the refined flour. From the 7 treatmentsT_6 (3.8 cm) had the highest baked depth after control (T_7) and T_2 (3.30) had the lowest baked depth. The difference in raw depth and baked depth varied from 0.03 cm to 1cm.Thispoints out that the increase in refined flour increases the expansion.

4.7.1.1.5 *Baking time*

The baking time indicates the time required to change from dough to the baked stage. In this study, for all the 7 treatments the baking time was same (25 minutes).

4.7.1.2*Physical properties of bun*

4.7.1.2.1 *Raw weight*

Raw weight of the bun can be described as the weight of the dough which was taken before baking i.e. the weight of dough after mixing, kneading and proofing. The weight was identical for all the 7 treatments (80g) from which the baked weight was measured.

4.7.1.2.2 *Baked weight*

Baked weight can be defined as the decrease in weight after baking. It happens due to the evaporation of moisture content in the product during baking. The data revealed that there with decrease in weight of the product after baking. It is observed that the highest weight was obtained for T_3 (65.10cm) and the lowest

weight was obtained for the treatment T_6 (61.05) which was on par with control. T_5 (61.10g) was on par with T_6 (61.05g) and T_6 was also on par with control T_7.

Table-10 Physical properties of bun

Treatments	Raw weight (g)	Baked weight (g)	Raw depth (cm)	Baked depth (cm)	Mean Difference (cm)	Baking time (min)
T_1	80	61.25	3.80	3.9	0.1	30
T_2	80	63.00	3.46	3.9	0.5	30
T_3	80	65.10	3.00	3.4	0.4	30
T_4	80	63.30	3.05	3.7	0.64	30
T_5	80	61.10	3.55	4.2	0.65	30
T_6	80	61.05	3.15	3.9	0.75	30
T_7(control)	80	61.00	3.05	3.8	0.76	30
CD(0.5)	-	0.23	0.22	1.23	0.027	-

(Results are expressed as mean values of four replicates)

4.7.1.2.3 ***Raw Depth***

Raw depth of the bun was measured with a thin stick after the dough was moulded into round ball shape. The depth of the product was 3.80cm, 3.46cm, 3.0cm, 3.05cm, 3.55cm, 3.15cm and 3.05cmfor T_1 T_2 T_3 T_4 T_5 T_6 and T_7 Control respectively.

4.7.1.2.4 ***Baked depth***

Baked depth of bun was measured after proofing the dough for one hour and baking. In the case of bun also it was found that there was increase in baked depth compared to raw depth. The baked depth of the buns ranged between 3.4cm to 4.2cm. After baking, the difference between the raw depth and baked depth was calculated. From this calculation it was found that highest increase was found for

T_6 (3.9cm) after control and the lowest increase was found for T_1. From this experiment it was observed that, decrease in quantity of jackfruit bulb flour increased the baked depth.

4.7.1.2.5 *Baking time*

Baking time indicates, the time taken for the processing of bun from the dough stage to bun stage. In this study the baking time for all the treatments ($T1.T_7$) was the same, being 30 minutes.

4.7.1.3 *Physical properties of rusk*

Table-11 Physical properties of Rusk

Treatments	Yield (%)	Volume (cc)	Raw weight (g)	Baked weight (g)	Mean Difference (g)	Baking time (min)
T1	61.30	18.10	282.00	185.06	96.94	20
T2	63.15	22.12	280.66	190.11	90.55	20
T3	60.63	23.11	275.33	182.06	93.27	20
T4	56.38	24.90	264.33	170.00	94.33	20
T5	60.05	27.63	271.00	180.00	91.23	20
T6	57.21	33.20	263.00	172.00	91.0	20
T7	55.06	37.21	252.33	165.10	87.23	20
CD(0.05)	0.57	0.13	6.42	0.22	0.48	-

(Results are expressed as mean values of four replicates)

4.7.1.3.1 *Yield percent*

The product yield gives an estimate of the amount of baked product obtained from utilising known quantity of raw materials. The yield of rusk is given in Table 12. Statistical analysis done on the yield of rusk, revealed that rusk made from

the treatment T_2 (45:55) obtained highest yield (63.15%) and T_4 obtained the lowest yield (56.38 per cent) after the control. Values obtained by the treatments were seen to be significantly different from each other. It is found that the higher the amount of jackfruit bulb flours higher the yield. However T_1 revealed a deviance in this matter.

4.7.1.3.2*Volume*

The volume of the rusk was measured by the seed displacement method. The volume of a uniform loaves were taken. Data analysis done on the volume of rusk revealed that highest volume was obtained for treatment T_6 (33.20 cc) after control T_7 (37.20 cc). The lowest volume was seen in T_1 (18.10cc) .From this observation it can be concluded that, with increase in amount of jackfruit bulb flour, there was decrease in volume.

4.7.1.3.3 *Raw weight*

The raw weight of rusk was obtained from the weight of the bread kept for rebaking. After baking of bread, the raw weight of rusk was again weighed. They were recorded as (282.00g),(280.66g),(275.33g),(264.33g),(271.00g),(263.00g), (252.33g) for T_1,T_2 ,T_3, T_4 ,T_5 ,T_6 and T_7respectively.(Table-11) The products were further processed to rusk.

4.7.1.3.4 *Baked weight*

Baked weight of the rusk was obtained after the second processing or further processing of bread. It was found that there was a decrease in weight of the rusk. The decrease in weight was calculated by taking the difference between the raw weight and baked weight. From the difference it was found that highest decrease in weight was obtained for T_1 i.e. 96.94 g and lowest was obtained by T_2 i.e. 90.55g after the control T_7 (87.23 g), T5 (91.23g) was on par with T_6 (91.0g)and the other treatments were significantly different from each other.

4.7.1.3.5 *Baking time*

The baking time for the rusk was 20 minutes, i.e. the time taken to convert bread to rusk.

4.7.1.4 *Physical properties of pizza base*

4.7.1.4.1 *Raw weight and baked weight*

In the analysis of physical properties of pizza base raw weight and baked weight was measured. The raw weight was same for all the seven treatments, i.e. 120 g. After kneading, moulding, proofing and baking, weight was again measured. Analysis of data revealed that for baked weight, T_6 obtained the lowest baked weight 90.66 g from 120 g after control and highest baked weight was obtained for treatment T_1 (99) g which was significantly different from other values. From the analysis it can be concluded that there is increase in baked weight with the increase in amount of jackfruit bulb flour.

Table-12Physical properties of pizza base

Treatments	Raw weight (g)	Baked weight (g)	Raw depth (cm)	Baked depth (cm)	Baking time (min)
T_1	120	99.00	1.5	1.06	10
T_2	120	97.00	1.5	1.07	10
T_3	120	94.00	1.5	1.03	10
T_4	120	95.66	1.5	1.06	10
T_5	120	92.33	1.5	0.66	10
T_6	120	90.66	1.5	0.99	10
T_7	120	89.66	1.5	1.02	10
CD(0.05)	-	1.37	-	NS	-

(Results are expressed as mean values of four replicates).

4.7.1.4.2 *Raw depth and baked depth*

The raw depth and baked depth for pizza base was measured by piercing a thin stick before baking to the bottom of the product (after mixing and kneading).

This measurement was done even after baking. The raw depth was same for all the seven treatments. In case of baked depth it was found that there was a decrease from raw depth. The lowest depth was found for the treatment T_5 (0.66 cm).The highest depth was found in T_2 (1.07cm).

4.7.1.4.3 *Baking time*

Baking time was the time taken for the processing of Pizza base from the dough stage. From the study it was found that the baking time was same for all the seven treatments i.e. 10 minutes at 250^0 C.

4.7.2 Nutrient and Chemical Composition of Baked Products

The nutrients analyzed for the baked products were energy, protein fat and fibre. Moisture and acidity were the components analyzed in chemical composition.

4.7.2.1 *Nutrient and chemical composition of bread*

4.7.2.1.1 *Energy*

Energy generated by the combustion of food material in the presence of oxygen results in the production of heat in the body. This helps in carrying out various activities characteristic of the living body. The energy value was calculated from the levels of carbohydrate, protein and fat estimated. The study revealed that highest calorie was present in T_6 (299.00Kcal) after the control T_7 (310.00). The lowest calorie content was found in T_1 (247.00 Kcal). From the statistical analysis it was found that the contents were significantly different from each other. This analysis highlights the fact that with increase in amount of jackfruit flour there is decrease in calorie value which is ideal for various diseased conditions like cardiovascular disease, obesity and diabetes mellitus.

4.7.2.1.2 *Proteins*

Protein content embedded in starch varies, depending on the botanical sources. In general, cereal and pulses have higher protein content than tuber and

root starches. The presence of protein can cause unwanted color changes in starch due to starch hydrolysis and reaction between amino acid groups and reducing sugars (Mailard reaction). Moreover, proteins may also affect the surface charge and the rate of hydration (Sai*et al*., 2009).

From the analysis of protein content, it was found that T_6 (9.05g) obtained the highest protein contents after control T_7 (10.05g), where asT_1 (5.05) was found to be have the lowest level. Data analysis revealed that the protein values were significantly different from each other. As the jack fruit bulb flour has comparatively low amount of protein, with the increase of jackfruit bulb flour content the protein value was seen to decrease.

Table- 13 Nutrient and chemical composition of fruit bread

Treatments	Energy (Kcal)	Protein (g)	Fat (g)	Fibre (g)	Moisture (%)	Acidity (%)
T_1	247.00	5.05	2.95	6.41	21.05	0.14
T_2	258.00	5.71	3.06	5.93	19.95	0.13
T_3	266.00	6.16	3.11	5.23	19.75	0.13
T_4	280.00	7.13	3.24	5.01	19.35	0.10
T_5	287.00	8.12	3.34	4.92	19.55	0.12
T_6	299.00	9.05	3.48	3.51	18.75	0.13
T_7	310.00	10.05	3.50	3.00	18.15	0.14
CD (0.05)	0.67	0.14	0.11	0.06	0.30	0.03

(Results are expressed as mean values of four replicates)

4.7.2.1.3 *Fat*

Fat is an organic food group which includes lipids. These substances are insoluble in water but are soluble in organic solvents like ether, alcohol and benzene. Fats are esters obtained from higher fatty acids and glycerol; these esters are commonly referred to as glycerides. In the present study the fat was separated out by the solvent extraction method of AOAC 2005. From the analysis it was

observed that lowest fat was contained inT_1 (2.95g). T_2 was seen to be on par with T_3 (3.11g).T_6 (3.48g) revealed the highest fat content after T_7 (3.50g).

4.7.2.1.4 ***Fibre***

Fibre *is* the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fibre *i*ncludes polysaccharides, oligosaccharides, lignin, and associated plant substances. From the analysis of fibre content of fruit bread, it was observed that the highest fibre was present in treatment T_1 (6.41g) and the lowest fibre was obtained treatment T_6 after control T_7 (3.00g). The statistical analysis of data revealed that the values were significantly different from each other.

4.7.2.1.5 ***Moisture***

Moisture content of a product can be defined as the quantity of water contained in a material. Moisture content of the food material is important to ascertain that the food is suitable for consumption, because moisture content affects the physical and chemical aspects of food which inturn relates with the freshness and stability for the storage of the food. The moisture content determines the actual quality of the food before consumption and also to the subsequent processing in the food. The analysis of moisture content of fruit bread revealed that the moisture content was lowest in treatment T6(18.75%) after control T_7(18.15%).The moisture content was highest in T1(21.05%). The data analysis revealed that T_2 (19.95%) was on par with T_3 (19.75%) and others were significantly different from each other. From the experiment it can be concluded that with decrease in quantity of jackfruit bulb flour there was decrease in moisture content.

4.7.2.1.6 ***Acidity***

From the regulatory point of view, foods are classified as acid, low acid or acidified depending on the natural acidity of each product. A product's acidity was measured based on a pH scale. If the raw or initial product has a pH above

4.6 it was considered a low acid food. If the pH is below 4.6 then the food is classified as an acid food. From the analysis of acidity of fruit bread it was observed that the highest acidity was found in treatment T_1 and T_7 (0.14%). The lowest acidity was found in T_4 (0.10%).

4.7.2.2 ***Nutrient and chemical composition of bun***

Table-14Nutrient and chemical composition of bun

Treatments	Energy (Kcal)	Protein (g)	Fat (g)	Fibre (g)	Moisture (%)	Acidity (%)
T_1	261.00	5.31	3.15	6.07	18.55	0.42
T_2	269.00	5.60	3.21	5.81	18.36	0.23
T_3	272.00	6.04	3.23	5.07	18.15	0.13
T_4	282.00	7.15	3.25	5.02	18.24	0.05
T_5	295.00	8.11	3.47	4.47	18.01	0.06
T_6	304.00	9.02	3.48	3.58	17.90	0.13
T_7	313.00	9.04	3.53	2.95	17.81	0.14
CD (0.05)	1.133	0.69	0.07	0.28	0.13	0.16

(Results are expressed as mean values of four replicates)

4.7.2.2.1 ***Energy***

Energy or Calorie can be defined as a unit of heat equal to the amount of heat needed to raise the temperature of 1000 grams of water by one degree celsius. This unit is used as a measure of energy released by food as it is digested by the human body. It is also called as kilocalorie. From the analysis of bun it was observed that the highest energy was observed for T_6 (304.00 Kcal) after the control T_7 (313.00 Kcal), while the lowest calorie was for T_1 (261.00 Kcal).

The energy value ranged between 261.59 Kcal to 313.33 Kcal. The statistical analysis of data revealed that there was significant difference between the different treatments of bun at 5 per cent level.

4.7.2.2.2 *Protein*

Protein is a major nutrient found in food that is made up of many amino acids joined together, and is a necessary part of the diet. It is essential for normal cell structure and function. Protein is the building material for our skin, bones, muscles and other tissues in the body. Protein is a major component of enzymes, antibodies, and hormones. These are chemicals that play a major role in many processes in the body that among other activities, digest food, fight disease and allow enjoying a healthy life.

The protein content of developed buns are depicted in Table 14. From the above table it was observed that T_1 (5.31g) contained the lowest protein content and T_6 (9.02g) revealed the highest amount of protein after control (4.04g).

Statistical analysis revealed that T_1 (5.31g) was on par with T_2 (5.60g) and T_6 (9.02g) was on par with control T_7 (9.04g). Other values were significantly different from each other.

4.7.2.2.3 *Fat*

Fats are organic compounds that are made up of carbon, hydrogen, and oxygen. They are the main source of energy in *foods*. All fats are combinations of saturated and unsaturated fatty acids. Fat is a major source of energy in the diet.

From the above table, it can be noted that highest fat content was noticed in T_6 (3.48g) after control T_7 (3.53g). The lowest fat content was observed in T_1 (3.15g).

4.7.2.2.4 *Fiber*

Dietary fiber can generally be described as that portion of food that is not digested in the human small intestine. It passes into the large intestine where it is

partially or fully fermented. These characteristics of dietary fiber are associated with its numerous well documented health benefits.

Table-15 depicts the fiber content of the developed buns of seven treatments. The highest fiber was obtained for T_1 (6.07g) which was significantly different from others treatments and the lowest fiber was contained in T6 (3.58g) after control T_7 (2.95g) Statistical analysis of data revealed that T_3 (5.07g) was on par with T_4 (5.02gm).

4.7.2.2.5 *Moisture*

Moisture forms the major constituent in the analysis of food items in the world because foods are comprised of a considerable amount of water rather than other ingredients. *Moisture content* is *defined* as the percentage of water in a product or object. Proper *moisture content* is essential for maintaining fresh, healthy *foods*.

From the data analysis of moisture content, it was found that the lowest moisture was found inT_6 (17.90%) after control T_7 (17.81%) and the highest moisture content was found in treatment T_1 (18.55%) which showed significant difference at 5 per cent level with other treatments.

4.7.2.2.6 *Acidity*

An *acid product* would taste sour, while an alkaline *product* would taste bitter. From the data analysis of acidity, it was found that the highest acidity was obtained byT_1 (0.42%). T_2 (0.23%) was seen to be on par with T_3 (0.13%) and T_6 was on par with control T_7 (0.14%). Lowest acidity content was found for T_4 (0.05%).

4.7.2.3 *Nutrient and chemical composition of rusk*

Table-15 Nutrient and chemical composition of Rusk

Treatments	Energy (Kcal)	Protein (g)	Fat (g)	Fibre (g)	Moisture (%)	Acidity (%)
T_1	384.00	5.36	3.18	6.05	6.40	0.36
T_2	387.00	5.59	3.21	5.76	6.45	0.28
T_3	392.00	5.85	3.29	5.07	6.41	0.13
T_4	424.00	6.80	3.35	5.02	6.40	0.05
T_5	426.00	7.36	3.47	4.45	5.47	0.06
T_6	431.00	8.18	3.58	3.54	5.45	0.13
T_7	437.00	9.12	3.67	2.90	5.40	0.14
CD(0.05)	2.85	0.88	0.13	0.24	0.77	0.13

(Results are expressed as mean values of four replicates)

4.7.2.3.1 Energy

When the calorie value of the treatments were computed, it was found that calorie value was higher in T_6 (431.00 Kcal) after control T_7 (437.00Kcal). Statistical analysis of data revealed that T_4 (424.00 Kcal) was on par with T_5 (426.00 Kcal).The lowest calorie was contained in treatment T_1 (384.00Kcal) which was significantly different from other values. From the study it can be concluded that after rebaking the calorie value decreased with the increase in amount of jackfruit bulb flour.

4.7.2.3.2 *Protein*

Proteins are organic compounds made up of building blocks called “amino acids. The protein content of the developed rusk treatments are depicted in

Table16. From the table it is observed that the lowest protein content was in T_1 (5.36g). Data analysis revealed that T_2 (5.59g) was on par with T_3 (5.85g). The highest protein content was found in T_6 (8.18g) after the control T_7 (9.12g).

4.7.2.3.3 *Fat*

Fat is one of the three main macronutrients, along with carbohydrate and protein. The statistical analysis of data revealed that there was a significant difference between fat content of developed treatment of rusk. The maximum fat content was noted for T_6 (3.58g) and this was only next to T_7 (3.67g). The lowest fat content was found in T1 (3.18g) followed by T_2 (3.21g), T3 (3.29g) T_4 (3.35g) and T_5 (3.47).

4.7.2.3.4 *Fibre*

Fibre denotes carbohydrate polymers with ten or more monomeric units, which are not hydrolyzed by the endogenous enzymes in the small intestine of human beings. The total fiber content of rusk is depicted in Table 16. Fibre content of the treatments of rusk ranged between 2.90g to 6.05g among the seven treatments. The highest fibre content was found in T_1 (6.05gm) and lowest fiber content was in T_6(3.54g) after control T_7(2.90g).The table also revealed that the difference in fiber values of all the treatments were statistically significant.

4.7.2.3.5 *Moisture*

Moisture content *is* defined as the percentage of water in a product or object. Optimum *moisture content* is essential for maintaining fresh, use of foods. Moisture content of developed rusk ranged between 5.40 per cent to 6.45 per cent. The statistical analysis of data revealed that highest moisture content was found in T_2 (6.45%) which was on par with T_3 (6.41%) and T_4 (6.40%). The lowest moisture content was found in T_6 (5.45%) after control T_7 (5.40%).

4.7.2.3.6 *Acidity*

Acidity of a food product can be defined as the quality or state or degree of being acid. Data analysis revealed that the highest acidity content was obtained in T_1 (0.36%) which was on par with T_2 (0.28%). T_4 was on par with T_5 (0.06%). The lowest acidity content was obtained for T_4 (0.05g).

4.7.2.4 *Nutrient and chemical composition of Pizza base*

4.7.2.4.1 *Energy*

The calorie content of 7 treatments of Pizza base is presented in Table-16. The statistical analysis revealed that there was significant difference in calorie content of developed treatments. The energy content was found to be highest in T_6 (312.00 Kcal) after control T_7 (321.00g) and the minimum calorie content was found in T_1 (265.00 kcal)

4.7.2.4.2 *Protein*

The protein content of developed Pizza base is depicted in Table 17. From the table it was observed that the lowest protein content was found in T_1 (5.41g) which was on par with T_2 (5.64g). Statistical analysis revealed that T_3 (6.35g) was on par with T_4 (6.30g). The highest protein content was found in T_6 (8.18g) after control T_7 (8.79g).

4.7.2.4.3 *Fat*

The fat content of the developed Pizza base is presented in Table 16. The highest fat content was observed in T_6 (3.47g) after control T_7 (3.53g). The lowest fat content was found in T_1 (3.13 g). Treatment T_5 and T_6 were on par with each other

4.7.2.4.4*Fibre*

Fibre can be defined as carbohydrate polymers which have been obtained from food raw material by physical, enzymatic or chemical means and which have

been shown to have physiological benefits to health as demonstrated by generally accepted scientific evidence of competent authorities. When the fibre content of different treatments were computed it was found that the highest fibre content was in T_1 (6.14g).Statistical analysis of data revealed that T_3 (5.07g) was on par with T_4 (5.03g). The lowest fibre content was found in T_6 (3.54 g) after control T_7 (2.95g).

Table-16Nutrient and chemical composition of Pizza base

Treatments	Energy (Kcal)	Protein (g)	Fat (g)	Fibre (g)	Moisture (%)	Acidity (%)
T_1	265.00	5.41	3.13	6.14	21.22	0.41
T_2	268.00	5.64	3.16	5.81	21.27	0.28
T_3	282.00	6.35	3.24	5.07	21.11	0.14
T_4	290.00	6.30	3.25	5.03	21.00	0.06
T_5	301.00	7.36	3.45	4.44	20.96	0.14
T_6	312.00	8.18	3.47	3.54	20.16	0.13
T_7	321.00	8.79	3.53	2.95	19.62	0.14
CD (0.05)	3.10	0.59	0.09	0.22	0.48	0.11

(Results are expressed as mean values of four replicates).

4.7.2.4.5 *Moisture*

The *water content* is what we know as *moisture content* of the *food*. The moisture content of developed treatments of the product ranged between 19.62 percent to 21.27 percent. Statistical analysis revealed that the highest moisture content was in T_2 (21.27%) which was on par with T_3 (21.11 %). T_3 was also on par with T_4 (21.0%). The lowest moisture was found in T_6 (20.16%) next to control T_7 (19.62%).

4.7.2.4.6*Acidity*

The quality, state or degree of being sour is chemically called acid. From the analysis of acidity content it was found that the highest acidity content was in T_1(0.41%) and the lowest acidity content was found in T_4(0.06%). Statistical analysis of data reveals that T_3 was on par withT_5 (0.14%) andT_6 (0.13%). $T_6$was also on par with control T_7 (0.14%).

4.7.3 Sensory quality of baked products

Sensory analysis is a scientific discipline that applies the principles of experimental design and statistical analysis to the use of human senses (sight, smell, taste, touch and hearing) for the purpose of evaluating consumer products.

Table -17Sensory quality of fruit bread

Treatments (ranks)	Appearance	Texture	Taste	After taste	Flavor	Over all acceptability
$T_{1\ (VI)}$	25.50	21.65	24.75	23.20	21.40	23.50
$T_{2\ (V)}$	28.60	26.25	25.22	27.60	26.30	26.40
$T_{3\ (IV)}$	33.75	31.40	29.75	29.80	28.50	28.60
$T_{4\ (III)}$	35.54	26.25	29.18	27.05	30.70	32.05
$T_{5\ (II)}$	38.36	43.45	39.25	42.85	42.20	40.75
$T_{6\ (I)}$	46.55	46.30	41.75	45.60	46.10	44.90
T_7 (Control)	49.45	53.20	58.20	52.40	53.30	52.30
K value	12.76	25.48	23.08	21.78	23.31	20.49
CD(0.5)	0.362					

(Scores indicated are mean rank values)

4.7.3.1 *Sensory quality analysis of fruit bread*

Sensory evaluation scores are the mean rank scores of 10 judges who were selected to evaluate the product. They rated the appearance, texture, taste, after taste, flavour and overall acceptability for fruit bread.

Appearance

Man generally regards the appearance of food item with great interest. The look of food item can have a great effect on appetite, stimulation and digestion. The mean rank score obtained for the appearance of the developed bread ranged from 25.50 – 49.45. T6 with the ratio of 80:20 (refined flour and jackfruit bulb flour) got the highest rank after the control T_7 (49.45). While T_1 (25.50) with the ratio of 40: 60 (refined flour and jackfruit bulb flour) got the lowest rank.

Texture

Texture can be defined as the way; something feels when it is touched or the way that a *food* feels in the mouth. From the statistical analysis of data it was revealed that T_6 (46.30) got the highest mean rank value after control while T_1 (21.65) got the lowest mean rank value. The differences in these scores were found to be significant.

Taste

Taste is the most important characteristic of a food item, because a person generally value food for its taste. From the sensory evaluation of taste for fruit bread it was found the mean rank value ranged between 24.75-58.20. The highest score was obtained for T_6 (41.75) after control T_7 (58.20), while the lowest score was obtained by T_1 (24.75). Statistical analysis of data showed that the scores were significantly different from each other.

After taste

After taste can be defined as the unpleasant mouth feel of the product after taking it. Therefore higher score depicted low after taste or good acceptable taste.

From the data analysis it was found that the maximum score with respect to after taste was noted for T_6 (45.60) followed by control T_7 (52.40) meaning that there was no unpleasant taste after consumption. The least mean rank (23.20) was obtained for T_1. Data on the mean rank score obtained for after taste of different treatments revealed a significant difference.

Flavour

Flavour is generated by the stimulation of sensory cells with specific volatile compounds present in the food. In this study the fruity and yeasty flavour was considered as the main characteristic. Mean rank score for the flavour of fruit bread was found to be varying among the seven treatments. The highest rank was obtained for T_6 (46.10) following control T_7 (53.30) while the lowest rank was obtained for T_1 (21.40). Statistical analysis of data showed that the rank values were significantly different from each other.

Overall acceptability

Overall acceptability is the important parameter to evaluate the acceptability of a product. It was calculated by taking the total of mean score assigned by 10 judges**.** Statistical analysis revealed that there was a significant difference in this parameter between the formulations of the developed treatments T_1 to T_7. It is noted that T6 obtained the highest rank value (44.90) preceded only by control T_7 (52.30).The next position was obtained by T_5 (40.75) and least position was noted for T_1 (23.50)

4.7.3.2*Sensory quality analysis of bun*

Sensory evaluation is a scientific method to measure, analyze and interpret responses to products through sight, smell, touch, taste and hearing, with a trained panel. It provides unique analytical methods to help perfect the product.

Appearance

Appearance is a desirable criterion for selection of any food product. The sensory evaluation revealed that the mean rank value for appearance ranged between 27.20 -42.50. From Kruskal Wallis Test it was analyzed that T_6 obtained the first rank with the mean rank value (42.50) after control T_7 (53.60). While T_1 got the last rank with mean rank value 27.20. The mean rank values were significantly different from each other.

Table-18 Sensory evaluation of bun

Treatments (ranks)	Appearance	Texture	Taste	After taste	Flavor	Over all acceptability
$T_{1\ (VI)}$	27.20	23.65	21.65	23.50	23.43	22.75
$T_{2\ (V)}$	25.20	26.1	24.45	25.40	24.30	24.70
$T_{3\ (IV)}$	30.30	25.85	23.70	28.30	28.90	26.65
$T_{4\ (III)}$	31.75	36.65	37.60	34.60	35.30	35.70
$T_{5\ (II)}$	37.95	38.85	40.40	37.50	39.90	38.50
$T_{6\ (I)}$	42.50	41.30	46.00	44.80	42.40	45.60
T_7(Control)	53.60	56.10	54.70	54.40	53.40	54.60
K value	18.27	21.36	27.02	21.34	18.64	23.44
CD (0.05)	0.086					

(Scores indicated are mean rank values)

Texture

Texture can be defined as the sensation experienced by the tongue or skin and it is characterized by coarseness or fineness. Coarse textured crystalline products are said to be grainy. From the evaluation of texture it was found that T_6 got the highest mean rank value 41.30 for this attribute after the control T_7 (56.10)

and T_1 got the lowest mean rank value of 23.65.The difference in these scores were found to be significant

Taste

Generally a food is evaluated through its taste. Tasteis the sensation which the taste buds register. The taste was superior in the case of T_6after control with the proportion of refined flour and jackfruit flour in the ratio 80:20 and got the mean rank value of 46.0. The lowest mean rank value was obtained by T_1 (21.65). Statistical analysis of data revealed that the values were significantly different at 5 per cent level. From the study it can be concluded that with the increasing amount of jackfruit flour there was decrease in taste.

After taste

After taste of a product can be defined as the taste of ingredients which are used in the processing of the product that would prevail after consuming the food item. When after taste was less, higher scores were given. The mean rank value of after taste ranged between 23.50 to 54.40 including control. It can be noticed from data sheet the highest mean rank value was obtained by T_6 (44.80) after control, while T_1 obtained the lowest mean rank value 23.50. Statistical analysis of data revealed that the values were statistically significant.

Flavour

The flavor of a food has three components odour, taste and a composite of sensation known as mouth feel. The mean rank values for sensory evaluation of bun are presented in Table 19. From the table it was found that the maximum mean rank value was obtained for the treatment T_6 (42.40) after control T_7 (53.40).While the minimum mean rank value was obtained for T_1 (23.43). From the statistical analysis of data it was found that there was significant difference between the mean rank values.

Over all acceptability

Over all acceptability of a food product can be judged through its appearance colour, texture and taste of the product. Statistical analysis revealed that there was significant difference in this parameter between the treatments (T_1-T_7). It was noted that T_6 obtained the highest mean rank value of 45.60 after control T_7 (54.60). Second and third position was obtained byT_5 (38.50) and T_4 (35.70) respectively. The least mean rank value was obtained by T_1i.e. 22.75.

4.7.3.3*Sensory quality analysis of rusk*

Sensory evaluation is a scientific discipline that analyses and measures human responses to the composition of food and drink, e.g. appearance, touch,

Table-19 Sensory evaluation of rusk

Treatments (ranks)	Appearance	Texture	Taste	After taste	Flavor	Over all acceptability
$T_{1\ (VI)}$	21.95	21.95	21.65	22.00	21.50	22.00
$T_{2\ (V)}$	24.7	24.70	22.70	24.45	24.25	22.00
$T_{3\ (IV)}$	27.35	27.85	26.45	27.70	26.35	24.2
$T_{4\ (III)}$	27.85	40.50	39.06	38.12	39.12	36.37
$T_{5\ (II)}$	36.95	35.45	37.75	37.95	36.05	39.50
$T_{6\ (I)}$	43.45	41.60	42.60	43.55	45.15	47.80
T_7 (Control)	49.45	50.65	52.20	48.45	50.00	50.0
K value	18.20	18.75	23.30	17.35	20.84	25.02
CD (0.05)	0.32					

(Scores indicated are mean rank values)

odour, texture, temperature and taste. In schools this method provides an ideal opportunity for students to evaluate and give feedback on their dishes and test products.

Appearance

Surface characteristics of food products contribute to the appearance. From the analysis of score of sensory evaluation for appearance of rusk it was found that the sample varied in appearance from even surface to broken surface. Mean rank value for the appearance of rusk was superior in T_6 (43.45) after control T_7 (49.45). While the lowest value was obtained for T_1 (21.95) followed by T_2, T_3, T_4 and T_5 with the mean rank value 24.7, 27.35, 29.85 and 36.95. Statistical analysis of the data revealed that there was significant difference between the mean rank scores at 5% level

Texture

Texture of a food product can be defined as the moderate resistance and friction in response to the pressure of the teeth. The texture of developed rusk varied between crispy to difficult to break. From the sensory analysis of texture it was noticed that T_6 obtained the maximum mean rank value 41.60 after the control T_7 (50.65). While T_1 obtained the minimum mean rank value 21.95. Data analysis revealed that the values were significantly different.

Taste

Among all the parameters used for sensory analysis, taste is the most desirable characteristic for acceptability. The mean rank values for taste of the seven treatments of rusk ranged between21.65 to 52.20.The highest mean rank score (42.60) for taste was obtained by T_6after control T_7 (52.20) while the lowest mean rank value was obtained for T_1 (21.65). The score obtained for seven the treatments of rusk were significantly different from each other.

After taste

In the present study the after taste of the product was judged by whether the taste of jackfruit bulb flour is remaining or not, after the product leaves the mouth. Statistical analysis of data revealed that there was significant difference between the mean rank values. From the sensory analysis of after taste it was observed that the highest mean rank value was obtained by T_6 (43.55) and the lowest mean rank value 22.0 was obtained by T_1.

Flavour

The flavour of the product varied between starchy flavour to burnt flavour. From the sensory analysis it was the observed that the superior value for flavour was obtained by T_6 (45.15) after control T_7 (50.0). While the minimum mean rank value (21.50) was obtained by T_1.

Overall acceptability

Overall all acceptability of the seven treatments is clearly depicted in table 20.Among the seven treatments. T_6 obtained the maximum mean rank value of 47.80 after the control T_7 (50.0). Least mean rank value of 22.0 and less acceptability was noted for T_1. Result of tests indicates that there was significant difference in the mean rank score obtained for the seven treatments T_1 to T_7.On the basis of analysis of scores T_6 was selected as the best combination.

4.7.3.4*Sensory quality analysis of pizza base*

*S*ensory evaluation is the assessment of food products through the senses. Sensory evaluation *is* a scientific discipline used to analyse reactions to stimuli perceived through the senses – sight, smell, touch, taste and sound.

The sensory evaluation of Pizza base was analyzed by the parameters suggested by Limongi *et al* (2012). The parameters constituted of wooden appearance, softness, taste, colour of edge, aroma, and porosity.

Wooden appearance

Wooden appearance of Pizza base varied between light brown to blackish brown. With regard to this parameter highest mean rank value of 48.30 was obtained by T_6after control T_7 (49.35), while the lowest mean rank value of 20.75 was obtained by T_1 which comprised of refined wheat flour and jackfruit flour in the ratio 40:60. From the study it can be concluded that with increase in amount of jackfruit flour, there was decrease in mean rank score for wooden appearance.

Table-20Sensory evaluation of pizza base

Treatments	Wooden appearance	Softness	Taste	Color of edge	Aroma	Porosity	Crispiness of edge
$T_{1\ (VI)}$	20.75	18.25	19.40	20.15	19.65	17.70	18.12
$T_{2\ (V)}$	20.75	18.25	19.40	20.15	20.45	17.70	18.25
$T_{3\ (IV)}$	25.15	27.45	24.70	25.35	24.85	27.30	28.56
$T_{4\ (III)}$	34.62	35.12	33.25	34.25	33.87	35.06	37.23
$T_{5\ (II)}$	42.60	40.35	41.50	42.45	42.00	43.7	43.56
$T_{6\ (I)}$	48.30	47.40	48.00	47.90	49.70	47.35	48.21
T_7 (Control)	49.35	54.80	55.00	51.20	50.85	52.80	52.11
K value	26.82	33.72	33.49	28.52	29.77	34.10	33.10
CD (0.05)	0.077						

(Scores indicated are mean rank values)

Softness

Softness is a deserved characteristic for baked products. Statistical analysis of data revealed that the mean rank scores of pizza base were significantly different. From Table 20 it was clear that the highest mean rank value 47.40 was

obtained by T_6 after control T_7 (54.80). While the least mean rank value 18.25 was obtained for T_1.

Taste

Taste is the most important sensory impression of a food product. From the analysis of sensory evaluation of taste of Pizza base it was noted the T_6 obtained the highest mean rank value (48.00) after control T_7 (55.0) compared to other treatments. T_1 and T_2 the obtained the least rank value 19.40 followed by T_3 (24.70), T_4 (33.25) &T_5(41.50). Statistical analysis of data revealed that the mean rank values were significantly different.

Aroma

Aroma refers to sensation perceived by means of the olfactory nerves,that may be agr eeable or disagreeable, actually or figuratively.Statistical analyses of values of mean rank values of aroma were significantly different from each other. The mean rank values are presented in the Table 20. From the table it was clear that T_6 got the maximum mean rank value (49.70) after control T_7 (50.85). While T_1 got the lowest mean rank value of 19.65.

Porosity

Porosity is *defined* as being full of tiny holes that allow water or air to get through. The mean rank value of porosity is depicted in the Table 20. From the table it is noticed that T_1 obtained the lowest mean rank value (17.70). T_6 obtained the highest mean rank value 47.35 after the control T_7 (52.80).

Crispiness of edge

This is a special characteristic of pizza base suggested by Limongi, which varied between crispy to hard. From this evaluation it was found that the superior quality and maximum mean rank value was 48.21 which was obtained by T_6aftercontrol T_7(52.11) while T_1 got the least mean rank value of 18.12.The mean rank values were found to be significantly different.

4.8 SELECTION OF BEST COMBINATION

From the sensory evaluation of the four baked products with respect to the different parameters like appearance, texture, taste, after taste, flavour and overall acceptability it can be concluded that T_6 got the maximum mean rank values in all aspects. So T_6 with the combination of refined flour and jackfruit bulb flour in the ratio 80:20 was the most acceptable treatment followed by T_5, T_4, T3, T2 and T_1 forall the four products viz., fruit bread, bun, rusk, pizza base

So from the above study it can be concluded that T_6 was the best combination among the seven treatments

Table-21 Hedonic rating value of the baked products

Rating scale	Scores	Bread	Bun	Rusk	Pizza base
Like extremely	9	-	-	18(2)	27(3)
Like very much	8		-	40(5)	48(6)
Like moderately	7	14(2)	14(2)	21(3)	7(1)
Like slightly	6	36(6)	42(7)	-	-
Neither like or dislike	5	10(2)	5(1)	-	-
Dislike slightly	4	-	-	-	-
Dislike moderately	3	-	-	-	-
Dislike very much	2	-	-	-	-
Dislike extremely	1	-	-	-	-
Max score	90	60	61	79	82

(Scores indicated are total scores and figures in parentheses are the no of members)

To assess the acceptability of the four products the selected treatments of each product then rated with a 9 point scale (hedonic rating) where the score 9 represented ‘like extremely’ and 1 represented ‘dislike extremely’, the middle values representing intermediated ratings

A ten member panel which comprised of students from the department of Home science evaluated the selected treatments of all the four products, using the 9 point hedonic scale; Evaluation of the products were conducted 24 hours after baking.

Among all the four products, 'bread' scored a total of 60, 'bun' scored 61, rusk scored 79 and pizza base scored 82 indicating that pizza base was the most acceptable product. These four products (best treatments) were kept for storage studies. Pizza base was adjudged the best among the four products.

Texture analysis of selected products

Table-22

Sample name	Hardness(N)	Brittlenes s(mm)	Crispines s	Crunchines s(mm)	Firmnes s(N)	Elasticity (mm)
Bread	23.85	0.68	31.17	12.95	23.85	0.68
Bun	17.94	0.32	27.61	5.36	17.94	0.32
Rusk	49.02	0.42	80.72	158.68	44.89	0.76
Pizza base	44.89	0.21	88.38	178.20	49.02	2.31

The texture analysis of the selected products were conducted by the Food texture analyser (LLOYD instrument TA PLUS 50N). The results are predicted in Table-22. From the table it was seen that lowest hardness was found in bun (17.94N). Bread obtained the highest value for brittleness (0.68mm) and pizza base had the lowest value (0.21mm). For crispiness, pizza base obtained the maximum value (88.38) followed by rusk (80.72). Pizza base and rusk obtained higher values in crunchiness (178.20mm and 158.68mm respectively). Highest firmness (49.02N) and elasticity (2.31mm) was observed in pizza base

4.9 STORAGE STABILITY OF BAKED PRODUCTS

Most food products are perishable in nature, especially the baked products as these are semi perishable in nature. These are prone to spoilage due to the high moisture content and acidity content which favours microbial growth. Due to this

risk, storage stability is a matter of concern. In this study, for judging the storage stability, the selected treatments were analyzed periodically for sensory qualities, moisture and acidity content and microbial growth. Among the seven treatments the best treatment T_6 of each product was taken for the analysis of storage stability.

4.9.1 Sensory evaluation of baked product during storage.

Among the several factors which influence the quality of products, sensory quality is considered as the major characteristic which is most likely to change during storage. Sensory evaluations were done by selected panel members during the storage. The panel members rated the product on a five point scale for three days periodically. The details of periodical evaluation of baked products during storage bread are presented in the table-23.

Table-23 Sensory evaluation of fruit bread during storage

	Scores				
Parameters	Initial	After 1st day	After 2nd day	After 3rd day	CD(0.05)
Appearance	46.55	45.20	42.10	38.10	1.39
Texture	46.30	45.10	40.20	37.20	0.67
Taste	41.75	40.10	38.12	35.10	0.32
After taste	45.60	44.20	40.60	36.30	1.11
Flavour	46.10	45.10	41.50	35.20	1.02
Over all acceptability	44.90	43.20	40.50	37.20	0.78

(Scores indicated are mean rank values)

4.9.1.1 *Sensory evaluation of fruit bread during storage*

Appearance is the first impression of a food product. The highest mean rank score for appearance (46.55) was obtained when the analysis was conducted on the fresh sample, which gradually decreased during storage period. The lowest

mean rank value of 38.10 was obtained after the third day. The mean rank values were found to be significant different between the initial and final stage.

The results show that the mean rank values for texture was higher in fruit bread initially (46.30). The scores decreased after the third day to 37.20 .Statistical analysis indicate that the mean rank values were significantly different.

Taste is a major parameter of value for any food product. During the storage period, it was found that there was a gradual decrease in the mean rank scores with regard to this attribute. For the taste initially the value was 41.75 for the fresh sample, while after third day it was found to decrease to 35.10.

After taste refers to the unpleasant taste persisting after swallowing food. With respect to acceptability of the product with reference to after taste, initially the score was 45.60 but gradually the values decreased which may be because jackfruit taste was persistent after swallowing. The mean rank score obtained after the third day was 36.30 preceded by 44.20 and 40.60after first day and second day respectively.

While comparing the mean values of flavour, highest mean rank score was found in the fresh sample (46.10) and after first day and second day there was a decrease in rank scores (45.10 and 41.50 respectively). After third day the scores further decreased to 35.20.

Results indicated that highest mean rank score of 44.90 for overall acceptability was found in the fresh product, which decreased to 43.20 and 40.50 after first day and second day. Scores further decreased on third day (37.20).

From the above observation it may be concluded that the scores in sensory attributes namely, appearance, texture, taste, after taste, flavour, and over all acceptability were gradually decreasing during the storage period. However the products were acceptable for consumption.

4.9.1.2 Sensory evaluation of bun during storage

The mean rank values for appearance in the initial and after first day of storage, were found to be on par (42.50 and 41.20). The highest score for appearance was obtained by fresh bun (42.50) and the value was found to gradually decrease with storage. The value decreased to 37.40 after the third day.

The results revealed that the mean rank value for texture was highest in the freshly prepared bun (41.20). The lowest mean rank score was obtained after the third day (36.20). The texture of the product gradually changed from soft to slightly hard stage.

Table-24Sensory evaluation of bun during storage

	Scores				
Parameters	Initial	After1st day	After 2nd day	After3rd day	CD(0.05)
Appearance	42.50	41.20	39.20	37.40	1.31
Texture	41.20	40.12	38.12	36.20	1.36
Taste	46.00	43.00	41.23	39.23	0.33
After taste	44.80	42.80	41.20	39.20	0.54
Flavour	42.80	41.40	39.24	37.20	1.24
Over all acceptability	45.60	43.60	41.60	39.60	0.77

(Scores indicated are mean rank values)

Change in values for taste was observed throughout the storage period. The highest mean rank score (46.00) for taste was obtained when freshly prepared. It gradually decreased and a lower score was obtained after the third day (39.23).

Results revealed that the mean rank values with respect to after taste was higher in bun when freshly prepared (44.8), i.e. the taste was more acceptable

initially. Lower mean rank score was obtained after the third day 39.20. Intermediate values of42.80 and 41.20 were obtained on the first and second days

While comparing the mean values of flavour highest mean rank score was found in the freshly prepared sample. After first and second day of storage there was slight variation in mean rank score (41.40 and 39.24).A lower mean rank score was obtained after the third day (37.20).

Results indicated that the highest mean rank score for overall acceptability of bun was found in the sample prepared fresh (45.60) followed by first day and second day (43.60 and 41.60). Lowest mean rank score of(39.60) was got on third day. There was significant variation in overall acceptability of bun. However it was acceptable for consumption despite lowering of scores.

4.9.1.3 Sensory evaluation of rusk during storage

Table-25Sensory evaluation of rusk during storage

	Scores				
Parameters	Initial	After 1st month	After 2nd month	After 3rd month	CD(0.05)
Appearance	43.40	43.10	42.20	41.70	0.85
Texture	42.60	41.10	40.70	39.10	1.12
Taste	41.10	41.70	40.20	39.70	0.99
After taste	43.50	42.10	41.70	40.20	0.87
Flavour	45.10	44.10	43.10	42.10	0.36
Over all acceptability	47.80	45.20	43.20	42.10	0.58

(Scores indicated are mean rank values)

Rusk (selected treatment) was stored for three months and sensory evaluation of the product was done on a monthly basis, periodically. The parameters assessed for evaluating rusk were appearance, texture, taste, after taste, flavour and over all acceptability.

Though the product was acceptable, statistical analysis showed that there was a decrease in scores. In the initial evaluation, the mean rank score for appearance was 43.40 and after first month the value was on par with initial (43.10).After the second month, it was found to decrease to 42.20. After third month a lesser mean rank value of41.70was obtained. From the periodical sensory evaluation it can be concluded that there was a slight decrease in scores during the three months of storage.

Texture is the property of food products which is associated with the sense of feel or touch experienced by fingers or mouth. It can be felt through sensations and mostly evaluated by the feel of the mouth. It was found that, there was significant change in texture scores during the storage period. It was noted that the mean rank values decreased from 42.60 to 39.10 after 3 months of storage. But still the product was acceptable for consumption during storage period.

One of the most important characteristics of any food product is its taste, which decides the preference among the consumers. During the storage period of rusk, it was found that, there was a decreasing trend in values. Initially it was 41.10which decreased to 39.70 after third month. But the taste of the product was still acceptable after third month.

Sensory evaluation with respect to after taste values was noted to be 43.50initially and it was found to decrease to 42.10 and 41.70 after first month and second month respectively. After the third month, a lesser score (40.20) was obtained in this regard. There was significant difference between the values but rusk was acceptable during storage. The prominence of the taste of jackfruit with storage could be the factor contributing to the lowering of values.

Flavour gives a pleasant sensation for any food product. A good flavour attracts the consumer towards food products. During storage of rusk it was found that there was a gradual decrease in mean rank values of flavour from initial period (45.10) till after third month (42.10).

Over all acceptability rating consists of evaluation of all the aspects like appearance, texture, taste and flavour of the developed product. The data in Table 25 revealed that overall acceptability was higher in the fresh sample during storage (47.80). Later it was found to decrease to 42.10 in the third month. But still the rusk was acceptable even after three months.

4.9.1.4*Sensory evaluation of pizza base during storage*

Table-26 Sensory evaluation of pizza base during storage

	Scores				
Parameters	Initial	After 1st day	After 2nd day	After 3rd day	(CD 0.05)
Wooden appearance	46.55	45.20	42.10	38.1	0.32
Softness	46.30	45.10	40.20	37.20	0.57
Taste	41.75	40.10	38.12	35.10	1.12
Color of edge	45.60	44.20	40.60	36.30	0.94
Aroma	46.10	45.10	41.50	35.20	0.66
Porosity	44.90	43.20	40.50	37.20	1.03
Crispiness of edge	48.21	46.23	45.31	42.12	0.73

(Scores indicated are mean rank values)

Pizza base was rated on the Limongi *et al's* scale (2012) during storage. All the parameters were found to decrease during storage period from first to third day. In the case of wooden appearance, the initial the score was 46.55 which decreased to 38.10 after third day. While evaluating the softness of the product, the initial mean rank value was 46.30which decreased to 37.20 after the third day. For taste the initial mean rank value was 41.75 which decreased to 35.10after the third day. The mean rank value for colour of edge was 45.60 in the fresh sample and it decreased to 36.30after the third day. Mean rank value for aroma of pizza base was 46.10 initially, which gradually decreased to 35.20after the third day. Porosity is an important factor for pizza base, initially, uniform holes were found

in the product which gave a mean rank value of 44.90, and this gradually decreased to37.20 after the third day. In the case of crispiness of edge, initially the mean rank value was 48.21 that gradually decreased to 42.12 after the third day. The crispiness gradually decreased with storage.

From the sensory evaluation of the four products viz. bread, bun, rusk and pizza base it was noticed that there was a gradual decrease of mean rank values of all product with respect to each sensory parameter. But the product was acceptable and could be consumed up till the last stage.

4.9.2 Evaluation of moisture during storage

Table-27

Evaluation of moisture content of fruit bread, bun and pizza base during storage

Moisture %			
Storage period	Bread	Bun	Pizza base
Initial	18.75	17.90	20.33
After1st day	18.35	17.75	20.27
After 2nd day	18.23	17.65	20.18
After 3rd day	18.05	17.55	20.16

(Result expressed are mean rank values)

Moisture content of the stored product was evaluated from first day to third day periodically. From the analysis of moisture content, it was found that there was a gradual decrease in moisture content. This could be due to the retro gradation of starch molecules leading to moisture loss thus making the product more dry. From Table 27 it is seen that for bread the initial moisture content was 18.75 per cent but it gradually decreased to 18.05 percent.

For bun also it was noted that the moisture content during initial stage was 17.90 percent and it gradually decreased to 17.55 per cent after the third day. In the case

of pizza base also, for the fresh product, the moisture content was 20.33 percent at the initial stage which gradually decreased to 20.16 percent after the third day.

4.9.3 Evaluation of acidity during storage

From the evaluation of acidity content of the baked products, it was found that there was a gradual increase in acidity content during storage period.

Table-28

Evaluation of acidity of baked products during storage

(Acidity %)			
Storage period	Bread	Bun	Pizza base
Initial	0.13	0.14	0.16
After 1st day	0.19	0.17	0.21
After 2nd day	0.25	0.23	0.28
After 3rd day	0.28	0.24	0.30

(Results expressed are mean values)

For bread in the initial period, the acidity content was 0.13 per cent and it gradually increased to 0.28 per cent after the third day. In the case of bun, in the fresh product the acidity content was noticed as 0.14 percent at the initial stage, which was found to increase to 0.24 per cent after the third day. For pizza base also, initially the acidity content was 0.16 percent and this gradually increased up to 0.30 per cent during the storage period.

Evaluation of moisture and acidity of rusk during storage

Among the four products rusk was kept for storage stability studies up to three months, while other products were kept for only three days. So, to judge the storage stability of rusk the moisture content and acidity content was evaluated periodically at monthly intervals.

Table 29 represents the moisture and acidity percent of rusk during the storage period for three months. From the table it was noticed that in the case of moisture, the initial value was 5.35 percent which gradually increased to 5.62 percent and 5.83 percent after the first month and second month respectively. A higher increase in moisture content was noted after the third month (6.31 percent).

Table-29

Evaluation of moisture and acidity content of rusk during storage

Storage period	Moisture (%)	Acidity(%)
Initial	5.35	0.35
After 1st month	5.62	0.62
After 2nd month	5.83	0.73
After 3rd month	6.31	0.81
CD(0.05)	0.89	0.11

(Results are expressed as mean values of four replicates)

The statistical analysis showed that there was significant difference in values of acidity content during storage period and the acidity value was found to be increase after each month interval. Initially the acidity content of rusk was 0.35 percent, while after first month and second month it was noticed to increase 0.62 percent and 0.73 percent respectively. Higher acidity content was noted after the third month of storage (0.81 percent). But the product was acceptable up to the third month.

4.9.4 Microbial study of stored products

Usually food products are the carriers of micro organisms which can cause deleterious effects to the body. So microbial population in baked foods is an important factor, which determines the quality and safety of the products. Microbial profile of the baked products in the study was conducted to determine

the keeping quality. In this study, to assess the rate of contamination, bacterial colonies, fungal colonies and coli form were analyzed to ascertain the microbial profile.

Table 30

Bacterial profile of the baked products cfu/g ($1x10^{-6}$)

Products	Initial	After 1^{st} day	After 2^{nd} day	After 3^{rd} day	After 4^{th} day
Bread	ND	ND	ND	ND	144 colonies
Bun	ND	ND	ND	ND	1colony
Pizza base	ND	ND	ND	ND	ND

(Results are expressed as mean values of four replicates)ND-Not detected

Bacterial profile of the rusk cfu/g ($1x10^{-6}$)

Product	Initial	1^{st} month	2^{nd} Month	3^{rd} month	-
Rusk	ND	ND	ND	ND	-

(Results are expressed as mean values of four replicates) ND-Not detected

It is evident from the Table 30 that in $1x10^{-6}$dilution, up to 3 days of storage, no bacterial colonies were found to appear in the developed products viz., bread, bun and pizza base. But, on the fourth day 144 colonies were observed in bread and 1 colony in bun. For rusk, the analysis was conducted at monthly intervals, and no bacterial colonies were found during the three months of storage.

Table 31

Bacterial profile of the baked products cfu/g ($1x10^{-7}$)

Products	Initial	After 1st day	After 2nd day	After 3rd day	After 4th day
Bread	ND	ND	ND	ND	25 colonies
Bun	ND	ND	ND	ND	ND
Pizza base	ND	ND	ND	ND	ND

(Results are expressed as mean values of four replicates) ND-Not detected

Further study of bacterial colonies at cfu $1x10^{-7}$ dilution, it was revealed that,after thefourth day 25 colonies were found in bread, while in other products no bacterial colonies were found.

Table 32

Fungal profile of the baked product cfu/g($1x10^{-3}$)

Products	Initial	After 1st day	After 2nd day	After 3rd day	After 4th day
Bread	ND	ND	ND	ND	ND
Bun	ND	ND	ND	ND	ND
Pizza base	ND	ND	ND	ND	44 colonies

(Results are expressed as mean values of four replicates) ND-Not detected

Microorganisms like yeast causes fermentation that is desirable food products. But after a certain point, it causes spoilage of food. Spoilage depends

upon the extent to which alcohol is produced due to fermentation. Microbial study of fungal colonies (cfu/g1x10^{-3}) was conducted for four days periodically on a daily basis, for bread, bun and pizza base. For rusk it was conducted for three months at monthly intervals.From the study it was noticed that 44 colonies (1x10-3 dilution) were detected in pizza base on the fourth day. In other products no fungal colonies were noticed.

No fungal colonies were detected in 1x 10^{-4} dilution. Coliform was not detected in any of the dilutions (1x$10^{-6}$and 1x10^{-7}).

4.9.5 Shelf Life at Room Temperature

Table 33 Shelf life of products at room temperature

Product	Shelf life	Shelf life of market product
Bread	3 days	5 days
Bun	3 days	6 days
Rusk	3 months	3 months
Pizza base	3 days	4 days

Based on the analysis of microbial profile and sensory evaluation during storage, the shelf life of the best treatment was confirmed and it was compared with the market products. For bread, the shelf life was 3 days while the market product had 5 days of shelf life. In case of bun, the shelf life was 3 days while the market product had 6 days. Rusk was having a shelf life comparable with market products (3 months). For pizza base, the shelf life was 3 days while the market pizza was having the shelf life of 4 days.

From the study, it can be concluded that the shelf life of the developed products were comparatively lower than the market products because the developed products did not have any added preservatives. These contained only

natural additives. Thus they can be affirmed to be healthier than the market products.

4.10 COST OF THE PRODUCT

In order to find the economic feasibility of the developed baked product, the cost of the products were worked out by taking into account the cost of raw materials (including adjuncts), labour charge, electricity charge, other expenses like packing, labeling etc. along with the 10 per cent as over head cost. The cost thus arrived at is presented in Table 34.The price of the product was calculated by the addition of 10 percent profit. It may be observed that price of the products available in the market is higher than the products standardized; excepting bread. This can be accounted to be due to bulk production of market products.

Table 34 Cost of the baked products

Products	Weight per unit (g)	Cost in Rs/-	Price of the product(Cost+ 10% profit)	Price of market product(1)	Price of the market product(2)
Bread	260	17/-	18.70/-	18/-	18.50/-
Bun	60	5/-	5.50/-	5.50/-	6/-
Rusk	180	16/-	17.60/-	20/-	18/-
Pizza base	100	12/-	13.20/-	14/-	15/-

The four baked products standardized were thus evaluated for their physical, chemical and nutrient qualities along with shelf life stability and cost. The discussion pertaining to the results obtained is discussed in the ensuing chapter.

DISCUSSION

5. DISCUSSION

The results of the present investigation entitled "Value added baked products from raw jackfruit" is discussed below, under the following heads:

5.1 Selection and collection of jackfruit

5.2 Processing of flour

5.3 Functional quality analysis of flours

5.4 Preparation of composite flour

5.5 Processing of candy

5.6 Standardization of baked products

5.7 Quality analysis of baked products

5.8 Selection of the best combination

5.9 Storage stability of selected products

5.10 Cost of the products

5.1 SELECTION AND COLLECTION OF JACKFRUT

Jackfruit (*Artocarpus heterophyllus* Lam.) belongs to the family, 'Moraceae' a native of India as well as Kerala. Kerala is a coastal state of India with abundant native fruit trees like jackfruit, karonda, and jamun .Among these fruit crops, jackfruit produces abundant crops every year even under neglected conditions. However the consumption of jackfruit is disproportionate to the fruit production in the state. Among the different types of jackfruit, k*oozha* is the most unexploited group. So there is need and scope for value addition of this produce (Priya *et al*., 2014).

Jackfruits are perishable and cannot be stored for long time because of its inherent compositional and textural characteristics. Every year, considerable

amounts of jackfruits, especially those obtained in the glut season (June-July) goes waste both in (quality and quantity) due to lack of proper postharvest knowledge of harvesting, transporting and storing.

Proper postharvest technology for prolonging shelf life has, therefore become necessary. Besides, finding alternate ways of using jackfruits in season, also plays significant role in reducing the postharvest losses. Among the various alternatives, processing is an important avenue. It adds diversified and attractive food items in the dietary as well as contributes to income and employment generation.

Jackfruit is a nutritious fruit, rich in carbohydrates, proteins, potassium, calcium, iron, and pro-vitamins such as A, B, and C. Due to the high levels of carbohydrates; jackfruit supplements other staple foods in times of scarcity in many regions. The presence of vitamins, isoflavones, antioxidants, and phytonutrients in the fruits indicate that jackfruit has cancer-fighting properties. It also helps to cure ulcers and indigestion (Amrik, 2012).

In spite of this vast potential and usefulness, jackfruit remains an underutilized fruit species and therefore deserves to be given the needed thrust for research and development.

Raw jackfruit is used to a lesser extent in our day to day dietary. It is conventionally consumed as a vegetable for the preparation of curries like‘thoran’, ‘avial’ etc. Noticeable effort has not has been given for the proper utilization of this unexploited fruit crop. So effort is required for the post harvest processing of jackfruit.

Therefore, in the present study, jackfruit *cv koozha* in the raw mature state was selected. The fruits were harvested from the trees grown in the Instructional Farm, College of Agriculture, Vellyani.

The selection criteria for the jackfruit were 90-110 days after fruit set along with light greenish colour of the outer cover, dull sound on tapping and flattened spines on the outer surface.

5.2 PROCESSING OF FLOUR

Among the various food groups fruits and vegetables are perishable commodities. High degree of perishability of these fruit crops, particularly those locally produced and grown in abundance in areas that are remote and inaccessible to markets, warrant scientific post harvest management and processing to procure high value for the products. Processing of fruit crops have multiple objectives, of which extending the consumption period, value addition and possibility of wide diversification to a range of products suiting consumer preferences are the most focussed ones.

Usually these fruits are destroyed due to the high amount of moisture content that makes them susceptible to attack of micro organisms. The shelf life of the fruit can be improved if the water content is reduced. Drying inhibits the growth of bacteria, yeasts, and moulds through the removal of water. Dehydration is a suitable method for extending the shelf life of perishable products. The dehydrated products can be used as such or further processed to use as food. Flour is a powder made by grinding and drying uncooked cereal grains, or other seeds, roots, fruits and vegetables.

In the present study, whole bulbs were removed from the fruit. It was washed and separated into bulbs, seeds and perigones. Only the bulbs were selectively taken for drying, (not the seeds and perigones). Raw jackfruit flour was prepared from the bulb using standardized procedures and stored in PP covers for analysis.

5.2.1 Preliminary Processing

Preliminary processing is the primary step involved in the processing of flour. In this step the unwanted parts of the fruits were removed and made ready

for further processing. This is released as an essential step to ensure quality of the product. In this study the preliminary processes like cleaning, cutting, blanching, immersing, drying and milling constituted the various steps in the processing of raw jackfruit bulb flour.

After harvesting, when the fruit crops come from the field it contains different types of undesirable particles like dust, insects etc which may affects the shelf life of product. So the jackfruits were washed in running water, then to inactivate the enzymes, it was further washed in distilled water.

After selection of raw materials, cleaning and cutting is an important preliminary step in the manufacture of various jackfruit products. As jackfruit is a big fruit, it was first cut into big pieces, then into smaller pieces for easy handling. After this, the whole bulbs were removed from the fruit and the weights of the whole bulbs were taken. From the whole bulbs the seeds were separated and the weights of the bulbs were taken.

Dimension is an important factor for easy drying and obtaining quality products. Hence the bulbs were sliced into 2x1 cm dimension with a steel knife.

Blanching is a process where the food substance, usually a vegetable or fruit, is plunged into boiling water, removed after one or two minute interval, and finally plunged into iced water or placed under cold running water (for refreshing) to halt the cooking process.

Blanching is important for fresh fruits and vegetables before drying them. Sometimes, it is used to remove undesirable flavours from foods before using them. All fruits and vegetables contain enzymes; blanching can turn off enzymatic activity, prevent browning and also deactivate the microbial growth. Blanching also helps to achieve a crisp-tender texture.

In this study, the cut raw jackfruit bulbs were blanched in hot water for 2 minutes and immersed in ice cold water with 0.2 percent potassium metabisulphite (KMS) solution.

Drying is one of the oldest methods of preserving food. It is simple, safe, and an easy method. Dried foods make great sources of quick energy. The principle involves removing water from the food, which inhibits the growth of bacteria yeasts, and mould and slows down enzymatic action without deactivating them. These factors ensure that the food does not spoil easily and hence, makes drying an effective food preservation technique and has been practiced worldwide since ancient times to preserve food.

In the present study, the pre treated bulbs were kept for drying at 65^0C in hot air oven for 14 hours. After drying the dried bulbs were ready for milling then the dried bulbs were packed in PP covers and were given for milling.

Milling is an act or instance of subjecting something to the operation of a mill. This is defined as a process of grinding, especially grinding grains, or any dried products into flour or meal.

Dried jackfruit bulbs were milled into flour and sieved in the mesh size of 0.05 mm. Residue, leftover after sieving was removed to get a uniform fine powder. The processed jackfruit bulb flour was packed in PP coversand kept in closed containers and stored under dry conditions at room temperature, until used for further applications (Veena, 2015).

In the present study, a significant portion of refined wheat flour used for the development of the baked product was replaced with jackfruit bulb (JFB) flour, with the aim of improving the nutritional quality.

5.3FUNCTIONAL QUALITY ANALYSIS OF FLOUR

Functional properties are the fundamental physico-chemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical properties of food components together with the nature of environment in which these are associated and measured (Kaur and Singh, 2006).

Functional characteristics are required to evaluate how proteins, fat, fibre and carbohydrates may behave in specific systems, as well as demonstrate whether or not such proteins can be used to stimulate or replace conventional protein (Siddiq *et al*., 2009).

In the present study, the jackfruit bulb flour was analyzed for its functional properties viz. water absorption index, oil absorption index, foaming capacity, swelling power and solubility.

5.3.1 Water Absorption Index

Water absorption capacity of flour is defined as the difference in weight of the flour before and after water absorption, (Abbey and Ibeh, 1988). It describes the ability for association with water under limited supply. Imbibing of water is an important functional trait in foods such as sausages, custards and dough. (Adebowale and Lawal 2003).

Water absorption capacity is specific for each type of starch, and it depends on several factors such as amylase : amylopectin ratio, intra and inter molecular forces and size of granules, (Rahman *et al.*, 1999).The smaller the size of the granules, the higher the absorption capacity (Singh *et al.,* 1991).

High water absorption capacity of flours suggests the possibility of presence of some hydrophilic constituents, such as polysaccharides. Increase in water absorption capacity may be due to the water adsorption via existing polar binding sites distributed over the protein surface, and molecular rearrangement leading to the exposure of more polar binding sites. High water absorption may also be due to the nature of the starch and possible contribution to water absorption by the cell wall materials (Sathe and Salunkhe, 1981).

A study conducted by Oppong *et al*., (2015) reported a water absorption capacity of 2.27 per cent in cowpea.In the present study, water absorption index of jackfruit bulb flour was compared with the refined wheat flour and from the analysis it was found that jackfruit bulb flour had higher (2.95%) water absorption

index than wheat flour (1.50%).It suggests that jackfruit bulb flour would be useful in foods such as bakery products which require hydration to improve handling features.

5.3.2 Oil Absorption Index

Oil absorption capacity of a food material can be defined as the difference in weight of flour before and after oil absorption (Giami *et al.*, 2004). Oil absorption capacity is an important criteria in food formulations. Oil absorption capacity aids food formulations and gives an indication of the flavour-retention capacity of flours (Odoemelam, 2000). Moreover, it is useful in the physical structural interactions of food, including extension of shelf life, particularly in bakery or meat products (Adebowale and Lawal, 2003). Hydrophobic proteins show superior binding of lipids, implying that non-polar amino acid side chains bind to the paraffin chains of fats (Adejuyitan *et al*., 2009).

Oil absorption index of bread fruit flour was analyzed and it was found to be ranging between 0.50 ml per gram to 1.25 ml per gram. Udensi and Okoronkwo (2006) reported that all the flours of the *Artocarpus spp.* had higher oil absorption capacities than mucuna bean (2.2g/g).

Aremu *et al.* (2006) reported relatively high oil absorption capacity of *T. africana* flour suggested that it could be useful in food formulations where oil holding capacity is needed such as in sausage making, soups and cakes. According to Sreerama *et al*. (2012), it was observed that decrease in solid content (carbohydrate) resulted in increased oil absorption in chickpea flour. Osundahunsi (2009) observed decreased oil absorption with decreased carbohydrate content in ripe plantain flour.

In this study, the oil absorption capacity of jackfruit bulb flour (1.61%) was lower than refined wheat flour (3.40%).The lower oil absorption capacity of jackfruit flour could be due to lower concentration of hydrophobic proteins. The relatively low oil absorption capacity of JFB flour suggested that it could absorb only little fat, which is a healthy characteristic.

5.3.3 Foaming Capacity

Adebowale and Lawal(2003) had reported that, increase in concentration of proteins enhances greater protein–protein interaction, which increases viscosity and facilitates formation of a multilayer cohesive protein film at the interface. So, increase in concentration could again lead to the formation of thicker films, which limits the drainage of protein from films. Foam stability is important, since the usefulness of whipping agents depends on their ability to maintain the whip foam as long as possible (Lin *et al*., 1974).

From the study, it was noted that the foaming capacity of refined wheat flour was 20.12 per cent which was higher than the jackfruit bulb flour (13.20%), which suggests that the jackfruit flour had low protein with foaming capacity.

According to (Jones et al., 2000), increased unfolding and fragmentation of protein may enable the formation of more continuous phases of thin liquid layers which trap air bubbles, resulting in increased foaming capacity The foam capacities of the flours of the breadfruit cultivars were found to be between 5.83 per cent and 25.00 per cent.

According to Narayana and Narayasimga (1982), foam capacity is attributable to protein content and solubility since foam ability is a function of solubilised proteins. Nwokolo (1985) reported that, the amount of polar and non-polar lipids in a sample affects foam capacity of a sample.

5.3.4 Swelling Power

According to Loos *et al*. (1981), swelling power is an indication of the water absorption index of the granules during heating. Dengate (1984) stated that, swelling power is seen as mainly the result of swelling of granules permitting the exudation of amylose. King (2005) reported that, usually the higher the swelling power, the more soluble the flour is in solution.

Iwe (2003) stated that, swelling is often affected by the processing time. In the present study the swelling power of the jackfruit bulb flour was 16.35 percent

and for refined wheat flour it was 12.75 percent. It proves the fact that higher the water absorption capacity, higher the swelling power.

5.3.5 Solubility

According to Singh (2001), solubility is indicative of water penetration ability into starch granules of flours. Modification of starches could be important for absorption and retention of water, which leads to increase in swelling powers of starches required in the manufacture of confectionery goods. Increased leaching of solubilized amylose molecules from swelled starch granules results in increased solubility (Tumaalii and Wooton, 1988).

From the study it was obtained that solubility of jackfruit bulb flour was 12.11 percent and for refined flour it was 11.50 percent. So it can be observed that the jackfruit flour is having higher solubility capacity than refined wheat flour which has been reiterated in literature that higher water absorption capacity and swelling power revealed greater the solubility.

According to Johnson (2001), higher solubility would permit better digestibility. Solubility of the bread fruit flours in distilled water ranged between 8.01 percent and 11.9 percent.

5.4 PREPARATION OF COMPOSITE FLOUR

Composite flour is a mixture of flours, starches and other ingredients intended to replace wheat flour totally or partially in bakery and convenience products. Composite flours are the mixture of different vegetable flours rich in starch or protein, with or without wheat flour for certain group of bakery products.

Noorfarahzilah *et al*. (2014) reported that the development of food products using composite flour has increased and is attracting much attention from researchers, especially in the production of bakery products and pastries and has found to give positive effects with respect to functional and physicochemical

properties. There was also improvement in health benefits of raw blended flour with increased percentage of blending.

Igbabul *et al*. (2015) prepared samples of bread A to E. Sample A was the control with 100 percent wheat flour, while Sample B to E had maize and sweet potato flours added in an increasing order of 5 to 20 percent for the preparation of bread. The sensory qualities of the treatments were found to be on par with control.

In a study by Giwa and Abiodun (2010), composite flour from quality protein maize (QPM) flour and wheat flour was utilized for the production of biscuit, with the bid to increase the protein quality of biscuit and promote the utilization of QPM. The QPM and wheat flours were blended at various ratios to give five blends. The ratios were (wheat: QPM) 100:0; 70:30; 50:50; 30:70 and 0:100.The blends were thoroughly mixed using mixer. The biscuits produced from the composite flour were acceptable and compared favorably with the control.

Abdelghafor *et al*. (2010) reported that whole and decorticated sorghum flours were used to replace 0, 5, 10, 15, and 20 per cent by weight of bread wheat flour. Sensory evaluation results showed that up to 20 percent wheat replacement with whole or decorticated sorghum flour produced acceptable ‘pan’ and ‘balady’ breads.

The wheat flour fortified with different proportions of Jerusalem artichokes tubers flour (5%, 10%, 15% and 20%) and with partially defatted hemp seeds flour (5%, 10%, 15% and 20%), as well as with a mixture of these two ingredients (5% Jerusalem artichokes tubers flour + 6%, 10% and 15% partially defatted with hemp seeds flour), was analyzed in terms of composition; the influence of these ingredients on the nutritional composition and rheological traits of the wheat flour were observed to be acceptable. (Livia, 2015)

In this study refined wheat flour (RF) and jackfruit bulb flour (JFB) were the basic materials used for the development of composite flour. The different combinations 40:60(T_1), 45:55(T_2), 50:50(T_3), 60:40(T_4), 70:30(T_5), 80;20(T_6) and (T_7)100 percent refined flour (control), were attempted for the composite flour formulations of the baked products.

5.5 PROCESSING OF CANDY

Jack fruit candy was added to enhance the sensory appeal of the product (Poornima, 2014).

Nur *et al.,*(2014)experimented with watermelon rind (Citrullus lanatus). Dehydrated candy was prepared by using osmotic dehydration process that involved slow impregnation of syrup before drying at 50°C for 8, 14 and 20 hours. From the study, it was seen that the drying time significantly affected the moisture content of the watermelon rind dehydrated candy. The moisture content was significantly decreased with drying time. For colour evaluation, the L* value of watermelon rind dehydrated candy was slightly decreased with drying time while the a* value was slightly increased. Watermelon rind dehydrated candy that dried for 14 hours was the most preferred sample by the panellists as it received the highest score for texture, taste and overall acceptability attributes. So, it was concluded that 14 hours of drying time is the most appropriate time to dry the candied watermelon rind.

Jakia *et al* (2014) conducted a study to develop and investigate pineapple (*Ananas comosus*) preserve and candy to assess its prospect in marketability and study their storage life. Pineapple slices were treated with 2 per cent solution of common salt to prevent browning, then cut into cube shape and treated with 1 percent calcium chloride and 0.25 percent potassium metabisulphite solution and finally processed. The preserves were processed at in60° Brix, 65° Brix and 70° Brix sugar syrup. Initially the compositions of pineapple preserves processed with different levels of sugar were found to have moisture content in the range of 33.09-35.65 percent. The sensory results showed that colour, flavour, texture, taste and overall acceptability scores differed significantly ($p<0.05$).The preserve (P_2) processed from 65° Brix sugar syrup and the candy (C2) processed from 70° Brix sugar syrup was the favourite sample of the sensory evaluation with the highest overall acceptability among others of the similar product.

5.6 STANDARDIZATION OF BAKED PRODUCT

Usually, people with sedentary life style have the habit of taking snacks during day time. Baked foods are more healthier and nutritious than fried foods. It offers great convenience and variety. Moreover It is affordable by all economic groups of people and provides an easy source of energy.

Stevenrio(2012) reported that, bakery products are becoming prominent day by day. They are very popular because of their taste and ease in digestion. Bakery items are usually loved by all. Now a days, individuals have virtually no time to spare in making breakfast, thus breads, buns or biscuits have taken their place.

Moreno *et al*. (2008) reported about breads were made from pure wheat flour(WF) (control) and four formulations of flour composed of WF and cactus pear stem flour SF, I (WF 100%; control), II (SF 5%), III (SF 10%), IV (SF 15%) and V (SF 20%). Farinaceous test analysis revealed that flours composed of formulations II and III showed the best baking behavior and concluded that prickly pear stem flour is a viable alternative for making bakery products.

In this study, four acceptable baked products were processed. *viz.,* fruit bread, rusk, bun and pizza bases. They were formulated following standardized recipes. The products were developed at the Asian Bread Factory Kaniyapuram Trivandrum.

Marić *et al.*(2008)reported that bread is a product which is obtained by mixing, fermenting, forming and baking of dough obtained from basic raw materials such as: flours obtained from cereals, water or other allowed liquids, baker's yeast and other fermentation aids and table salt. With the aim of the improvement of the physical and sensory properties and shelf life of bread, the use of additives is permitted.

Michael *et al.* (2013) experimented with blends of wheat flour and rice bran (95:5, 90:10 and 85:15) to bake bread along with 100% wheat flour as control. Bread was baked from the flour samples using the straight dough method of. All the ingredients were thoroughly mixed in a dough mixer to form dough,

which was put into a baking pan greased with plasticized fat and covered with greased bread wrapper. The dough was fermented for 90 minutes at room temperature (28°C - 30°C), proofed at 35°C - 40°C for 90 minutes, and baked at 250°C for 30 minutes. The bread loaves were packaged in low density polyethylene bags for consumption and stored at room temperature for future analysis.

In the present study, the bread and bun were prepared following the straight dough method at Asian bakery. Rusk was processed by the rebaking the bread. Pizza base was also processed by following a standardized recipe.

5.7 QUALITY ANALYSIS OF THE BAKED PRODUCTS

Now a days, consumers are becoming more aware of the importance of safe, high quality products both from sensory and nutritional point of view. In order to improve and control the product quality, it is essential to fully understand the meaning of the term quality. A common definition is "achieving agreed customer expectations or specifications".In other words, the ‘customer’ defines the quality criteria needed in a product.

Aleksandar (2006) reported that, Food industry occupies a special place in the processing industry, especially when it is discussed in the context of manufacturing of bakery products. Baking industry is characterized with a variety of different products that daily find their place in the market. Their quality targets all possible generations of consumers.

In this study, quality of the baked products were assessed from the point of view of physical, chemical, nutritional and sensory qualities. Analyses were conducted for all treatments of the four products.

5.7.1 Physical Properties of Baked Products

Physical properties are often characterized as intensive and extensive properties. An intensive property does not depend on the size or extent of the system, nor on the amount of matter in the object, while an extensive property shows an additive relationship. These classifications are in general only valid in

cases when smaller subdivisions of the sample do not interact in some physical or chemical process when combined

Sani *et al*. (2014) reported that, baking is a complicated process and optimum conditions vary with the type of food being prepared and even with the specific formulae within the food type. They also mentioned that the final product properties are not only affected by the formulation (choice and quantity of ingredients) but also by processing conditions

5.7.1.1 and 5.7.1.2*Physical properties of bread and bun*

The characteristics assessed in the physical properties of fruit bread and bun were raw weight, baked weight, raw depth, baked depth and baking time. These were analyzed and the observed values were compared with control T_7.

***Raw weight** and baked weight*

Raw weight can be expressed as the total weight of main raw materials which are used for the processing of baked products. In the present study the raw weight remained same (300gm) for bread and bun (80gm) to yield product of similar dimensions.

Summu *et al.* (1999) stated that, baked weight can be measured by determining both the initial weight of the batter as well as the weight of baked products after removal from the oven and made cool. In this study, for bread it was observed that T_6obtained the lowest weight 263.00g after control andT_1obtained the highest weight (282.00g).It was noticed that higher the amount of jackfruit flour, higher was the weight of the product. In case of bun the highest weight (65.10)g was obtained for T_3 and the lowest weight of 61.05g was obtained for the treatment T_6. It can be concluded that after baking, there was decrease in weight owing to the decrease in moisture.

Raw depth and baked depth

Depth of a baked product is measured usually downward from an upper surface by using the scaling device, horizontally inward from an outer surface. The

measurement of the distance between top or surface to the bottom of the product was done.

In this study the raw depth of bread and bun was measured by inserting a thin sleek stick before baking and the baked weight was measured similarly, after baking. The difference in depth was measured. From the study it was observed that there was an increase in depth of the baked products in comparison with the raw depth. In the case of bread highest baked depth of 3.8cm was obtained by T_6 after control and lowest baked depth 3.30cm was observed in T_2.

The study again points out that, increase in refined flour increased baked depth and decrease in baked depth was observed with increase in raw jackfruit flour in the case of both fruit bread and bun.

Baking time

Shibukawa *et al.*(1989) reported that, baking time and temperature highly influenced heat transfer and the quality of a baked product, due to complex physicochemical interactions that occur between the ingredients, leading to the differences in texture, aroma and colour of the products.

Nwosu *et al.*(2014) standardized the time for the processing of bread from wheat and African oil bean flour which was 15 minutes and the temperature was 250^0 C.

In a study on composite flour based bread, the proofed dough was baked at 220^0C for 7min in an oven with air circulation. Then, the bread was cooled for 60min at ambient temperature (Maria *et al.,*2013).

A study was conducted by Mongi (2011) on Cocoyam wheat composite bread. In this study the dough was proofed in a proofing cabinet for 90 min at 30°C in 85% relative humidity and baked at 250°C for 30 min.

The baking time standardized for the fruit bread was 25 minutes at 230^0 C and for bun it was 30 minutes at 230^0C which was almost similar with various studies.

5.7.1.3*Physical properties of rusk*

Yield percent

Conventionally the yield of a product can be expressed from a known quantity of raw material to assess the quantity of processed product obtained. In the present study on rusk, the highest yield (63.15 percent) was obtained by T_2 which was processed from 45 percent refined flour and 55 percent jack fruit bulb flour and the lowest yield after control of 57.21 percent was noted in T_6 with 80 percent and 20 percent refined flour. From the study it can be concluded that with increase in quantity of JBF there was an increase in yield, which indicated that JFB can affect bulk of processed products.

Volume

In the present study volume of rusk was measured by the grain displacement method. The highest volume of 33.20cc was obtained by treatment T_6after control and the lowest volume of 18.10cc was noted for T_1. So from the above study it can be concluded that, with the increase in amount of refined flour there was an increase in volume of rusk.

Raw weightand baked weight

Raw weight of a baked product is the weight of the dough before baking. Literature shows that weight loss is noted after baking due to different factors like moisture loss, change in structure of protein etc. This is a common outcome seen in baked products. Baked weight of a bakery product is taken after baking and cooling. The difference in weight after baking was higher for T_1 with jackfruit flour and refined flour in the ratio 60:40 and T_6 noted the least difference. This indicates that jackfruit bulb flour gives bulk to the products.

Baking time

The baking time for the rusk was 20 minutes, while for the raw material bread the baking was 25 minute at 250^0c. Kulkarni and Joshi (2014) prepared

rusk with a standard recipe consisting of refined wheat flour 100g, sugar 50g, fat 60 g, sodium bicarbonate 0.5 g and custard powder 2 g and baked for 30 minutes. The physical nature of rusk can be compared with products like biscuits and cakes.

Biscuits were prepared by replacing wheat flour with pumpkin powder at different levels viz. 0, 2.5, 5.0 7.5 and 10% (w/w) in standard formulations as reported by Pongjanta *et al.* (2006) Baking was carried out at 175^0C for 12 min.

Ogunjobi,(2010)formulated circular biscuits with cassava flour and cashew apple powder with a diameter of 5.52cm.They were cut, placed on greased trays and baked in an electric oven at 150^0C for 20 minutes.

5.7.1.4*Physical properties of pizza base*

Raw weight and baked weight

In the present study, raw weight was same for all the seven treatments, i.e. 120 g, after kneading, moulding and proofing. With regard to baked weight, it was found that T_6 obtained the lowest baked weight 90.66 g from 120 g and highest baked weight of 99 g was obtained for treatment T_1.Increase in refined flour accounts for more air incorporation and hence lighter weight.

Raw depth and baked depth

The raw depth and baked depth for Pizza base was measured by piercing a measuring scale to the bottom of the product before baking (after mixing and kneading) and also after baking. The raw depth was same for all the seven treatments. In case of baked depth it was found that there was a decrease in baked depth with addition of refined flour. Probably the effect of pressure in kneading of spreading also contributed to the baking depth and horizontal spread was more than upward spread.

Baking time

Jack fruit seed based baked products were prepared with wheat flour mixed in varying inclusions of 0, 25, 35, 45 and 55% .The composite flours were mixed with rest of baking ingredients and kneaded for 5 min into consistent dough

and the resulting dough was molded and placed in a pre-oiled baking bowl. The dough was proofed for 40 min at 35^0C and then baked in oven for 35 min at 217^0C (Ndife *et al.,* 2011)

Baking time was the time taken for the processing of Pizza base from the dough. For this study, the baking time was same for all the seven treatments i.e. 10 minutes at 250^0 C. Uniform amount of dough and similar processing methods accounts for the similarity in baking time.

5.7.2 Nutrient and Chemical Composition of Baked Products

Nutrient and chemical analysis of food is the discipline dealing with the development, application and study of analytical procedures for characterizing the properties of foods and their constituents. These analytical procedures are used to provide information about different characteristics of foods, including their composition, structure, physicochemical properties and sensory attributes.

In the present study the nutrient and chemical constituents such as energy, protein, fat, fiber, moisture and acidity were analyzed using the methods suggested by AOAC (2005).

5.7.2.1 *Nutrient and chemical composition of bread*

Energy is essential for growth, maintenance, activity and rest (Joosen *et al*., 2005).In the present study the energy value was calculated from the levels of carbohydrate, protein and fat estimated. The study revealed that highest calorie value of 299.00 Kcal was obtained by T_6after control T_7 (310.00 K cal.) The lowest calorie content 247.00 Kcal was found in T_1 of bread which was processed from the RF and JBF with ratio of 40:60.The lowest calorific value of T_1 and T_2 indicated that with increase in quantity of jackfruit flour there was decrease in calorific value. Veena (2015) pointed out that the jackfruit bulb flour had lower calorific value than refined flour. So these low calorie bread can be recommended for obese and diabetic patients.

Protein is one of the most important nutrients required by the body to carry out a wide range of functions, essential for the maintenance of life (Gopalan *et al*., 2009).In this study, from the analysis of protein content it was found that T_6

obtained the highest protein content (9.05g) after control T_7(10.05g), where as $T_1$was found to be have the lowest level of protein content 5.05g. This is because jack fruit bulb has lesser amount of protein than refined flour.

In a study on bread formulated from of wheat flour (WF) and sesame flour (SF), the wheat flour (WF) was substituted with SF at 0, 5, 10, 15 and 20 per cent. The proximate composition of wheat and sesame flours and bread samples were determined using standard procedures. From the analysis it was found that the fat content of developed product ranged between 3.72g to 10.04 g.

In the present study from the analysis of fat it was observed that lowest fat content of 2.95g was obtained by T_1 and the highest fat content of 3.48g was noted for T_6 after control T_7 3.50g.This difference in fat content was due to the lower fat value of jackfruit bulb flour compared to refined flour.

Plant foods, have indigestible complex molecules, namely fibre which contribute to the bulk of intestinal contents thus serving the digestive tract. It is the indigestible portion of food derived from plants. From the analysis of fibre content of fruit bread it was observed that the highest fibre was present in treatment T_1 (6.41g) and the lowest fibre obtained for treatment T_6 after control T_7 (3.00g).This is owing to the fact that refined flour has lesser quantity of fibre than raw jackfruit bulb flour. Raw jackfruit flour based bread, would thus be suitable for different diseased conditions like cardiac diseases, obesity, diabetes mellitus.

Moisture content of the food material is an important attribute as it affects the physical and chemical aspects of food and relates to the freshness and stability of food. The analysis of moisture content of fruit bread revealed that the moisture content was lowest in treatment T_6 (18.75%) after control T_7 (18.15%), while the moisture content was highest in T_1 (21.05%). This was due to lesser moisture of JBF.

From the analysis of acidity of fruit bread it was observed that the highest acidity was found in treatment T_1 and T_7 (0.14%). The lowest acidity was found in T_4 (0.10%).Acidity is affected by biochemical reactions accompanying the processing methods and also changes during storage.

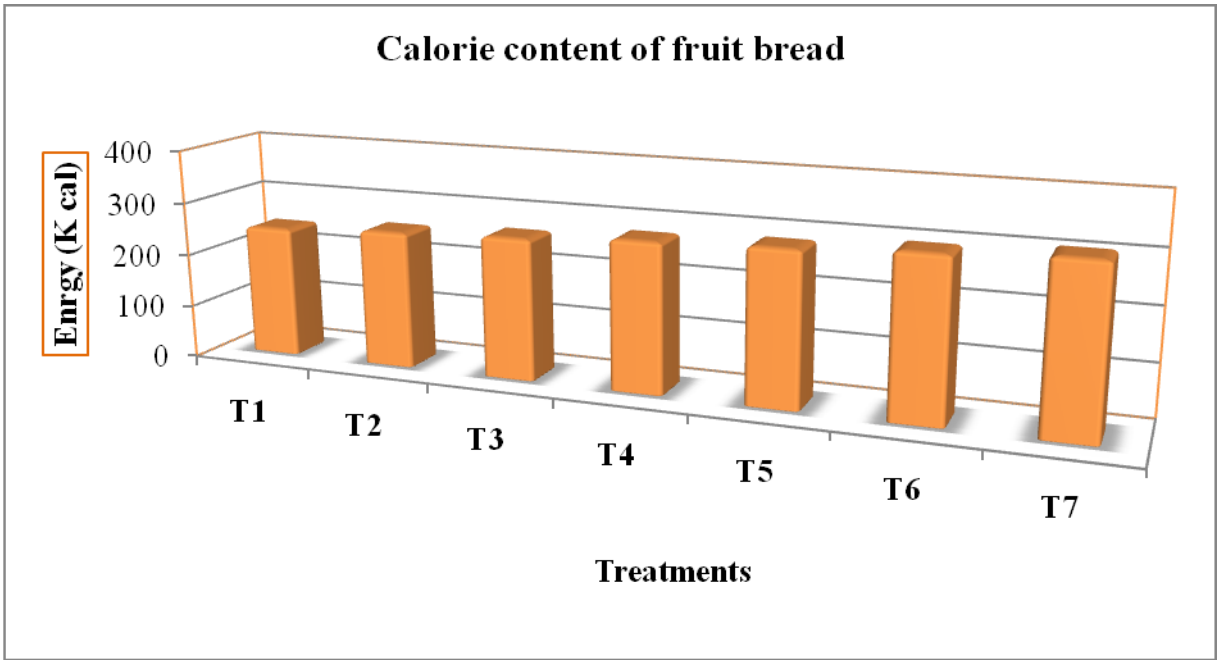

Calorie content of fruit bread
Enrgy (K cal)
400
300
200
100
0
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-2

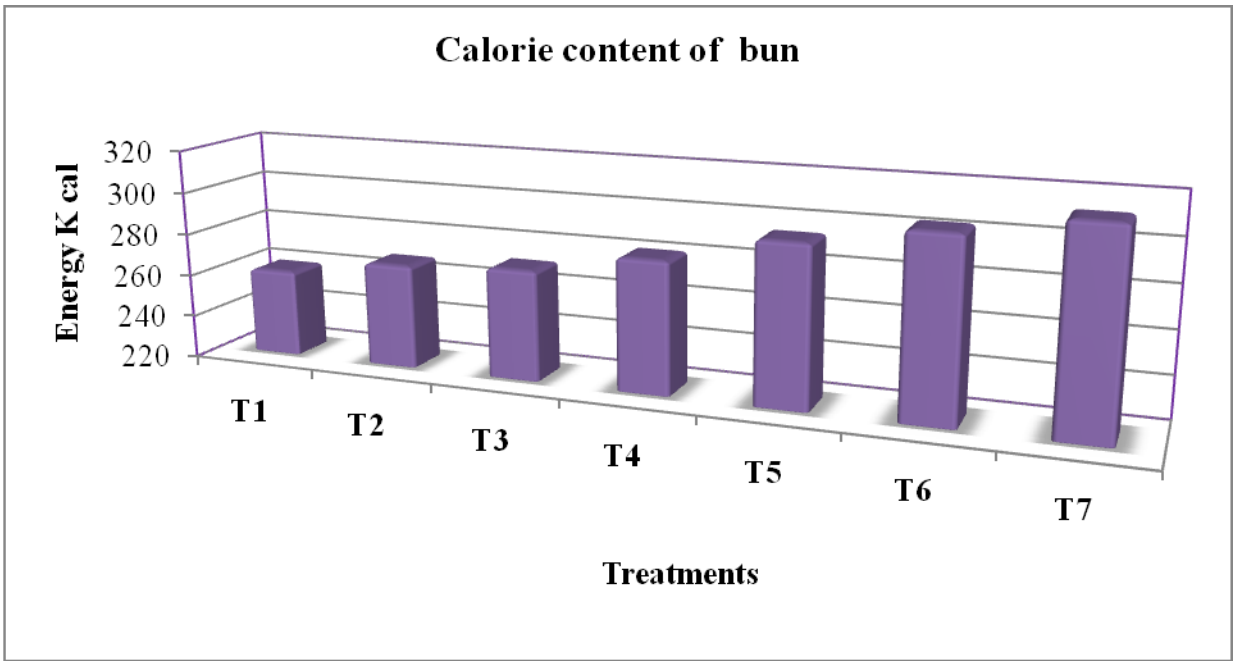

Calorie content of bun
Energy K cal
320
300
280
260
240
220
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-3

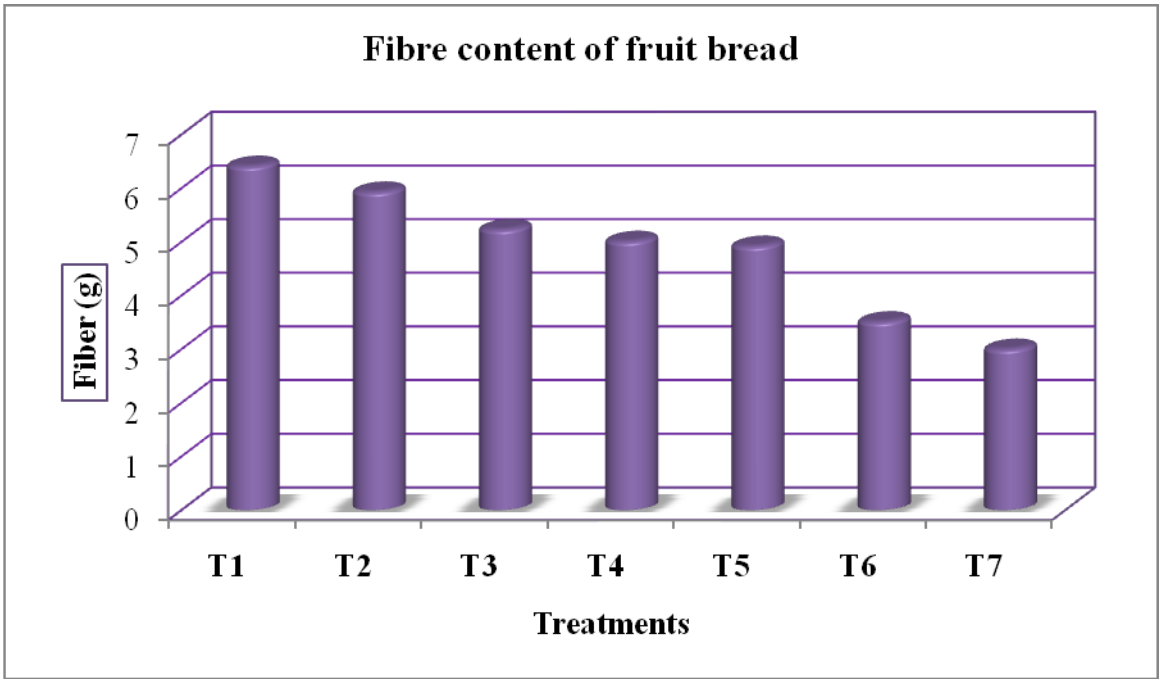
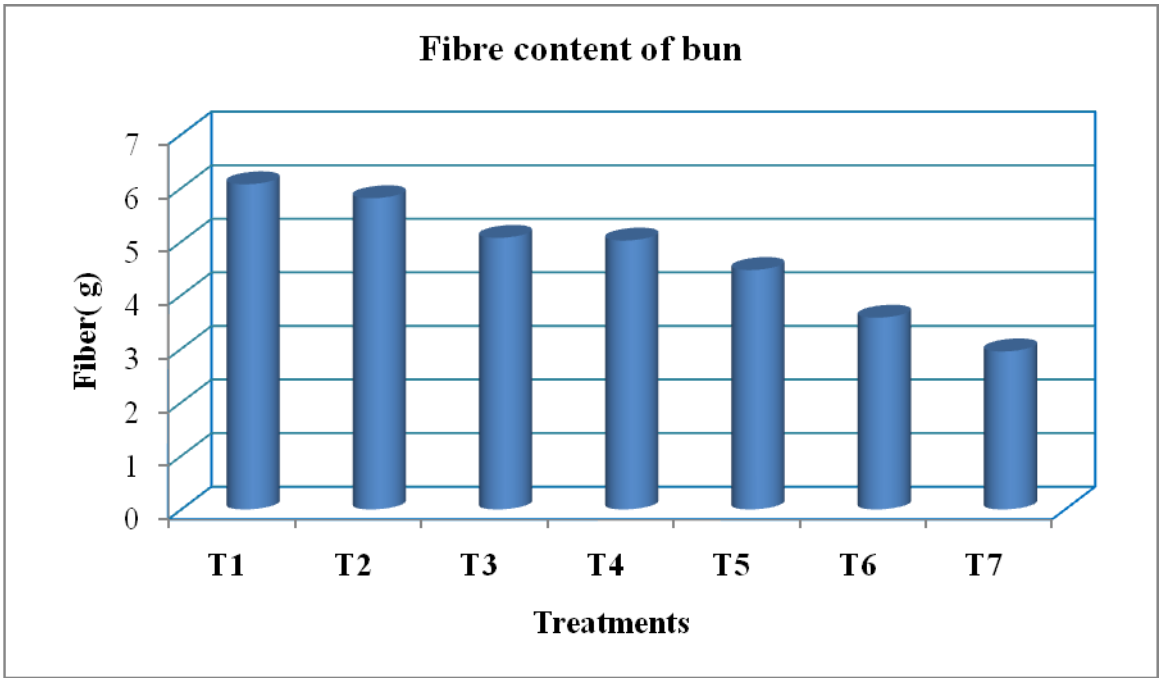

Fibre content of fruit bread
Fiber (g)
0
1
2
3
4
5
6
7
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-4


Fibre content of bun
Fiber(g)
0
1
2
3
4
5
6
7
T1
T2
T3
T4
T5
T6
T7
Treatments

5.7.2.2 Nutrient and chemical composition of bun

Serem *et al*. (2011) reported fortification of wheat flours with defatted and non-defatted soy flour, respectively. The composite breads from this flour contained energy values in the range of 241 to 266 Kcal, and hence conformed to the recommended minimum energy content of 1674 kJ/ 100 g.(FAO/WHO, 2003)

In this study, from the analysis of calorie value of bun it was observed that the highest energy content 304.00 Kcal was observed for T_6after the control T_7 (313.00 Kcal), while the lowest calorie value261.00 Kcal was obtained for T_1.Here again raw jackfruit flour based products had low calorie than refined flour based products. So jackfruit bun can be recommended as a low calorie bun.

Protein is the building material for our skin, bones, muscles and other tissues in the body. Protein is a major component of enzymes, antibodies, and hormones. These are chemicals that play a major role in many processes in the body that, among other activities, digest food, fight disease and allow enjoying a healthy life. From the study it was observed that T_1 contained the lowest protein content 5.31g and T_6 revealed the highest amount of protein 9.02g after control. Protein content of predominantly raw jackfruit based products are less as jackfruit has lesser content of protein.

In the present study from the analysis of fat content, it was noted that, high fat content of 3.48g was noticed in T_6 after control T_7 (3.53g). The lowest fat content of3.15g was observed in T_1 which can be useful in dietary management of obesity and also maintaining health and controlling diseased conditions.

Dietary fibre components exert beneficial effects mostly by way of their swelling properties, thereby increasing transit time in the small intestine. Consequently, they reduce the rate of release of glucose and its absorption, thus help in the management of lifestyle disease.

In the present study among the seven treatments the highest fibre content of 6.07g was obtained by T_1 which was significantly different from others treatments and the lowest fibre content of 3.58g was obtained in T_6 after control T_7 (2.95g). This is because the JBF is rich in fibre while RF is a poor source of fibre. Hence RJF bun could be acceptable in places where fibre diets and low fat foods are prescribed. Supplementation of jack fruit seed flour to the wheat flour in bread increased fibre and slightly decreased protein (Ejiofor *et al*., 2014).

Moisture is one of the important parameters which determine the shelf life quality of food product. Low moisture is highly important for longer storage period. From the analysis of moisture content it was found that the lowest moisture was found in T_6 that was 17.90% after control T_7 (17.81%) and the highest moisture content 18.55% was found in treatment T_1.Probably jackfruit flour incorporates with it more moisture content, this resulting in higher moisture content for treatments T_1 to T_3.

From the analysis of the acidity content it was found that the highest acidity content for bun was obtained for T_1 i.e. 0.42% while the Lowest acidity content was found for T_4 (0.05%). Acidity of raw jackfruit had increased the acidity content of treatmentsT_1 to T_3.

5.7.2.3 Nutrient and chemical composition of rusk

The calorie value of developed rusk was compared with two branded rusk in the market. From the comparative study it was found that the energy content was 407 kcal and 461 kcal respectively.

When the calorie value of developed products and branded product were compared.T_4 to T_6revealedcalorie values almost nearer to the market product. But T_1 with refined flour and jackfruit flour in the ratio 60:40 had comparatively low calorific value, which proves that with increase in amount of JBF there is decrease in calorie value.

In a study conducted by Ahmad *et al.*(2012), on impact of Xylitol on physicochemical and sensory parameters of rusks, it was revealed that the protein content of developed rusk ranged between 7.42 percent to 7.54 percent.

Protein in terms of quantity and quality is a vital nutrient. The protein content of the developed rusk treatments were analyzed and from the analysis it was observed that the lowest protein content of 5.36gwas obtained for T_1. The highest protein content was found in T_6 (8.18g) after the control T_7 (9.12g). There was slight difference between the protein content of related products reviewed. This may be due to the difference in ingredients.

In this study the maximum fat content 3.58g was noted for T_6 after control T_7 (3.67g) and the lowest fat content of 3.18g was observed in T_1.A study by Ahmad *et al,*(2012)on cookies revealed that the fat content ranged between 11.55 percent to11.58 per cent which was processed using commercial ingredients like xylitol refined wheat flour , ghee, sugar, yeast, salt and eggs. The ingredients of the products in this study have relatively lower fat content.

Dietary fibre components helps to bind to bile salts, thereby promoting cholesterol excretion from the body and thus reducing blood cholesterol levels, and food toxins in the gut (Gopalan *et al*., 2009).The highest fibre content was found in T_1 (6.05gm) and lowest fibre content was in T_6(3.54g) following control T_7(2.90g).

A study by Bose and Sams (2010) on production of wheat biscuits fortified with chick pea flour revealed that with addition of 25 percent chickpea flour in the refined wheat flour the fiber content became 2 g. But in the present study the fiber content is comparatively higher as JBF is a rich source of fibre.

A study by Noor *et al.*(2012) showed that, in fortified cookies which were prepared with refined wheat flour, chickpea flour and mung bean flour, the moisture content ranged between 2.75 percent to 2.92 percent. The moisture content was comparatively high as the moisture content of JBF was higher than usual ingredients of rusk..

Fig-5

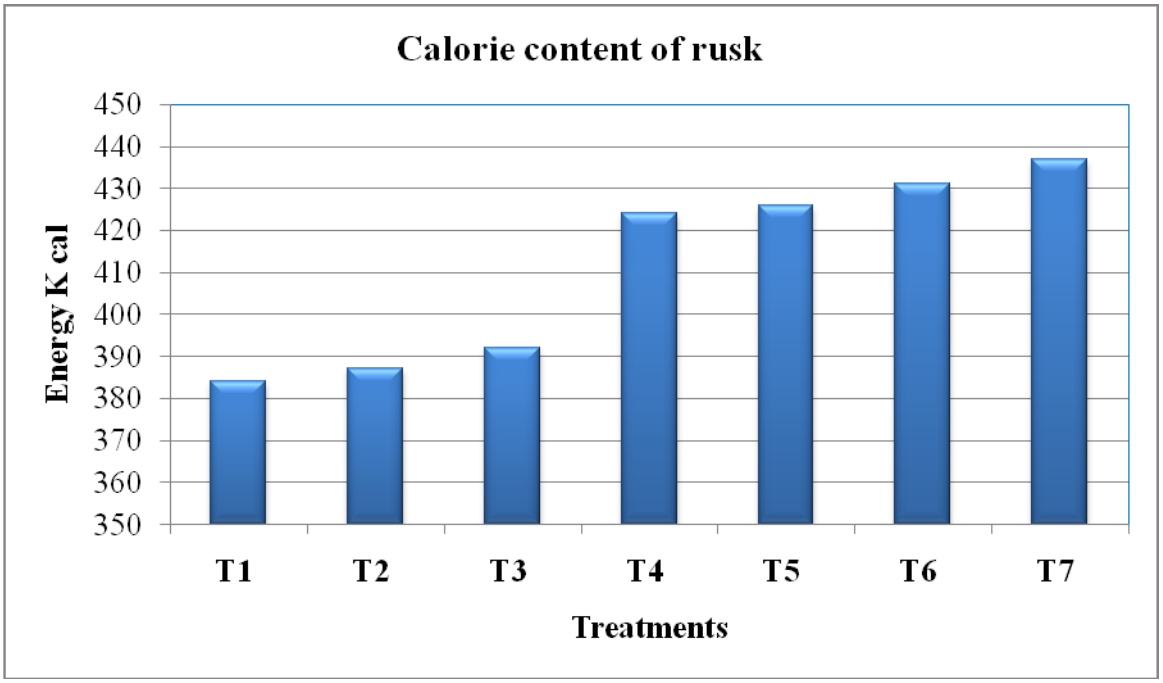

Calorie content of rusk
Energy K cal
450
440
430
420
410
400
390
380
370
360
350
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-6

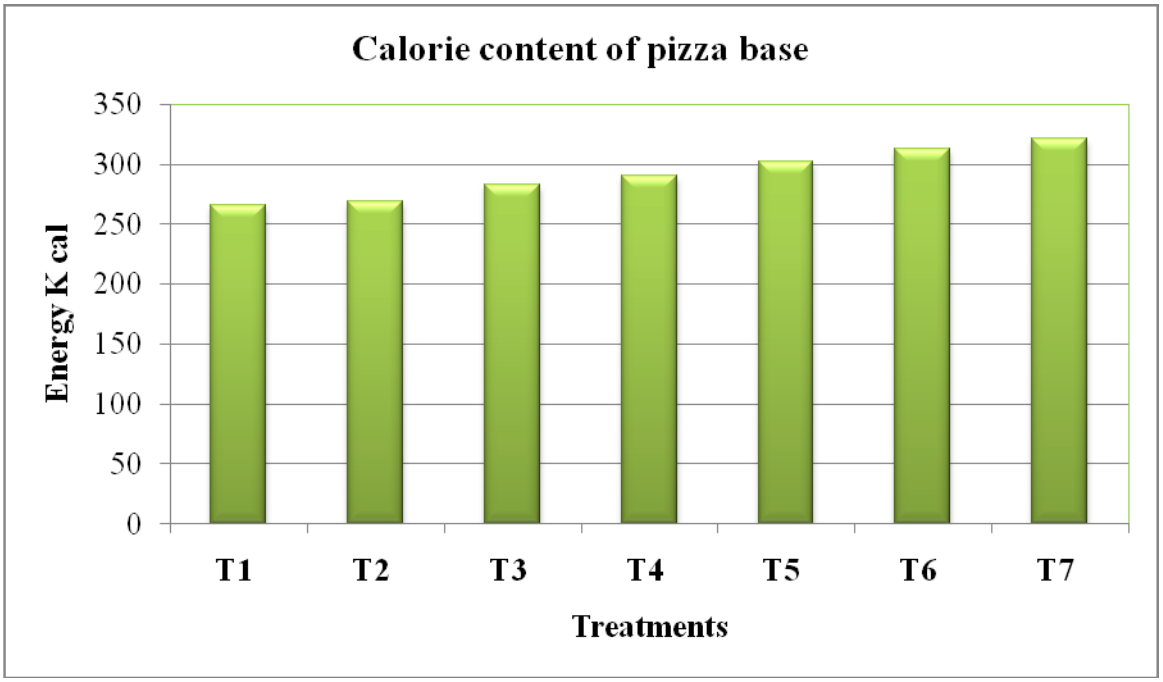

Calorie content of pizza base
Energy K cal
350
300
250
200
150
100
50
0
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-7

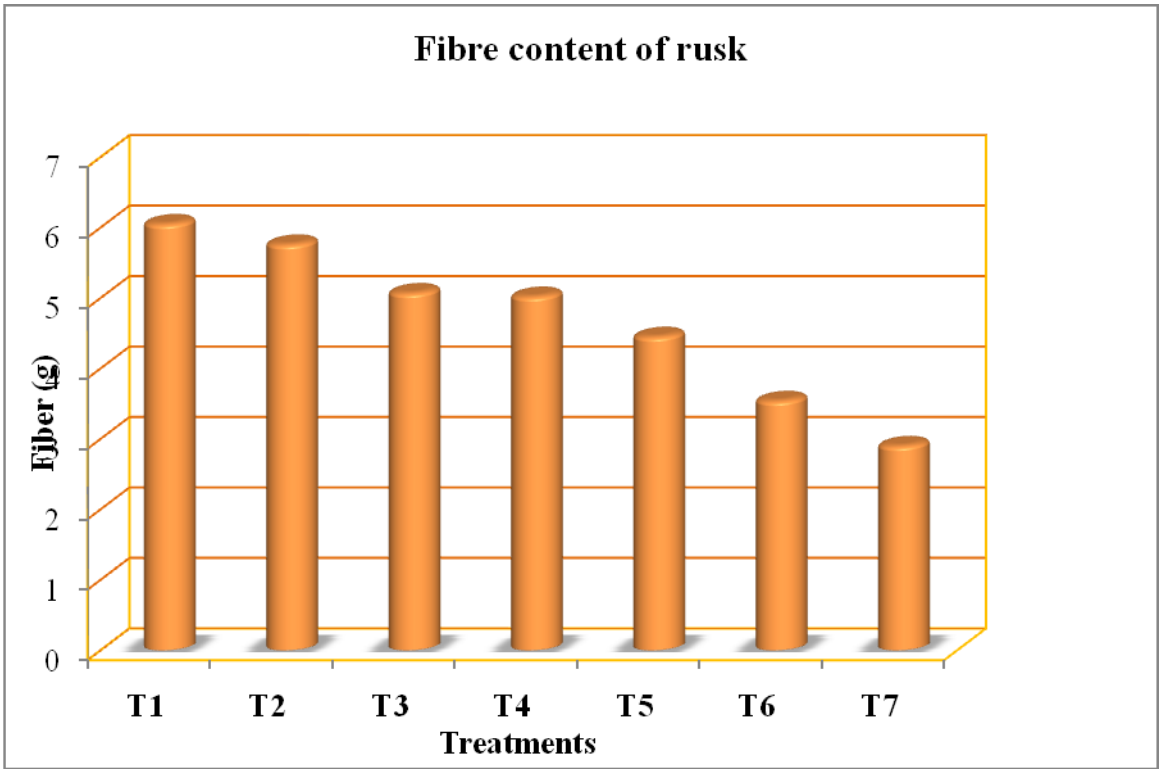
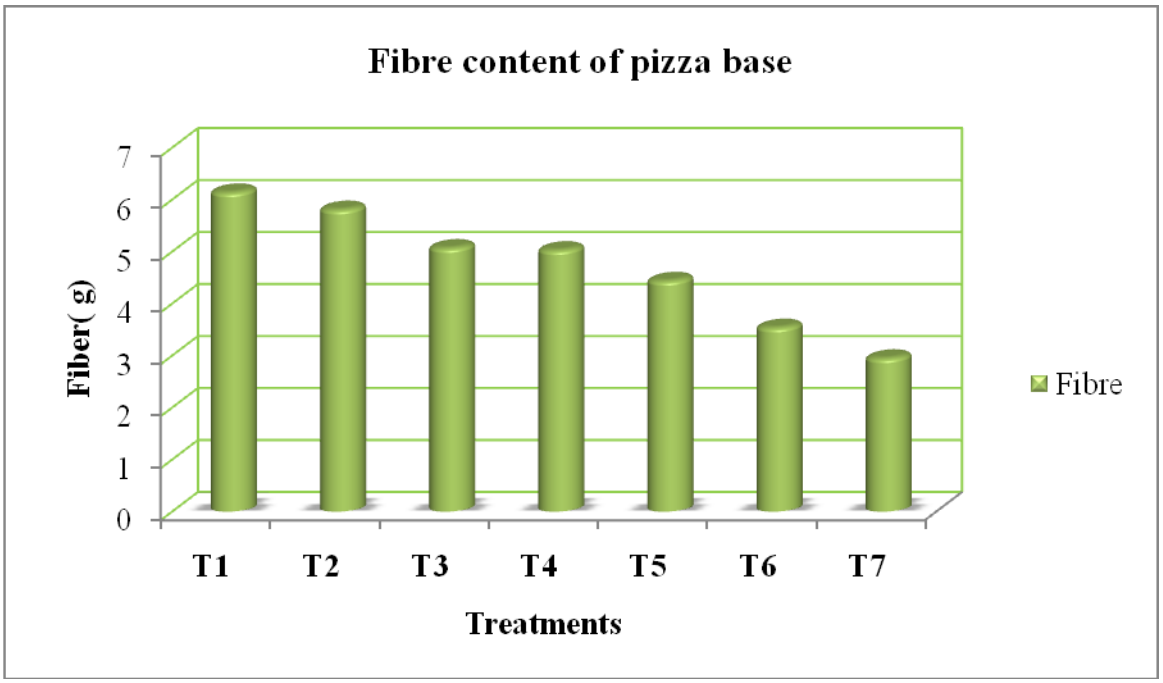

Fibre content of rusk
Fiber (g)
0
1
2
3
4
5
6
7
T1
T2
T3
T4
T5
T6
T7
Treatments

Fig-8


Fibre content of pizza base
Fiber(g)
0
1
2
3
4
5
6
7
T1
T2
T3
T4
T5
T6
T7
Treatments
Fibre

In this present study, acidity content of the rusks were analyzed and it was found that, the highest acidity content 0.36% was obtained in $T_1$and the lowest acidity content 0.05g was obtained for T_4.

5.7.2.4Nutrient and chemical composition of Pizza base

In a research conducted by Dorina *et al.*(2014), on fortification of pizza dough with whole soybean flour, it was observed that the energy value ranged between 312 kcal to 345 kcal. In the developed jackfruit pizza base energy content was found to be highest in T_6(312.00K cal) after control T_7(321.00 K cal) and the minimum calorie 265.00 kcal content was found in T_1.The lower calorie value in jackfruit based pizza base indicated that jackfruit based pizza base can be considered as a 'low calorie pizza'.

Protein content has a key role in wheat flour because it relates to many processing properties such as water holding capacity and gluten strength. It was also related to finished product attributes like texture and appearance.

A study based on suitability of spring wheat varieties for the production of best quality pizza was conducted by Saima *et al.*(2012).The protein content of developed pizza from different wheat varieties ranged between9.43 to 13.96% .(Shouket *et a.,l* 2007).

In the present study, it was observed that the lowest protein content of 5.41g was found in T_1The highest protein content of 8.18g was found in T_6 after control T_7(8.79g). The protein content is comparatively low because JBF is low in protein.

The highest fat content was observed in T_6(3.47g) after control T_7 (3.53g). The lowest fat content was found in T_1(3.13 g).Low fat is characteristic feature of raw jackfruit.

Fibre produces healthy compounds during the fermentation in the intestine (via its passive hygroscopic properties) helping to increase bulk, soften stool, and shorten transit time. In this study, fibre content of different treatments were

analyzed and it was found that the highest fibre content was in T_1 (6.14g). The lowest fibre content was found in T_6 (3.54 g) after control T_7 (2.95g).High fiber however affected the sensory quality of the product.

Literature reveals that formulations with 30 percent and 50 percent soybean flour were classified as good sources of dietary fiber and the formulations with 70 percent, as excellent source in processed products.

Maria *et al.*(2013) reported that, four pizza dough formulations were developed with whole soybean flour in partial replacement of refined wheat flour (30%, 50% and 70%) along with control The moisture content of developed pizzas were 20.26,20.13, 20.62, 19.03 percent respectively.

The highest moisture content 21.27 per cent was noticed was in T_2while the lowest moisture was found in T_6 (20.16g) after control T_7(19.62g). From the experiment it was observed that the moisture content of developed pizza was almost similar to the above study and with increase in amount of JBF there is increase in moisture content.

In the present study, from the analysis of acidity content of pizza base it was found that the highest acidity content of 0.41 percent was found in T_1 and the lowest acidity content 0.06% was found in T_4.Acidity is the outcome of fermentation products which is affected by ingredients and processing method.

FSSAI specifies the amount of additives in baked products. Since the standardized products here are additive free the scope for comparison does not arise.

5.7.3 Sensory Quality of Baked Products

The sensory evaluation is an essential feature in the food industry. In this study the baked products prepared from refined wheat flour with different levels of raw jackfruit bulb flour were stored in PP covers after processing and placed in the laboratory shelf at ambient temperature. These were evaluated for various sensory attributes like color, taste, flavor, crispness, texture and overall acceptability. The results regarding each product is discussed here.

5.7.3.1*Sensory quality of fruit bread*

Crina et *al*. (2012) prepared Graham bread and bread with eggplant and oregano. Samples were made following recipes without the use of improvers. The samples were evaluated by 15evaluators, aged 20-25 years students control and food, Faculty of Agriculture, University of Agricultural Sciences. The attributes were recognized by the sensory panel as properties of the bread products. From the assessment test points, the Graham bread was rated as superior class.

Appearance of a product refers to the size, shape, color, and condition of the outside and interior surface.T_6 with the ratio of 80:20 refined flour and jackfruit bulb flour got the highest rank (46.55)after control T_7(49.45). While T_1 (25.50) with the ratio of 40: 60 refined flour and jackfruit bulb flour got the lowest rank. The heaviness of jackfruit flour in comparison to refined flour could be affecting the appearance of the product.

Texture is a combined sensation of many rheological and structural parameters of a product during chewing and biting. A study revealed that breads prepared with 10 and 20 percent sorghum flour were not significantly different in texture from the control. Breads prepared from 30 to 50% sorghum flour showed low score intexture. Sorghum flour gave a drier and gritty (sandy) texture.From the sensory evaluation of the treatments of this study it was observed that for texture T_6got the highest mean rank value 46.30 after control while T_1 got the lowest mean rank value 21.65.Higher content of refined flour essentially adds the sensory quality of the products.

Taste is a sensation perceived by the taste buds and is also influenced by the texture, flavour, and composition of the product. It is one of the essential parameters related to acceptability of food products. *Breads* prepared with 10 and 20 per cent sorghum flour and maida were not significantly different in taste from the control. *Breads* prepared from 30 to 50% sorghum flour showed low scores for taste.

Abdelghafor *et al.* (2011) reported similar results for taste of bread from composite flour of sorghum and hard white winter wheat.From the sensory evaluation of taste for fruit bread, it was found the mean rank value ranged between 24.75-58.20. The highest score was obtained for T_6 (41.75) after control T_7(58.20),while the lowest score was obtained by T_1(24.75).The conventional taste gets affected with addition of JBF, this could be the reason for lower scores of $T_1$to T_3.

Aftertaste is thought to be the 'left over' flavour of whatever food or drink was consumed, without the input of the other sensory systems. This is the result of the chemicals in food and drink which continues to interact with the specific taste receptor cells within our taste buds.

This study indicated that T_1, T_2, T_3, T_4 carried some amount of 'after taste' with incorporation of jackfruit bulb flour.

Flavour is another criterion that makes a product acceptable. The perception of flavour is a combination of taste, smell, impression and texture.The highest mean rank value for flavour was obtained by T_6(46.10) following control T_7(53.30) ,while the lowest rank was obtained by T_1(21.40).The blend of raw jackfruit flour and maida in the proportion of 20:80 was found appropriate for the acceptable flavour.

Breads prepared with 10 per cent and 20 per cent sorghum flour along with maida were not significantly different in flavour from the control. Breads prepared from 30 per cent to 50 per cent sorghum flour showed low scores in flavour. A similar decrease in the flavour of breads with increase in the supplementation levels of fenugreek flour was noticed by Sharma and Chauhan (2000). This finding also agrees with the findings of Joel (2011), who reported that the substitution of wheat flour with soy flour decreased flavour of bread.

Overall acceptability of a food product indicates if the product is adequate to satisfy a need, requirement, or standard. It was noted that T_6 obtained the highest rank for over all acceptability value (44.90) preceded by control T_7(52.30).The next position was obtained by T_5 (40.75) and last position was obtained by T_1(23.50).

Agiriga, (2014) conducted a study on effect of whole wheat flour on the quality of wheat-baked bread. The bread samples were subjected to sensory evaluation by ten panelists. The bread samples were evaluated for crust colour, crumb texture, taste and overall acceptability. Sensory evaluation was done on the same day of preparation. Scores of bread decreased significantly as whole wheat flour substitution level increased. The control received the highest score for overall acceptability followed by the 10 per cent and 20 per cent whole wheat flour breads. The bread with the highest whole wheat flour (40%) was unacceptable Thus, bread substituted with up to 10 per cent and 20 per cent whole wheat flour were acceptable and these bread samples were comparable with the control of the bread.

5.7.3.2 ***Sensory evaluation of bun***

According to Srilakshmi, (2010), the appearance of food products is contributed by the surface characteristics viz. size, shape, color, transparency, opaqueness, turbidity, dullness etc. In the developed bun T_6 obtained the first rank with the mean rank value 42.50 for appearance after control T_7 (53.60), while T_1 got the last rank with mean rank value 27.20. From which it can be concluded that with increase in amount of jackfruit flour, a dull appearance resulted.

Texture is the physical feel of something smooth or rough or fuzzy or slimy, and many more such surface characteristics.From the evaluation of texture it was found that T_6 got the highest mean rank value of 41.30 for this attribute after control T_7 (56.10) and T_1 got the lowest mean rank value of 23.65.The difference in these scores were found to be significant. The characteristic texture of bun was obtained only with refined flour and jackfruit flour in the proportion of 80:20.

Taste is a major attribute which determines the acceptability of food. It is not only a sensory response to soluble materials but also the aesthetic appreciation of taste buds. The sense of taste affects ingestion and uptake of the food into the body. (Lawless and Heymann 1998).From the sensory evaluation of taste of treatments of bun, it was observed that the minimum mean rank value was scored by T_1i.e. 21.65 followed by T_2, T_3, T_4, T_5, T_6 and T_7 (control).

Aftertaste is generally defined as any taste that remains in the mouth after a food or drink has been swallowed or spit out. The exact mechanism that causes these sensations isn't fully understood. In fact, understanding how our brain perceives specific tastes is still a subject of debate.The mean rank value of after taste ranged between 23.50 to 54.40 including control. It can be noticed from data that the highest mean rank value was obtained by T_6 (44.80) after control, while T_1 obtained the lowest mean rank value of 23.50.After taste was observed to a great extent in the treatments where RJBF was above 50 percent.

Flavour of a food can be expressed as the sensory impression of food or other substances, and is determined primarily by the chemical senses of taste and smell. In the present study,It was found that the maximum mean rank value obtained for flavor was for the treatment T_6 (42.40) after control T_7 (53.40), while the minimum mean rank value obtained by T_1 (23.43).This again explains the need to include refined flour to balance the flavor of the product

Overall acceptability of a product can be described as the sensory profile of appearance, colour, texture, flavour and taste.It is noted that from the overall acceptability scores of bun that T_6 obtained the highest mean rank value 45.60 after control T_7(54.60). Second and third positions were obtained by T_5 (38.50) and T_4 (35.70) respectively. Raw jackfruit, though a nutritive ingredient needs the assistedsupport of refined flour to improve its functional qualities.

Karen *et al.* (2013) prepared gluten free bread substituted with amaranth and montina™ Flour. The final level of substitution for the amaranth and Montina™ flour was 20%. A five-point scale was used to assess appearance, texture, flavor, tenderness, and overall acceptability. The montina™- and amaranth-based breads were acceptable products with means > 5.5 out of 9 for all categories of evaluation.

5.7.3.3 ***Sensory Evaluation of Rusk***

Noor *et al*.(2012) reported that cookies prepared from legumes were rated high in flavour, crispiness, aftertaste, colour and overall acceptability with

significant difference ($p<0.05$) as compared to control. Although aftertaste was found to be pronounced in the mung bean and chickpea cookies these cookies were significantly acceptable than the control.

In the present study sensory evaluation of rusk was conducted with respect to parameters like appearance, texture, taste, after taste, flavour and over all acceptability. Mean rank value for the appearance of rusk was superior in T_6 (43.45) after control T_7 (49.45),while the lowest value was obtained for T_1(21.95) followed by T_2, T_3, T_4 and T_5 with the mean rank values of 24.70, 27.35, 27.85, 36.95 and 43.45.The functional quality of flour improved only in the proportion of 80:20(RF: RJBF)

Sensory and instrumental texture profile analysis allows for the quantitative description of the textural attributes in a variety of products. Texture has to do with how an object feels with all its ingredients. Texture is a very important characteristic in food products. The texture of the developed rusk varied between 'crispy' to 'difficult to break'. Trained panellists describe a product's behaviour in the mouth (qualitatively and quantitatively). From the sensory analysis of texture it was noticed that T_6 obtained the maximum mean rank value 41.60 after the control T_7 (50.65), while T_1 obtained the minimum mean rank value 21.95. Here again texture improved with the addition of refined flour to RJBF in the ratio 80:20.

Taste is a compounded attribute of the ingredients and their combinations.T_6 obtained the maximum mean rank value of 42.60 after the control T_7 (52.20) for taste. Least mean rank value to 21.65 was noted for T_1.

After taste of a food product can be defined as the taste persisting in the mouth after the food no longer is present in the mouth .From the sensory analysis of after taste it was observed that the highest mean rank value with respect to after taste was scored by T_6 (43.55) after control and the lowest mean rank value (22.00) was obtained by T_1.

Mc Watters (1978) suggested that the beany flavour in legume flour could be reduced by exposing the material to moist heat. The aftertaste could have resulted from the beany flavour of the legumes. In spite of substitution with 35 per cent legume flour, the cookies made from this bean scored high. This was

contradicting with the result reported by Hoojjat and Zabik (1984), where in the cookies scored low with more than 10% sesame seed incorporation.

Flavour of a food product can be defined as the the distinctive sensation of a material as experienced in the mouth. From the sensory analysis it was the observed that the superior value for flavour was obtained by T_6 (45.15) after control T_7 (50.0). While the minimum mean rank value of 21.50 was obtained by T_1.

Overall acceptability of a product can be described as the quality or state of meeting one's needs adequately which can obligate the following terms viz., sufficiency, adequacy, satisfaction.

Chavan *et al.* (2016) prepared cookies from sorghum flour and found that addition of more than 20 per cent sorghum flour in cookies and more than 30 per cent in nankatai preparation indicated that, the sensory properties such as colour and appearance, flavour, texture, taste and overall acceptability decreased drastically.

Jaybhaye *et al*., 2014 prepared millet based biscuit with 10 to 20 percent addition of pearl millet flour. The sensory parameters such as colour, taste, texture, flavor and over all acceptability was assessed and it was found that, the biscuits were acceptable with respect to all parameters.

5.7.3.4 *Sensory evaluation of pizza base*

The sensory evaluation of Pizza base was analyzed by the parameters suggested by Limongi *et al.*(2012). The parameters evaluated were wooden appearance, softness, taste, colour of edge, aroma, and porosity.

A study was conducted by Dorina *et al*. (2014) on fortification of pizza dough with whole soya bean flour. Sensory analysis of the developed pizza was compared with the product in supermarket. The consumers rated the pizza based on overall acceptability. Consumers in general preferred the formulations of control and with 30% soybean, which presented a higher number of scores.

However, all the formulations were well accepted, probably due to the use of soybean.

Wooden appearance of Pizza base varied between light brown to blackish brown. With regard to this parameter, highest mean rank value of48.30 was obtained by T_6 after control T_7 (49.35), while the lowest mean rank value of 20.75 was obtained by T_1 with the ratio of refined wheat flour and jackfruit flour in the ratio 40:60.Jackfruit flour does not get dextrinised as much as refined flour, which accounts for the less wooden colour.

Softness of pizza can be described as easy to press, bend and cut, and not hard or firm, along with being smooth and pleasant to touch. From the evaluation of softness it was noticed that the highest mean rank value was obtainedbyT6 (47.40) after control T_7 (54.80), while the least mean rank value of 18.25 was obtained by T_1, which shows that T_1 was less soft. Thus softness increased with blending in refined flour.

From the sensory evaluation of taste it was noted the T_6 obtained the highest mean rank value 48.00 after control T_7 (55.00) among others. In this study the blending of flours affected the taste of the final product, which was optimized as 80:20.

For pizza, colour of edge is an important characteristic, because edge of pizza usually is deep brown and this edge helps to keep in the stuffing. The score was superior in T_6 (47.90) followed by control and a lower value of 20.15 was obtained by T_1.

Aroma of a food product can be defined as the distinctive pervasive and usually pleasant or savoury smell or the odour of the raw material from which it is made. From the sensory evaluation of pizza base it was observed that T_6(49.70) got the maximum mean rank value after control T_7(50.85),while T_1 got the lowest mean rank value 19.65.The characteristic baked aroma was obtained from the proportion of 80:20(RF: RJBF)

Porosity is defined as being ‘full of tiny holes that allow water or air to get through. In the present study from the evaluation it is marked that T_1 obtained the lowest mean rank value (17.70),T_6 obtained the highest mean rank value of 47.35 after the control T_7 (52.80).Lack of gluten could be the reason for lower pores in T_1-T_3.

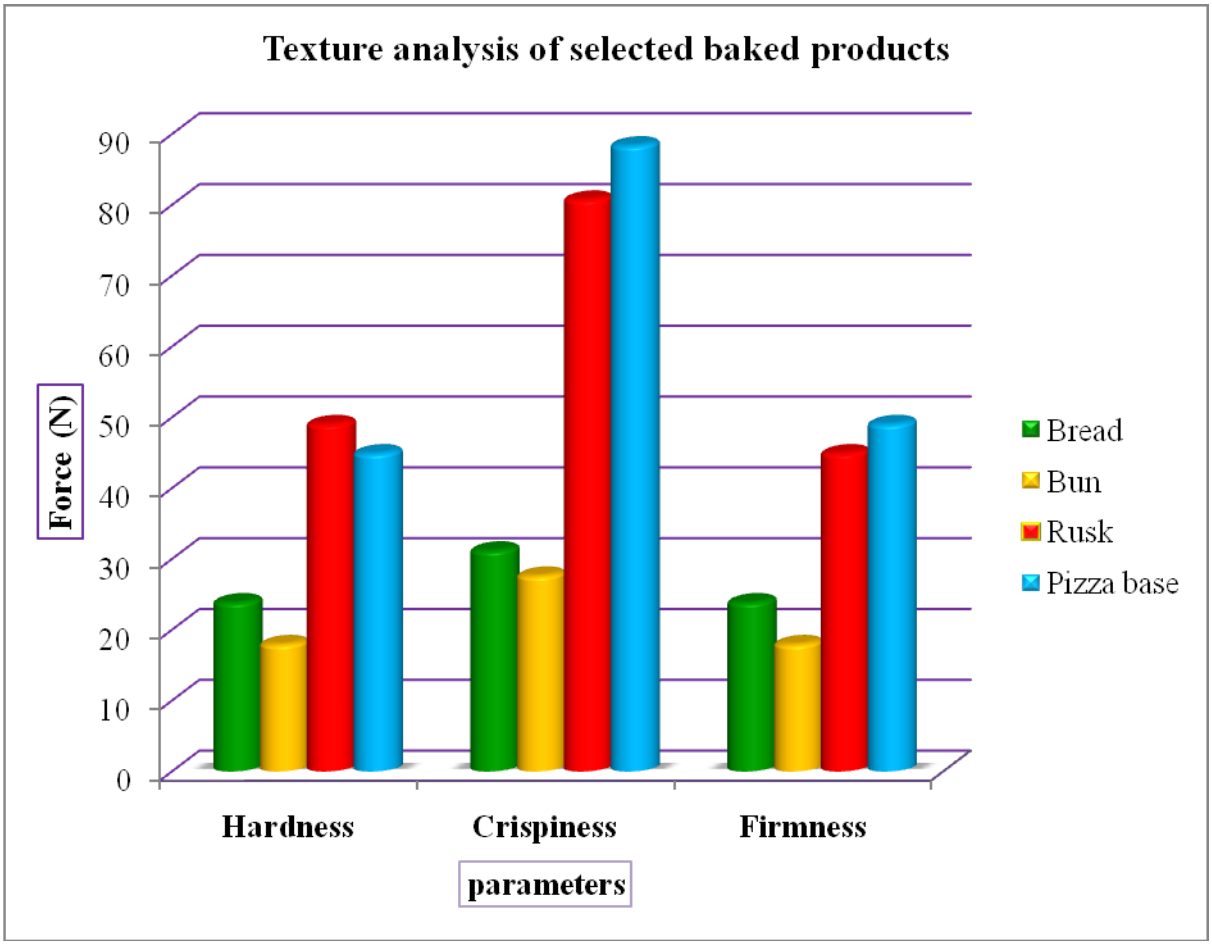
Crispiness of a food product can be expressed as, sensation of brittleness in the mouth, such that the food item shatters immediately upon mastication. Crispiness differs from crunchiness in that a crunchy food continues to provide sensation after a few chews. Crispiness of edge is a special characteristic of pizza base as suggested by Limongi, From this evaluation it was found that the superior quality and maximum mean rank value of 48.21 was obtained by T_6after control T_7(52.11),while T_1 got the least mean rank value of 18.12.The blending affects the texture of a product and also its further response to dry heat.

5.8 SELECTION OF BEST COMBINATION

On comparing the sensory qualities of the 7 treatments with respect to the six parameters of appearance, texture, flavour, taste, after taste and over all acceptability, for all the 4 products ,T_6 was rated as the best. It comprised of jack fruit flour and refined flour in the ratio 20:80, ultimately consumer preference is for sensory appeal; health and cost are factors considered after that. Though control treatment obtained higher values, the intention was to substitute refined flour and identify the best combination.

To find out the most acceptable among the four products, hedonic rating test was conducted. Ten members were selected to judge the products; they rated the products using the parameters like ‘extremely’ to ‘dislike extremely’ on a 9 point scale(hedonic). From this rating test, it was found that pizza base got the maximum score 82 from 90, while bread got the minimum score of 60 from 90.

Fig-9


Texture analysis of selected baked products
Force (N)
90
80
70
60
50
40
30
20
10
0
Hardness
Crispiness
Firmness
parameters
Bread
Bun
Rusk
Pizza base

Texture Analysis of Selected Products

Fig- gives the comparison of textural parameters namely hardness, brittleness, crispiness, crunchiness, firmness, elasticity. The values were comparatively lower than whole wheat products as reviewed from literature. Waxy wheat flour and Chinese spring flour yielded breads with lower crunchiness and crispiness than control in the study conducted by Morita *et al.,* 2002.

5.9 STORAGE STABILITY OF BAKED PRODUCTS

According to Shankar et al.(2000) several factors such as quality of raw material, storage temperature, storage containers, processing methods, the environment in which it is processed etc will affect the sensory quality, microbial quality and shelf life of products.

5.9.1 Sensory Evaluation of Baked Products During Storage.

During storage, the most important quality which affected food products is their sensory quality and it can be observed through different parameters. Especially in case of bakery products, the taste becomes less acceptable, flavour changes to odd flavour and texture changes to soggy. Such changes are evident during storage by testing them subjectively. In this study also, sensory quality of the four acceptable products were evaluated during storage.

5.9.1.1 *Sensory evaluation of fruit bread during storage.*

A study was conducted by Chavan et al. (2016) on bread sprepared using sorghum flour at different levels ranging from 0 to 50% with wheat maida. The breads were evaluated with respect to colour and appearance, flavour, taste, crumb and crust texture and overall acceptability. From sensory evaluation of these composite bread sit was observed that addition of flour for preparation of composite bread showed higher sensory score values for colour, flavour, taste, crumb and crust texture and overall acceptability. But during storage, there was decrease in sensory scores with the increase in addition of sorghum flour.

In the present study it was seen that though sensory attributes namely, appearance, texture, taste, after taste, flavour, and over all acceptability were gradually decreasing,in three days, the product was acceptable and consumable.

Overall acceptability of bread incorporated with 2 percent glycerol and 4 percent sorbitol, decreased with increased storage period.(Bhise and Kaur 2014).Shelf life studies on breads evaluated during a 72 hour storage period revealed that loaves with hydrocolloids incorporated were softer than control.(Kohazadova and Karvicova ,2008)

5.9.1.2 ***Sensory evaluation of bun during storage***

Sensory analysis is a scientific discipline that applies to the use of human senses-sight, smell, taste, touch and hearing for the purpose of evaluating consumer products. The discipline requires a panel of human assessors, on whom the products are tested, and the responses are recorded.

Ranasalva (2014) conducted a study on development of bread from Composited fermented pearl millet flour (CFPM).Composite bread was evaluated for general appearance, crumb grain, odour, softness, taste, mouth feel and overall acceptability. The result predicted that, there was significant difference in the overall acceptability with increasing level of CFPM flour with the refined wheat flour. The color of the composite breads made with 5 and 10 per cent substituted CFPM flour was similar to control (100 per cent refined wheat flour); whereas at higher levels of substitution, samples were significantly darker. The mouth feel scores decreased significantly as the level of CFPM flour increased. The mouth feel score of 10 and 15 per cent composite bread were found to be similar with each other with the mean score of 7.59 and 7.5. The sensory evaluation score for the composite bread prepared from the 25 per cent substitution of CFPM flour substituted refined wheat flour ranged from 5.22 to 6 for the sensory attributes. Overall the bread quality at the different levels of cooked fermented pearl millet flour substitution levels from 10 to 20 per cent was found to be acceptable.

In this study also the sensory scores were seen to decrease with storage but the product was acceptable.

When bread loaves prepared from wheat flour and addition of different levels of acidulants like acetic acid, lactic acid and calcium propionate were evaluated for shelf life for 96 hours. Volume of bread, colour of crust, symmetry of crust grain and crumb colour differed significantly while aroma, taste and texture were not affected significantly.

5.9.1.3 ***Sensory evaluation of rusk during storage***

The sensorial quality of food products plays an important role in the choice of food. Itis often used to determine consumer attitude towards a food by measuring the degree of acceptance to a new product or improving the existing food product. Rusk was stored for 3 months and sensory evaluation was conducted by 10 selected panellists on monthly intervals. Though values of sensory scores decreased with time the product was acceptable.

Hozova *et al*. (2002) conducted a research on sensory quality of stored croissant-type bakery products which were evaluated at time intervals of 0, 30, 45, 60, 75 and 90 days. The six-member panel evaluated the following sensory parameters: shape, crust, odour, hardness, crumb, taste, and the appearance of the product. Scores were lower in the products made of the croissant dough as manifested by the minimum value of 30. Whereas in the products made of the brioche dough the maximum value of 35.7 was observed during the storage period.

5.9.1.4. ***Sensory evaluation of pizza base during storage***

Pizza base was rated using the Limongi *et al'*s scale (2012) even during storage. All the parameters in rating pizza base were found to decrease during storage period; from the initial to the third day.

From the sensory evaluation of the four products viz. bread, bun, rusk and pizza base, it was observed that there was a gradual decrease in mean rank values of every product with respect to each parameter. But the product was acceptable and could be consumed up to the last stage of sensory analysis.

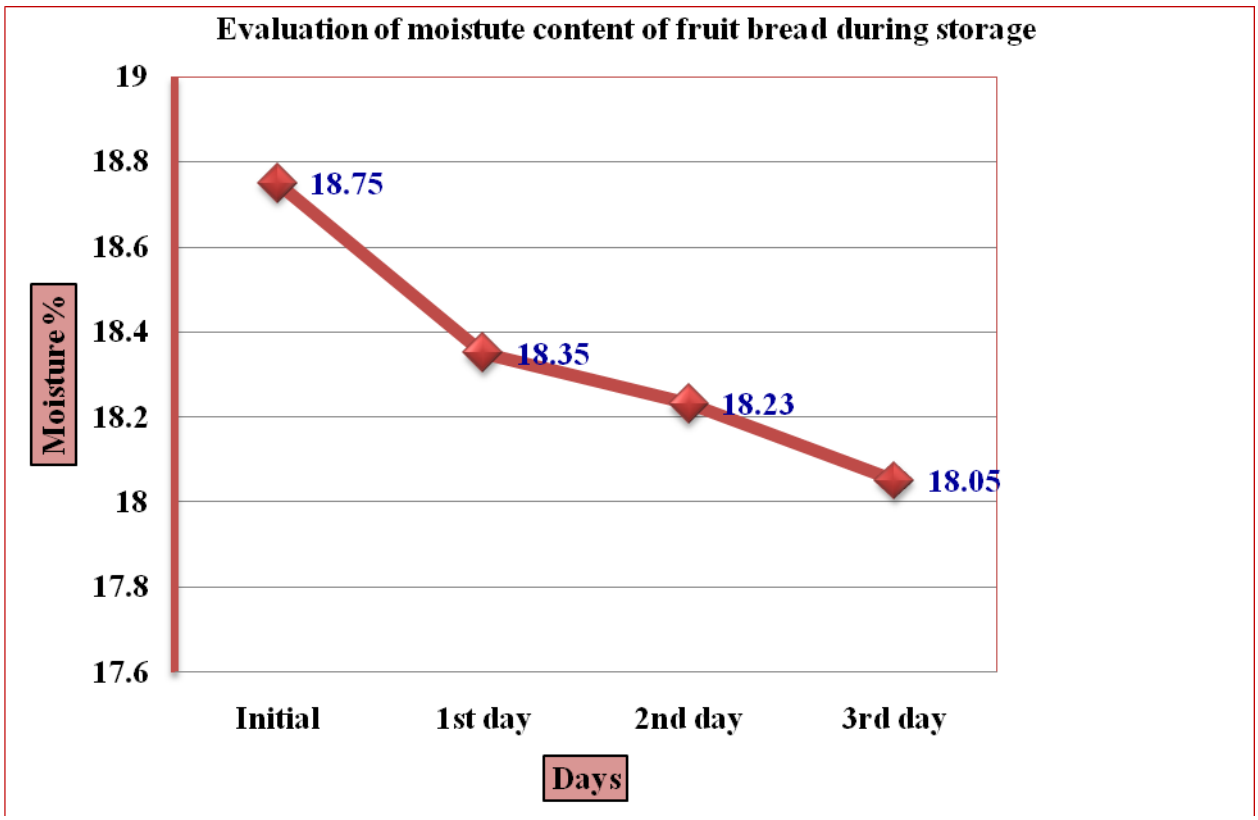

Evaluation of moistute content of fruit bread during storage
19
18.8
18.6
18.4
18.2
18
17.8
17.6
Moisture %
18.75
18.35
18.23
18.05
Initial
1st day
2nd day
3rd day
Days

Fig-11

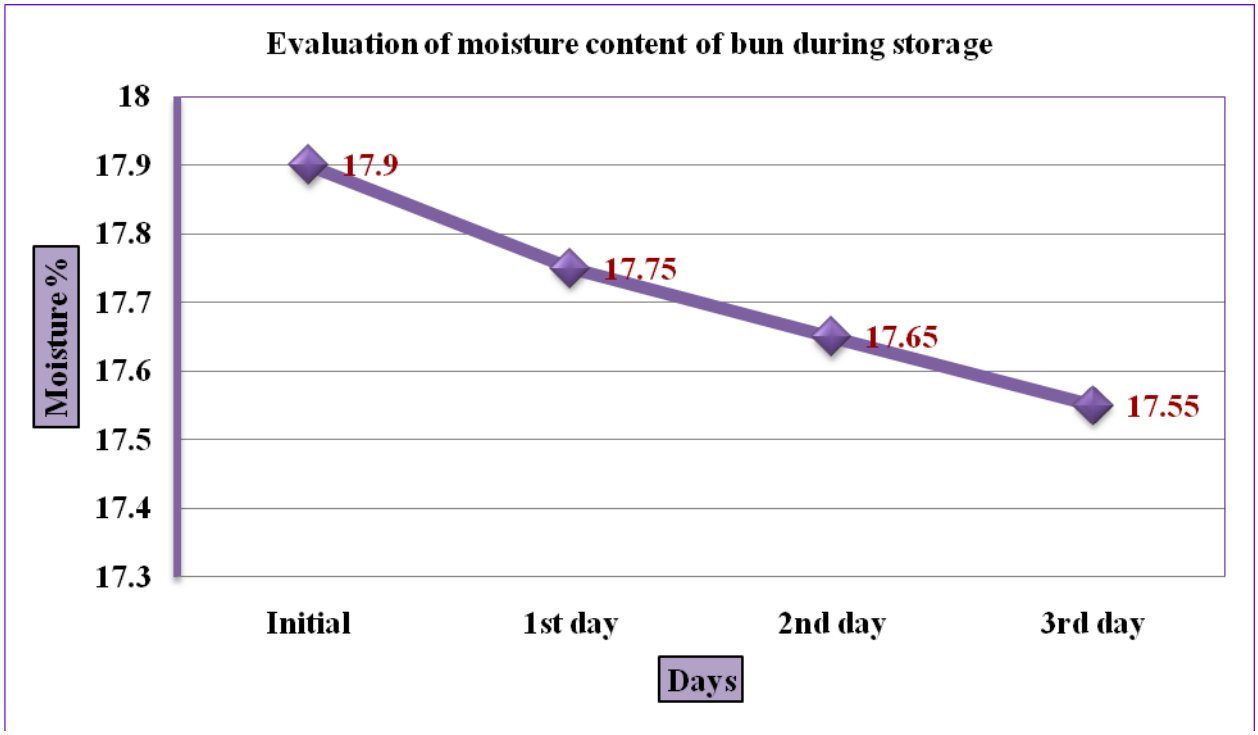

Evaluation of moisture content of bun during storage
18
17.9
17.8
17.7
17.6
17.5
17.4
17.3
Moisture %
17.9
17.75
17.65
17.55
Initial
1st day
2nd day
3rd day
Days

Fig-12

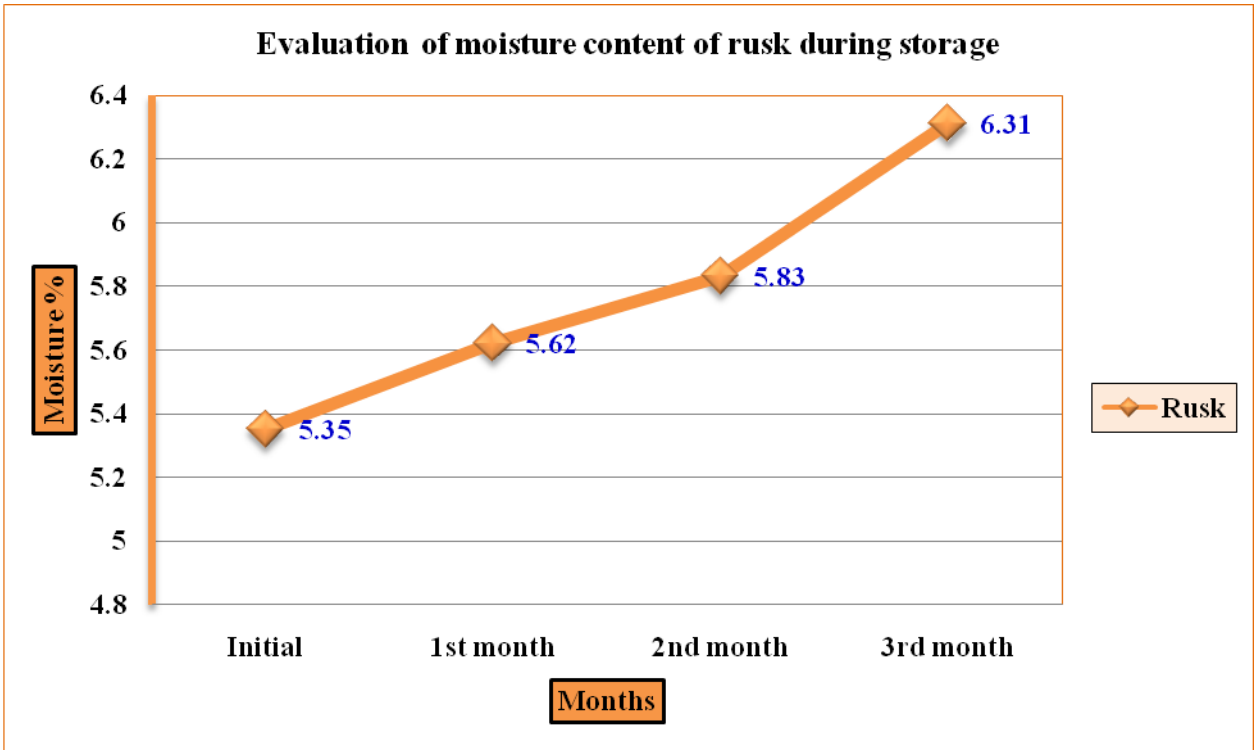
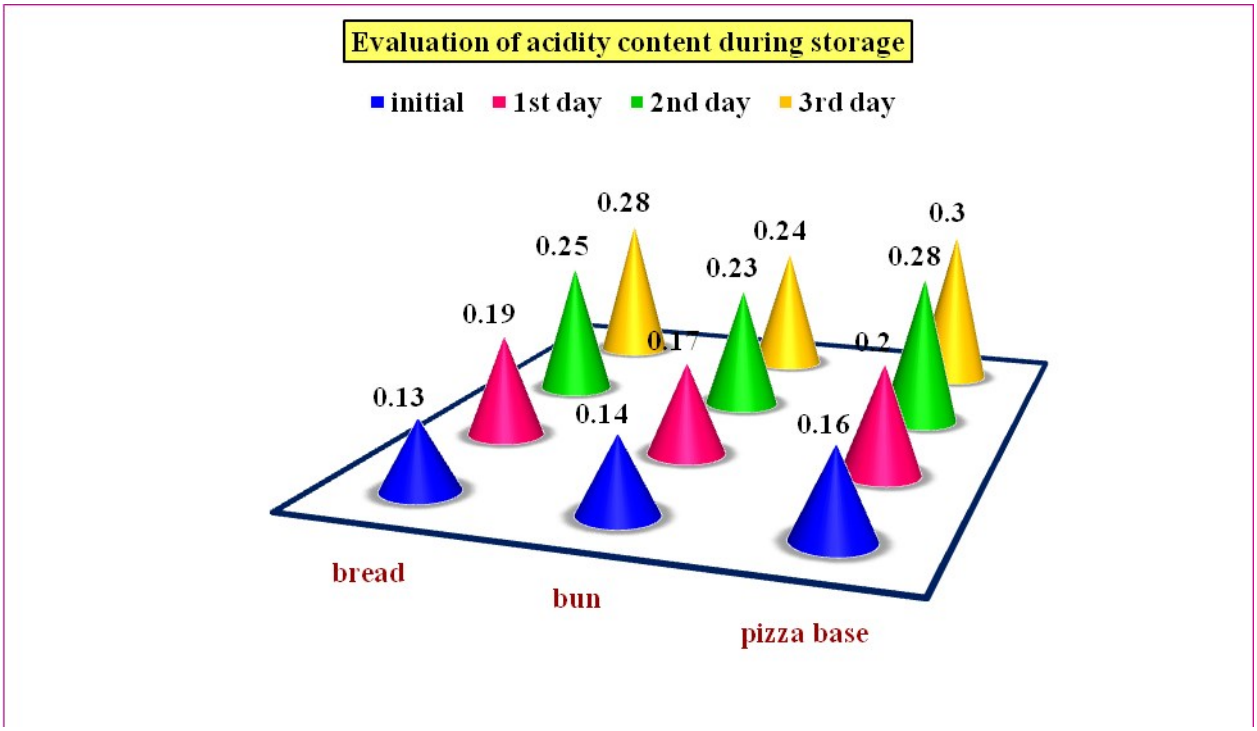

Evaluation of moisture content of rusk during storage
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
Moisture %
6.31
5.83
5.62
5.35
Initial
1st month
2nd month
3rd month
Months
Rusk

Fig-13


Evaluation of acidity content during storage
initial
1st day
2nd day
3rd day
0.28
0.25
0.24
0.23
0.3
0.28
0.19
0.13
0.14
0.16
bread
bun
pizza base

5.9.2. Evaluation of Moisture during Storage

Moisture content is one of the vital characteristics which interfere with the quality of the baked products during storage. This affects the physical and nutritional composition of the developed products.

Moisture can adversely affect the quality of food. It is an important parameter in baked products, which directly influences the microbial activity, non enzymatic browning, solubility and hygroscopicity.

Rathore *et al.* (2007) reported that lower moisture content would give longer shelf stability. Most of the stored products are considered to be safe when stored at the prescribed moisture content.

A study by Nwosu, *et al*.(2014) on breads produced from substitution of wheat flour with cassava flour using soybean as an improver where in wheat flour and cassava flour were blended in the ratios of 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80 and 10:90,revealed that the moisture content ranged between 20- 22 percent during the storage period.

From the analysis of moisture content, it was found that there was a gradual decrease in moisture content. This can be due to the retro gradation of starch molecules after absorbing moisture, thus making it more dry.Retro gradation occurs when gelatinized starch cools, starch molecules especially amylose with its linear structure will re-associate highly at various degrees which will lead to more firmness. (Zaidul *et al*., 2007).

5.9.3. Evaluation of Acidity during Storage

Acid content is one of the prime chemical constituents which indicates the deteriorative changes in the product. According to Shi and Maguer (2010), acidity is measured by the number of free hydrogen ions available in the food which causes a sour taste.

From the evaluation of acidity content of the baked products, it was found that there was gradual increase in acidity content during storage period.

Storage characteristics of control and cookies with 5 per cent roasted ground flax seed (RGF) flour showed no significant change with respect to acidity due to storage of cookies for 90 days in polyester pouches.(Rajiv *et al.,* 2012).

Titrable acidity of 8 types of dough were relatively higher after baking, when 8 types of baked products were selected for viability of bacillus coagulants. The products were cookies, cakes, mung cakes, muffins, breads, soda cookies, sponge cakes and toast. (Jao *et al*., 2012).

The acidity content was found to increase in the selected developed products.

5.9.4. Microbial Study of Stored Products

Simpson *et al.* (2006) suggested that processed foods and other food materials provide ample scope for contamination with spoilage organisms, thus necessitating microbial quality assessment as an integral part of processing. The microbiological safety of food is achieved as much as possible by ensuring the absence of pathogenic microorganisms and preventing their multiplication by all possible means. Food products that have been subjected to adequate heat- treatments during processing are free of vegetative pathogens.

Hozova *et al.*(2002) reported after a 90 days storage study on bakery croissant type products that no mould growth occurred in any of the products during the whole products.

The total bacterial count of bread samples ranged from $3.0x10^5$ to $1.0x10^6$ cfu per gram with the highest being recorded for bread made from 100% sweet potato flour with the lowest ($3.0x\ 10^5$) cfu per gm obtained in bread made from Iris potato flour. Coli were not detected (Joshi *el.,* 2014).

Oat bran biscuit had least bacterial count ($11.15x10^2$ cfu g-1), where as rice bran biscuit had maximum bacterial count ($21.68\ x\ 10^2$ cfu g^{-1}) after 3 months of storage. (Nagi *et al*., 2012).

The developed products in this study were microbially safe till 3 days.

Shelf Life at Room Temperature

Shelf life is the length of time that a commodity may be stored without becoming unfit for use, consumption, or sale. In other words, it might refer to whether a commodity should no longer be on a pantry shelf (unfit for use), or just no longer on a supermarket shelf (unfit for sale, but not yet unfit for use). This is a matter of great concern for food items. Usually for such perishable products, an indicatory label on 'best before' or 'mandatory use by' or 'freshness' date is essential from the consumer's health point of view.

Based on the microbial profile and sensory evaluation the shelf life of the best treatment was evaluated. For bread, bun and rusk, the shelf life was 3 days while for rusk it was 3 months. The shelf life is comparatively low because all the four products were prepared without any additives.

5.10 COST OF THE PRODUCTS

Costing can be defined as the process of determining how much a product costs to prepare and sell a product. Costing is very important as the cost of the product can decide its profit or loss. The cost of processed products depends on the purchase of the raw material, cost involved in processing, packaging and marketing and the profit margin set by the industry (Kumbhar and Singh, 2001).

Best and Placide (2006) reported that while developing new products, the cost is to be kept to the minimum and the strategy for the development of the food product is to be based on affordable prices and cost effectiveness.

In order to realize the economic feasibility of the developed products, cost per packet with a specific amount was computed separately. All the products developed under the present study were found to be reasonable in cost. For bread of 260 g cost was worked out as 17 rupees, for bun of 60 g cost was worked out as 5 rupees, and for rusk of 180g, it was worked out as 16 rupees and for pizza base the cost per 100g was 12 rupees. Costs of products were comparable to the price

of products in the market. The market prices of 2 branded products were found to be slightly higher than the standardized products..

Excepting bread, the price of market products are found to be higher than the price of standardized products. The cost of production of the standardized product could further be reduced through mechanisation and bulk production.

In the present investigation the results revealed that the four products, bread, bun, rusk, and pizza base, developed from raw jackfruit bulb flour are rich in nutrients and have a reasonable shelf life. They were also adjudged with good sensory quality. The recommendation of the present study is to transfer the technology to large scale processors after scaling up and there by harness the potentials of raw jackfruit.

SUMMARY

6. SUMMARY

The present study entitled, “Value added baked products from raw jackfruit flour” was aimed at developing value added baked products from the bulbs of raw jackfruit (c v *koozha*). The developed products viz. fruit bread, bun, rusk and pizza base were studied in depth for their physico-chemical properties, functional qualities, sensory qualities and nutritional profile shelf life and cost of production. The study comprised of collection of jackfruit, processing of flour, functional quality analysis of flour, formulation of composite flour, standardization of baked products, their quality analysis, and storage stability after selection of the best treatment. The major findings of the study are summarized below.

Raw mature jackfruits were collected from the trees grown in the Instructional farm, College of Agriculture, Vellayani and also from the adjacent home yards. The fruits were washed and bulbs and seeds were separated. Only bulbs were taken up for the study. The separated bulbs were sliced into dimensions of 2.5 x 1 cm. In order to control enzymatic activities and to prevent browning of slices, the bulb slices were blanched for 1 min and then immersed in 0.2% KMS. Then the bulbs were dried, milled and packed in PP cover and kept for further study.

Functional Quality of bulb flours was analyzed. Bulb flour had higher water absorption index, (2.95%), swelling power (16.35 %) and solubility (12.11%) and lower oil absorption index (1.61%) and foaming capacity (13.20%), as compared to refined wheat flour.

Refined wheat flour (RF) and jackfruit bulb flour (JFB) were used as the basic materials for development of composite flour. The different combinations attempted for the composite flour formulations with RF and JFB flour of the baked products were 40:60, 45:55, 50:50, 60:40, 70:30, 80:20 and 100 percent refined wheat flour taken as control. Jack fruit based candy was processed to

enhance the sensory quality of the product. The candy processed was crispy in texture and sweet in the taste and was incorporated to the baked product.

Four acceptable baked products were processed. *viz.,* fruit bread, rusk, bun and pizza bases which were formulated following standardized recipes .The treatments were baked at Asian Bread Factory Kaniyapuram.

The developed products were further taken for detailed investigation with respect to quality aspects like physical, chemical, nutritional and sensory qualities. Shelf life of the best treatment was then assessed. The developed baked products were compared with the control.

Physical properties of bread was assessed the raw weight was 300g for all the 7 treatments, T_6 obtained the lowest baked weight(263.00gm) and T_1 obtained the highest weight (282.00g). Raw depth varied between 3.00cm to 3.35 cm and T_6 obtained the highest baked depth (3.80cm) and lowest depth was obtained by T_2.Baking time was 25 minutes for all the seven treatments.

Physical Characteristics of bun revealed that, the raw weight was 80g for all the 7 treatments. T_6 obtained the lowest baked weight (61.05gm) after control and T_3 obtained the highest weight (65.10g). Raw depth varied between 3cm to 3.80cm and T_5 (4.2cm) obtained the highest baked depth and lowest depth was obtained by T_3.For all the 7 treatments baking time was same i.e. 30 minutes.

For rusk the highest yield was obtained for the treatment T_2(63.15%) and lowest forT_6 (57.21 percent). The highest volume was obtained for T_6(33.20cc). The highest difference between raw weight and baked weight was found in T_1 (96.94g). Baking time for bread was 25 minutes and it was again re baked for 20 minutes.

Physical properties of pizza base, when analyzed revealed that the raw weight was 120g for all the 7 treatments. T_6 obtained the lowest baked weight (90.66g) after control and T_1 obtained the highest baked weight (99.00g). Raw depth was 1.5cm for all the 7 treatments and T_2obtained the highest baked depth

(1.07cm) and lowest depth was obtained for T_5 (0.66cm).For all the 7 treatments baking time was same i.e. 10 minutes.

The analysis of nutritional and chemical composition of bread revealed that the highest calorie was present in T_6 (299.00Kcal) and the lowest calorie content was found in T_1 (247.00 Kcal).T_6 obtained the highest protein content (9.05g) after control T_7 (10.05g), and T_1 (5.05) was having the lowest level. The lowest fat content was contained in T_1 (2.95g) it was on par with T_2 (3.06g). T_2 was on par with T_3 (3.11g) and T_4 (3.24g) was on par with T_5 (3.34). T_6 (3.48g) revealed the highest fat content after control. The highest fibre content was present in treatment T_1 (6.41g) and the lowest fibre in T_6after control. The moisture content was lowest in treatment T_6 (18.75%) after control T_7 (18.15%), and highest in T_1 (21.05%).The highest acidity was found in treatment T_1 and T_7 (0.14%) and the lowest acidity was in T_4 (0.10%).

Analyzing the nutritional and chemical composition of bun it was revealed that the highest calorie was contained in T_6 (304.00Kcal) and the lowest calorie content was found in T_1 (261.00Kcal). T_6 (9.02g) obtained the highest protein content after control and T_1 (5.31g) was having the lowest level. The lowest fat was contained in T_1 (3.15g) and T_6 (3.48g) revealed the highest fat content after control. The highest fibre was present in treatment T_1 (6.07g) and the lowest fibre in T_6 (3.58g) after control. The moisture content was lowest in treatment T_6 (17.90%) after control T_7 (18.15%), and highest in T_1 (18.55%).The highest acidity was found in treatment T_1(0.42%).T_2 (0.23%) was on par with T_3 (0.13%)and the lowest acidity was observed in T_4 (0.10%).

From the analysis of nutritional and chemical composition of rusk it was observed that calorie value was higher in T_6 (431.00 Kcal) after control T_7 (437.00Kcal) and lowest calorie was in T_1 (384.10 Kcal).The lowest protein content was in T_1 (5.36g) and the highest protein content was found in T_6 (8.18g) after control T_7 (9.12g).The maximum fat content was noted for T_6 (3.58g) after control T_7 (3.67g). The lowest fat content was found in T_1 (3.18g).The highest

fibre content was found in T_1 (6.05gm) and lowest fibre content was in T_6 (3.54g) after control T_7 (2.90g).The moisture content in T_2(6.45%) was on par with T_3(6.41%) and T_4(6.40%). The lowest moisture content was found in T_6 (5.45%) after control T_7 (5.40%).the highest acidity content was obtained in T_1 (0.36%), which was on par with T_2 (0.28%). T_2 was on par with T_3 (0.13%) and the lowest content was obtained for T_4 (0.05g).

The energy content of pizza base was found to be highest in T_6 (312.00 K cal) after control T_7 (321.00g) and minimum in T_1 (265.00 kcal).The lowest protein content was found in T_1(5.41g) and it was on par with T_2 (5.64g).The highest protein content was found in T_6(8.18g) after control T_7(8.79g).The highest fat content was observed in T_6(3.47g) followed by control T_7 (3.53g). The lowest fat content was found in T_1(3.13 g).The highest fibre content was in T_1(6.14g) and the lowest fibre content was found in T_6(3.54 g) after control T_7 (2.95g).The highest moisture content was in T_2(21.27%) and it was on par with T_3(21.11 %) and T_1 (21.22%).The lowest moisture was found in T_6 (20.16%) after control (19.62%).The highest acidity content was observed in T_1(0.41%) and the lowest acidity content was found in T_4(0.06%).

The sensory quality of the baked products was evaluated by a panel comprising of 10 members using a 5 point score card. Results revealed that all the sensory scores for T_6 were higher than the other treatments with respect to parameters like appearance, texture, taste, after taste, flavour and overall acceptability. So T_6 was selected as the best treatment. From the hedonic rating test, it was observed that pizza base was the most acceptable product.

Shelf life studies for 3 days were conducted regularly for the selected bread, bun and pizza base treatments and for rusk the best treatment was assessed for 3 months. The products were packed in PP covers and stored in room temperature and analysed periodically for their sensory qualities, chemical changes and also microbial count.

From the sensory evaluation of the baked products during storage, though there was decrease in mean rank values, the products were declared as acceptable by the panel.

Moisture analysis during storage revealed that for bread, bun and pizza base, there was decrease in moisture content due to retrogradation. During the three month storage period the moisture content of rusk was found to increase. Acidity analysis during storage revealed that, there was gradual increase in acidity content in all the four products.

Bacterial colonies were found to appear in the developed products on fourth day. Fungi were detected only in pizza within permissible limits. No pathogenic organisms like coli form could be detected in the treatments.

.For bread, bun and rusk the shelf life was 3 days while for rusk it was 3 months.

Cost analysis of the developed product was calculated and for bread of 260 gm, it was worked out as 17 rupees, for bun of 60 g, it was 5 rupees, for rusk of 180g it was 16 rupees and for pizza base the cost per 100g was 12 rupees.

The products developed were essentially more healthy as there were no chemical additives and the nutritional quality was certainly better than pure refined flour based baked products. The scope for utilizing jackfruit in this section of food products is proved to be successful. However the product needs scaling up before commercialization.

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APPENDIX- 1

Scorecard for sensory qualities of bread and bun

Product: Date:
Tested by: Age:

Particulars	Criteria	Scores	1	2	3	4	5	6	7
Appearance	Excellent	5							
	Good	4							
	Satisfactory	3							
	Mediocre	2							
	Poor	1							
Texture	Soft	5							
	Soft but slightly hard	4							
	Moderately hard	3							
	Very hard	2							
	Very soft and soggy	1							
Taste	Excellent	5							
	Good	4							
	Satisfactory	3							
	Mediocre	2							
	Poor	1							
After taste	Excellent	5							
	Good	4							
	Satisfactory	3							
	Mediocre	2							
	Poor	1							
Flavour	Starchy	5							
	Starchy & slightly bitter	4							
	Starchy & very bitter	3							
	Bitter	2							
	Burnt	1							
Over all acceptability	Excellent	5							
	Good	4							
	Satisfactory	3							
	Mediocre	2							
	Poor	1							

Any comments: sign:

APPENDIX- 2

Scorecard for sensory qualities of the rusk

Product: Date:

Tested by: Age:

Particulars	Criteria	Scores	1	2	3	4	5	6	7
Appearance	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							
Texture	Crispy Slightly hard Hard Very hard Unbreakable	5 4 3 2 1							
Taste	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							
After taste	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							
Flavour	Starchy Starchy & slightly bitter Starchy & very bitter Bitter Burnt	5 4 3 2 1							
Over all acceptability	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							

Any comments: sign:

APPENDIX- 3

Scorecard for sensory qualities of the pizza base

Product: Date:

Tested by: Age:

Particulars	Criteria	Scores	1	2	3	4	5	6	7
Wooden appearance	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							
softness	Soft Soft but slightly hard Moderately hard Very hard Very soft and soggy	5 4 3 2 1							
Taste	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							
Colour of edge	Cream Yellowish cream Brownish cream Light brown Dark brown	5 4 3 2 1							
Aroma	Starchy Yeasty Starchy and yeasty Starchy and fruity Yeasty and fruity	5 4 3 2 1							
porosity	Large uniform pores Small uniform pores Non uniform pores Non uniform small pores Non uniform large pores	5 4 3 2 1							
Crispiness of edge	Excellent Good Satisfactory Mediocre Poor	5 4 3 2 1							

Any comments: sign:

APPENDIX- 4

Hedonic rating test for baked products

Sl No.	Criteria	Scores	Bread	Bun	Rusk	Pizza base
1	Extremely good	9				
2	Very good	8				
3	Good	7				
4	Less liked	6				
5	Neither like nor dislike	5				
6	Unpleasant	4				
7	Slightly unpleasant	3				
8	Moderately unpleasant	2				
9	Extremely unpleasant	1				

ABSTRACT

VALUE ADDED BAKED PRODUCTS FROM RAW JACKFRUIT

by

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(2014-16-259)

Abstract of the thesis

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN HOME SCIENCE

(Food Science and Nutrition)

Faculty of Agriculture

Kerala Agricultural University

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE

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KERALA, INDIA

2016

8. ABSTRACT

The study entitled "Value added baked products from raw jackfruit" was carried out at the Department Of Home Science, College Of Agriculture,Vellayani during the period 2014-2016. The main objective of the study was to develop value added baked products *viz.* Fruit bread, Bun, Rusk and Pizza base, based on raw jackfruit bulb flour and ascertain their physical, chemical, nutritional and shelf life qualities.

Raw jackfruit bulbs were processed into flour by standardized procedures and its functional qualities were evaluated. Analysis of functional quality revealed higher levels of water absorption index (2.95%), swelling power (16.35%) and solubility (12.11%) in jackfruit bulb flour than refined wheat flour.

Seven treatments comprising of various combinations and proportions of refined wheat flour and raw jackfruit bulb flour (RJBF) were tried out for processing of baked products. The proportion of raw jackfruit flour ranged from20-60% among the treatments T_1 to T_6. These combinations of composite flour formed the base material for the baked products. The products were processed following standardized procedures which involved weighing, mixing, kneading, moulding, panning and proofing. The products made from these treatments were then baked in the Rotary diesel oven at Asian Cakes, Kaniyapuram, Thiruvananthapuram.

The quality parameters were ascertained for the 7 treatments of all the 4 products. When the various treatments for fruit bread were evaluated, baked weight(282.00g) was highest for Treatment T_1 and energy, protein and fat content was found to be highest in T_6(299.00kcal,9.05g, 3.48g respectively).As for fibre, moisture and acidity,T_1 revealed the highest values being 6.41g, 21.05%, 0.14% respectively. Sensory evaluation revealed that T_6 obtained the highest scores for appearance,

texture, taste, after taste, flavour and over all acceptability. The shelf life ofthe selected product was found to be 3 days at room temperature.

All the treatments of Bun showed an increase in depth after baking which ranged from 0.1-0.76 cm. Among the 7 treatments lower calorie, fat and protein were observed for the treatment T_1 being 261.00 Kcal, 5.31g, and 3.15g. Moisture content was found to be lowest inT_6 (18.5%).Fibre and acidity was significantly higher in T_1 (6.07g and0.42% respectively). The shelf life of the selected treatment was 3 days.

Among the 7 treatments of Rusk T_2 (45:55) obtained the highest yield (63.15%) and T6 was seen to yield the highest volume (33.20cc).Proximate composition analysis revealed that energy, protein and fat content was highest in T_6 (431.00kcal, 8.18g and 3.58gm respectively). Treatment T_1 had the highest fibre content (6.05g) which was significantly different from others.T_6constituted of refined flour and jackfruit flour in the ratio 80:20 obtained the highest scores in sensory evaluation. The shelf life for the best treatment was found to be 3 months.

In the case of Pizza base, treatment T_1 revealed the highest baked weight (99.0g) and T6 gave the lowest value (90.66g). Energy, protein and fat value of treatment $T_1$was observed to be significantly lower than other treatments (265.00kcal, 5.41g and 3.13g). However the fibre content for treatment T_1 was 6.14g. T6 obtained the highest scores in sensory evaluation based on Limongi's Scale. Shelf life of the selected best treatment was found to be 3 days.

The costs of the products were found to be less than that of proprietary products in market. When product acceptability was analyzed, Pizza base obtained the highest rank followed by Rusk, bun, and Fruit bread.

Incorporation of RJBF into baked products is thus seen to improve quality of the product economically, nutritionally and also with respect to sensory qualities.