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# DEVELOPMENT AND CHARACTERIZATION OF FUNCTIONAL FOOD PRODUCTS FROM JACKFRUIT SEED

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***Abstract***: Jackfruit (*Artocarpus heterophyllus*) is a fruit found in many parts of Asia. It has been gaining popularity due to its delicious, sweet taste and various health benefits. A single jackfruit may contain 100-500 edible and nutritious seeds. Despite their beneficial nutrients, the seeds are typically discarded as a waste. Jack fruit seeds can be promoted as a good substitute for seasonal vegetables and the shelf life can be extended by making into powder. This research aims to develop and formulate functional food products from jackfruit seed. Malnutrition one of the major problems in India and this COVID-19 pandemic made the situation even worst. The major reasons are due to limited access to nutritious foods and poor economic conditions. Only limited functional food products are available in the market and even those products are not accessible to low economic group due to its high cost. The jackfruit seeds are nutritionally similar to grains and rich in Carbohydrate, Protein, Vitamin B complex, Vitamin C, fibre and low in fat. The present study was carried out to develop the value-added functional food products from powdered dried jackfruit seed flour and to analyze the physiochemical characteristics of the jackfruit seed powder, to analyze the proximate principles of developed product and to assess the consumer acceptability of the developed functional food products. Hence providing nutritionally dense, cost effective, accessible food products for everyone made from locally available food will be the sustainable solution to improve the nutritional status of the community. This Jackfruit seeds can be used as an economically alternative nutritious source to tackle the malnutrition problem and to provide additional income to rural community.

**Keywords**: Jackfruit Seeds, Malnutrition, Functional food products

## I. INTRODUCTION

Food is a substance whether in liquid, concentrated, solid, frozen, dried or dehydrated form, that are sold for ingestion or chewing by humans and are consumed for their taste or nutritional value. Food does not include alcoholic beverages, dietary supplements, soft drinks or tobacco **(Mary Earle, 2014).** Food is any substance consumed to provide nutritional support to the body. It is usually of plant or animal origin, and contains essential nutrients such as carbohydrates, protein, fat, vitamins and minerals. Liquid used for energy and nutrition are often called 'drinks' **(Sancho-Madriz, 2012).** New product development is important because today's market is more dynamic as compared to the past, it keeps on changing due to the wide variety of customer needs. Due to increased literacy rate, globalized market, heavy competition and availability of a number of substitute products have tremendous challenges in today's market **(Bruijyan, 2014).**

Jackfruit *(Artocarpus heterophyllus Lam.)* is widely cultivated in India and its neighboring countries as well as in parts of Africa. After the consumption of the edible portion of the ripe fruit, the seeds, rich in carbohydrate and protein, are usually discarded as a waste. Jackfruit seed flour contains vitamin C and also a significant amount of protein and dietary fiber and it is feasible to produce nutritionally value added products from jackfruit seed flour. As jackfruit seed flour is a good source of high quality amino acids and rich in antioxidants, it can compete industrially with other protein ingredients such as soy protein isolate and egg albumin. The jackfruit seed powder can be utilized to produce high protein products that would be an option to provide nutrient rich food for consumers. Due to perishable nature, the seeds are usually discarded as waste, but when stored in a cool, moist environment, they have a shelf-life of about one month. To extend the shelf-life, the roasted seeds can be made into powders and used to add value to different products. Jackfruit seed powder is used as an alternative flour in bakery and confectionary products by blending it with wheat flour and other low-cost flours **(Hossain, 2014).** In certain parts of India, the seeds are consumed by boiling or roasting them or used to supplement potato **(Banerjee & Datta, 2015).**

In countries with high population where the food requirements are not being fulfilled by seasonal vegetables, jackfruit seeds can be used as a good substitute. As jackfruit seeds have shorter shelf life, they go waste during the seasonal gut. So, the seed flour can be an alternative product, which can be stored and utilized, for value addition, as jackfruit seed flour was found to be rich in proteins, carbohydrates and minerals. Malnutrition is one of the major problems in India and this COVID-19 pandemic made the situation even worst. Jackfruit seeds could be used as an economic alternative protein source to tackle the malnutrition **(Roy Chowdhury et al, 2012).** The demand for jackfruit seeds has been increased due to increased consumer awareness regarding the diet-disease relationship. It is believed to be a potent functional food ingredient since it imparts additional physiological benefits in addition to basic nutrition **(Nagma Menon et al, 2019).** Only limited functional food products are in the market and even those products are not accessible to low economic group due to its high cost. Hence providing food products which is cost effective made from locally available foods will be the best solution to improve the nutritional status. Jackfruit seeds could be used as an economic alternative

protein source to tackle the malnutrition. Jackfruit seed powder is a rich source of dietary fibre, protein, carbohydrate, vitamins A, B, C and minerals. It helps to prevent constipation and indigestion. The powder is rich in thiamine and riboflavin which help in turning the food you eat into energy and keep your eyes, skin and hair healthy. As the seeds are rich in dietary fiber and B-complex vitamins and due to their high fiber content, they help lower the risk of heart disease, prevent constipation and promote weight loss. Jackfruit seeds also contain resistant starch, which controls blood sugar and keeps the gut healthy and also the seed flour has the property to overcome malnutrition problems.

The present study is aimed to develop value-added functional food products from jackfruit seed flour is as it contains good amount of nutrients and health benefit. In this study, different types of functional food products were developed and formulated out of Dried Jackfruit seed flour and nutritional benefits of jackfruit seed powder were discussed.

## II. MATERIALS AND METHODS:

### 2.1 Raw material procurement:

The jackfruit seeds were procured from local market from the street vendor in Coimbatore, Tamil Nadu. Other ingredients were procured from local supermarket, Coimbatore.

### 2.2 Processing of Jackfruit Seed Flour:

The jackfruit seeds (3kg) were cleaned manually and white arils (seed coat) were manually peeled off. The peeled seeds were cut into thin slices and dried at 80° C to constant moisture content. The dried seeds were powdered in a medium size grinder and sieved to fine powder and packed in a polyethylene pouches and stored in a proper room temperature for further processing and analysis. The flowchart **(fig.1)** given below depicts the process of jackfruit seed flour

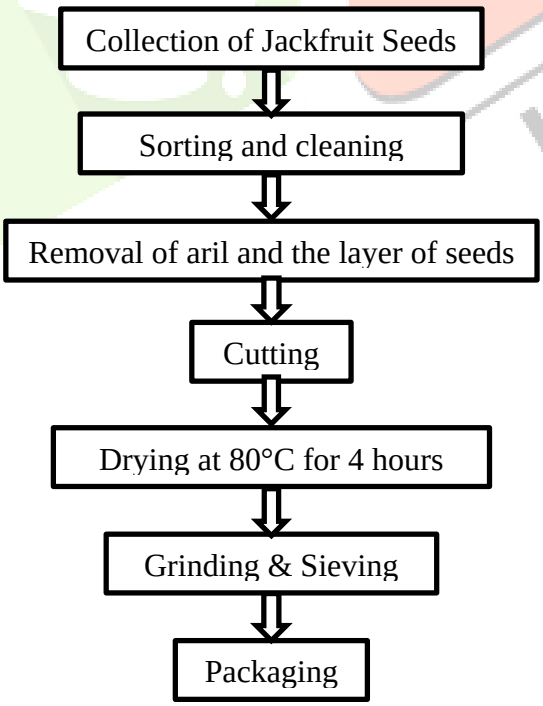



**Fig (1): Flow chart of processing of Jackfruit Seed flour**

## 2.3 Preparation of Jackfruit seed products:

Three different types of food products were formulated and standardized with jackfruit seed flour(JSF) and the products are Chunks, Energy Bar, Pasta (Noodle).

### 2.3.1. Preparation of Chunks:

Table 1- Illustrate the Jackfruit seed chunks recipe was formulated using the above ingredients and different variation were taken to standardize the recipe.

**Table (1): Trials for the development of jack fruit seed chunks**

| INGREEINTS | SAMPLE 1 | SAMPLE 2 | SAMPLE 3 | SAMPLE 4 | SAMPLE 5 |
|---|---|---|---|---|---|
| Jackfruit seed flour | 100g | 20g | 20g | 20g | 20g |
| Soya flour | - | 10g | 20g | - | - |
| Defatted soya flour | - | - | - | 10g | 20g- |
| Guar gum | - | - | - | - | 10g |

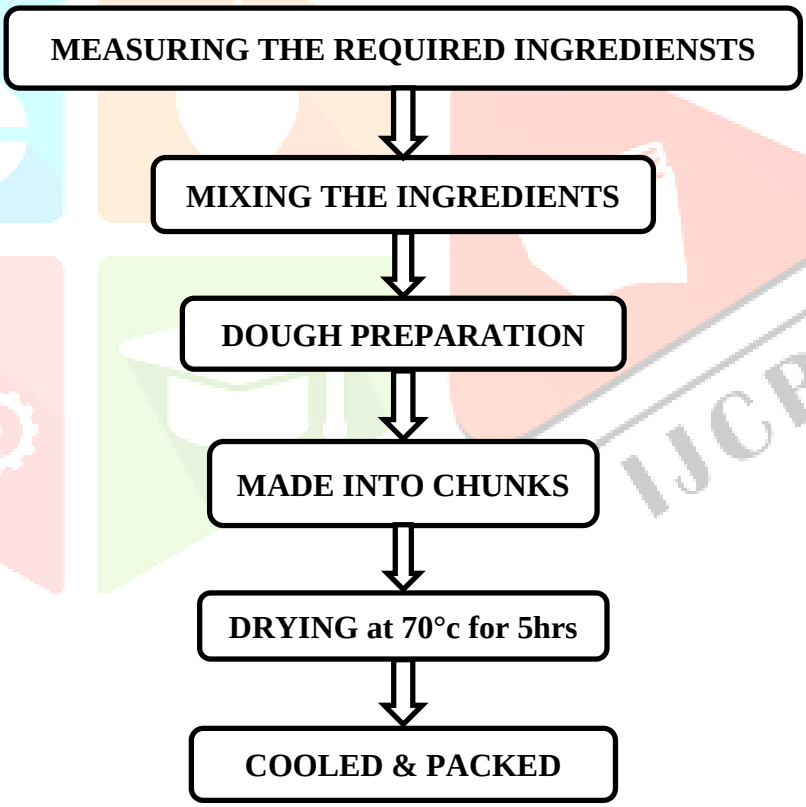



**Fig (2): Flow chart of processing of chunks**

### 2.3.2 Preparation of Energy Bar:

The Energy Bar was formulated using the above ingredient and (Table-.2) shows the different variations were taken to standardize the bar.

**Table (2): Trials for the development of energy bar**

| INGREDENTS | SAMPLE 1 | SAMPLE 2 | SAMPLE 3 |
|---|---|---|---|
| Jackfruit seed flour | 30g | 40g | 50g |
| Ragi flour | 10g | - | - |
| Black dates | 50g | 100g | 100g |
| Nuts | 6g | 15g | 30g |

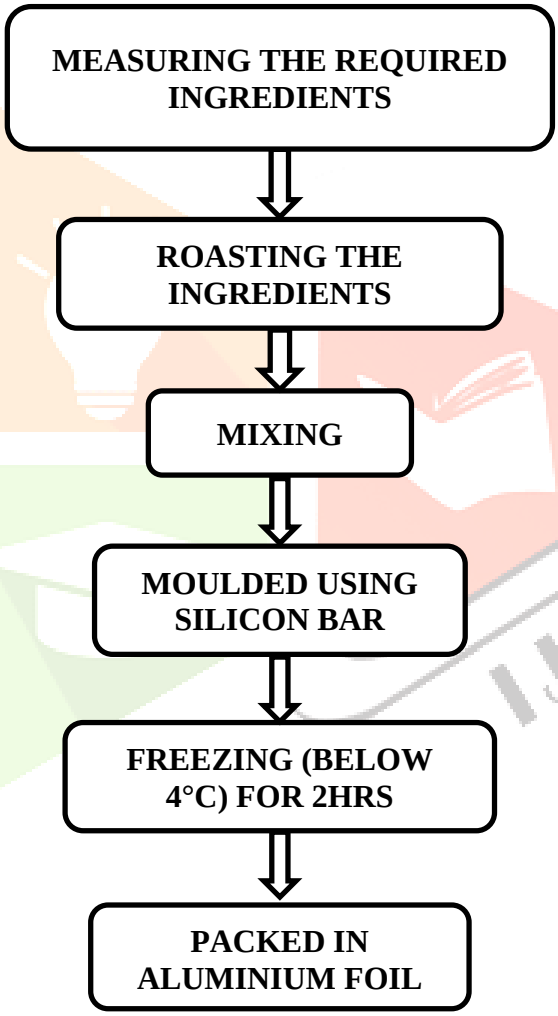



**Figure (4): Flow chart of processing of Energy Bar**

### 2.3.3. Preparation of Pasta (Noodles):

The Pasta (Noodles) was formulated using the above ingredient and (Table-.3) shows the different variations were taken to standardize the product.

**Table (3): Trials for the development of Pasta (Noodles)**

| INGREDIENTS | SAMPLE 1 | SAMPLE 2 | SAMPLE 3 |
|---|---|---|---|
| Jackfruit seed flour | 40g | 50g | 30g |
| Maida | 60g | 50g | 70g |
| Salt | 1g | 1g | 1g |
| Oil | 5ml | 10ml | 15ml |

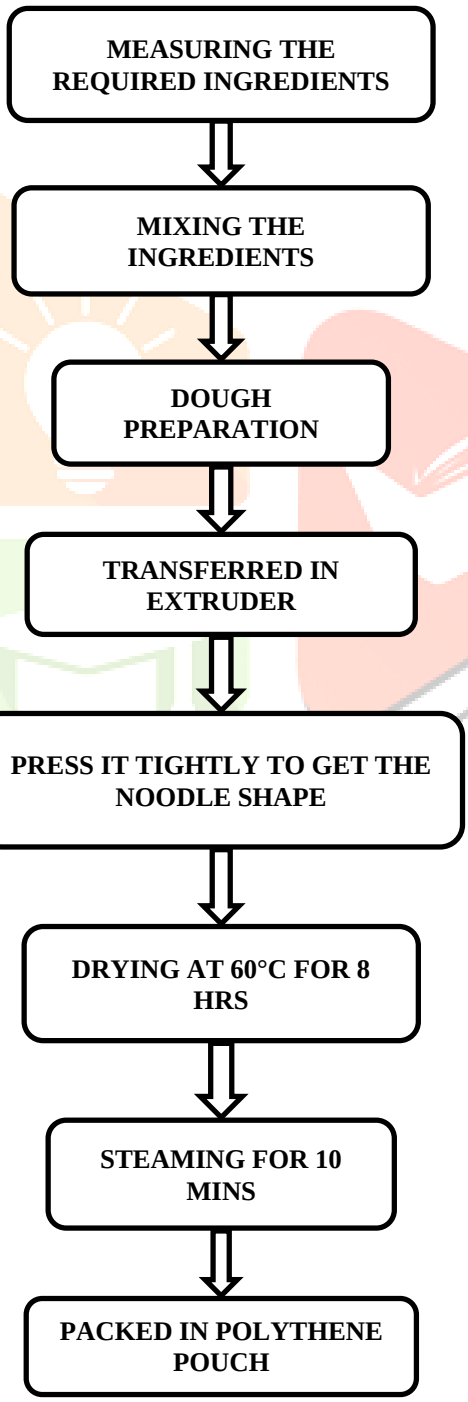



**Figure (5): Flow chart of processing of Pasta (Noodles)**

## 2.4. FUNCTIONAL PROPERTIES OF JSF:

### 2.4.1 Water Absorption Capacity:

This was determined using methods described by **(Ocloo et., al, 2010).** One-gram sample was weighed into 25 ml graduated conical centrifuge tubes and about 10 ml of water added. The suspensions were allowed to stand at room temperature (30 ± 2 °C) for 1 hr. The suspension was centrifuge at 200 x g (2000 rpm) for 30 minute. The volume of water on the sediment was measured and the water absorbed expressed as percent water absorption based on the original sample weight.

### 2.4.2 Fat/oil Absorption Capacity:

This was determined using methods described by **(Ocloo et., al, 2010).** One-gram sample was weighed into 25 ml graduated conical centrifuge tubes and about 10 ml of refined vegetable oil added. The suspension was centrifuge at 200 x g (2000 rpm) for 30 minute. The volume of oil on the sediment was measured and the oil absorbed expressed as per cent oil absorption based on the original sample weight.

## 2.5 PROXIMATE ANALYSIS:

a) **Energy:** Energy is in everything that consumed, or used. It repairs cells and body tissue, is used to build muscle, and is necessary to maintain homeostasis. This is done in accredited lab by (FAO) method.

b) **Carbohydrates:** The main function of carbohydrate is supplying energy to the body. This is done in accredited lab by AOAC (21$^{st}$ Edn.Ch-50) method.

c) **Total protein:** The main function of protein is to build and repair tissues. and also body use protein to make enzyme, hormones and other body chemicals. Protein is an important building blocks of bones, muscles, cartilage, skin and blood. This is done in accredited lab by IS 7219:1973 (RA 2010) method.

d) **Ash:** The ash content in food is simply burning away of organic content, leaving inorganic minerals to determine the amount and type of minerals in food, to estimate the amount of minerals. This is done in accredited lab by AOAC (21$^{st}$ Edn.Ch-4) method.

e) **Total fat:** Dietary fats are essential to give your body energy and to support cell growth. Fats help your body to absorb some nutrients and produce important hormones. This is done in accredited lab by AOAC (Ch-4, P-44 21$^{st}$ Edn.2019) method.

f) **Crude fibre:** The crude fibre is the indigestible carbohydrate in foods. The components present in crude fibre have little food value but provide the bulk necessary for proper peristaltic action in the intestinal tract. This is done in accredited lab by AOAC (21$^{st}$ Edn.Ch-4) method.

g) **Moisture:** Moisture content is one of the most important analysis performed on a food. The moisture content of food varies greatly. The propensity of microorganisms to grow in foods depends on their water content and for this reason many foods are dried below the critical moisture content. This is done in accredited lab by AOAC (21$^{st}$ Edn.Ch-4) method.

**h)** **Starch:** Starch is a carbohydrate commonly found in nature and one of the primary sources of food energy for human beings. Starches are the most widely known thickening agents and we often encounter them in recipes. This test is determined by TNTH/SOP/FOOD/102 method in accredited lab.

## 2.6. MICROBIAL ANALYSIS:

i. **Total Bacteria Count:** The total bacteria count (TBC) of a substance is a quantitative estimate of the number of microorganisms present in a sample. This measurement is represented by the number of colony-forming bacterial units (CFU) per gram (or millilitre) in the sample. This is done according to DPHA protocol.

ii. **Yeast & Mould:** Total Yeast and Molds Counts (TYMC) are used to detect and quantify the amount of fungal growth on plant material, and allow for identification of viable yeast and molds species present. The amount of fungi is reported as the number of colony forming units (CFUs). This is done according to DPHA protocol.

## 2.7 SENSORY EVALUATION OF PRODUCT:

The prepared samples were subjected to sensory evaluation by the 25 semi-trained panelist from the institution. The Sample A (Jackfruit seed chunks), Sample B (Energy Bar), Sample C (Pasta) were coded and given for sensory evaluation. The sensory parameters namely appearance, colour, flavour, texture, aroma and overall acceptability were analyzed using 5-point hedonic scale.

## III RESULTS AND DISCUSSIONS:

The results of the study entitled, "Development and characterization of functional food products from jackfruit seed", is presented and discussed.

## 3.1 FUNCTIONAL PROPERTIES OF JSF:

### 3.1.1 Water Absorption Capacity:

**TABLE (4): WATER ABSORPTION CAPACITY OF JSF (%):**

| NAME OF ANALYSIS | PRODUCT | VALUES (ml/g) | RESULT (%) |
|---|---|---|---|
| Water Absorption Capacity (%) | JSF | 2.2 | 22 |

The water absorption capacity for the Jackfruit seed flour was found to be 22% (2.2 ml/g). The value is found to be lower however comparable to 2.5ml/g reported for jackfruit seed flour **(Ocloo et., al.2010)**. The disparities observed could be attributed to the method used as well as the varietal differences. The result obtained shows that the flour has a good ability to bind water. This result suggests that Jackfruit seed flour could be used for new product formulation.

### 3.1.2Oil Absorption Capacity:

**TABLE (5): OIL ABSORPTION CAPACITY OF JSF (%):**

| NAME OF ANALYSIS | PRODUCT | VALUES (ml/g) | RESULT (%) |
|---|---|---|---|
| Fat/Oil Absorption Capacity (%) | JSF | 0.83 | 8.3% |

The fat/oil absorption caption was found to be 8.3% (0.83ml/g). The value is found to be lower however comparable to 1.7 ml/g reported for jackfruit seed flour **(Ocloo et., al.2010).** The disparities observed could be attributed to the method used as well as the varietal differences. The result obtained shows that jackfruit seed flour is a high flavor retainer and may therefore it can be incorporated for new product formulation.

### 3.2 PROXIMATE ANALYSIS OF JSF:

The proximate analysis of jackfruit seed flour was determined using standard methods of analysis. Table 6- represents the proximate values of the jackfruit seed flour.

**TABLE (6): Proximate composition of Jackfruit seed flour**

| S.NO. | PARAMETERS | UNITS | RESULT |
|---|---|---|---|
| 1. | Energy | Kcal/100g | 365.23 |
| 2. | Carbohydrate | g/100g | 76.51 |
| 3. | Total Protein | g/100g | 14.01 |
| 4. | Ash | g/100g | 5.09 |
| 5. | Total Fat | g/100g | 0.35 |
| 6. | Crude Fibre | g/100g | 16.50 |
| 7. | Moisture | g/100g | 4.04 |
| 8. | Starch | % | 42.1 |

The caloric value (energy) of the Jackfruit seed flour was 365.23 kcal/100g. This value is higher than that reported by **Akinmutimi (2006)** for Jackfruit seed (292 – 313 kcal/100g). The major component of the flour was carbohydrate. The value obtained from the study was 76.51g. The total protein content in the flour was found to be 14.01g. Ash refers to inorganic residues remaining after either ignition or complete oxidation of organic matter in food sample. It was found to be 5.09g in JSF (100g). The fat content of the jackfruit seed flour was observed to be 0.35g. The crude fibre was found to be 16.50g. The moisture content of the seed flour was 4.04g. The lower the moisture content of flour, the better its shelf stability and hence increases the quality of flour. Moisture contents of flour generally is depended upon the duration of the drying process. The values are slightly lower than reported by **(Agbemavor et., al.2010)**. The differences observed could be attributed to the analytical methods used for estimation, the variety of Jackfruit and the geographical location of the plant. The determination of starch is estimated to be 42.1 percentage.

### 3.3 MICROBIAL ANALYSIS OF JSF:

The microbial load in the jackfruit seed flour was tested after the three months' storage period of time. Table 7 – represents the microbial growth present in the jackfruit seed flour stored at room temperature.

**Table (7): MICROBIAL LOAD IN JACKFRUIT SEED FLOUR**

| S.NO. | PARAMETERS | TEST RESULT |
|---|---|---|
| 1. | Total Bacteria Count | $1.09X10^4$ cfu/gm |
| 2. | Yeast & Mold | Absent |
| 3. | *Coliform* | Absent |
| 4. | *Salmonella* | Absent |
| 5. | *Shigella* | Absent |

The Total Bacteria Count (TBC) present in the flour was found to be $1.09x10^4$cfu/gm and the maximum requirement as per FSSAI is 50,000 cfu/gm. Bacteria such as *Coliform, Salmonella, Shigella* was found to be absent in the jackfruit seed flour. Also the yeast and mold was found to be absent and the maximum requirement as per FSSAI is 10,000 cfu/gm. This may be due to preparing the product in hygienic condition and sealed quickly. Hence the flour was suitable for consumption even after the storage period of 3 months and it could be applied in food systems.

### 3.4 FORMULATION STANDARDIZATION OF THE PRODUCTS:

Various trials have been undertaken to formulate and standardize the products. Few variations were tried varying the composition of the ingredients to develop the products. The composition of the ingredients and the type of pre-processing plays an important role in the shape retention of products during processing. On the basis of the composition of the ingredient different variants were built for the formulation of fucnctionl food products. All the prepared samples were subjected to sensory analysis to standardize the products.

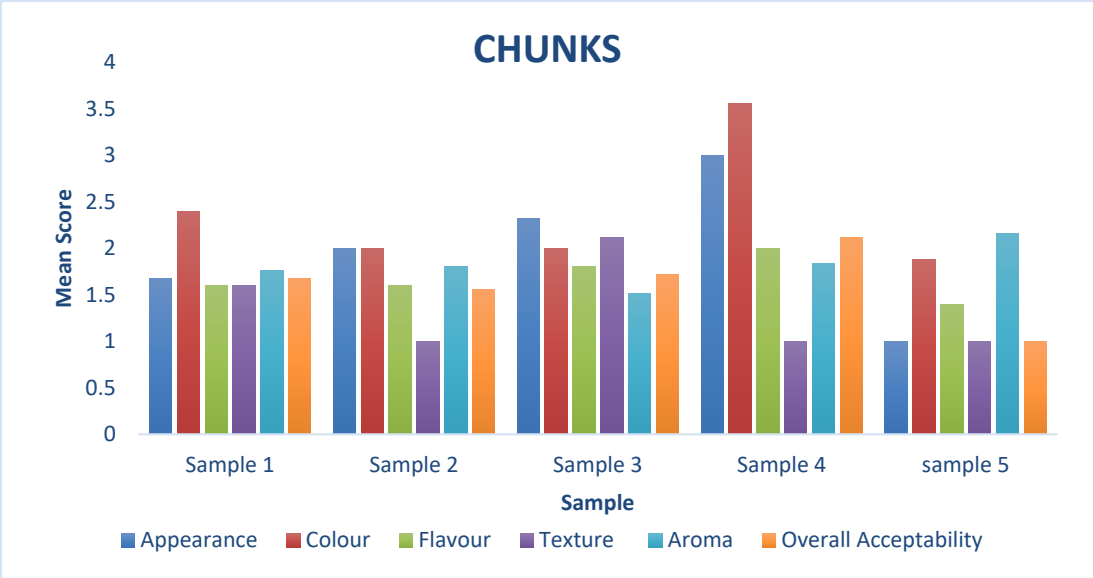
#### 3.4.1 Sensory Evaluation of Chunks:

The sensory attributes of appearance, color, flavor, texture, aroma and overall acceptability of chunks were evaluated by semi-trained panelist consisting of 25 members and the data was evaluated statistically. The mean score and SD value for all the sensory parameters of **Sample 1, Sample 2, Sample 3, Sample 4, Sample 5** in the following table-8 and chart-1 is given below.

**Table-8: Mean Score ± SD of chunks for sensory parameters**

| Sample | Appearance | Color | Flavor | Texture | Aroma | Overall Acceptability |
|---|---|---|---|---|---|---|
| Sample 1 | 1.68±0.74 | 2.4±0.81 | 1.6±0.64 | 1.6±0.70 | 1.76±0.43 | 1.68±0.55 |
| Sample 2 | 2±0.81 | 2±0.28 | 1.6±0.57 | 1±0 | 1.8±0.70 | 1.56±0.50 |
| Sample 3 | 2.32±0.74 | 2±1 | 1.8±0.70 | 2.1±0.83 | 1.52±0.77 | 1.72±0.73 |
| Sample 4 | 3±0 | 3.56±0.50 | 2±0 | 1±0 | 1.84±0.8 | 2.12±0.66 |
| Sample 5 | 1±0 | 1.88±0.43 | 1.4±2 | 1±0 | 2.16±0.62 | 1±0 |

**Chart -1: Sensory Analysis of Chunks**




To develop the jackfruit seed chunks 5 samples were developed and it was subjected to sensory analysis to standardize the product. It dispersed in the water when the cooking quality is checked and not able to achieve the desired shape of the product. Hence further more researches has to be done in future to develop the jackfruit seed chunks using extrusion technology.

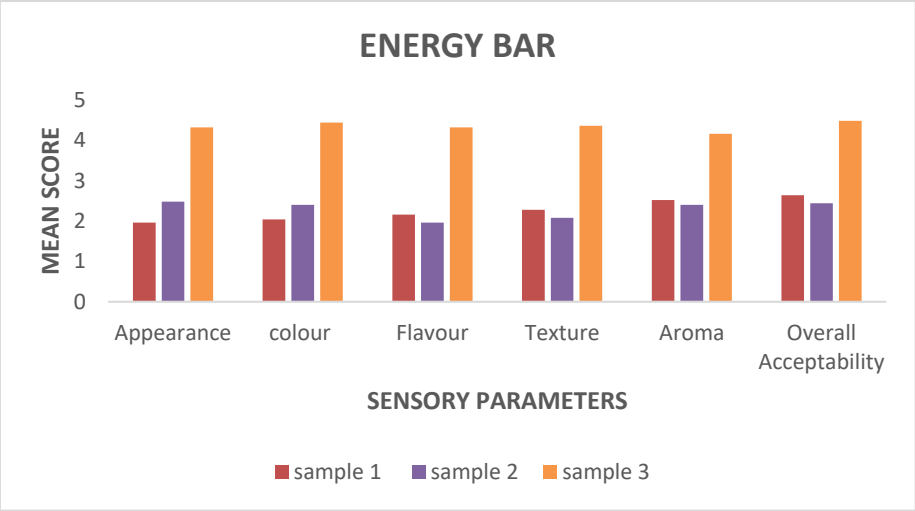
### 3.4.2 Sensory Evaluation of Energy Bar:

The sensory attributes of appearance, color, flavor, texture, aroma and overall acceptability of chunks were evaluated by semi-trained panelist consisting of 25 members and the data was evaluated statistically. The mean score and SD value for all the sensory parameters of **Sample 1, Sample 2, Sample 3** in the following table-9 and chart-2 is given below.

**Table-9: Mean Score ± SD of Energy Bar for sensory parameters**

| Sample | Appearance | Color | Flavor | Texture | Aroma | Overall Acceptability |
|---|---|---|---|---|---|---|
| Sample 1 | 1.96±0.78 | 2.04±0.78 | 2.16±0.74 | 2.28±0.67 | 2.52±0.50 | 2.64±0.48 |
| Sample 2 | 2.48±0.50 | 2.4±0.5 | 1.96±0.84 | 2.08±0.75 | 2.4±0.76 | 2.44±0.50 |
| Sample 3 | 4.32±0.62 | 4.44±0.65 | 4.32±0.69 | 4.36±0.63 | 4.16±0.68 | 4.48±0.50 |

**Chart-2: Sensory Analysis of Energy Bar**




Totally 3 samples were undertaken to standardize the energy bar using jackfruit seed flour and it was subjected to sensory analysis. In sample 1 using 10g of ragi flour and 30 g of JSF was done and in sample 2 only 40% of JSF with other ingredients were tried and sample 3 only 50% of JSF with other ingredients were done. From the sensory data Sample 3 was most preferred by the panel members.

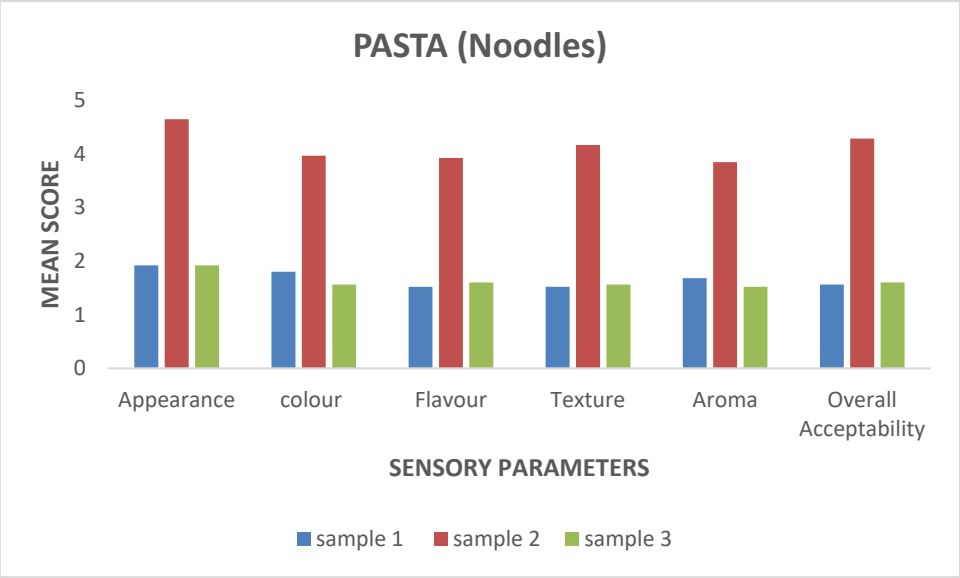
**3.4.3 Sensory Evaluation of Pasta (Noodles):**

The sensory attributes of appearance, color, flavor, texture, aroma and overall acceptability of chunks were evaluated by semi-trained panelist consisting of 25 members and the data was evaluated statistically. The mean score and SD value for all the sensory parameters of **Sample 1, Sample 2, Sample 3** in the following table-10 and chart-3 is given below.

**Table-10: Mean Score ± SD of Pasta (Noodles) for sensory parameters**

| Sample | Appearance | Color | Flavor | Texture | Aroma | Overall Acceptability |
|---|---|---|---|---|---|---|
| Sample 1 | 1.92±0.75 | 1.8±0.70 | 1.52±0.50 | 1.52±0.50 | 1.68±0.55 | 1.56±0.50 |
| Sample 2 | 4.64±0.48 | 3.96±0.67 | 3.92±0.27 | 4.16±0.8 | 3.84±0.8 | 4.28±0.45 |
| Sample 3 | 1.92±0.81 | 1.56±0.58 | 1.6±0.57 | 1.56±0.50 | 1.52±0.50 | 1.6±0.5 |

**Chart- 3: Sensory Analysis of Pasta (Noodles)**




In this 3 Samples have done to develop noodles from jackfruit seed flour. In sample 1 ratio of (6:4), sample 2 (5:5) and in sample 3 (7:3) were tried using Maida and Jackfruit seed flour and it was subjected to sensory analysis. From that sample 2 has taken as standard product as it was most preferred by panel members retained its desired shape of noodles and the cooking quality of Pasta (noodles) were checked.

**3.5 NUTRITIVE VALUE OF THE PRODUCT:**

The nutritive value of developed functional food products is calculated using **"Nutritive Value of Indian Foods" by ICMR (Revised Edn.2016).** Nutritive value of Energy Bar (Sample 3) and Pasta (Sample 2) were taken as a standard product from the sensory evaluation which was most preferred by the panelists. Table – 11, 12 shows the carbohydrate, protein, fat and fibre content of the developed products.

**Table (11): Nutritive Value of Energy Bar**

| S.NO | PARAMETERS | VALUES (g) |
|---|---|---|
| **1.** | Carbohydrate | 80.57g |
| **2.** | Protein | 45.65 |
| **3.** | Fat | 20.5 |
| **4.** | Fiber | 18.1 |

**Table (12): Nutritive Value of Pasta (noodles)**

| S.NO | PARAMETERS | VALUES (g) |
|---|---|---|
| **1.** | Carbohydrate | 76.1 |
| **2.** | Protein | 12.16 |
| **3.** | Fat | 10.16 |
| **4.** | Fiber | 9.65 |

## IV CONCLUSION:

From the study it was concluded that Jackfruit seed flour (JSF) is a good source of protein and rich in fibre, it can compete industrially with other protein ingredients such as soy protein isolate and egg albumin. JSF can be utilized to produce high protein products that would be an option to provide nutrient rich food for consumers. It is believed to be a potent functional food ingredient since it imparts additional physiological benefits in addition to basic nutrition. So, one of the most convenient ways to utilize jackfruit seed flour to prepare supplementary food which can eventually minimize protein malnutrition among the countries. So in this study, a healthy low cost nutritious and safe functional food products were developed from the jack fruit seed flour. As the flour has longer shelf life, it can be applied in food systems.

## V. ACKNOWLEDGEMENT:

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