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Proximate analysis of jack fruit seed flour (Non-germinated and germinated) and value addition to bread

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Abstract
Introduction: *Artocarpus heterophyllus* is an excellent plant due to its multifaceted medicinal properties. (Tejpa., 2016). Jack fruit is highly seasonal. Seeds are used occasionally as a minor supplement in culinary recipes but are mostly wasted. (Roy Chowdhury., 2012). The study was conducted with the objective to analyse the nutrient composition of germinated and non-germinated jack fruit seeds and the possibility of its incorporation into bread.
Materials and Methods: Jack fruit are one of the abundantly grown fruits next to banana and mango. (BBS, 2011). Fully ripen fresh jack fruits were bought from the local markets of Coimbatore. The seeds were separated, washed and soaked in water for 24 hours, tied in cloth for germination. Both germinated and non-germinated seeds were sun dried, powdered and stored in airtight container. Proximate composition (Moisture, ash, carbohydrates, protein, fat, crude fiber) and mineral analysis (calcium, sodium, potassium) were carried out in both seed flours (germinated and non-germinated). The seed flours were incorporated into bread and evaluated the sensory characteristics. Nutrient analysis and shelf life of formulated product was carried out for comparison.
Results: The proximate composition of the non-germinated and germinated jack fruit seeds were evaluated. On comparison, germinated seeds had higher nutritional content to that of Non-germinated seeds. Both the seeds were incorporated at varying proportions (5,10,15,20%) into bread. Sensory evaluation revealed that the acceptable level of incorporation was 5% for non-germinated seed flour and 10% for Germinated seed flour.
Conclusion: The study concludes that bread incorporated with 5% Jack seed flour had higher acceptability level than other variations. On comparing control and variations only slight increase in nutritive value was observed and the sensory qualities was similar. Shelf life studies indicates the presence of inhibitory substances towards molds.

Keywords: *Artocarpus heterophyllus*, proximate composition, mineral composition, germination, incorporation, microbial analysis

1. Introduction
Jackfruit is widely grown as an important tree. It is popularly known as poor man's fruit in the eastern and southern parts of India. (Sidhu A S 2012). The jackfruit seed flour is not only a rich source of protein, starch and dietary fibres but can also be regarded as an abundant yet cheap source of the said nutrients. The jack fruit seed flour may also be blended with wheat flour to explore the potential of low-cost flour from jackfruit seed as an alternative raw material for bakery and confectionary products. (Roy Chowdhury A., 2011). The main objective of the study was to incorporate germinated and non-germinated jack seed flour to breads and compare its nutritional value.

2. Methodology
2.1. Procurement of fruit
Jack fruits are seasonal fruits which provide health and nutritional benefits. Fully ripened fresh jackfruit was procured from local markets in Coimbatore district, Tamil Nadu, India.

2.2. Processing of seed flour
From the procured jackfruit, seeds were removed and its outer layer was removed. For germination, jack fruit seeds were soaked in water for 24 hours and tied in a muslin cloth.

Water was sprinkled frequently for a period of two weeks. Both germinated and non-germinated seeds were sliced and dried under sunlight. The dried seeds were powdered and stored in polyethylene pouches for further analysis.

2.3. Proximate compositional Analysis

2.3.1. Determination of Moisture

All foods, no matter whatever the method of processing be contain more or less water or moisture. It comprises between 60 to 95 percent in all-natural foods. It may be said to exist in two general forms: "free water" or "bound water". (Hart. 1971) [5].

The moisture content of 2g of the sample was determined by measuring the mass of a food before and after the water is removed by evaporation:

$$\% \text{ moisture} = \frac{\text{M initial} - \text{M dried}}{\text{M initial}}$$

M initial –and M dried are the mass of the sample before and after drying. The sample was heated at 104-105°c for 3-4 hrs in the oven and cooled. Final weight was recorded and the percentage of moisture content was calculated (AOAC Reference method - 1990) [6].

2.3.2 Determination of Ash

Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food.

2g of the sample was taken and heated several times using muffle furnace. By continued heating, the substance charred with the removal of moisture leaving only the ash of the food. The ash content can be determined by the formula

$$\text{Total ash (on dry basis) percentage by mass} = \frac{100 \text{ x } (M2\text{-}M)}{(M1\text{-}M)}$$

M2 : Mass in gram, of the dish with the ash
M1 : Mass in gram, of the empty dish and
M : Mass in gram, of the dish with the dried material. (AOAC reference method 1990) [6].

2.3.3. Determination of Carbohydrates

Carbohydrate is the most important food energy provider among the macronutrients, accounting for between 40 and 80 percent of total energy intake. The estimation of carbohydrates was done difference method. The sum of other proximate components are subtracted from 100 to yield the total carbohydrates in the food. (FAO. 2003)

Total CHO = 100 – (weight in grams (protein + fat+ water + ash +) in 100 g of food)

2.3.4. Estimation of Protein

Proteins are complex organic compounds. They provide energy for the body. Body uses protein to build and repair tissues. Protein is used to make enzymes, hormones, and other body chemicals. (zieve. 1977) [9] 0.5ml of digested sample was treated with reagents like 0.1N NaoH and 0.5% CuSo4. It was mixed well and incubated. To the solution folin's phenol reagent was added. The blue colour developed was measured at 660nm in spectrophotometer (Lowry, O.H *et al*., 1951).

2.3.5. Estimation of Fat

Essential fatty acids (EFAs) are long- chain polyunsaturated fatty acids, which play an important role on human health promotion, and since they cannot be synthesized by the human body they must be obtained through diet (Guine., 2009) [11].

To 1g of the sample, 2ml of chloroform and 3ml of methanol was added. After complete mixing of the solution it was kept in the shaker for 1hour. The solution was filtered using filter paper and the residue was collected. It was mixed with methanol, chloroform and water in the ratio 55:25:12. The mixed solution was well shaken and allowed to settle down. The lower phase was collected and dried in an oven for 3-5 hrs at 105°c and then the constant dry weight was recorded. The percentage of fat was determined using the formula

$$\text{Percentage of the fat in 100 g of sample} = \frac{W3\text{-}W1 * 100}{W2}$$

2.3.6. Estimation of Crude fibre

Dietary fibers are defined as plant polysaccharides that are indigestible by humans. Functional fiber is something that manufactures deliberately adds to food products to provide similar health benefits to those of dietary fiber. (Castillejo *et al*., 2006) [13]. The estimation of crude fibre was done by fibra plus. Weigh the sample accurately and note down the weight. Transfer the weighed sample into an oven dried fibra plus crucibles. Place the crucibles into the metal adapters of fibra plus hot extraction unit and ensure proper sealing of crucibles against the adapter rubber. (AOAC reference method).

2.4. Mineral Analysis

2.4.1. Estimation of Calcium, Sodium and Potassium

Calcium is the most abundant mineral in the body. Calcium provides a "structural role" in providing rigidity (structure and strength) to the skeleton. (Nordin, 1997) [15]. Sodium and potassium are essential in maintaining cellular homeostasis. The functions of the electrolytes are maintenance of osmotic pressure and water distribution in various body fluid. (Hanna., 2013). 10g of sample was weighed and homogenised with deionised water for 90 seconds. It was centrifuged for 20 mins at 1000 rpm. Supernatant was filtered and serial dilution was made with dilute HCL. Sodium, potassium and calcium was determined using photometer.

2.5. Incorporation of Jack fruit seed flour (germinated and non-germinated) in the preparation of bread

Bread dough was prepared using straight dough method. Yeast was activated with warm water. The fat was shortened with sugar and to this activated yeast and wheat flour was added. After kneading the dough was left for proofing for 45 mins. Once proofing is done, dough was shaped, moulded and baked at 170 C for 20 mins. To this formulation both germinated and non-germinated Jack fruit seed flour were incorporated at various proportions (5%,10%, 15%, 20%) in place of wheat flour respectively.

2.6. Sensory evaluation

Breads made by incorporation of jack fruit seed flour (germinated and non-germinated) was subjected to sensory evaluation. They were compared with the control sample i.e. without jack fruit seed flour. A panel of 25 semi-trained members evaluated the recipe based on the five-point hedonic scale. Sensory characteristics including appearance, texture, taste, distribution of holes, colour and overall acceptability of breads were the criteria chosen for evaluation. The variation which scored the highest score was considered as the ideal proportion for incorporation.

2.7. Nutrient analysis of bread

The variation which scored highest score in both germinated and non-germinated seed flour variation was analysed for nutrient content using standard procedures. Nutrients such as Moisture (Oven drying method); Carbohydrate (Difference method); Protein (Lowry method); Fibre (Fibra plus); Calcium, sodium and potassium (Flame photometry) were evaluated.

2.8. Shelf life analysis

Shelf life is the length of time that the commodity may be stored. It is very important in case of food commodities. Total Plate Count was used for the identification of microbial load. 1g of the sample was weighed and added to 100ml of sterile water. Serial dilution was carried out. 0.1 ml of the two dilutions (10-6, 10-7) was poured in the petri plates containing nutrient agar and spreaded evenly using L rod. The plates were inverted and incubated at room temperature for 24 hours. After incubation, the colonies were counted manually (Cappucino and Sherman, 2009).

3. Results and Discussion

3.1. Proximate Compositional analysis of Jack fruit Seed Flours

Proximate analysis is one of the most effective ways to analyze nutritional value and energy value in food. The proximate composition of Non-germinated and germinated jack fruit seeds was tabulated in Table – 1.

Table 1: Proximate composition of Non-germinated and Germinated jack fruit seeds

S. No	Parameter	Non-Germinated	Germinated
1	Moisture content (%)	20.6	22.4
2	Ash content (g/100g)	2.43	1.87
3	Carbohydrate content (g/100g)	67.5	63.8
4	Protein content (g/100g)	7.77	8.843
5	Fat content (g/100g)	1.04	1.12
6	Fibre content (g/100g)	1.3	1.9

- Total moisture content was found to higher after germination. The increase in moisture content is because of germination process which takes about two weeks.
  A similar study conducted by Shadab, 2013 on value addition using Jack fruit seed flour had moisture content of about 31.1%. The difference in moisture content can be attributed to the variety of jack fruit and method of processing the seeds.
- The Ash content was found to be higher in non-germinated jack fruit seed (2.43g/100g), when compared to germinated jack seed (1.87g).
- A study conducted by Deepika Gupta., 2011, on nutrient analysis of jackfruit seed found the ash content to about 0.15g which is much lesser compared to our study being 2.43 and 1.87g/100g in non-germinated and germinated jack fruit seed respectively. The difference may be due to the variety and processing method of the seed.
- The carbohydrate content of non-germinated jack fruit seed was analyzed to be 67.5g/100g, whereas after germination the total carbohydrate content decreased to 63.8g/100g.
  A study by the Albi Abraham.,2014 [22]on jack fruit seed analyzed the carbohydrate content to be 70.71g, whereas in the present study result it was between 63 to 68 g which may be due to the variety of the fruit used.
- The protein content of non- germinated jack seed was found to be 7.77g which increased after germination to 8.84g.
  A study by Mohammad., 2014 [24] on nutrient analysis of germinated and non-germinated jack fruit seed found the protein content to about 8.25g. The results also compared with that reported by Tazzal., 2014. The present study agrees with the results of the reported study.
- The fat content present in non-germinated jack seed was analyzed to be 1.04g, whereas germinated jack fruit seed had a slightly higher amount (1.12g).
  A similar study conducted by Shariful Isham *et al*., 2015 on germinated and Non-Germinated Jack fruit seed found the fat content to about (1.77-1.05g) when compared to our study only a small difference was noted which may be due to variety of fruit
- The fibre content of non-germinated jack fruit seed was found to be 1.3g while fibre content of germinated jack fruit seed being 1.9g/100g.
  A study on Jack fruit seed incorporated biscuits by Shrikant *et al*., (2012) found the fibre content to about 1.0 to 1.5g/100g. The present study confirms with the reported study.

3.2. Estimation of Calcium, Sodium and Potassium

In humans, sodium is essential mineral that regulates blood volume, blood pressure, osmotic equilibrium and pH; the minimum physiological requirement for sodium is 500mg / day. Potassium chloride and bicarbonate are used by those seeking to control hypertension. Calcium is an important component of a healthy diet and a mineral necessary for life (Marciniak, 2010) [28].

Table 2: Calcium content of Non-germinated and Germinated jack fruit seeds

S. No	Seed type	Sodium (mg/100g)	Potassium (mg/100g)	Calcium (mg/100g)
1	Non-germinated	59.7	395	47.8
2	Germinated	62.2	410	52.10

The sodium content of non-germinated Jack seed was found to be 59.7mg/100g and a very small rise was found after germination. The potassium content of non-germinated Jack fruit seed was found to be 395mg/100g, after germination it was found to be 410mg/100g. Calcium content of germinated Jack fruit seed was determined to be 52.1mg/100g and in non-germinated Jack fruit seed it was 47.8mg/100g.

A study conducted by Shrikam Baslingappa *et al*., 2012 on nutrient analysis of germinated and non-germinated Jack fruit seed resulted that the calcium content was found to be 50.0 - 52.0mg whereas the present study results are similar to this result (47.8-52.10mg).

Sodium and potassium content of jack fruit seed flour was evaluated by Ocloo., 2010 [29] which resulted in 60.66 and 14781 mg/kg of flour. The difference in the reported study may be due to the variation in the growing area, climate and soil conditions.

3.3. Comparison of Germinated and Non germinated Jack seed flour bread

3.3.1. Texture

Texture means give a rough or raised texture of surface in food substance. The mean score for texture of bread samples is given in figure 1

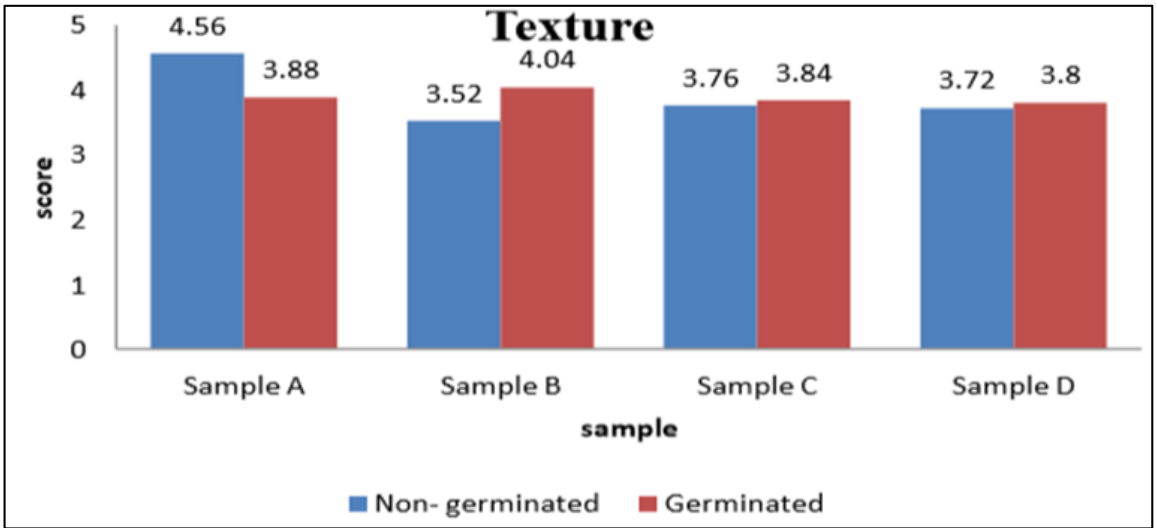

Fig 1: Mean score for Texture of bread sample

Sample – A: control; **Sample – B**: 5% incorporation; **Sample – C:** 10% incorporation; **Sample – D:** 15% incorporation

When compared to germinated and Non-Germinated the highest score for texture was obtained for Non-Germinated Sample A (4.56) and lowest score for Germinated Sample B being 3.52.

3.3.2. Taste

The sensory score of taste for germinated and Non-Germinated bread samples were evaluated and presented in Figure 2

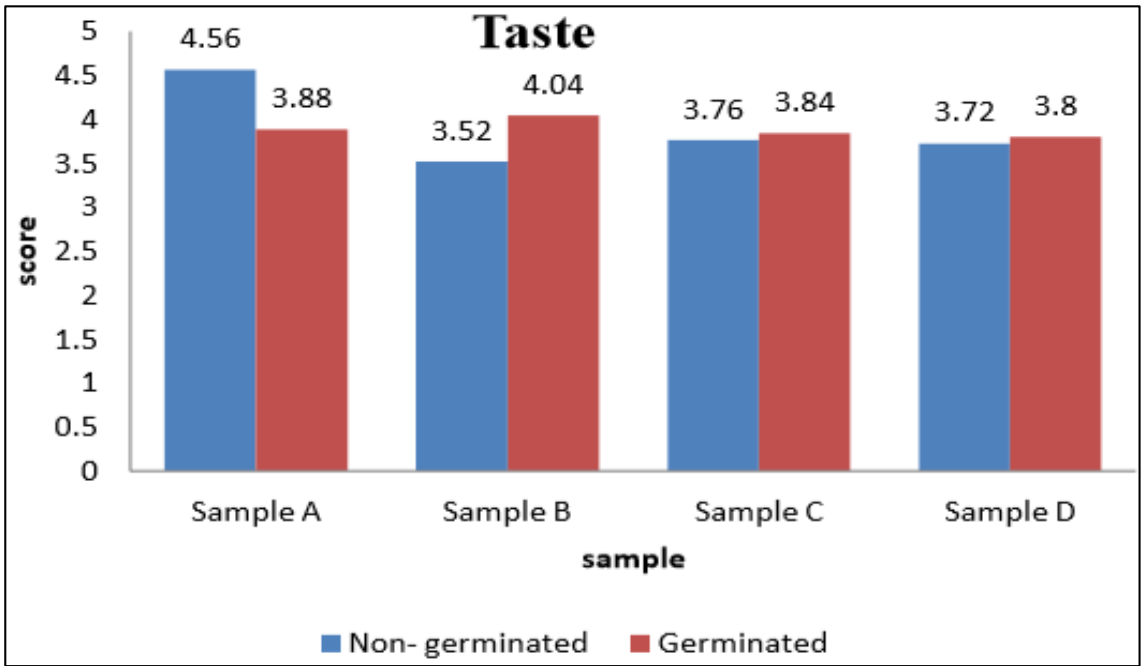

Fig 2: Mean score for Taste of bread sample

Sample – A: control; **Sample – B**: 5% incorporation; **Sample – C:** 10% incorporation; **Sample – D:** 15% incorporation

Sample A non-germinated got a higher score compared to other samples. Sample B non-germinated got the least score.

3.3.3. Holes of distribution

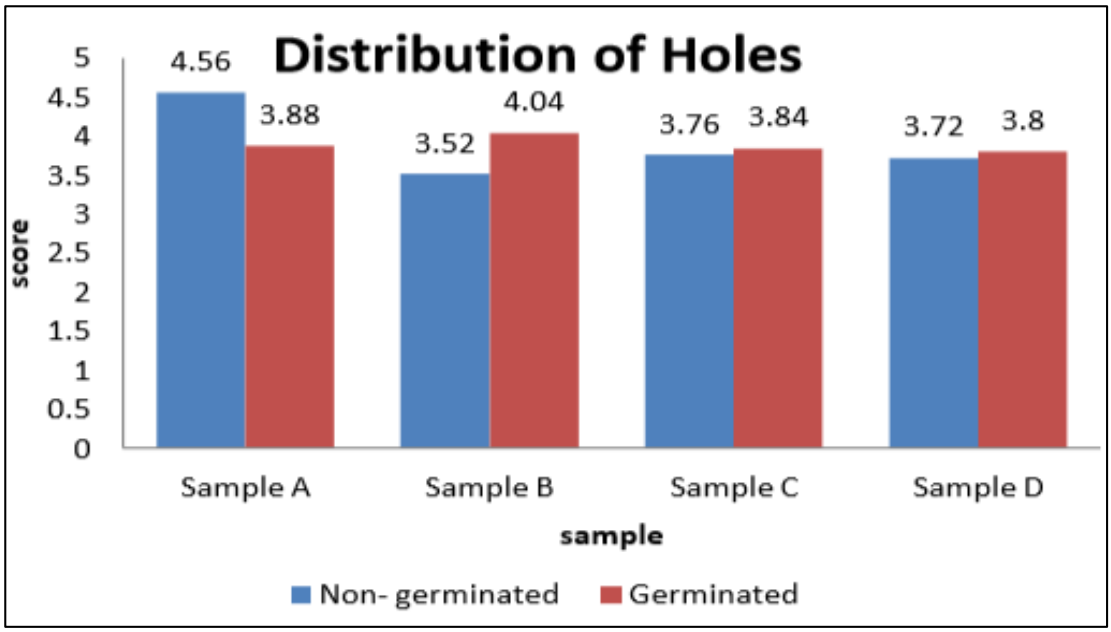

Fig 3: Mean score for Hole Distribution of bread sample

Sample – A: control; **Sample – B**: 5% incorporation; **Sample – C:** 10% incorporation; **Sample – D:** 15% incorporation

From figure 3, it is clear that the highest score for holes of distribution was got for sample A (non-germinated). The least score was for sample B (non-germinated).

3.3.4. Overall acceptability

Food acceptance is a complex field influenced by many factors, requiring both acceptances, perceptual and clinical and physical information if it is to be understood. The mean score for the overall acceptability of the juices is given in Figure 4

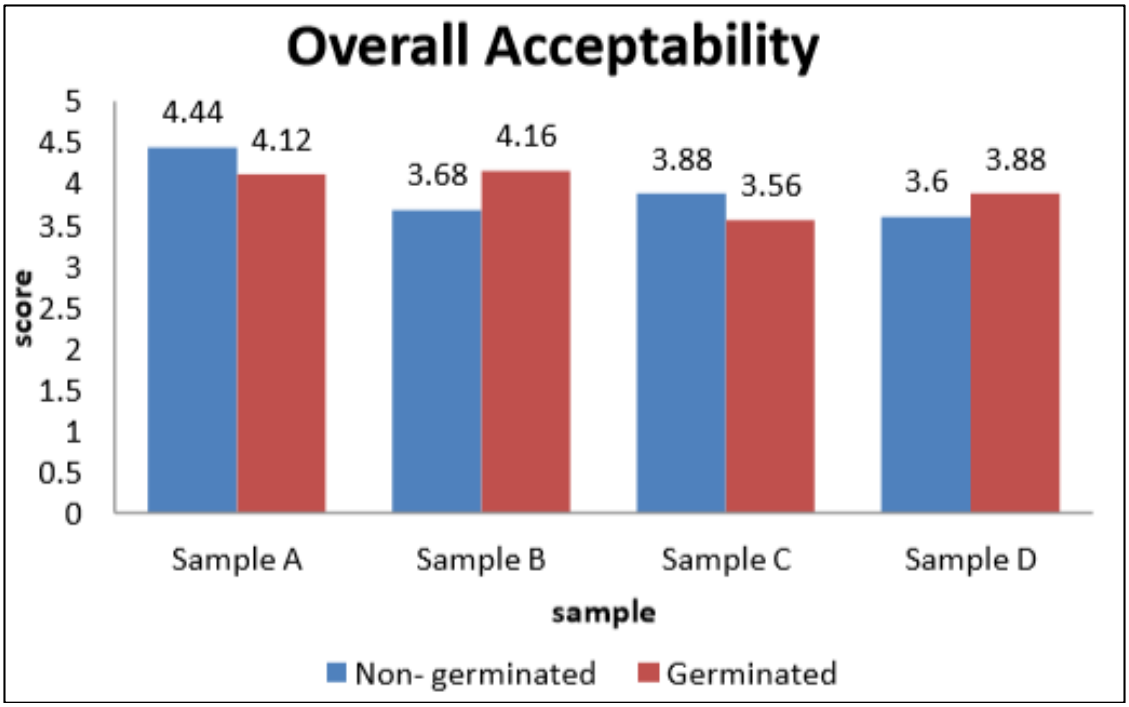

Fig 4: Mean score for Overall acceptability of bread sample

Sample – A: control; **Sample – B**: 5% incorporation; **Sample – C:** 10% incorporation; **Sample – D:** 15% incorporation

When compared the variations, we can observe that, overall acceptability was higher in sample A non-germinated (4.44), followed by sample B germinated (4.16).

3.4. Organoleptic evaluation of formulated Jack seed flour bread

Quality is the ultimate criterion of the desirability of any food product. Food quality can be evaluated by sensory and objective methods (Morten *et al*., 2007).

The formulated Jack seed flour bread variations were given to 25 semi- trained panel members. Sensory quality of jack

seed flour bread attributes viz., color and appearance, taste, texture, distribution of holes and overall acceptability were evaluated. This test measures the consumer's acceptability. The mean scores of the prepared jack seed flour bread by panel members were consolidated and tabulated in Table – 3.

Table 3: Sensory Mean value of Non-germinated Jack Fruit Seed

Parameter	Control	Sample A (5%)	Sample B (10%)	Sample C (15%)	Sample D (20%)
Appearance	4.64±0.57	4.68±0.48	3.6±0.58	3.68±0.63	3.52±0.65
Texture	4.68±0.48	4.52±0.59	3.8±0.50	3.92±0.76	3.44±0.58
Taste	4.32±0.69	4.68±0.48	3.88±0.73	3.24±0.78	3.2±0.71
Distribution of holes	4.12±0.73	4.56±0.65	3.52±0.51	3.76±0.66	3.72±0.54
Colour	4.44±0.65	4.48±0.59	3.96±0.54	3.44±0.65	3.44±0.65
Overall acceptability	4.12±0.67	4.44±0.51	3.68±0.48	3.88±0.33	3.6±0.50

According to Table 3, Organoleptic scores for overall acceptability was 4.12±0.67, 4.44±0.51, 3.68±0.48, 3.88±0.33 and 3.6±0.50 for Control, sample A, sample B, sample C, and Sample D respectively. Sample A was highly accepted for its appearance, texture, taste, distribution of holes and overall acceptability than the Control. Sample A outscored control bread in quality attributes such as appearance, texture, taste and flavour

Table 4: Sensory Mean value of Germinated Jack Fruit Seed

Parameter	Control	Sample A (5%)	Sample B (10%)	Sample C (15%)	Sample D (20%)
Appearance	4.32±0.69	4.28±0.61	4.28±0.61	3.72±0.84	4.16±0.62
Texture	4.16±0.55	4.04±0.68	4.16±0.90	3.4±1.04	4.08±0.86
Taste	4.24±0.44	4.04±0.61	4.08±0.70	3.52±0.65	3.84±0.80
Distribution of Holes	3.84±0.80	3.88±0.73	4.04±0.93	3.84±0.94	3.8±1.12
Colour	4.24±0.52	3.92±0.76	3.96±0.68	3.64±0.86	3.88±0.83
Overall acceptability	4.61±0.75	4.12±0.60	4.16±0.55	3.56±0.65	3.88±0.73

According to Table 4 Organoleptic scores for overall acceptability was 4.16±0.75, 4.12±0.60, 4.16±0.55, 3.56±0.65 and 3.88±0.73 for Control, sample A, sample B, sample C, and Sample D respectively. Sample B and control had a similar value for overall acceptability than the other samples. When compared to the other samples, Sample B had greater significance in the sensory qualities.

From the sensory evaluation, it is observed that the sample A(5%) of non-germinated jack fruit seed flour and sample B (10%) of germinated jack fruit seed flour were highly acceptable.

3.5. Nutrient composition

Table 5: Nutrient composition of Ideal Proportion of bread

S. No	Variables	Control	Ideal proportion of Non-Germinated Seeds (5%)	Ideal Proportion of Germinated seeds (10%)
1	Moisture (%)	6.0	3.7	5.7
2	Ash (g)	0.9	0.87	1.21
3	Protein (g)	5.8	6.8	7.9
4	CHO (g)	51	41.2	44
5	Fibre (g)	1.4	1.5	2.9
6	Sodium (mg)	59.3	58.4	59.9
7	Potassium (mg)	374	372	374.8
8	Calcium (mg)	24.3	23.3	25
9	Fat (g)	1.1	1.20	1.34

On comparing the ideal proportions of Non-germinated and Germinated jack seed flour incorporated Breads with the control bread, change in nutritional value is insignificant.

3.6. Shelf life analysis of formulated bread

Microbiological analysis is important to determine the safety and quality of food. Shelf life determination is one of the important criteria to evaluate its stability and the rate of spoilage.

Table 6: Microbial count of Germinated and Non-Germinated Jack seed Flour Bread

Total Aerobic bacterial and fungal counts @ 37 C (cfu/ gram)				
Storage intervals	10^{-6} dilution		10^{-7} dilution	
	Total aerobic bacterial count	Fungal count	Total aerobic bacterial count	Fungal count
0^{th} day	Absent	Absent	Absent	Absent
1^{st} day	Absent	Absent	Absent	Absent
2^{nd} day	Absent	Absent	Absent	Absent
3^{rd} day	Absent	Absent	Absent	Absent
4^{th} day	Absent	Absent	Absent	Absent
5^{th} day	1 X 10^{-6}	Absent	1 X 10^{-7}	Absent
6^{th} day	2 X 10^{-6}	Absent	1 X 10^{-7}	Absent

Microbial quality was estimated by Total Plate Count. No colonies of bacteria were detected till 4th day, whereas at the end of 6th day the colonies were within the limit (2 X 10^{-6}). Fungal growth was not detected till 6th day of the storage.

4. Conclusion

Jack fruit is an ancient fruit that is widely consumed as a fresh fruit. The use of jack fruit seed has been reported since ancient times because of its therapeutic qualities. Jack fruit seed flours (germinated and non-germinated) were analysed for nutritional characteristics and incorporated into bread. On comparing the breads with control, only slight increase in nutrient content was observed and they had similar organoleptic characters. If the functional characteristics of flour was altered level of incorporation can be increased. It was surprising to notice even in sixth day no fungal growth was noticed. The jack fruit flour might have certain inhibitory substances towards mold. Since consumers look for additive free products this flour finds scope for preparation of preservative free breads.

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