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Development of Jackfruit Seed Based Idli Batter Mix and Their Consumer Acceptability

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Abstract
The aimed of the present study to develop a fortified idli premix using jackfruit seed powder and to assess its nutritional, sensory, PHysicochemical and morPHological characteristics. The study started with development of jackfruit seed powder based idli premix using varying level of jackfruit seed powder incorporate in traditional idli composition. A Comparative study was conducted between control and different formulation on the basis of sensory and PHysicochemical attributes or characteristics. Sensory evaluation was conducted on different attributes like appearance, colour, aroma, texture and taste using 9-point hedonic scale. T3 formulation recorded as a highest sensory acceptability among the developed formulation. T3 formulation showed similar characteristics to control sample. In PHysicochemical analysis, PH and TSS were analysed with gradual decrease and increase with increasing incorporation of jackfruit seed powder respectively. Proximate analysis of T3 and control sample revealed that comparative high energy, carbohydrate, protein and ash content along with lower in moisture, fat, sugar and fiber content in T3 with respect to control sample. SEM and EDS analysis demonstrate that irregular and agglomerated surface with predominance of carbon and oxygen with minor minerals and toxic heavy metal was not detected in analysis. The overall findings of this study indicate that incorporation of jackfruit seed powder was not adversely affects its sensory qualities and given improved nutritional properties with indirect improved shelf life with lower moisture content. the T3 sample demonstrate that utilization of underutilized resources in traditional food product and made it value- added traditional food product with cost effective or economic protein alternative for individuals. this developed food product is also a functional food product which was made up with agro-waste utilization and sustainable food product with valuable foundation for future exploration in innovative food products.

Keywords: Jackfruit seed powder, idli premix, sensory evaluation, proximate analysis, SEM–EDS, functional food, economic protein

1. Introduction

Jackfruit scientific name is Artocarpus heterophyllus, which is member of moraceae botanical family. Its widely grown in many countries like Philippines, Malaysia, India, Pakistan, Bangladesh, Thailand, Sri Lanka, Burma as well as tropical country like Brazil, Queensland, Africa, Australia, and America **(Shajahan, M. et al.,2024)**. Jackfruit having edible bulb and seed. Jackfruit bulb can be consumed in two

forms, first one is unripe which can consume after cooking and second form is ripe bulb which can consume fresh or processed into snacks, juices, jam or canned fruits **(Kaushalya & Wijesinghe, 2024)**.

Jackfruit seeds holds 10%-15% weight of the fruit and having nutrional benefits. It is underutilized due to less acknowledge by peoples. It is utilized in many parts of south India through seed collected from ripe fruit, sun-drying of seeds and stored adequately for use in all season. Massive number of seeds are wasted annually due to difficulties states in processing and storage. Jackfruit seed is perishable in nature, it is one of the major reasons of discarded seed as a waste. If we stored in cool and moist environment than its shelf life extends up to 1 month and stored through roasting seeds or sun drying can be made into powder form than its shelf life can be extend for long time **(Waghmare, R. et al.,2019)**.

Proximate composition of jackfruit seed (g/100g of dry weight) is like that energy content is 175.09± 0.85kcal, carbohydrate content is 30.84±0.22%, protein content is 11.83±0.06, fat content is 0.49±0.02%, crude fiber is 0.94±0.03%, ash content is 3.16±0.15% and moisture content 52.74±0.24% **(Thatsanasuwan, N. et al.,2023)**.

Idli is traditional fermented food which is based on rice and black gram. For the preparation of idli batter, polished parboiled rice and decorticated black gram soaking in water for 4hr at 30±1°C. after soaking, the mass was ground with adequate amount of water using grinder. The ratio of rice and black gram can be taken in different form like 2:1, 3:1 and 4:1 which were allowed for fermentation for different time with addition of 2% salt. The 3:1 of rice and black gram is best ratio than rest because 3:1 had maximum production of riboflavin and thiamine were found to be 0.76mg/100gm and 0.73mg/100gm respectively and folic acid content was also found maximum 0.75mg/100gm after 10h fermentation of batter **(Ghosh & Chattopadhyay, 2010)**.

2. Material and Methods: -

Procurement of jackfruit seed

Preparation of jackfruit seed powder

Jackfruit seeds were cleaned manually through removed pulp and extraneous matter. After removed all extraneous matter, washed by running portable water to remove dirt and sticky residue. After washing remove both layers, first one was outer seed coat (Testa) and second one was brown inner layer (Spermoderm). The dehulled seeds were cuts into pieces and drying in dehydrator on 70°C for 24h. after removing moisture in range, grind into powder through grinder. Jackfruit seed powder stored in glass jar after sieving.

Preparation of idli mix

Traditional Idli mix is made up with main constituent polished parboiled rice and decorticated black gram in 3:1 respectively. After proper washing and sun drying, idli mix were grinded into powder through grinder. After grinding mix, stored in glass jar for further processing.

Formulation of jackfruit seed based idli premix

the formulation of fortified idli with incorporating jackfruit seed powder into traditional idli premix. Five treatments were prepared like T0, T1. T2, T3 and T4. T0 named as control with no jackfruit seed powder.

T1 with 5% jackfruit seed powder, T2 with 10% jackfruit seed powder, T3 with 15% jackfruit seed powder and T4 with 20% jackfruit seed powder.

Preparation of idli from premix

For the preparation of idli, idli premix mixed with portable water to obtain smooth and Semi- thick consistency. The salt was added with 2% or appropriate level. After all this, batter was kept to fermentation for 10-12h at room temperature(26-27°C). after fermentation, the batter was transferred into greased idli mold. This mold kept into idli steamer for 10-15 minutes for steaming. After cooking, the idles were cooled for 2-3min and remove gently from mold for further analysis.

sensory evaluation of idli

sensory evaluation of five formulated jackfruit seed based idli samples like T0, T1, T2, T3 and T4. The sensory evaluation was conducted using 9-point hedonic scale. The evaluation was performed by 30 Semi-trained panels under hygienic laboratory conditions. The evaluation is conducted with freshly prepared idli sample and labelled to avoid bias or reduced error. The samples were evaluated for appearance, colour, aroma, texture and taste. The hedonic scale marked with 1(dislike extremely) to 9(like extremely). For genuine evaluation, portable drinking water and tissue paper were provided between evaluation to prevent flavour carryover. Based on sensory scores, the most suitable formulation among all 4 formulated samples was selected for further evaluation.

SPSS

All formulated idli sample's sensory score were analysed using IBM SPSS Statistics software. The experiment's result was expressed as mean ± standard deviation. For determination of significant difference, One-way analysis of variance (ANOVA) was performed for among the treatments (T0, T1, T2, T3 and T4). Differences in between means of among treatments for different attributes were considered statistically significant at $p < 0.05$. Post-hoc LSD Multiple Comparisons of Sensory Attributes among Different Samples were also considered.

Determination of PH for formulated idli premix

The PH of the jackfruit seed based idli batter mix samples (T0, T1, T2, T3 and T4) were determined through digital PH meter. In the way of obtained uniform suspension, 10gm of sample was homogenised with 90ml distilled water. The calibration of PH meter was using standard buffer solution of PH 4.0 and 7.0 prior to analysis. The electrode of the digital PH meter was immersed in the prepared uniform sample suspension and after attaining a stable reading, the PH value was recorded. To avoid contamination, the PH electrode was immersed into distilled water after each measurement. All readings were carried out in triplicate and result were expressed as mean value (**Bates, R.G., 1960**).

Determination of TSS

The TSS of the jackfruit seed based idli batter mix samples (T0, T1, T2, T3 and T4) were determined through digital hand refractometer. In the way of obtained uniform suspension, 10gm of sample was homogenised with 90ml distilled water. The homogenised sample was filtered through muslin cloth to obtained clear filtrate. After cleaning prism surface through distilled water, few drops of filtrate sample were placed on the prism surface of the hand refractometer and taken reading from screen in Brix at room temperature. To avoid contamination, the prism surface was cleaned with distilled water and dried after

each observation. All readings were carried out in triplicate and result were expressed as mean value **(Paul et al., 2010)**.

Proximate analysis

The determination of protein, fat, carbohydrate, fiber, salt, sugar, ash and moisture according to AOAC standards.

SEM with EDS

SEM and EDS analysis were applied in both control and T3 samples to study its surface morphology and elemental composition of food samples **(Newbury & Ritchie, 2013)**.

3. Result and Discussions

Sensory Evaluation

Table 1: Sensory Evaluation Scores of Jackfruit Seed-Based Idli Samples

Attribute	T0	T1	T2	T3	T4	F-value	*P* value
Appearance	8.13±0.50	7.53±1.00	7.36±0.96	7.86±0.93	7.46±1.00	3.709	0.007
Colour	8.20±0.71	7.60±0.85	7.46±1.07	7.96±0.92	7.20±1.06	5.425	0.000
Aroma	8.06±0.58	7.26±1.01	7.36±0.88	8.00±0.94	7.30±1.17	5.339	0.000
Texture	7.96±0.96	7.36±0.88	7.56±0.86	8.13±0.86	7.53±0.97	3.689	0.007
Taste	8.0±0.78	7.46±0.73	7.70±0.87	7.96±0.92	7.63±1.09	2.279	0.064NS

In sensory evaluation, taste showed non-significant variation($p>0.05$) whereas significant differences were observed for appearance, colour, aroma and texture among treatments($p<0.05$). The control sample recorded the mean score for appearance is 8.13 and among all, treatment t3 demonstrate closer mean score is 7.86. now the control sample recorded the mean score for colour is 8.20 and among all, treatment t3 demonstrate closer mean score is 7.96. now the control sample recorded the mean score for aroma is 8.06 and among all, treatment t3 demonstrate closer mean score is 8.00. now the control sample recorded the mean score for texture is 7.96 and among all, treatment t3 demonstrate closer mean score is 8.13. now the control sample recorded the mean score for taste is 8.0 and among all, treatment t3 demonstrate closer mean score is 7.96, that score indicate that t3 formulation is the best formulation among all with good consumer acceptability. In that way, t4 formulation shown lower sensory scores for all attributes, suggesting that higher incorporation of jackfruit seed powder may negatively influence sensory quality. At the final, t3 demonstrated as the most acceptable formulation among all formulation.

PH of idli samples

The PH value of all treatments ranged from 6.120 to 6.400. the PH value of control, T1, T2, T3 and T4 were recorded 6.400, 6.318, 6.284, 6.160 and 6.120 respectively. T3 and T4 showed comparatively higher fermentation efficiency due to lower PH value among the treatments. The T4 exhibited the lowest PH value (6.120), whereas the control sample was observed highest PH value (6.400).

Table 2: - PH for idli mix samples

SAMPLE	VALUE
C	6.400
T1	6.318
T2	6.284
T3	6.160
T4	6.120

TSS of idli samples

The total soluble solids (TSS) value of all treatments ranged from 0.1 to 0.6 °Brix. The TSS value of control, T1, T2, T3 and T4 were recorded 0.1, 0.3, 0.6, 0.6, and 0.6 respectively. T2, T3 and T4 showed positively influenced the soluble solid content due to higher TSS value among the treatments. The T2, T3, and T4 exhibited the higher TSS value (0.6 °Brix), whereas the control sample was observed lowest TSS value (0.1 °Brix).

Table 3: - TSS for idli mix samples

SAMPLE	VALUE
C	0.1
T1	0.3
T2	0.6
T3	0.6
T4	0.6

Proximate analysis for control sample:

Table 4: - Proximate analysis for control sample

S.NO	PARAMETERS	CONTROL(C)
1.	ENERGY	353.2
2.	CARBOHYDRATES	77.59
3.	MOISTURE	12.30
4.	PROTIEN	7.65
5.	FAT	1.36
6.	FIBER	1.77
7.	ASH	1.10
8.	SUGAR	11.36
9.	SALT	0.92

The control sample recorded as a carbohydrate value of 77.59% with energy value of 353.2 kcal, indicating that carbohydrate was the major contributor to the calorific value of the product. The control sample recorded as a moisture content of 12.30%, which was comparatively higher than the T3 formulation, indicating lower storage stability. The control sample recorded as a protein value of 7.65%. the control sample recorded as a fat value of 1.36%. the fiber content was observed 1.77% in control sample. The ash content was recorded 1.10% in control sample. The fat and moisture content comparatively higher than

T3 treatment may influence shelf life and product texture. The sugar content and salt content were observed 11.36% and 0.92% respectively.

Proximate analysis for T3 sample

Table 5: - Proximate analysis for T3 sample

S.NO	PARAMETERS	T3
1.	ENERGY	361.04
2.	CARBOHYDRATES	80.07
3.	MOISTURE	9.62
4.	PROTIEN	7.94
5.	FAT	1.00
6.	FIBER	1.68
7.	ASH	1.37
8.	SUGAR	11.07
9.	SALT	0.92

The T3 sample recorded as a carbohydrate value of 80.07% with energy value of 361.04 kcal, indicating that carbohydrate was the major contributor to the calorific value of the product. The T3 sample recorded as a moisture content of 9.62%, which was comparatively lower than the control formulation, indicating higher storage stability. The T3 sample recorded as a protein value of 7.94%. the T3 sample recorded as a fat value of 1.00%. the fiber content was observed 1.68% in T3 sample. The ash content was recorded 1.37% in T3 sample. The fat and moisture content comparatively lower than control treatment may influence shelf life and product texture. The sugar content and salt content were observed 11.07% and 0.92% respectively.

Overall, the T3 sample demonstrated improved nutritional quality with lower moisture and fat levels along with higher energy, carbohydrate, protein and mineral content compared to the control sample.

SEM with EDS

Morphological and elemental analysis for control sample

An exploration by scanning electron microscopy of the raw or control idli premix revealed a heterogenous type of microstructure containing both intact starch pieces and irregular flour particles. Sizing up with lower magnification (1,000-2,000) reveals separate oval and elliptical granules of different sizes with some aggregation at most. The higher magnifications (5,500-10,000) demonstrate mainly smooth granules; however, some irregularities on the surface of granules and tiny residues of other materials can still be seen. The absence of large cracks, holes, or collapse of the structure implies that the original morphology of starch was retained after processing of milling and preparation of the premix.

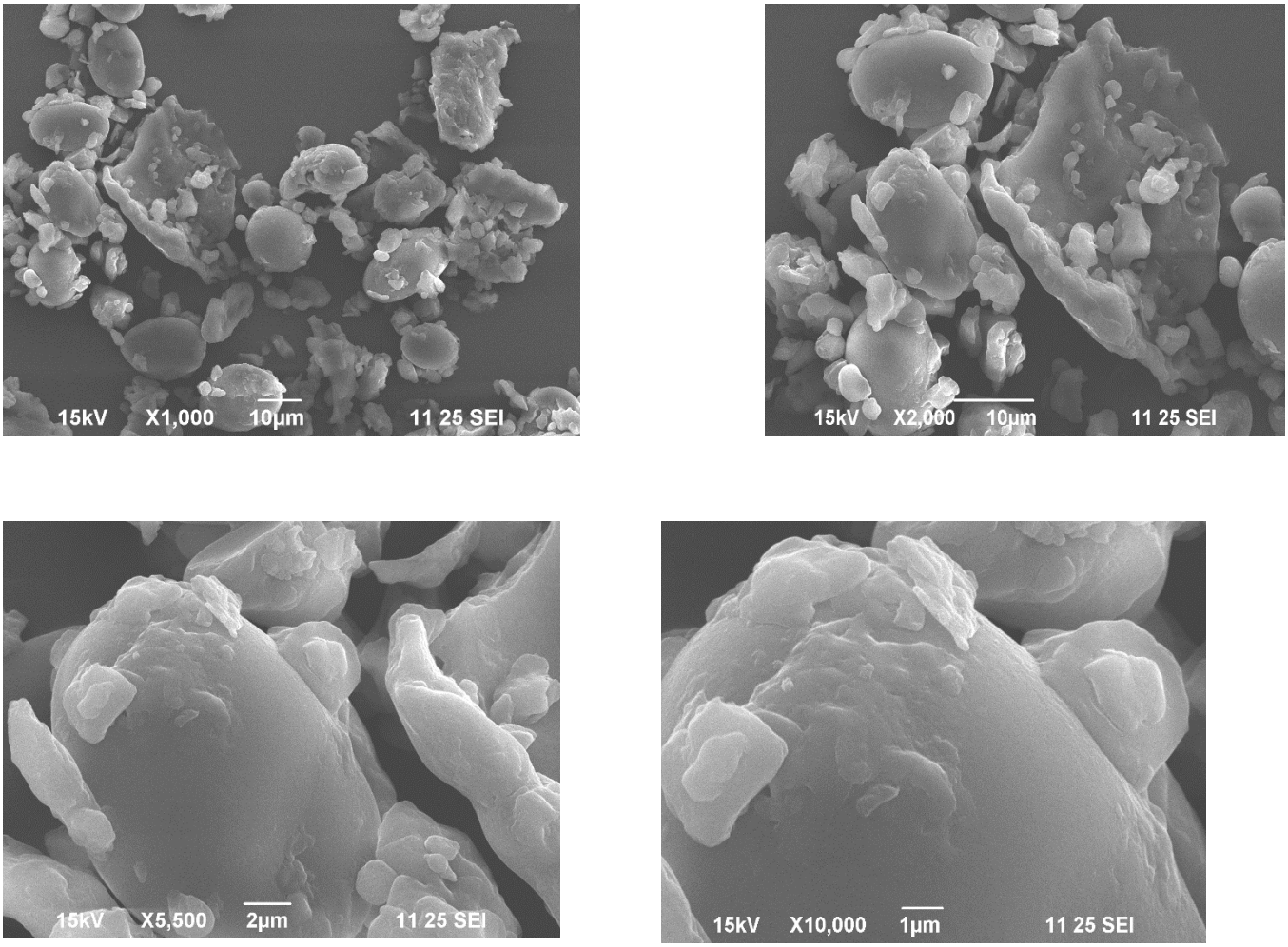

Figure 1: - SEM for control sample

The Energy Dispersive X-ray Spectroscopy (EDS) analysis

The Energy Dispersive X-ray Spectroscopy (EDS) analysis of the control sample recorded that carbon element were detected with weight percentage of 51.73% and atomic percentage of 59.73%. the oxygen element of control sample was recorded as weight percentage and atomic percentage was 44.78% and 38.79% respectively. The magnesium (Mg) element of control sample was recorded as weight percentage and atomic percentage was 0.73% and 0.42% respectively. The Phosphorus (P) element of control sample was recorded as weight percentage and atomic percentage was 0.86% and 0.38% respectively. The Sulphur (S) element of control sample was recorded as weight percentage and atomic percentage was 0.36% and 0.15% respectively. The Potassium (K) element of control sample was recorded as weight percentage and atomic percentage was 1.54% and 0.55% respectively. These values revealed that carbon and oxygen were predominant elements and magnesium, Phosphorus, sulphur and potassium were limited mineral impurities.

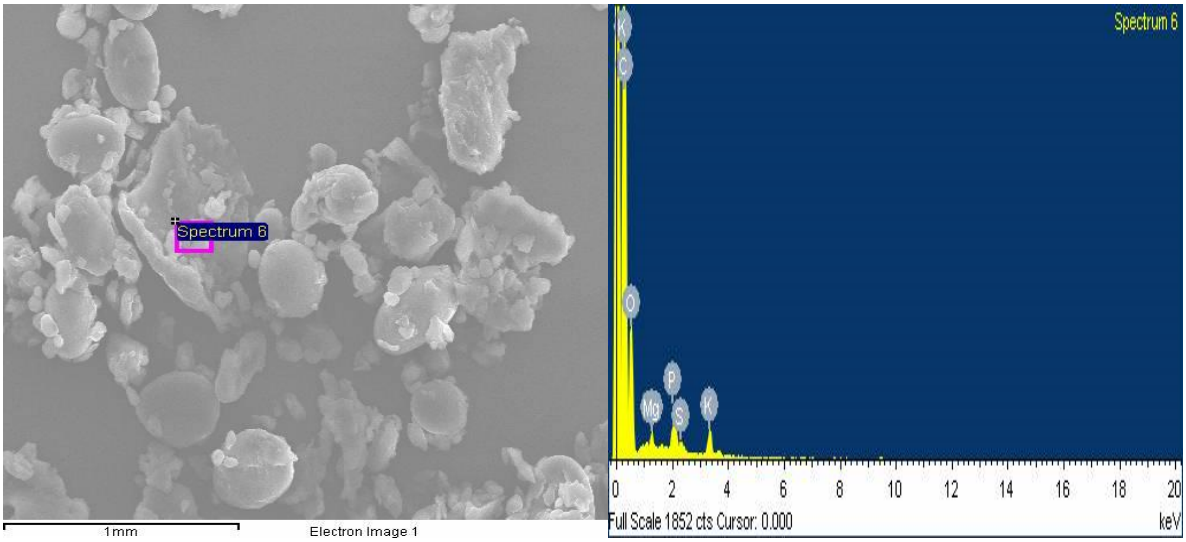

Figure 2: - EDS for Control Sample

Table 6: - EDS Analysis for control idli sample

Element	Weight (%)	Atomic (%)
Carbon (C)	51.73	59.70
Oxygen (O)	44.78	38.79
Magnesium (Mg)	0.73	0.42
PHosPHorus (P)	0.86	0.38
Sulfur (S)	0.36	0.15
Potassium (K)	1.54	0.55

Morphological and Elemental Analysis for T3 Sample

In SEM analysis T3 sample show more sophisticated structure with compared to control one. This is noticed by the observation of aggregated starch grains encapsulated in a uniform suspension matrix. The discerned granules have smooth surfaces with partial melting and closely positioned grains, implying good contact between them. The presence of irregular flake-like structures and fine grains attached to the starch grains is indicative of good consistency of the matrix. It can be concluded that the reduction of the visible intergranular space and compact aggregates are caused by the improved adhesion of the granules. Despite the increase of compactness, the granules maintain their structure and have no signs of collapsing or damaging. The compact nature of the structure will result in better retention of water and batter homogeneous behaviour and texture stability during rehydration.

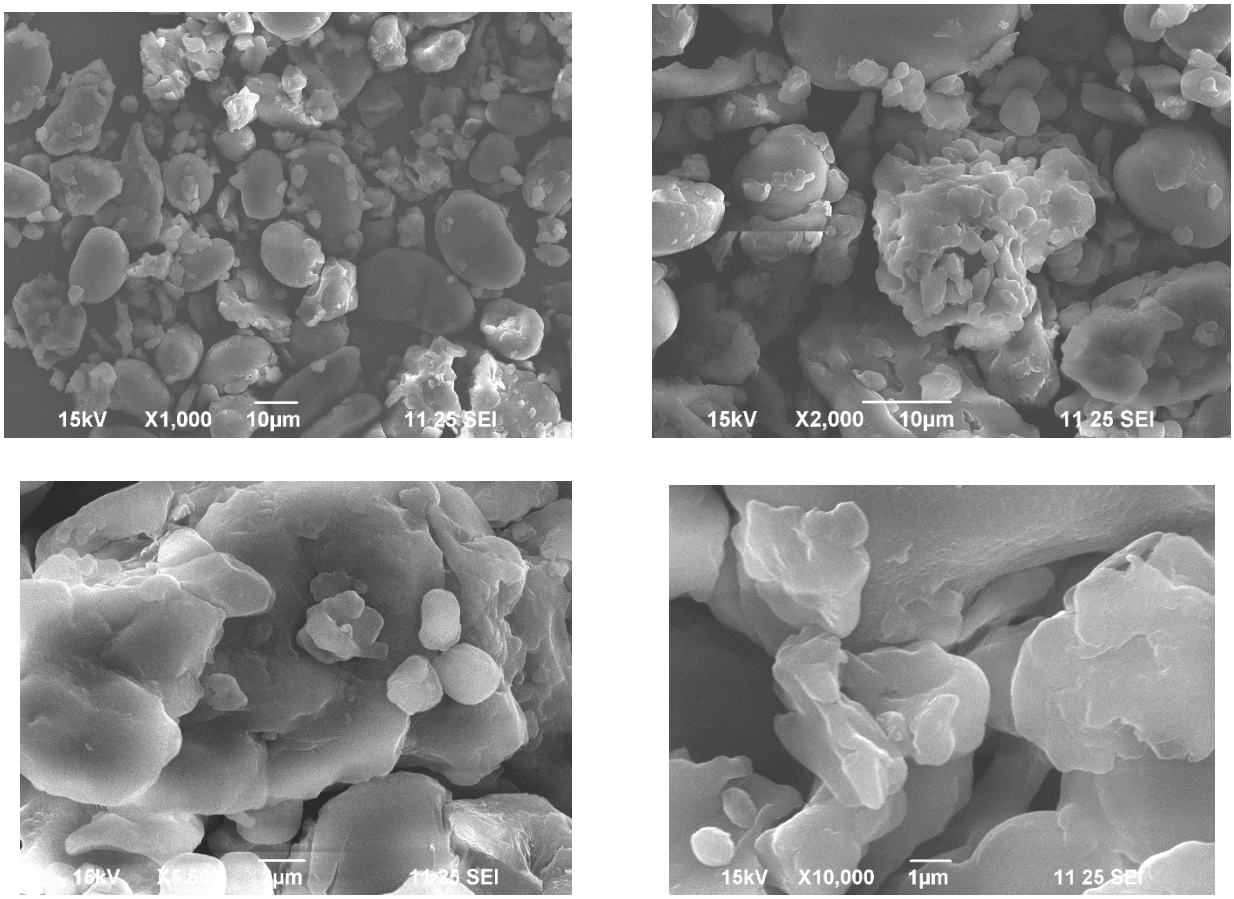

Figure 3: - SEM for T3 Sample

The Energy Dispersive X-ray Spectroscopy (EDS) analysis

The Energy Dispersive X-ray Spectroscopy (EDS) analysis of the T3 sample recorded that carbon element were detected with weight percentage of 50.87% and atomic percentage of 58.41%. the oxygen element of control sample was recorded as weight percentage and atomic percentage was 47.52% and 40.97% respectively. The Phosphorus (P) element of control sample was recorded as weight percentage and atomic percentage was 0.58% and 0.26% respectively. The Potassium (K) element of control sample was recorded as weight percentage and atomic percentage was 1.03% and 0.36% respectively. These values revealed that carbon and oxygen were predominant elements, Phosphorus and potassium were limited mineral impurities. In T3 sample suggested that minimal mineral impurities with low abundance of inorganic elements comparatively control sample. The EDS spectrum revealed that absence of toxic heavy metals in sample.

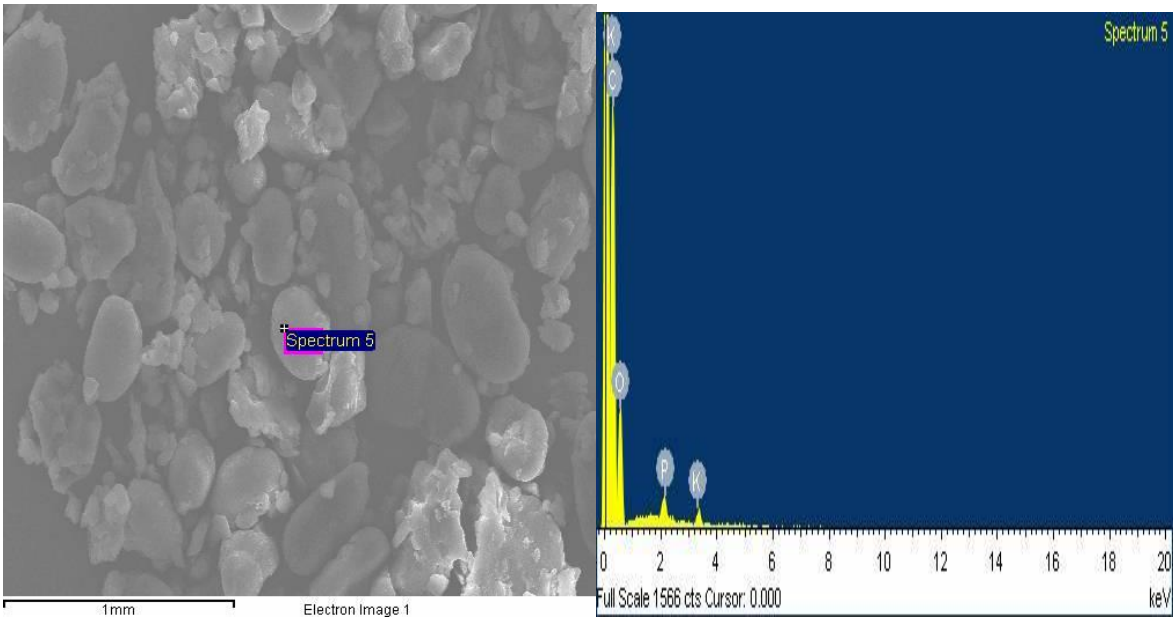

Figure 4: - EDS for T3 Sample

Table 7: - EDS Analysis for T3 idli sample

Element	Weight (%)	Atomic (%)
Carbon (C)	50.87	58.41
Oxygen (O)	47.52	40.97
Phosphorus (P)	0.58	0.26
Potassium (K)	1.03	0.36

Conclusion

The present study revealed that developed jackfruit seed powder based idli premix improved nutritional and functional characteristics. Developed idli samples significantly influenced the sensory, Physicochemical, nutritional and morphological properties due to incorporation of jackfruit seed powder. T3 formulation was accepted with the highest overall acceptability among the all treatment samples and showed sensory characteristics comparable to the control sample through sensory evaluation with the help of IBM SPSS Statistics software. In sensory evaluation, taste showed non-significant variation whereas significant differences were observed for appearance, colour, aroma and texture among treatments, indicating that incorporation of jackfruit seed powder shown even palatability. Incorporation of jackfruit seed powder with increasing levels, the Physicochemical parameters PH and TSS had gradual reduction and increase respectively, suggesting enhanced fermentation behaviour and soluble solid content in developed formulation. Proximate analysis of T3 and control sample indicate that T3 sample express improved nutritional quality with respect to the control sample with higher energy, protein, ash content and carbohydrate with reduced fat and moisture content. The characteristics of storage stability and shelf life of the premix may contribute by lower moisture content of T3 formulation. SEM analysis of both control and T3 formulation expressed irregular and agglomerated surface morphology and EDS analysis confirmed the predominance of carbon and oxygen with minimum mineral constituents. The elemental safety and purity of the developed product due to the absence of toxic heavy metals. Overall, the study

shown that jackfruit seed powder can be effectively utilized in the development of nutritionally enriched idli premix with enhanced functional properties and acceptable sensory quality. T3 sample was identified as the optimized formulation due to its superior nutritional profile, high consumer acceptability and desirable Physicochemical properties. The developed T3 sample highlights as a value-added functional ingredient in traditional food products due to utilization of underutilized jackfruit seeds.

References

APA

1. Paul, V., Singh, A., & Pandey, R. (2010). Estimation of total soluble solids (TSS). laboratory manual on post-harvest Physiology of fruits and flowers, Indian Agricultural Research Institute, 41-43.
2. Bates, R. G. (1960). Electrometric PH determination. Chimia, 14(4), 111-111.
3. Waghmare, R., Memon, N., Gat, Y., Gandhi, S., Kumar, V., & Panghal, A. (2019). Jackfruit seed: an accompaniment to functional foods. Brazilian Journal of Food Technology, 22, e2018207.
4. Shajahan, M. S., Susmita, D., Arti, S., Ab, W. W., Neha, R., Sanjeev, K., & Meraj, A. (2024). Jackfruit seed: A Functional Food Companion. African Journal of Biological Science., 6(12), 2330-2351.
5. Thatsanasuwan, N., Duangjai, A., Suttirak, P., & phanthurat, N. (2023). Proximate composition and sensory attributes of gluten-free pasta made from jackfruit seeds. Functional Foods in Health and Disease-Online ISSN: 2160-3855; Print ISSN: 2378-7007, 13(1), 11-21.
6. Kaushalya, S. D. N., & Wijesinghe, W. A. J. P. (2024). Gluten-free biscuit prepared using jackfruit (Artocarpus heterophyllus L.) seed flour: An approach towards utilization of unexploited food source. Tropical Agricultural Research and Extension, 27(4).
7. Ghosh, D., & Chattopadhyay, P. (2011). Preparation of idli batter, its properties and nutritional improvement during fermentation. Journal of food science and technology, 48(5), 610-615.
8. Newbury*, D. E., & Ritchie, N. W. (2013). Is scanning electron microscopy/energy dispersive X-ray spectrometry (SEM/EDS) quantitative? Scanning, 35(3), 141-168.