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Studies on Physical Properties and Organoleptic Qualities of Jackfruit Seed Powder based Extruded Product

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ABSTRACT: Rapid urbanization has brought changes in occupation pattern, people's life style and family structure. Today, consumer demand is for much more than just safe and shelf stable food, they demand higher quality food with greater convenience. The aim of this study was to standardize the flour combination for the development of jackfruit seed powder extruded product that is similar to commercial kurkure, as it satisfies the function of convenience food, which is a non-traditional cereal-based food product that is becoming increasingly popular around the world for its nutritional benefits, palatability and convenience.. Product was prepared by extrusion cooking of maize grits, jackfruit seed powder and tapioca powder. The product was prepared at temperatures at barrel-1: 50°C, barrel-2: 75°C, barrel-3: 110°C temperatures and 12, 14 and 16 per cent of feed moisture content and stored in aluminium laminated polyethylene packages. The effect of extrusion was investigated in terms of expansion ratio, bulk density and moisture content of the extruded product. Expansion ratio of extruded product decreased with increase in feed moisture content and jackfruit seed powder. Bulk density and moisture content of the extruded product increased with increase in feed moisture content and jackfruit seed powder. Extruded product with the flour combination of 75% maize grits, 10% jackfruit seed powder and 15% tapioca flour with 14% feed moisture (L_1M_2) showed the best result in all the physico-chemical investigation.

Keywords: Extrusion, expansion ratio, bulk density, moisture content.

INTRODUCTION

Consumer demand for convenience foods is now on the rise around the globe. Convenience has an immense impact on the food choices of today's consumers. Today, consumer demand is for much more than just safe and shelf stable food. They demand higher quality food with greater convenience. Moreover, their demand is for food products that are novel, wholesome, nutritious and convenient but still retain their natural characteristics as much as possible.

Jackfruit (*Artocarpus heterophyllus* L.) is a member of the Moraceae family, grown sporadically in India and in other tropical parts of the world and mostly as a backyard tree. Seeds make-up around 10 to 15 per cent of the fruit weight and are rich in protein, fiber, vitamins, carbohydrate and minerals with moderate quantity of phytochemicals and strong antioxidant properties (Ocloo *et al*., 2010).

Jackfruit seed and seed powder is used for the baked products, topping of salads, pasta, noodles, spaghetti, ice cream, smoothies and jackfruit-seed butter. In addition to the overall value-added product made from jackfruit seed, jackfruit seed flour added more nutrition while developing noodles through the extrusion process (Nandkule *et al*., 2015). Therefore, jackfruit seed powder can be utilized for the production of extruded products.

Extrusion processing is high temperature short time process whereby the food product is exposed to very high temperature for only few seconds. During which

the structural change in the food is bound to occur thereby leading to expansion of the product. Extrusion works on the principle of gelatinization of starch, the macromolecule structure of starch molecule opens up and viscous plasticized mass is produced (Rossen and Miller, 2020). Due to the lesser amount of starch content in the jackfruit seed flour, there is a need to supplement other starchy ingredients like maize grits and tapioca flour for the development of jackfruit seed powder extruded product.

Tapioca is one of the cheapest source of calories for human nutrition and third largest source of carbohydrate for human food in the world. It also have bland taste and pale in colour thus it can be used an excellent base to which colours, flavours and texture modifiers can be added. In some developing countries such as Brazil and African continent, tapioca is provided as a nutritional supplement and is also considered as an indispensible part of their daily diet (Adebowale and Sanni, 2013).

Based on the above understandings, the present research was focused on the development of the extruded product using underutilized jackfruit seed powder that is similar to commercial kurkure, as it satisfies the function of convenience food, which is a non-traditional cereal-based food product that is becoming increasingly popular around the world for its nutritional benefits, palatability and convenience. The research work was done at the Department of Postharvest Technology, College of Horticulture, Bengaluru.

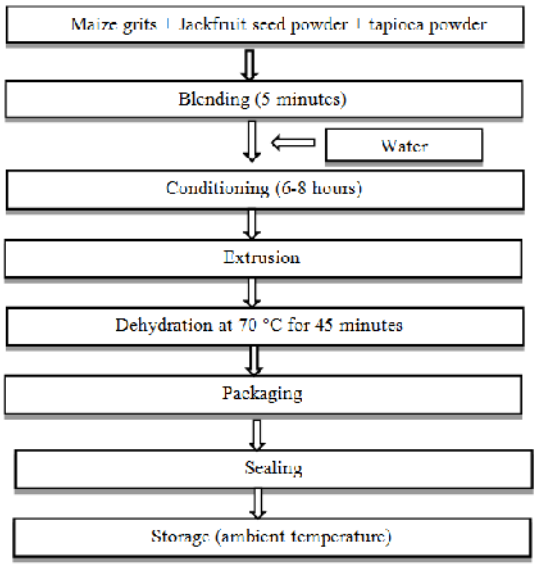
MATERIALS AND METHODS

The investigation was carried out in the Department of Post Harvest Technology, College of Horticulture, Bangalore, Karnataka, during the year 2019-20.

Procurement of raw materials: Jackfruit seed powder was procured from Malabar fruit products, Kerala. Tapioca was procured from MORE retail store, Vidhyaranyapura, Bengaluru. Further, they were washed in clean water, peeled, sliced, dehydrated, powdered and packed in polyethylene packages and placed at room temperature for further usage. Maize grits were brought from Mamtha store, Vidyaranyapura, Bengaluru.

Preparation of jackfruit seed powder extruded product: Extruded product was prepared by mixing different flour combination (Table 1) like maize grits, jackfruit seed powder and tapioca flour. The product was extruded at three different levels of feed moisture content i.e., 12, 14 and 16 per cent and barrel temperatures at barrel-1:50°C, barrel-2:75°C, barrel-3:110°C temperatures. The extruded product was dehydrated and packed in aluminium laminated polyethylene packages.

Process flow chart for production of extruded product



Treatment details:

L_1M_1: Maize (75%) + Jackfruit seed powder (10%) + Tapioca flour (15%) with 12% moisture

L_1M_2: Maize (75%) + Jackfruit seed powder (10%) + Tapioca flour (15%) with 14% moisture

L_1M_3: Maize (75%) + Jackfruit seed powder (10%) + Tapioca flour (15%) with 16% moisture

L_2M_1: Maize (75%) + Jackfruit seed powder (12.5%) + Tapioca flour (12.5%) with 12% moisture

L_2M_2: Maize (75%) + Jackfruit seed powder (12.5%) + Tapioca flour (12.5%) with 14% moisture

L_2M_3: Maize (75%) + Jackfruit seed powder (12.5%) + Tapioca flour(12.5%) with 16% moisture

L_3M_1: Maize (75%) + Jackfruit seed powder (15%) + Tapioca flour (10%) with 12% moisture

L_3M_2: Maize (75%) + Jackfruit seed powder (15%) + Tapioca flour (10%) with 14% moisture

L_3M_3: Maize (75%) + Jackfruit seed powder (15%) + Tapioca flour (10%) with 16% moisture

Table 1: Combination of maize grits, jackfruit seed powder and tapioca flour.

Treatments	L_1	L_2	L_3
Maize grits (%)	75	75	75
Jack fruit seed flour (%)	10	12.50	15
Tapioca flour (%)	15	12.50	10

Observation recorded: The following physico-chemical parameters were recorded immediately after preparation of extruded (Kurkure type) product initially and at 15 days interval during storage up to 45 days.

Expansion ratio: The extrudate diameter was calculated as the mean of 10 random measurements performed using a digital Vernier calliper on the extrudates (Yuryev *et al*., 1995). The expansion ratio of the extrudates was then measured as:

$$\text{Expansion ratio} \quad \frac{\text{Mean extrudate diameter (m)}}{\text{Die diameter (m)}}$$

Bulk Density: A perfect rectangular wooden box was taken and its volume was determined by multiplying length with width and height (l × b × h) and then the box was completely filled with extruded product exactly to the top level. The weight of the product required to fill the box was recorded and the bulk density was determined using the following relationship (Altan *et al*., 2008).

$$\text{Bulk density (g cm}^{-3}) = \frac{\text{Mass of extrudate (g)}}{\text{Volume of extrudate (cm}^{3})}$$

Moisture content(%): The moisture content of extruded product sample was determined by using an electronic moisture analyser (Sartorius MA 35) and was expressed in per cent.

Organoleptic evaluation: Extruded products were evaluated for sensory quality on the basis of colour, taste, texture, flavour and overall acceptability by semi-trained panellists consisting of Teachers and Post-Graduate students of College of Horticulture, Bengaluru with 9 point Hedonic scale (1 = dislike extremely, 2-like only slightly, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6-like slightly, 7 like moderately, 8 like very much and 9 like extremely).

Experimental design: The data obtained from the experiment was analysed by using Completely randomized design (CRD).

RESULTS AND DISCUSSION

A. Expansion ratio

Expansion of extrudates will vary considerably depending primarily on feed composition and processing conditions. Expansion ratio of jackfruit seed powder extruded product recorded a decreasing trend with an increase in feed moisture content and jackfruit seed powder concentration. The expansion ratio of extruded products ranged from 4.93 to 3.45. The expansion ratio was seen higher in the treatment combination having higher concentration of tapioca flour and lower level of moisture content. Nutritionally, it is well known information that, tapioca is rich source of starch and thereby starch will act as a gelatinizing agent during extrusion. Whereas, increased jackfruit seed powder concentration led to lower expansion ratio. Similar results of decreased expansion ratio in jackfruit seed powder based extruded products were reported by Hsieh *et al*. (1990); Liu *et al*. (2000); Giri and Bandyopadhyay, (2000) and Seth *et al*. (2015). Decrease in moisture content, increased expansion ratio and vice-versa. The similar outcomes were reported by Jyothi *et al*. (2009) in arrowroot extruded product with the expansion ratio of 3.02 to 6.9 depending on the feed moisture content.

B. Bulkdensity (g cm^{-3})

Bulk density is essential parameter in the packaging of the food material, as it decides the amount of product that can be filled into the packaging material. Bulk density of the jackfruit seed powder extruded product ranged from 0.10 to 0.17. The present study represented that the bulk density of extruded product increases with the increase in moisture content and jackfruit seed powder concentration. Similar change in bulk density with increase in concentration of jackfruit flour and feed moisture content was reported by Surender *et al*. (2011) and Jyothi *et al*. (2009) in jackfruit and arrowroot extruded product, respectively.

C. Moisture content (%)

Moisture content in food has a significant influence on texture, appearance, weight and shelf life. Food safety and Standard Authority of India (FSSAI), 2006 specifies less the 6.3 per cent moisture in extruded type breakfast product. The moisture content of the extruded product ranged between 1.08-2.57 per cent. The moisture content of extruded product registered an increase during the 45 days of storage. Treatment with higher jackfruit seed powder concentration (15%) and feed moisture content (16%) showed the highest moisture content. The moisture content increases during 45 days of storage may be attributed by water vapour permeability through packaging material and the hygroscopic nature of the extruded product. Similar results were reported by Oluwole *et al*. (2013) in pasta, Bhattacharya and Prakash (1994) in chickpea and rice blended extruded product and Devi, (2015) in jackfruit seed and bulb flour pasta.

Sensory evaluation (9-point Hedonic scale):

Sensoryscoreplaysamajorroleinacceptanceorrejectionof anyfoodproduct.Hencefoodproductswithhighest sensory score are known to dominate the customer market at large. The treatment combination with 10 per cent of jackfruit seed powder, 15 per cent of tapioca flour and 14 per of cent moisture content registered a highest score for overall acceptability. Higher sensory score of overall acceptability can be attributed towards textural properties and better appearance of the extruded product. The results are in consonance with the findings of Nandkule *et al*. (2015) in soy flour and jackfruit seed noodles and Selani *et al.* (2020) in pineapple pomace incorporated ready to eat extruded product.

Table 2: Effect of treatments and storage period on expansion ratio and bulk density of jackfruit seed powder extruded product.

Treatments	Expansion ratio				Bulk density(g/cm^3)			
	Days after storage							
	Initial	15	30	45	Initial	15	30	45
L_1M_1	4.93	4.91	4.88	4.87	0.10	0.11	0.11	0.12
L_1M_2	4.46	4.43	4.41	4.40	0.12	0.12	0.13	0.13
L_1M_3	4.10	4.08	4.05	4.04	0.12	0.12	0.13	0.14
L_2M_1	4.87	4.84	4.82	4.81	0.11	0.12	0.12	0.13
L_2M_2	4.31	4.29	4.26	4.24	0.13	0.14	0.14	0.15
L_2M_3	3.80	3.77	3.75	3.73	0.13	0.13	0.14	0.15
L_3M_1	4.70	4.68	4.65	4.64	0.12	0.13	0.13	0.14
L_3M_2	4.25	4.21	4.19	4.18	0.14	0.15	0.16	0.17
L_3M_3	3.51	3.49	3.46	3.45	0.15	0.16	0.17	0.17
Mean	**4.32**	**4.30**	**4.27**	**4.26**	**0.12**	**0.13**	**0.13**	**0.14**
S.Em ±	0.05	0.06	0.07	0.05	0.02	0.01	0.03	0.02
C. D. @ 1%	0.17	0.24	0.29	0.19	0.08	0.05	0.12	0.09

Treatment details:

L_1 : Maize : Jackfruit seed flour : Tapioca = 75 :10 :15 — M_1 = 12% moisture

L_2 : Maize : Jackfruit seed flour : Tapioca = 75 :12.5 :12.5 — M_2 = 14% moisture

L_3 : Maize : Jackfruit seed flour : Tapioca = 75 :15 :10 — M_3 = 16% moisture

Table 3: Effect of treatments and storage period on moisture content of jackfruit seed powder extruded product.

Treatments	Moisture content (%)			
	Days after storage			
	Initial	15	30	45
L_1M_1	1.08	1.17	1.24	1.32
L_1M_2	1.84	1.96	2.05	2.14
L_1M_3	2.12	2.26	2.34	2.43
L_2M_1	1.48	1.57	1.62	1.69
L_2M_2	1.96	2.04	2.11	2.19
L_2M_3	2.26	2.39	2.47	2.54
L_3M_1	1.69	1.77	1.84	1.93
L_3M_2	2.08	2.15	2.22	2.30
L_3M_3	2.37	2.44	2.50	2.57
Mean	**1.88**	**1.97**	**2.04**	**2.12**
S.Em ±	0.10	0.09	0.09	0.08
C. D. @ 1%	0.40	0.39	0.40	0.35

L_1 : Maize : Jackfruit seed flour : Tapioca = 75 :10 :15 — M_1 = 12% moisture

L_2 : Maize : Jackfruit seed flour : Tapioca = 75 :12.5 :12.5 — M_2 = 14% moisture

L_3 : Maize : Jackfruit seed flour : Tapioca = 75 :15 :10 — M_3 = 16% moisture

Table 4: Effect of treatments and storage period on colour and appearence and texture of jackfruit seed powder extruded product.

Treatments	Colour and appearance				Texture			
	Days after storage							
	Initial	15	30	45	Initial	15	30	45
L_1M_1	7.27	7.17	7.09	6.95	7.34	7.19	7.12	7.03
L_1M_2	7.52	7.46	7.31	7.22	7.58	7.48	7.37	7.25
L_1M_3	6.96	6.85	6.76	6.88	7.00	6.97	6.88	6.76
L_2M_1	7.17	7.09	6.96	6.84	7.27	7.16	7.04	6.96
L_2M_2	7.39	7.26	7.17	7.02	7.49	7.31	7.24	7.11
L_2M_3	6.87	6.79	6.71	6.63	6.98	6.89	6.80	6.71
L_3M_1	7.05	6.97	6.88	6.74	7.15	7.06	6.98	6.86
L_3M_2	7.28	7.20	7.09	6.98	7.40	7.31	7.19	7.01
L_3M_3	5.71	5.55	5.43	5.30	5.52	5.40	5.28	5.13
Mean	**7.02**	**6.92**	**6.82**	**6.70**	**7.08**	**6.97**	**6.87**	**6.76**
S.Em ±	0.06	0.05	0.03	0.08	0.04	0.05	0.04	0.05
C. D. @ 1%	0.28	0.21	0.16	0.27	0.21	0.21	0.17	0.17

Treatment details:

L_1 : Maize : Jackfruit seed flour : Tapioca = 75 :10 :15 — M_1 = 12% moisture
L_2 : Maize : Jackfruit seed flour : Tapioca = 75 :12.5 :12.5 — M_2 = 14% moisture
L_3 : Maize : Jackfruit seed flour : Tapioca = 75 :15 :10 — M_3 = 16% moisture

Table 5: Effect of treatments and storage period on mouth feel and overall acceptability ofjackfruit seed powder extruded product

Treatments	Mouth feel				Overall acceptability			
	Days after storage							
	Initial	15	30	45	Initial	15	30	45
L_1M_1	7.25	7.20	7.12	7.03	7.29	7.18	7.11	6.99
L_1M_2	7.47	7.40	7.34	7.25	7.52	7.45	7.34	7.24
L_1M_3	7.07	6.99	6.91	6.84	7.04	6.96	6.88	6.79
L_2M_1	7.21	7.14	7.10	7.02	7.22	7.13	7.03	6.94
L_2M_2	7.32	7.25	7.17	7.10	7.45	7.27	7.19	7.07
L_2M_3	6.98	6.94	6.85	6.78	6.97	6.89	6.81	6.73
L_3M_1	7.15	7.11	7.05	6.98	7.12	7.05	6.97	6.86
L_3M_2	7.30	7.22	7.15	7.08	7.33	7.24	7.14	7.03
L_3M_3	5.22	5.20	5.11	5.05	5.48	5.38	5.27	5.17
Mean	**7.00**	**6.93**	**6.86**	**6.80**	**7.04**	**6.95**	**6.86**	**6.75**
S.Em ±	0.03	0.05	0.05	0.04	0.05	0.05	0.02	0.04
C. D. @ 1%	0.15	0.17	0.14	0.12	0.17	0.16	0.11	0.12

Treatment details:

L_1 : Maize : Jackfruit seed flour : Tapioca = 75 :10 :15 — M_1 = 12% moisture
L_2 : Maize : Jackfruit seed flour : Tapioca = 75 :12.5 :12.5 — M_2 = 14% moisture
L_3 : Maize : Jackfruit seed flour : Tapioca = 75 :15 :10 — M_3 = 16% moisture

Plate 1. Flow chart for the preparation of jackfruit seed powder extruded product.

Plate 2. Influence of different levels of maize, jackfruit seed powder and tapioca flour on extruded product.

L_1= Maize : Jackfruit seed flour : Tapioca = 75 :10 :15
L_2= Maize : Jackfruit seed flour : Tapioca = 75 :12.5:12.5
L_3= Maize : Jackfruit seed flour : Tapioca = 75 :15 :10

M_1 = 12% moisture
M_2 = 14% moisture
M_3 = 16% moisture

CONCLUSION

Among different levels of treatment combinations, flour combination (L_1M_2) of 75 per cent maize grits, 10 per cent jackfruit seed powder and 15 per cent tapioca flour preconditioned with 14 per cent feed moisture and extrusion at barrel-1:50 °C, barrel-2:75 °C, barrel-3:110 °C temperatures showed best results in all the physico-chemical and sensory quality. Thus jackfruit seed powder can also use for the production of extruded product.

FUTURE SCOPE

1. In the present research challenges were faced regarding expansion ratio of the developed fortified extruded product. Hence, certain suitable ingredients have to be explored to attain good expansion ratio.
2. Underutilized but nutritionally rich tuber crops like arrowroot and yams have to be explored for the development of novel extruded products.
3. Fortified extruded products can be utilized in the development of weaning foods.

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