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Study on Effect of Jackfruit Seed Flour Particle Size in Baking

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Abstract: ***The study was undertaken with the objectives to utilization of jack seed flour in convenience food i.e. biscuit. Jackfruit seed was converted into flour and used as a protein and carbohydrate supplement in diets or also used as a functional agent in a variety of formulated foods in bakery product. The seeds were lye peeled, dried and milled into flour. The flour has good ability to bind water and lipid. The seed flour was effectively used in some food stuffs such as biscuit. In research the biscuit with 20% concentration of jackfruit seed flour with different particle size was prepared. The particle size of jackfruit seed flour was taken 0.69mm. 0.73 mm, 0.77 mm and 0.82 mm. The overall acceptability of biscuits and cake with jack seed flour particle size 0.77mm and 0.72mm respectively was judged as very good.***

Keywords: Biscuits, Cake, Jack fruit seeds, Lye peeling, Particle size, Physical properties, Sensory quality

1. Introduction

Jackfruit (Artocarpusheterophyllus Lam.) is one of the evergreen trees of family moraceae from tropical areas and widely grown in Asia. India has annual production of jackfruit as 1.436 million tons from an area of 0.102 million hectors (Baruah B., 2014). India is the second largest producer of jackfruit in the world (Nandkule et al., 2015). On an average, in ripe jackfruit, the bulb, seeds and rind form 29 %, 12 % and 59 % respectively (Jagadeesh et al., 2007). Jackfruit also referred as "nutrients of giants". Up to 500 seeds can be found in a single fruit (Islam et al., 2015). The jackfruit seed contains moisture 61.8 % (wb), protein 11.85 %, fiber 3.19 % and carbohydrate 26.20 %. The Jackfruit seed flour contains an appreciable value of calcium 308.7 mg/100g, Iron 13.07 mg/100g, potassium 1478.1 mg/100g, sodium 6.066 mg/100g, copper 1.045 mg/100g and manganese 0.112 mg/100g. Jackfruit seed contains (54mg/100g) magnesium elements. Jackfruit seed is nutritionally important in the absorption of calcium which helps to strengthen the bone and prevents bone-related disorders such as osteoporosis. Jackfruit seed can be converted into flour and to be used as a protein and carbohydrate supplement in diets or can also used as a functional agent in a variety of formulated foods in bakery product (Otegbayo et al., 2013). The flour has good ability to bind water and lipid. (Swami et al., 2012). As stored seeds are recalcitrant, they germinate immediately after maturity. Therefore, fresh seeds cannot be stored for long time. If seeds are dried to the safe storable moisture content, it can be preserved for longer duration. The seed flour can be an alternative product to be used in some food stuffs such as white bread, cake, extruded product and it can also used as thickening and stabilizing agent. The seed flour can be an alternative intermediatory product, which can be stored and utilized both for value addition and to blend with other grain flours without affecting the functional and sensory profile of the final product (Butool and Butool, 2013). The jackfruit 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 products (Chowdhury et al., 2012).

2. Material

The jackfruit seeds and row material required for preparation of biscuit and cake were purchased from local market of Dapoli.

3. Methodology

These materials were used for conducting the experiment. The methods followed for the experiments are discussed as follows. The method used for jackfruit seed flour preparation and baking is discussed as follow.

3.1 Pretreatment Jackfruit Seed

These seeds were cleaned manually. White arils get separated in cleaning. To separate the spermoderm, five percent solution of sodium hydroxide was used. The seeds deeped in this solution for 3-5 minutes at 80ºC temperature. Thereafter the solution drained out and the seeds rubbed between the palms. On rubbing the spermoderm get separated from the endosperm. These rubbed seeds brought under running water so that the separated spermoderm get washed.

3.2 Preparation of jackfruit seed flour

The pretreated seeds became moist. For further processing, the moist seeds were dried at 70ºC in tray dryer. On drying, the seeds skin get separated from endosperm. Particle size analysis of jackfruit seed flour.

3.3 Pulverization of Jackfruit seeds

The dried jackfruit seeds were pulverized in the pulverizer. Total four sieves were used during the experiment. The sieves are categorized by the manufacturer as (a) No. 0, (b) No. 1, (c) No. 2, and (d) No. 3. The numbers are provided based on the size. On visual observation, it is clear that, as the number of sieves increases the mesh size also increases.

3.4 Jackfruit seed flour

The pulverized flour as shown in Figure 3.6, was cooled at room temperature and sealed in 200 gauge polypropylene bags.

3.5 Particle size analysis

The sieves viz. Sieves No. 0, 1, 2 and 3 provided by the manufacturer with the pulverizer were used to get the jackfruit seed flour. The particle size analysis was done with the help of Ro-tap manually operated sieve shaker (Figure 3.7). On sieve shaker a set of IS sieve no. 100, 70, 50, 40, 30, 20 and 15 were arranged. Total four different lots of jackfruit seed flour with three replications each were taken to the sieve shaker.

3.5.1 Procedure of particle size analysis

The sample of 250 g jackfruit seed flour was taken for the particle size analysis. The sample was poured in top sieve of the Tylor sieve set and sieve was closed by the lid. Then the sieve shaking operation was performed for 10 minutes duration. Thereafter the samples retained on each sieves weighted separately to determine the fineness modulus. The value of fineness modulus was kept in following formula to get average particle size of jackfruit seed flour.

D = 0.135 (1.366) F.M. -------(3.1)

Where F.M. = Fineness modulus

D = Average particle size, mm

3.6 Biscuit making procedure

Biscuits are popular as quick breads in different forms throughout the world. It is made from a combination of flour, shortening agent, leavening agent and milk or water.

Row material:

Table 3.1: Treatment details

Treatment	BG1	BG2	BG3	BG4
Refined Wheat Flour (%)	80	80	80	80
Jackfruit Seed Flour (%)	20	20	20	20

Particle size: G1 = 0.69mm, G2 = 0.73mm, G3 = 0.77mm, G4 = 0.82mm

In 215.5 g of sample for all of treatments sugar, fat were taken as 50 g each. Whereas water and essence were 10ml and 3ml respectively. The baking powder was taken as 2.5 g. whereas sugar, fat, water, baking powder and essence were taken as 50, 50, 10, 2.5 and 3g respectively in all four treatment.

Procedure for making biscuit was as follow:

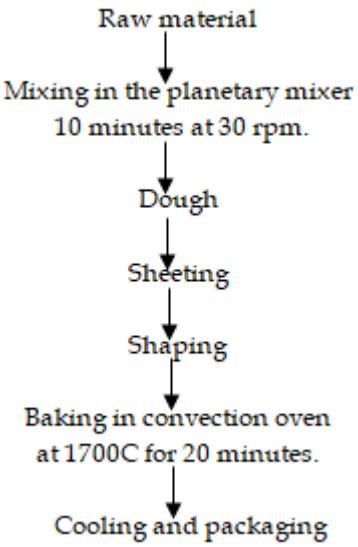

Figure 3.1: Flow chart of preparation of biscuit

3.7 Cake making procedure

Typical cake ingredients are flour, sugar, eggs, butter or oil or margarine, a liquid, and leavening agents, such as baking soda or baking powder. Common additional ingredients and flavorings include dried, candied, or fresh fruit, nuts, cocoa, and extracts such as vanilla, with numerous substitutions for the primary ingredients.

Raw material

Table 3.4: Treatment details

Ingredients	Samples			
	CG1	CG2	CG3	CG4
Refined Wheat Flour (%)	80	80	80	80
Jackfruit Seed Flour (%)	20	20	20	20

Particle size: G1 = 0.69mm, G2=0.73mm, G3=0.77mm and G4=0.82mm

In 260.5g of sample for all the treatments sugar and fat were taken as 50g each. Whereas essence taken 3ml. The baking powder, milk powder and no. of eggs were taken as 2.5g, 10g and 3 respectively. Whereas fat, sugar, baking powder, milk powder, essence and quantity of eggs was taken as 50g, 50g, 2.5g, 10g, 3ml and 3 respectively on all four treatments.

Procedure for making cake was as follow:

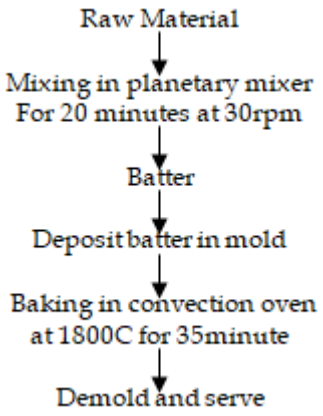

Figure 3.2: Flow chart of preparation of cake

3.8 Sensory evaluation of biscuit and cake

The sensory evaluation of the biscuit and cake done to find best combinations. The sensory evaluation was carried out at NAIP laboratory of CAET, Dr. BSKKV, Dapoli. Total 30 peoples of different age groups were selected for sensory evaluation. The nine point Hedonic scale was used for this evaluation.

3.9 Physical properties

3.9.1 Biscuit

3.9.1.1 Diameter of biscuit

Diameter (D) of biscuits was measured by digital using vernier caliper. The reading were recorded at three different location of biscuit on its 90° rotation of after every reading.

3.9.1.2 Thickness of biscuit

The thickness was measured with the help of a digital vernier caliper. This process was repeated thrice to get an average value and results are reported in millimeter.

3.9.1.3 Spread ratio of biscuit

Biscuit spread was determined with the help of the diameter and thickness, using following formula:
Spread = D/T
Where D = Diameter of biscuit
T = Thickness of biscuit
The other properties measured were textural and colour analysis.

3.9.2 Cake

3.9.2.1 Weight

The weight of the cake was measured by using electronic weighing balance having capacity to measure 0 to 5kg with least count 0.02.

3.9.2.2 Volume

The volume was measured with by considering the slope of the cake as spherical cap.

V= πr^2 h+ (π)/6 (H-h)[3r^2+(⟦H-h)⟧^2]----------(3.3)

Where r = Radius,

h = Height at edge
H = Height at center of cake
B and D = Height at three-fifth of distance from center to edge of cake
(Clock et al., 1984)

3.9.2.3 Specific Volume

The specific volume of cake was determined with the help of following equation.

Specific volume = (Volume of cake, cc)/(Weight of cake, g)
(Pinki and Pratima, 2012)

3.9.2.4 Density

The density was a reciprocal of specific volume. The density of cake was determined with the help of following equation.

Density, g/cc = 1/(Specific volume, cc/g)

3.9.2.5 Symmetry Index

The symmetry index is based on measurement of heights at specific locations of cross section of cake. Positive value of the symmetry index indicates as peaked cake, whereas negative value of symmetry index indicates the collapsed cake at the center. High value of the symmetry index is associated with the large tunnel which terminates in the center of cake. The symmetry index is calculated using the following formula.

Symmetry Index = 2H-B-D

Where,

H = Height at the center of cake

B and D = Height at three-fifth of distance from center to edge of the cake

(Cloke et al., 1984)

3.9.2.6 Uniformity Index

The uniformity index gives difference in height at two point between the center and edges of the cake. To get optimum cake, this index should be zero because the positive or the negative value appears when one side of cake is higher than the other. The uniformity index was calculated using following formula:

Uniformity index = B-D

Where,

B and D = Height at 3/5th of distance from center to edge of cake

(Cloke et al., 1984)

4. Result and Discussion

4.1 Product development

4.1.1 Biscuit

Jack fruit seed flour biscuit was prepared by incorporating 20 % jack fruit seed flour with different particle size in wheat flour. To prepare biscuit the standard procedure was adopted. To find the effect of particle size of jackfruit seed flour in baking, the refined wheat flour was partially replaced by 20% jackfruit seed flour. The prepared biscuit then packed in 200 gauge polypropylene bags. These biscuits further used for sensory evaluation. The biscuit developed is shown in Fig.4.1.

Figure 4.1: Biscuit prepared with different particle size of jackfruit seed flour

4.1.2 Cake

Jack fruit seed flour cake was prepared by incorporating 20% jack fruit seed flour of different particle size in wheat flour. To prepare cake the standard procedure was adopted. To find the effect of particle size of jackfruit seed flour in baking, the refined wheat flour was partially replaced by 20% jackfruit seed flour. These cake further used for sensory evaluation. The cake developed is shown in Fig.4.2

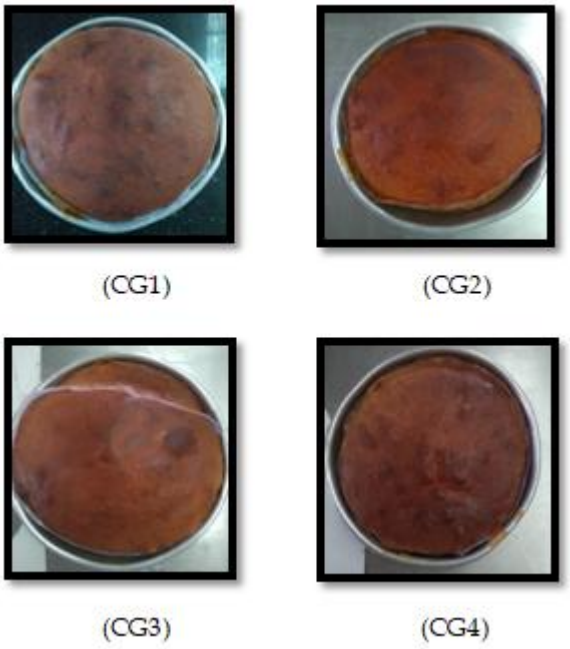

Figure 4.2: Cake prepared with different particle size of jackfruit seed flour

4.2 Sensory evaluation

4.2.1 Biscuit

The sensory evaluation of prepared biscuit was performed using nine point Hedonic scale. The quality attributes studied were appearance, colour, crispiness, texture, taste and overall acceptability. The sensory evaluation of biscuit results were estimated in Table No. 4.1

Table 4.1: Sensory Evaluation of biscuit with different particle size of jackfruit seed flour

Sample Code	Sensory Parameters					
	Appearance	Colour	Crispiness	Texture	Taste	Overall Acceptability
BG1	6.96	7.15	6.75	6.59	7.06	6.91
BG2	6.96	7.30	7.10	6.86	7.10	7.30
BG3	6.93	7.13	7.26	6.83	7.06	7.32
BG4	6.90	6.83	7.13	6.53	6.60	6.64

4.2.2 Cake

The sensory evaluation of prepared cup cake was performed using nine point Hedonic scale. The quality attributes studied were appearance, colour, sponginess, texture, taste and overall acceptability. These cake further used for sensory evaluation. A panel of 30 people of different age group evaluated the prepared cup cakes. The result of sensory scores is reported in the Table 4.2.

Table 4.2: Sensory Evaluation of cake with different concentration of jackfruit seed flour

Sample Code	Sensory Parameters					
	Appearance	Colour	Sponginess	Texture	Taste	Overall Acceptability
CG1	6.83	6.96	7.10	7.10	7.23	7.05
CG2	7.16	7.50	7.20	7.33	7.63	7.72
CG3	7.06	7.36	7.00	7.03	7.36	7.34
CG4	7.01	7.45	6.91	6.88	7.35	7.14

4.3 Physical properties

4.3.1 Biscuit

4.3.1.1 Biscuit diameter and thickness

Biscuit diameter and thickness was measured with the help of vernier caliper. The results are shown in Table 4.3. It was observed from table that the diameter of the biscuit was increased from 42.74 mm to 47.98 mm and thickness of baked biscuit decreased from 8.32 mm to 6.91mm.

Table 4.3: Diameter and thickness of biscuits

Treatment	Biscuit	
	Diameter, mm	Thickness, mm
BG1	42.44±1.73	8.32±0.76
BG2	45.35±1.02	8.11±0.83
BG3	47.04±1.15	7.21±1.05
BG4	47.98±0.97	6.91±0.89

4.3.1.2 Biscuit spread ratio

The Table 4.4 shows the spread ratio of raw and baked biscuit. The spread ratio of baked biscuit varied between 4.94 to 7.40 for all treatments (BG1 to BG2). The result of spread ratio indicates that as the particle size of jackfruit seed flour increases the spread ratio of the biscuit also increase.

Table 4.4: Spread ratio of biscuits

Treatment	Spread Ratio
BG1	5.01±0.65
BG2	5.62±0.42
BG3	6.53±0.77
BG4	6.95±0.59

4.3.2 Cake

4.3.2.1 Weight

To measure weight of the cake electrical weighing balance was used having least count of 2 gm. The weight loss in cake batter after baking was observed 18 to 20%. The weight of cake is shown in table no. 4.5.

Table 4.5: Weight of cake

Treatment	Weight of cake, g
CG1	327±8
CG2	330±6
CG3	322.5±7.5
CG4	324±9.5

4.3.2.2 Volume

The Table No. 4.6 shows the volume of cake. The volume of cake varied between 567.77cm3 and 626.97cm3 for all treatments (CG1 to CG4). The cake volume was maximum (626.97 cm3) in treatment CG3 and minimum (567.77 cm3) in cake treatment CG1.

Table 4.6: Volume of cake

Treatment	Volume of cake, cm3
CG1	591.30 ±23.53
CG2	600.99 ±0.57
CG3	602.97 ±7.39
CG4	607.63±7.21

4.3.2.3 Specific Volume

The Table No. 4.7 shows the specific volume of cake. The specific volume of cake varied between 1.69cm3/g and 1.99cm3/g for all treatments (CG1 to CG4). The cake specific volume was maximum (1.99cm3/g) in treatment CG3 and minimum (1.69cm3/g) in cake treatment CG1.

Table 4.7: Specific Volume of cake

Treatment	Specific Volume of cake, cm3/g
CG1	1.78 ±0.09
CG2	1.85 ±0.03
CG3	1.87 ±0.06
CG4	1.88±0.1

4.3.2.4 Density

The Table No. 4.8 shows the density of cake. The density of cake varied between 0.52 g/cm3 and 0.59 g/cm3 for all treatments (CG1 to CG4). The cake density was maximum (0.59 g/cm3) in treatment CG1 and minimum (0.52 g/cm3) in cake treatment CG4.

Table 4.8: Density of cake

Treatment	Density of cake, g/cm3
CG1	0.56 ±0.03
CG2	0.54 ±0.01
CG3	0.52 ±0.025
CG4	0.55 ± 0.04

4.3.2.5 Symmetry Index

The Table No. 4.9 shows the symmetry index of cake. The symmetry index of cake varied between -1.8 and -0.9 for all treatments (CG1 to CG4). The cake symmetry index was maximum (-0.9) in treatment CG2 and minimum (-1.8) in cake treatment CG3.

Table 4.9: Symmetry Index of cake

Treatment	Symmetry Index of cake
CG1	-1.2 ± 0.2
CG2	-1.1 ± 0.2
CG3	-1.65 ±0.15
CG4	-1.45 ±0.25

4.3.2.6 Uniformity Index

The Table No. 4.10 shows the uniformity index of cake. The uniformity index of cake varied between -0.2 and 0.3 for all treatments (CG1 to CG4). The cake uniformity index was maximum (0.3) in treatment CG4 and minimum (-0.2) in cake treatment CG1, CG2, CG4.

Table 4.10: Uniformity Index of cake

Treatment	Uniformity Index of cake
CG1	0
CG2	-0.15±0.05
CG3	0.05±0.15
CG4	0.05±0.25

5. Conclusion

1. The biscuit with treatment BG3 (proportion of refined wheat flour: jackfruit seed flour as 80:20, jackfruit seed flour particle size as 0.77mm) gave highest sensory scores viz., appearance 6.93, colour 7.13, crispiness 7.26, texture 6.83, taste 7.06 and overall acceptability 7.32 among all the treatments.
2. The cake with treatment CG2 (proportion of refined wheat flour: jackfruit seed flour as 80:20 and particle size of jackfruit seed flour as 0.73mm) gave highest sensory scores viz., appearance 7.16, colour 7.50, sponginess 7.20, texture 7.33, taste 7.63 and overall acceptability 7.72 among the treatments.
3. The biscuit prepared with 20% jackfruit seed flour and 80% refined wheat flour having particle size of jackfruit seed flour as 0.77mm was found best among the treatments.
4. The cake prepared with 20% jackfruit seed flour and 80% refined wheat flour having particle size of jackfruit seed flour as 0.73mm was found best among the treatments.

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