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Research paper

Development of Dehydrated Ripe Jackfruit Bulbs Based Cup Cake

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ABSTRACT

In the present study, the effect of incorporation different levels of dehydrated ripe Jackfruit bulbs i.e. at 10%, 20%, and 30% and Baking temperature 180, 200, and 220°C on quality of cup cake has been investigated. The effect of these independent parameters were accessed as the responses i.e. baking time (min), textural parameters i.e. Hardness, Cohesiveness, Springiness, Guminess, Chewiness, specific volume, and browning index of cupcake. The desirable quality of cup cake was based on the responses i.e. lower baking time, more specific volume, less browning index, and lower hardness. The optimum zone for acceptability of cup cake was observed at baking time 14 min., the lower value of Hardness 48.3-52.2g, Cohesiveness 0.346-0.354, Springiness 2.77-2.925 mm, Guminess 17.2-18.1, Chewiness 0.48-0.52, more Specific volume 1.97-2.03 (cm^3/g), and Browning Index 168.9-171 was observed at dehydrated ripe jackfruit bulbs were 19.7 to 22.4% and baking temperature was 194 to 201°C. The quality parameters were correlated with sensory score for acceptability of the cup cake. The cup cake could be prepared by using dehydrated ripe jackfruit bulbs 19.7-22.4% and Baking temperature 194-201°C for lower baking time, lower value of Hardness, Cohesiveness, Springiness, Guminess, Chewiness, more Specific volume, and Browning Index of cup cake.

Keywords: Cup cake, Dehydrated ripe jackfruit bulb, Textural analysis, Sensory analysis

Baking is a complex process that brings about a series of physical, chemical and biochemical changes in a product (Sablani *et al*. 1998). The baking process is considered to occur in three phases, which overlap with one another. In the first phase, expansion of the dough and moisture loss commences, while in the second phase both dough expansion and the rate of moisture loss reach a maximum. In the last phase, the structure of the air cells within the dough matrix collapses as a result of increasing vapour pressure, so that the product height and rate of moisture loss decrease (Megahey *et al*. 2005).

Cup cake is one of the popular bakery products which is any quick bread, it do not contain yeast. Generally, they fit in the palm of an adult and are intended to be consumed by an individual in a single sitting. In market, muffins are available in a wide range of size, shapes and flavours. Muffins commonly are eaten as breakfast or as snackfood, which is sold in many bakeries. Cup cakes are sweet, high-calorie baked

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products highly appreciated by consumers due to their good taste and soft texture. Cup cakes batter is a complex fat-in-water emulsion composed of an egg-sugar-water-fat mixture as the continuous phase and bubbles as the discontinuous phase in which flour particles are dispersed. Cup cakes are characterized by a typical porous structure and high volume, which confer a spongy texture. To obtain such a final structure, a stable batter lodging many tiny air bubbles is required (Martinez-Cervera *et al*. 2012).

Traditionally, cupcake recipe is mainly composed of wheat flour, sugar, vegetable oil, egg and milk etc. (Salvador *et al*. 2009), however many different ingredients and flavorings can be added to make a variety of flavors, which can then be topped in numerous ways. When looking for egg replacers in wheat cupcake, it is stated that, egg is a critical ingredient in the cupcake formulation to obtain expected product quality characteristics. Partial replacement of egg with commercial egg replacer changed product characteristics alter moisture retention, bulk volume, colour, texture and flavour, although those differences were not readily detected by sensory panelist (Geera *et al*. 2011; Gomez *et al*. 2012; Ronda *et al*. 2011). However the quality of cake depends on the quantity and quality of ingredient especially the flour used in preparation. It was found that mixing two or more of different materials will help to solve the deficiency problem of cereal as low nutritional value (Patel and Rao, 1995).

Various attempts have been made by different scientists to make cupcake with fruit based falvours. Rupasinghe *et al*. (2008) studied cupcakes incorporated with apple skin powder, Martínez-Cervera *et al*. (2011) have studied the feasibility of cocoa fibre as a fat replacer in chocolate muffins. Sreenath *et al*. (1996) and Grigelmo-Miguel *et al*. (2001) have studied the feasibility of peach dietary fibre to replace oil in a standard muffin recipe and also in order to increase the fiber content in cakes and muffins, Polizzoto *et al*. (1983) studied several raw materials such as bran and outer layers of cereals incorporated in muffins, Hudson *et al*. (1992) have studied legume outer layer incorporated in muffins, Sudha *et al*. (2007) and Rupasinghe *et al*., 2008 has studied the by-products of apple processing have been used in cup cake.

India is the country of tropical zone and konkan region of Maharashtra is included in the humid western coastal track. Jackfruit is a crop found commonly in this region mostly dispersed in various plantations and near household gardens. Jackfruit (*Artocarpus heterophyllus* L.) is an evergreen, monocious, small to medium, tropical tree native to India. A mature tree produces up to 150 to 250 fruits per year, each weighing 5 to 70 kg There are more than 100,000 trees in backyards and grown for shade (Swami *et al.* 2012). The total area planted to jackfruit in all India is calculated at 26,000 ha. Yield of 150 to 300 large fruits per tree is normal and fully mature tree may produce 500 fruits per tree. It is mainly of two types; Kapa (firm flesh) and Barka (soft flesh).Bulbs are used for making of jam, jelly, fruit bars, candies, ice-creams, beverages, and chips. The ripe jackfruit pulp has high nutritive value (0.24% fat, 1.54% protein, 16.20%) totalsugar and ascorbic acid 2.9 mg/100g, vitamin A and mineral matter) as well as a peculiar taste. Jackfruit is rich in dietary fiber. The fiber content helps to protect the colon mucous membrane by decreasing exposure time and as well as binding to cancer-causing chemicals in the colon. Fresh fruit is a good source of potassium, magnesium, manganese, and iron. Potassium is an important component of cell and body fluids that helps controlling heart rate and blood pressure (Swami *et al.* 2012).

As cup cake contains refined flour (maida), high fat and contributes high calories, partial replacement of refined flour (maida) with dehydrated ripe jackfruit bulbs would upgrade the nutritional quality of the product. An attempt has been made to explore the possibility of utilizing dehydrated ripe jackfruit bulbs in the preparation of cupcake.

MATERIALS AND METHODS

Experiments were carried out in the Bakery Unit, Department of Agricultural Process Engineering, College of Agricultural Engineering and Technology, Dr. Balasaheb Konkan Krishi Vidyapeeth, Dapoli.

The quality analysis was carried out in National Agricultural Innovation Project Laboratory of Department of Agricultural Process Engineering.

The study was under taken on the three different levels of rehydrated jackfruit bulbs (10%, 20%, 30%) w/w of *Konkan prolific* variety and three levels of Baking temperature (180°C, 200°C, 220°C). The results analyzed for optimization of cupcake quality parameters i.e. Moisture content (Top, Middle, Bottom layer of cup cake), Colour (Browning index), Hardness, Cohesiveness, Springiness, Guminess, Chewiness of cup cake, Baking time (min.), Specific Volume (cm^3/g), Sensory evaluation (Colour, Texture, Flavour, Mouthfeel, Taste, and Acceptability).

Process for Preparation of cup cake

Fig. 1 shows the process for the preparation of cup cake. Cup cake was prepared by using refined flour (29%), baking powder (0.75%), egg free mix (8%), sugar (27%), vegetable oil (5%), salt (weight basis) (0.25%), water (29%) purchased from local market. Dried ripe jackfruit bulbs having moisture content 10% (db) were taken in a proportion (10%, 20%, and 30%) by replacing equivalent amount of refined flour maida in the cup cake batter. The proportion of the other ingredients i.e. sugar, vegetable oil, baking powder, egg free mix, salt, water were kept constant. Table 1 shows the different formulation of cupcake used for the study.

Initially sugar and water was taken in a mixer and it was mixed well in a Planetary Mixer at 40 RPM for 5 minutes. Then cake improver was added to the mixture and it was mixed in a Planetary Mixer at 40 RPM for about 5 minutes. Another container a mixture of refined flour, egg free mix and baking powder (refined flour 90g, egg free mix 27.6g and baking powder 3g) was prepared. Now this mixture was added to the previous mixture and then it was mixed in the Planetary Mixer at 35 RPM for 3 minutes and at 25 RPM 4 minutes. Rehydrated jackfruit bulbs paste was made separately by taking 30% of total percent of water of total ingredients (place dehydrated ripe jackfruit bulbs and 30% water in separate container for 10 minutes to absorb water in jackfruit bulbs and then wet grind it in mixer grinder to make paste).

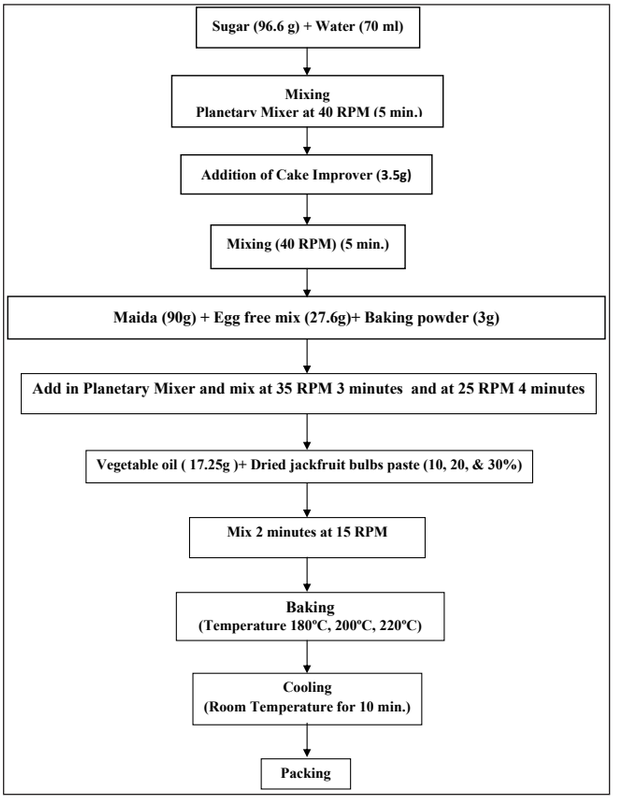

Fig. 1: Process Flow chart for preparation of cup cake

Vegetable oil and Jackfruit bulbs paste were added to the above mixture and mixing was done at 15 RPM for 2 minutes in Planetary Mixer. Now exactly 30 g of the prepared batter was poured in each 50 mm diameter paper moulds which were placed in aluminum mould shaped cups. The paper moulds with the aluminum shaping cups were kept in the convection oven for baking at 180°C. The batter placed in the moulds was observed continuously for each 2 minutes after 10 minutes interval from the initial time when moulds were kept in the oven for baking. The baking was continued till brownish colour developed on its crust. This was observed through the glass of convection oven from outside. When the crust get brownish colour the time for baking was recorded. The cup cakes after achieving the brownish colour

Table 1: Cup cake Formulations

Sl. No.	Ingredients (g)	Control	Sample 1	Sample 2	Sample 3
1	Maida	100	90	80	70
2	Baking powder	3	3	3	3
3	Cake improver	3.5	3.5	3.5	3.5
4	Rehydrated Dried ripe jackfruit bulbs	0	10	20	30
5	Egg free mix	27.6	27.6	27.6	27.6
6	Salt	0.86	0.86	0.86	0.86
7	Sugar	96.6	96.6	96.6	96.6
8	Vegetable oil	17.25	17.25	17.25	17.25
9	Water	100	100	100	100

was taken from the oven (Fig. 2) and allowed to cool at room temperature 26 ± 2°C for 10 min.

Fig. 2: Baked cup cake in tray at 200°C

The similar procedure was repeated for proportion of 20 and 30%dehydrated ripe jackfruit bulbs and at 200°C and 220°C baking temperature, the baking time of the cup cakes for each experiment was recorded. Table 1 shows the formulation of the cup cake used in the present investigation.

Estimation of Quality parameters for cup cake

Moisture Content

Moisture content of cup cake was recorded by hot air oven method as per AOAC, (2010). Cup cake sample werecut in three section from bottom at1cm height was taken in moisture box. Weight of moisture box and sample was recorded. Moisture box without lid was placed in hot air oven at 105°C for 24 h. Then lid was placed over the box and sample was taken out and kept inside the dessicator for 10-15 min. Weight after taking out sample from the dryer was recorded. Moisture content on dry basis was calculated by using Eq. (1). The experiment was repeated thrice for replication. The average moisture content was reported.

$$\text{Moisture}(\%) = \frac{(W_1 - W_2)}{W_2 - W} \times 100 \quad \ldots(1)$$

Where:

w_1= weight of sample + moisture box:

w_2= weight of sample after drying + moisture box:

w = weight of moisture box.

Colour

Colour of cup cake was measured by Konica Minolta colori Reader (Make: Minolta Camera co. Ltd. Japan, Model: CR-10). The cup cake colour is measured in dark room. The cup cake placed on white surface and by placing colori reader on crust of cup cake colour was measured. The colour was measured as per 10°/ D65 (ASTM) standard. The experiment was repeated for 5 times and average values were reported. The browning index (B_I) was calculated as per Sakin *et al*. (2013) is given in equation (2):

$$B_I = \frac{\left[100 \times \left(\frac{a + 1.79L}{5.645l + a - 3.012b} - 0.31\right)\right]}{0.17} \quad \ldots(2)$$

Where:

L = Lightness / darkness

a = Redness / greenness

b = Yellowness / blueness

Texture

The texture of cup cake was measured with QTS Texture Analyzer (M/s. Brookfield Engineering Labs, Inc., USA). The cup cakes were exposed to double compression test with Probe No. TA3/100 and Pretest speed was 0.5 mm/s, Compression depth was 6 mm, and trigger load was 5 g for cup cake. The equipment gives the values of hardness, cohesiveness, springiness, guminess, and chewiness of the cup cake. The experiment was repeated for 5 times for its replication and average hardness (g), cohesiveness, springiness (mm), guminess (g), and chewiness (mJ) of cup cake have been reported.

Weight, Volume, Specific Volume

Weight of cup cakes was measured by standard weighing balance (M/s Contacts Instruments, Mumbai) with least count 1 mg. The volume of cup cake was measured by rapeseeds displacement method (Campbell and Mougeot, 1999). An 850 cm^3 (9 × 9.5 × 10 cm) glass container was fabricated for the measurement of volume of cup cake. Initially the container was filled with rapeseed. The rapeseeds in the container were leveled by passing ruler across the top of the container and the volume of rapeseed inside the container was recorded. Then the cup cake was placed inside the container and the container was filled with rapeseeds. The rapeseeds in the container were leveled by passing ruler across the top of the container and the volume of rapeseeds displaced by the cup cake was recorded. The difference between two volumes is recorded as the volume of cup cake.

$$\text{Volume of cup cake } (V) = V_1 - V_2 \quad \ldots (3)$$

Where;

V_1– Initial volume of rapeseeds filled in container, cm^3

V_2 – Volume of rapeseeds displaced by cup cake in container, cm^3

W – Weight of cup cake

The specific volume (cm^3/g) of cup cake was calculated by the ratio of weight by volume.

$$\text{Specific volume} = \frac{V}{W}, (cm^3/g) \quad \ldots (4)$$

Sensory Analysis

Sensory evaluations of cup cakes prepared by using the combination of different independent variables were tasted by group of twenty-six peoples (Trained Sensory panelists). The panelists were from different age groups. Their scores were co-related with the mechanical testing of the product.

For evaluation of cup cake the sensory parameters i.e. Colour, Texture, Flavour, Taste, Mouth feel, and Acceptability are considered. There are total Ten different sample of cup cakes were placed, out of which Nine were from the treatments and one was control (Without jackfruit bulbs). The samples were coded A-J. The sensory score rating was based on Nine point Hedonic scale. The average scores from all the panelists were reported for each treatment including the control sample.

Optimization

The desirable qualities of cup cake was expected to have lower Baking time, Hardness, Cohesiveness, Springiness, Guminess, Chewiness, Browning Index and more Specific volume. The desirable quality of cupcake were correlated with the response of brownness, baking time, hardness, cohesiveness, springiness, guminess, chewiness, specific volume with the sensory scores for different treatments of dehydrated ripe Jackfruit bulbs (10, 20, 30%) w/w and Baking temperature (180, 200, and 220°C) using superimposed contour plots.

Cost Estimation of the Developed cup cake

Cost estimation of cup cake was done for 1 day (3 kg maida) production and also for 1 kg refined flour and relative proportions of other ingredients were taken. The labour charge, cost of raw materials, utilities etc. was based on the prevailing rates in the local market.

RESULTS AND DISCUSSION

This chapter deals with the Results of the study of

Jackfruit bulbs percent and baking temperature on quality of cup cakes. The main objective of study was accomplished by analyzing the data as per the observation recorded.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on moisture content

Table 2 shows the effect of dehydrated ripe Jackfruit bulbs and baking temperature on Moisture content of cup cake at crust, crumb, and bottom portion. Average moisture content of the cup cake showed that increase in percent dehydrated ripe jackfruit bulbs has no much variation in moisture content. Effect of percent dehydrated ripe Jackfruit bulbs and baking temperature on cupcake has no much variation in the final moisture content of the crust, crumb, and bottom portion of cup cakes. The average moisture content of the cup cake was 25.85±0.81 % db.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on baking time (B_t)

Fig. 3 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on baking time of cup cake. The baking time of the cup cake varied from 11-17.5 minutes**.** It was observed that increase in percent dehydrated ripe Jackfruit bulbs baking time slightly decreases. But as the baking temperature increases baking time decreases. It is also clear from contour plots shown in Fig. 3. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on baking time of cup cake eq.(5).

$$B_t = 78.111 - 0.200t - 0.492j - 0.002t^2 + 0.001j^2 + 0.001tj \quad \ldots(5);$$

$r^2 = 0.89$

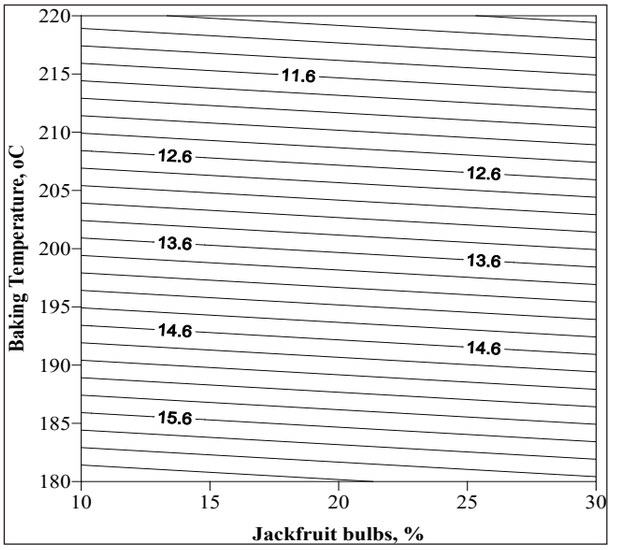

Fig. 3: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Baking Time of cup cake

Table 2: Moisture Content at Crust (top), crumb (middle) and bottom of cup cake

Independent Variables		Dependent			
Dehydrated ripe Jackfruit bulbs (%)	Temperature (^{0}C)	Moisture Content (% db)			
		Top	Middle	Bottom	Average
Control	Control	23.40	27.32	27.59	26.10
10	180	24.26	25.56	26.70	25.51
10	200	23.91	27.70	26.58	26.06
10	220	23.15	24.21	24.89	24.08
20	180	25.39	25.60	25.26	25.42
20	200	24.62	27.58	27.86	26.69
20	220	23.25	28.52	28.34	26.70
30	180	25.63	26.94	26.35	26.31
30	200	24.12	26.32	26.65	25.70
30	220	23.65	27.48	27.56	26.23
	Average	24.14±0.85	26.72±1.29	26.78±1.10	25.85±0.81

Where, *t*- Baking Temperature (°C) and *j*- Dehydrated ripe Jackfruit bulbs (%)

From equation (5) it is clear that no any difference due to combined effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on baking time of cup cake. The R^2 of the equation was 0.89.

Table 3(a) shows the ANOVA of baking time. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on baking time is highly significant at $F = 21.46$.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Hardness (H_R) of cup cake

Fig. 4 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Hardness (g) of cup cake. The hardness was from 44-83 g for all the treatments. It was observed that as the baking temperature increased from 180-220°C the hardness also increased. Similarly as the percent dehydrated ripe Jackfruit bulbs in cup cake increased the hardness gradually decreased as seen from contour plots Fig. 4. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Hardness of cup cake is given in eq.(6).

$$H_R = 767.22 + 3.7833t - 7.417j + 0.067t^2 + 0.020j^2 - 0.039tj \quad \ldots (6);$$

$R^2 = 0.91$

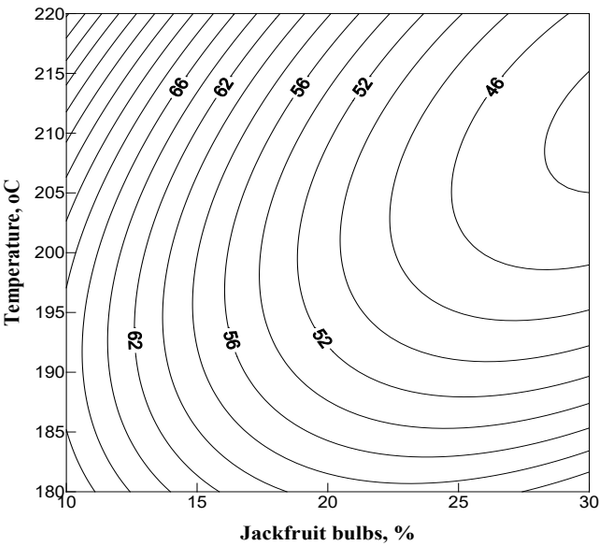

Fig. 4: Contour plot of effect of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Hardness of cup cake

Table 3: Analysis of Variance for (a) Baking time,(b) Hardness, (c) Cohesiveness, (d) Springiness, (e) Guminess, (f) Chewiness, (g) Specific Volume, (h) Browning Index

Responses	Degree of Freedom	Sum of Squares	Mean Square	Significance F
(a) Baking time				
Regression	6	1697.139	282.856	
Residual	3	0.861	0.287	230.40
Total	9	1698.00		
(b) Hardness				
Regression	6	34162.472	5693.745	
Residual	3	133.528	44.509	119.08
Total	9	34296.000		
(c) Cohesiveness				
Regression	6	1.009	0.168	
Residual	3	0.004	0.001	43.37
Total	9	1.013		
(d) Springiness				
Regression	6	82.389	13.732	
Residual	3	0.287	0.096	5034.09
Total	9	82.676		

(e) Guminess				
Regression	6	3492.702	582.117	
Residual	3	20.618	6.873	214.37
Total	9	3513.320		
(f) Chewiness				
Regression	6	3.510	0.585	
Residual	3	0.047	0.016	501.24
Total	9	3.557		
(g) Specific Volume				
Regression	6	39.506	6.584	
Residual	3	0.060	0.020	21.46
Total	9	39.566		
(h) Browning Index				
Regression	6	245587.022	40931.170	
Residual	3	323.538	107.846	232.65
Total	9	245910.560		

*$p \leq 0.01$.

From equation (6) it is clear that the combined effect of baking temperature and percent dehydrated ripe Jackfruit bulbs will also decreases the hardness of cup cake. The R^2 of the equation 0.91.

Table 3(b) shows the ANOVA of Hardness. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Hardness is highly significant at F = 119.08.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Cohesiveness of cup cake

Fig. 5 shows the effect of baking temperature and percentdehydrated ripe Jackfruit bulbs on Cohesiveness of cup cake. It was observed that as baking temperature increases from 180-220°C the cohesiveness decreases, As the percent dehydrated ripe Jackfruit bulbs increases the cohesiveness increase gradually followed by gradual decrease trend. It is also clear from contour plots Fig. 5. The cohesiveness value of cup cake increases as the increase in percent dehydrated ripe jackfruit bulbs after (20%) and increase in baking temperature after 200°C. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness of cup cake as given in eq. (7).

$$C_o = -0.009 - 0.0226t + 0.006j \quad \text{... (7);}$$

$R^2 = 0.93$

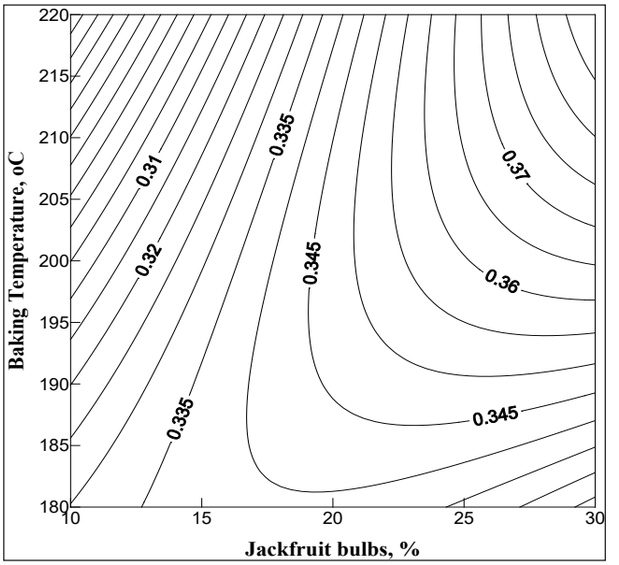

Fig. 5: Contour plot of effect of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Cohesiveness of cup cake

From equation (7) it is clear that there is no much difference due to combined effect of percent baking temperature and percent dehydrated ripe Jackfruit

bulbs cohesiveness of cup cake. The R^2 of the equation is 0.93.

Table 3(c) shows the ANOVA of cohesiveness. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness is highly significant at F = 43.37.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Springiness (S_p) of cup cake

Fig. 6 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Springiness of cup cake. The springiness of cup cake was from 2.25-3.5 mm. It was observed that as percent dehydrated ripe Jackfruit bulbs increased from 10-30% the springiness decreased. Similarly as the baking temperature increased springiness decreased gradually. It is also clear from contour plots Fig. 6. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on springiness of cup cake as given in eq. (8).

$$S_p = 30.496 - 0.358t - 0.245j - 0.001t^2 + 0.001j^2 + 0.002tj \quad \text{... (8);}$$

$R^2 = 0.96$

From equation (8) it is clear that the combined effect of percent baking temperature and percent dehydrated ripe Jackfruit bulbs woulds lightly increased the springiness of cup cake. The R^2 of the equation is 0.96.

Table 3(d) shows the ANOVA of springiness. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness is highly significant at F = 5034.09.

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Guminess (G_u)of cup cake

Fig. 7 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Guminess of cup cake. It was observed that as percent dehydrated ripe Jackfruit bulbs increases from 10-30% the guminess decreased and as the baking temperature increased from 180 to 220°C the first up to temperature 200°C guminess decreases gradually and then increases. It is also clear from contour plots Fig. 7. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on guminess of cup cake is shown in equation (9).

$$G_u = 241.756 - t - 2.117j - 0.007t^2 + 0.005j^2 + 0.003tj \quad \text{... (9);}$$

$R^2 = 0.86$

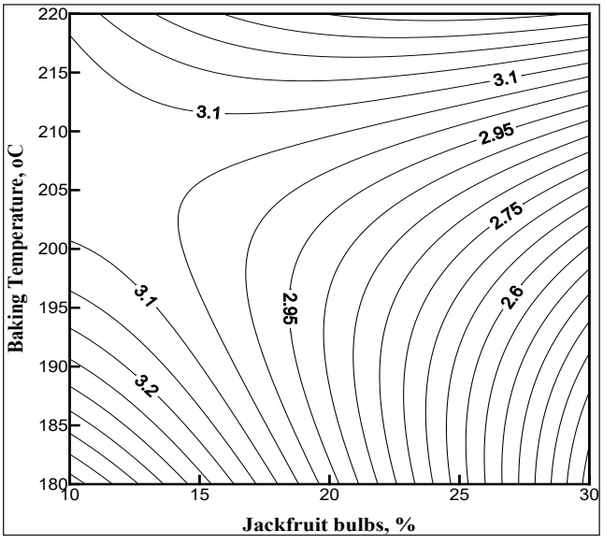

Fig. 6: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Springiness of cup cake

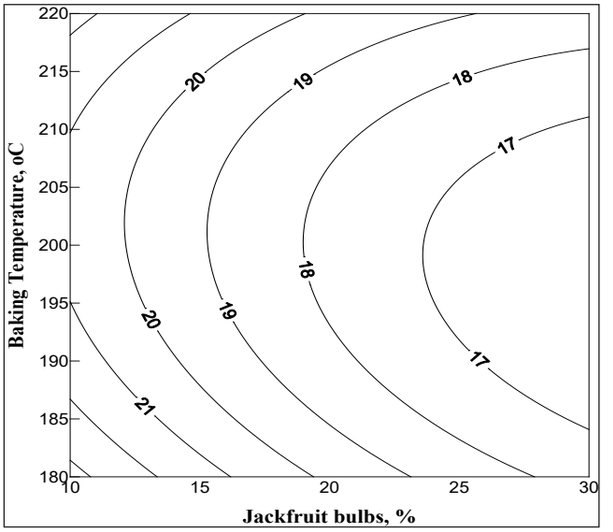

Fig. 7: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Guminess of cup cake

From equation (9) it is clear that the combined effect of percent baking temperature and percent dehydrated ripe Jackfruit bulbs slightly increased the guminess of cup cake. The R^2 of the equation is 0.86.

Table 3(e) shows the ANOVA of guminess. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness is highly significant at F = 214.37

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Chewiness (C_w) of cup cake

Fig. 8 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Chewiness of cup cake. The chewiness of the cup cake was from 0.36-0.78. It was observed that as percent dehydrated ripe Jackfruit bulbs increases from 10-30% the chewiness was decreases and as the baking temperature increases from 180 to 220°C the first up to temperature 210°C chewiness decrease then slightly increases. It is also clear from contour plots Fig. 8. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on chewiness of cup cake is shown in equation (10).

$$C_w = 14.184 - 0.153t - 0.1237j + 0.001tj \quad \text{... (10);}$$

$R^2 = 0.89$

From equation (10) it is clear that the combined effect of percent baking temperature and percent dehydrated ripe Jackfruit bulbs slightly increased the chewiness of cup cake. The R^2 of the equation is 0.86.

Table 3(f) shows the ANOVA of chewiness. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness is highly significant at F = 501.24

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Specific Volume (cm^3/g) of cup cake

Fig. 9 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Specific Volume of cup cake. The specific volume of the cup cake was from 1.90-2.6 cm^3/g**.** It was observed that as percent dehydrated ripe Jackfruit bulbs increases from 10-30% the specific volume was decreases. Similarly as the baking temperature increased specific volume decreased. It is also clear from contour plots shown in Fig. 9. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on specific volume of cup cake is shown in equation (11).

$$SV = 7.228 - 0.145t - 0.034j - 0.001t^2 \quad \text{...(11);}$$

$R^2 = 0.91$

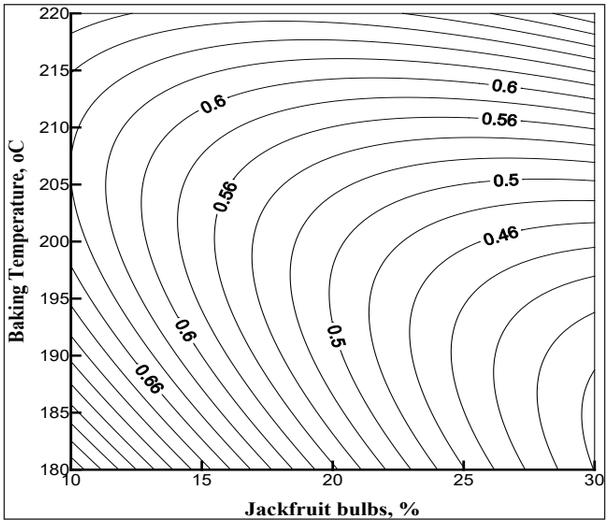

Fig. 8: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Chewiness of cup cake

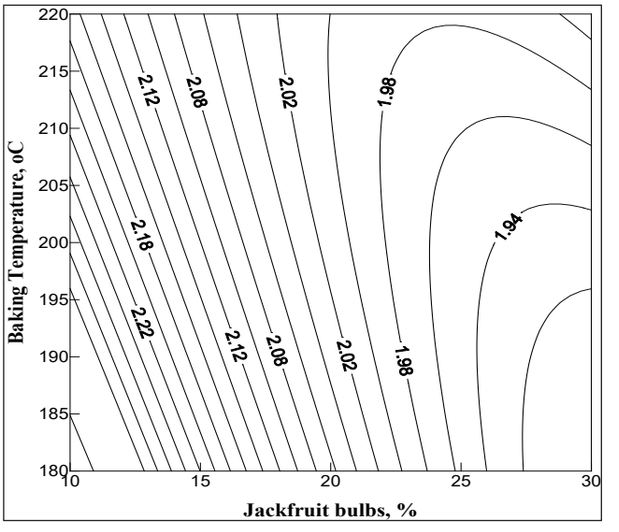

Fig. 9: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Specific Volume of cup cake

From equation (11) it is clear that no any difference due to combined effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on specific volume of cup cake. The R^2 of the equation is 0.91.

Table 3(g) shows the ANOVA of specific volume. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on cohesiveness is highly significant at $F = 21.46$

Effect of Baking temperature and percent Dehydrated ripe Jackfruit bulbs on Browning Index (B_I) of cup cake

Fig. 10 shows the effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Browning Index of cup cake. The browning index of the cup cake was from 152-176 for all treatments. It was observed that as baking temperature and percent dehydrated ripe Jackfruit bulbs in cup cake increased the browning index was increased. It is also clear from contour plots Fig. 10. The effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on browning index of cup cake is shown in equation (12).

$$B_I = -569.289 + 10.300t + 6.365j - 0.014t^2 - 0.014j^2 - 0.047tj \quad \text{... (12);}$$

$R^2 = 0.94$

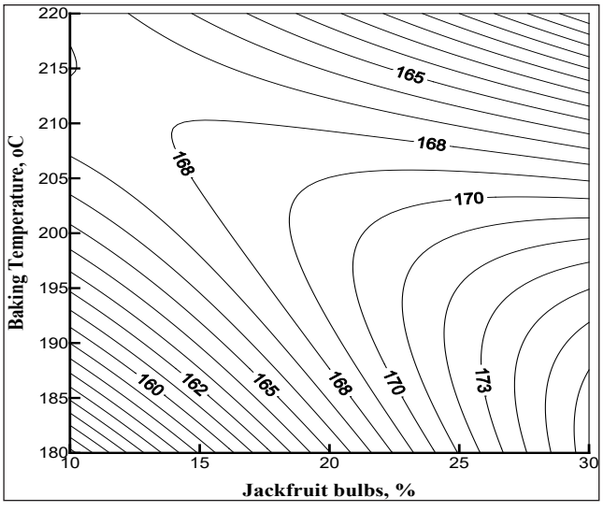

Fig. 10: Contour plot of Baking temperature and Dehydrated ripe Jackfruit bulbs (%) on Browning Index of cup cake

From equation (12) it is clear that the combined effect of percent baking temperature and percent dehydrated ripe Jackfruit bulbs increased the browning index of cup cake. The R^2 of the equation is 0.94.

Table 3(h) shows the ANOVA of browning index. It was observed that effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on browning index was highly significant at $F = 232.65$.

Optimization of Dependents for Baking time, Hardness, Cohesiveness, Springiness, Guminess, Chewiness, Specific volume and Browning Index of Dehydrates ripe jackfruit bulb based cup cake

Desirable qualities of cup cake should be lower Baking time, hardness, cohesiveness, springiness, guminess, chewiness, more specific volume, and lower, browning Index.

Fig. 11 shows the superimposed contour plots for effect of baking temperature and percent dehydrated ripe Jackfruit bulbs on Baking Time, hardness, cohesiveness, springiness, guminess, chewiness, specific volume, and Browning Index of cup cake.

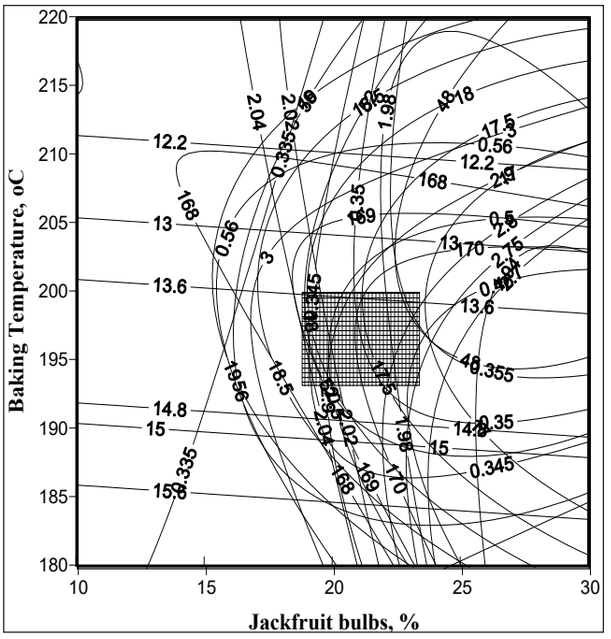

Fig. 11: Superimposed contour plots showing the optimum zone

It was observed that the lower value of Baking time 13.6-14.24 minutes, Hardness 48.3-51.6g, Cohesiveness 0.348-0.35, Springiness 2.84-2.88 mm, Guminess 17.5-17.75, Chewiness 0.4-0.5, more Specific volume 1.99-2.004 (cm^3/g), and lower Browning Index 169.6-169.9 was observed in optimum zone where the baking temperature 194-201°C and percent dehydrated ripe Jackfruit bulbs 19.8-22.5%. The optimum zone of lower hardness, cohesiveness, springiness, guminess, chewiness, more specific volume and browning index in Fig. 11.

Sensory evaluation

Table 4 shows the sensory scores for the cup cake. It was observed that six-cup cake having scored more than forty-five. Sample E and B are near about the acceptability limit but best score was observed at Sample code J (Control) followed by sample code E (Jackfruit bulbs 20% and Baking temperature 200°C). Sample H was not much accepted by judges. It had Jackfruit bulbs (30%).

Correlation of Objective (Baking time, Hardness, Cohesiveness, Springiness, Guminess, Chewiness) and Subjective (Sensory evaluation) tests

It was observed from Fig. 11 the optimum zone was observed in baking temperature 194-201°C and dehydrated ripe Jackfruit bulbs 19.7-22.5%. From the sensory scores it was observed that the best score was observed at dehydrated ripe Jackfruit bulbs20% and baking temperature 200°C. This is lying within the optimum zone of the superimposed contour plot.

Therefore it is recommended that the cup cake can be prepared by using dehydrated ripe Jackfruit bulbs 19.8-22.5% and baking temperature 194-201°C.

Cost Economics of developed cup cake

Table 5 shows the Cost Economics of developed cup cake. It was observed that benefits cost ratio developed cup cake with 20% dehydrated ripe jackfruit bulbs is 1.42 for 1 kg refined flour and 1.86 for 1 day (3 kg refined flour).

Table 4: Average Sensory scores for various samples (Sample A - J)

Sl. No.	Sample Code	Levels of Experiment		Sensory Attributes							Total Sensory Score
		Jackfruit bulbs (%)	Baking temperature (°C)	Colour	Texture	Flavour	Taste	Mouth feel	Acceptability	Overall acceptability	
1	A	10	180	7	7	7	7	7	7	7	47
2	B	10	200	7	6	7	6	6	6	7	46
3	C	10	220	7	7	7	7	7	7	7	47
4	D	20	180	7	7	7	7	7	7	7	48
5	E	20	200	8	7	7	7	7	7	7	50
6	F	20	220	7	6	6	6	6	6	6	45
7	G	30	180	6	6	6	6	6	6	6	42
8	H	30	200	6	6	6	6	6	6	6	41
9	I	30	220	6	6	6	6	6	6	6	44
10	J	Control	Control	8	8	8	8	8	8	8	57

Table 5: Cost Economics of developed cup cake

Items	Cost per kg	Quantity Required (kg)	Total cost (₹)	Total Quantity Required (kg/day)	Total cost per
Maida	28	1	28/-	3	84/-
Baking powder	110	0.036	4/-	0.108	12/-
Cake improver	225	0.042	9.5/-	0.126	28.5/-
Dried ripe jackfruit bulbs	60	0.2	12/-	0.6	36/-
Egg free mix	400	0.33	133/-	0.99	399/-
Salt	12	0.01	0.5/-	0.03	1.5/-
Sugar	33	1.2	39/-	3.6	117/-
Vegetable oil	98	0.20	20/-	0.6	60/-
Paper mould	25 ₹/100 Piece	90 Piece	23/-	270	69/-
Mixing			10/-		20/-
Jackfruit bulbs Grinding			5/-		10/-
Baking			40/-		80/-
Packaging			30/-		90/-
Labour @₹150/day			150/-		150/-
Total cost			504/-		1157/-
Total no. of cup cake		90 no.		270 no.	270
Total Selling price@ ₹ 8/cup cake		90 no.	720/-	270 no.	2160/-
Net profit (A-B)			216/-		1003/-
B:C Ratio			1.42		1.86

CONCLUSION

Following conclusion was drawn from the present investigation:

Cup cake can be prepared by using dehydrated ripe Jackfruit at bulbs 20% and baking temperature 200°C. Optimum baking time 13.6-14.24 minutes, hardness 48.3-51.6g, cohesiveness 0.348-0.35, springiness 2.84-2.88 mm, guminess 17.5-17.75, chewiness 0.4-0.5, more specific volume 1.99-2.004 (cm^3/g), and browning index 169.6-169.9. Benefits cost ratio of developed cake for 1 day (3 kg refined flour) was 1.86 and for 1 kg refined flour was 1.42.

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