International Food Research Journal 25(1): 196-203 (February 2018)

Journal homepage: *http://www.ifrj.upm.edu.my*

Optimization of chemical treatment on fresh cut tender jackfruit slices for prevention of browning by using response surface methodology

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Article history

Received: 27 October 2016
Received in revised form: 29 November 2016
Accepted: 1 Decemberr 2016

Keywords

Tender Jackfruit
Minimal Processing
Browning index
Firmness

Abstract

Jackfruit (*Artocarpus heterophyllus* L.) in its tender form is consumed as a vegetable and popular for its flavour, colour and meat like texture. In south Asian countries like Bangladesh, India, Pakistan and Indonesia the tender jackfruit market has a huge market potential. But, due to less edible portion per fruit (45-55% of whole fruit), the marketing and transportation of the fruit is a challenge. The possible solution to overcome the problem is to market the edible portion after necessary minimal processing. But, the processes like washing, sorting, peeling and cutting enhances oxidative stress in pre-cut fruits and vegetables. It also has the ill effects on quality of pre-cut fruits and vegetables by increase in microbial contaminations, excessive tissue softening, depletion of phytochemicals and browning. Hence, this study was conducted as a solution to the above problem. Fresh cut tender Jackfruit slices were processed by using the independent parameters such as concentration of $CaCl_2$ (2-5%), concentration of citric acid (1-2.5%) and treatment time (3-10 min.) and the response variables were Browning index (BI), colour change (ΔE), Firmness and Overall all acceptability (OAA) after the treatment. From the response variables the best combination of independent variables was resulted as 3.17% concentration of $CaCl_2$ and 1.37% concentration of citric acid for 6.78 minutes. The range for the response variables were, for Browning index (BI) 0.035 to .057, colour change 0.932 to 21.802, Firmness 0.686 to 6.572N and overall all acceptability was 4.32 to 8.23 after the treatment. This research could be potentially beneficial for development of residential business sector through expanded infiltration on locally available under-utilized foods.

Introduction

The minimal processing of vegetables and fruits have acquired the swift vogue among consumers because of its nutritional benefits, fresh like nature and ease in use. The processes like washing, cleaning, sorting, grading, peeling, cutting and slicing are some examples of minimal processing. According to Sexena *et al*. (2012) minimal processing of pre-cut fruit and vegetables effect the quality by increase the oxidative stress. Cause of degradation in quality are contaminations through microbes are increased, exhaustion of phytochemicals, tissue softening and browning. Many citations are available to illustrate the advantages of numerous processing techniques to retain the quality of minimally processed fruits and vegetables (Raju and Bawa, 2006; Albanese *et al*., 2007; Koukounaras *et al*., 2008). Storage of minimally processed fruits and vegetables at low temperature (4 to 6^{o}C) reported extension in their shelf life (Piga *et al*., 2000). Browning, tissue softening and weight loss are major problems in storage of minimally processed products (Koukounaras *et al*., 2008). The treatment of coating with sucrose, trehalose and NaCl on minimally processed apples reportedly solved those problems (Albanese *et al*., 2007). Use of anti-browning chemical such as ascorbic acid and citric acid prevent enzymatic browning in vegetables and fruits (Limbo and Piergiovanni, 2006). Technique like irradiation assisted with dip treatment chemicals like potassium metabisulphite and citric acid were reported favourable in retention of quality in minimal processed vegetables (Baskaran *et al*., 2007). According to Raju and Bawa (2006) dip-treatment solo or in amalgamation with further techniques results advantageous in terms of maintaining colour and texture, prevent browning, extend shelf life and improves sensory parameters of product. Optimization of treatments for minimal processing to withholding product's quality could results in increase of commercial market of minimal processed products. According to Kaur *et al.* (2009) response surface methodology (RSM) is a powerful tool for statistical analysis and optimization of process parameters of food products, especially where independent variables are influence the dependent

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Table 1. Independent Variables and their levels

Factor	Name	Unit	Low Actual	High Actual	Low Coded	High Coded	Mean
A	$CaCl_2$	%	2.00	5.00	-1.000	1.000	3.500
B	Citric acid	%	1.00	2.50	-1.000	1.000	1.750
C	Time	minute	3.00	10.00	-1.000	1.000	6.500

$CaCl_2$ - Calcium chloride

variables.

The jackfruit is a multi-purpose species providing food, timber, fuel and fodder, medicinal and industrial products. The primary economic product of jackfruit is the fruit, used both when immature and mature. In culinary use, tender fruit is made into various local delicious dishes including chutney and paste besides various types of curries. The tender jackfruit is nutritious and rich in antioxidants, but the processing of tender jackfruit is done traditionally as there is no research reported on processing of tender jackfruit. There is no information on state wise area and production for jackfruit except a few reports. Hence, it's very difficult to accurately determine the wastage, but on an approximate estimate jackfruit worth Rs. 214.4 crores waste every year. Kerala alone annual wastage is 35 crores jackfruits i.e. 75% of national wastage. (APAARI, 2012). Being second in the world in production of jackfruit, the technology of jackfruit processing is still handed-down and wastage is high. Transportation and marketing of tender jackfruit is troublesome due to its size and lesser yield.

There is a requisite to development of technology or process for fresh-cut tender jackfruit to grapple with the problems such as browning, flavour loss, colour loss, tissue softening and decaying. The optimization of minimal process parameter of jackfruit will be fruitful in overcome the problems of marketing, handling and transportation. Thus objective of this study is to optimize the treatment parameters for minimal processing of fresh-cut tender jackfruit slices and RSM is used to generate an empirical model to predict the response of independent variables ($CaCl_2$ concentration, citric concentration and treatment time) on dependent variables (firmness, browning index (BI), change in colour (ΔE) and overall acceptability (OAA).

Material and Methods

Sample preparation

40 Kg of tender jackfruit (*A. heterophyllus* L.) were collected from the fully developed jackfruit trees in NIT, Rourkela campus, Orissa, India. While collection of samples the special care was taken that all the jackfruit were of at same maturity level. The Jackfruit samples collected were green, fresh, without mechanical injuries or microbial infections. After acquiring of jackfruits, sanitization was carried out with the help of chlorinated water (100 ppm). The peeling and cutting of tender jackfruits was done manually with the help of sharped and serrated stainless steel knives. The peel and non-edible latex part was removed and the edible part was cut in small slices of size (4 X 3 X 2 cm). Then sliced samples were dipped in chilled chlorinated water (30 ppm) for 5 minutes for sanitization (Saxena *et al.*, 2009).

Experimental design

For determining the effect of minimal treatments on the quality of tender jackfruit slices the experiment were designed by using response surface methodology. Where the independent variables were concentration of calcium chloride (2 to 5% w/υ, X_1), concentration of citric acid (1 to 2.5% w/υ, X_2) and treatment time (3 to 10 minute, X_3). The dependent variables were firmness (N), browning index (BI), colour change (ΔE) and overall acceptance (OAA). The design used was central composite design (CCD), based on this twenty experiments were designed with 5 levels, 8 factorial points and 6 star points. Initially, the preliminary experiments were conducted to fix the range for independent variables (Table 1 and 2). Samples were dipped in the solutions for different time and concentration for $CaCl_2$ and citric acid. The change in dependent variables were determined after 2 hours of dipping in solution.

Firmness

The firmness of the jackfruit is a textural property. Firmness can be defined as the maximum force (N) recorded. Texture profile of jackfruit Fruit were measured using CT3 texture analyser [probe: needle probe (TA9, 20 mm L), pre-test speed: 1.00 mm/s, test speed: 0.50 mm/s, post- test speed: 0.5 mm/s; load cell: 10000 g]. The resistance of the material to these force is measured by a calibrated load cell and results were shown in either grams or Newton. The sample was kept on the base round table for providing quick and easy height adjustment to accommodate

Table 2. Experimental data in central composite design (CCD)

Experiment Run	$CaCl_2$	Citric acid	Time	Firmness	BI	ΔE	OAA
1	5.00	1.00	10.00	1.778	0.111	21.802	6.31
2	3.50	3.01	6.50	0.686	0.168	3.554	8.11
3	5.00	1.00	3.00	4.629	0.079	13.563	4.84
4	2.00	1.00	3.00	6.573	0.035	9.972	5.62
5	3.50	1.75	6.50	3.588	0.090	2.651	6.55
6	3.50	1.75	6.50	3.857	0.083	2.660	6.63
7	3.50	1.75	6.50	4.174	0.082	2.622	6.36
8	2.00	2.50	3.00	2.933	0.072	13.103	5.38
9	5.00	2.50	10.00	1.175	0.287	20.616	7.09
10	2.00	1.00	10.00	1.625	0.101	12.550	5.93
11	5.00	2.50	3.00	1.774	0.082	12.555	6.01
12	3.50	1.75	6.50	3.852	0.088	2.610	6.4
13	3.50	0.49	6.50	2.530	0.094	5.495	7.63
14	0.98	1.75	6.50	0.745	0.573	12.089	4.66
15	3.50	1.75	12.39	4.595	0.115	0.932	7.82
16	3.50	1.75	6.50	2.907	0.086	2.580	6.44
17	2.00	2.50	10.00	1.527	0.071	9.910	4.32
18	3.50	1.75	0.61	0.927	0.189	2.438	8.23
19	6.02	1.75	6.50	2.197	0.094	13.781	5.66
20	3.50	1.75	6.50	3.563	0.088	2.660	6.48

$CaCl_2$ - Calcium chloride; BI - Browning index; ΔE - Change in colour; OAA - Overall acceptability

the sample and allowed to penetrate the probe inside the sample. The results were taken from the installed Texture Pro CT Software.

Browning index

Browning index (BI) is measure to estimate the browning in jackfruit slices. The procedure followed was, 5 g sample was extracted in 100 ml ethanol (67%) for 60 minute. Then the extract was filter by using filter paper (Whatman filter No.1). Then filtrate was used to determine browning index by using UV-visible spectrophotometer (wavelength at 420 nm) with blank as 67% ethanol (Sexena *et al*., 2009).

Colour

Visual colour of samples were determined before analysing physical or chemical properties of tender jackfruit after washing them with warm water and rising of the surface moisture with the help of the cotton cloth or tissue. The triplicate of colour was measured from 6 different places of jackfruit and the average of it was taken to represent it colour. The colour measurement was with the help of colourflex (hunter colorimeter). The values was expressed in the term of L^*(black to white), a^* (red to green) and b^* (yellow to blue). Then the change in colour was determined by using formula:

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

Where,

ΔE_{ab} - Measure of change in visual perception of two given colours.

L^*, a^*, b^* - Measure of colours values for provided samples.

Sensory evaluation

The sensory evaluation of jackfruit was done on the basis of its colour, odour/smell, texture/ freshness, and overall acceptance. The most popular method nine point hedonic scale was used (Larmond, 1977) and the team of 10 trained panellists were selected. The product overview was presented to the panellists before the evaluation. The sensory evaluation was conducted in ideal conditions. The scores assigned to each parameters were 1 to 9, where 1 stands for extremely dislike and 9 stands for extremely like. The samples were coded and randomly drawn by the panellists.

Statistical analysis and optimization

Second order polynomial model was used to determine the response data from central composite design, the equation used was given below.

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_{11}X_1^2 + \beta_{22}X_2^2 + \beta_{33}X_3^2 + \beta_{12}X_1X_2 + \beta_{13}X_1X_3 + \beta_{23}X_2X_3$$

Where,

Y – Predicted response

β_0 – Regression co-efficient of fitted response at centre point

β_1, β_2 and β_3 – Regression co-efficient for linear effect terms

β_{11}, β_{22} and β_{33} – Regression co-efficient for quadratic effect terms

β_{12}, β_{23} and β_{13} – Interaction effect

The equation used is describing the effect of each independent variable, the combined effect of the independent variables and the interaction effect of independent variables on the response variable (Y). To determine the optimum conditions the contour plots of the interactions between independent variables over the responses were generated. Parameters used to find the acceptability of polynomial model were R^2 value, lack of fit and significance by ANOVA at p>0.05. The good fit of model was considered when R^2 was more than 0.8. The graphical representation was used for the optimization of the working condition and maximising the responses.

Results and Discussion

The experiments were conducted and optimization was done by using RSM, where the $CaCl_2$, citric acid and treatment time were independent variables and colour change (ΔE), browning index (BI), Firmness and overall acceptability (OAA) were the dependent variables after the treatment of the tender jackfruit slices were kept for 3 days in refrigerator at 4 to 8°C. The experiments were performed in different combinations of independent variables as shown in table 1 and 2. For statistical analysis ANOVA was done (table 3) and for optimising the parameters RSM was performed. From the analysis of variances it could be concluded that all the dependent variables have significant sum of squares (p>0.01). There is good fit for model because of high R^2 value (>0.9). Lastly it could be concluded that the polynomial model have goodness of fit for the given research.

Influence on firmness

According to Rico *et al.* (2007) texture is an important entity in determining the freshness of minimally processed fruits and vegetables. The firmness response to the independent variables has been shown in Figure 1(a). There was variation in

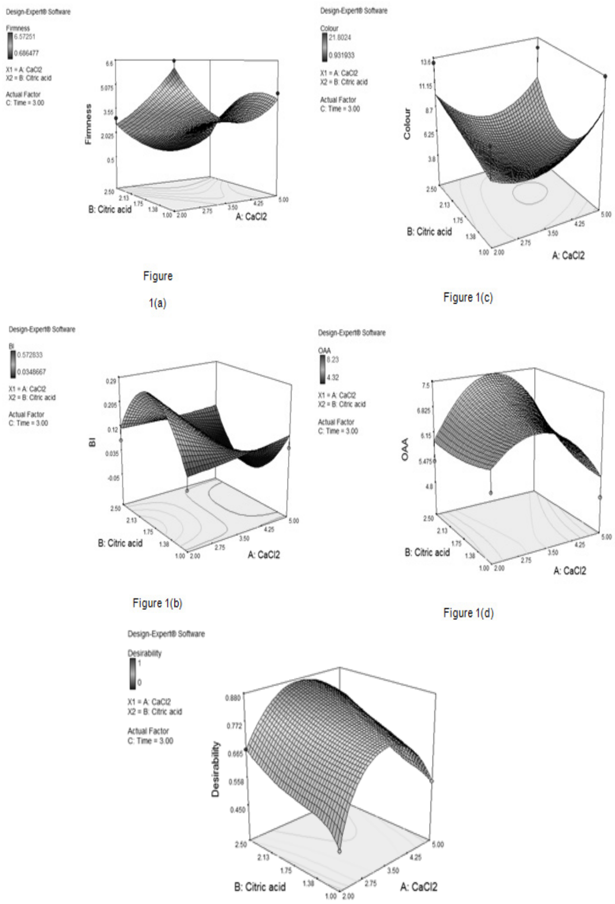

Figure 1(a). 3D surface curve for the effect of CaCl2 concentrations and Citric acid concentration on firmness in minimally processed tender jackfruit slices; (b). 3D surface curve for the effect of $CaCl_2$ concentrations and Citric acid concentration on BI in minimally processed tender jackfruit slices; (c). 3D surface curve for the effect of $CaCl_2$ concentrations and Citric acid concentration on change in colour in minimally processed tender jackfruit slices; (d). 3D surface curve for the effect of $CaCl_2$ concentrations and Citric acid concentration on overall acceptability in minimally processed tender jackfruit slices; (e). Superimposed 3D surface plot for the desirability from dependent variables at varying $CaCl_2$ concentration and citric acid concentration.

the firmness of jackfruit slices of different treatments. The range for firmness was 0.686N to 4.595N Out of all the treatment combination the treatment No. 15 was shown the maximum firmness value whereas the minimum value for firmness was 0.686 for treatment No. 2. From the results it could be concluded that the firmness was increasing as the concentration of $CaCl_2$ and the treatment time was increasing. The effect of $CaCl_2$ on the firmness was positive and it might be justified with the greater values for linear and quadric terms (β_1, β_{11}) of $CaCl_2$. The similar, significantly positive effect on firmness of tender jackfruit slices was shown by the concentration of citric acid and treatment time because of the greater

Table 3. ANOVA of the dependent variables for fitted second-order polynomial model

Source	df	Sum of Squares			
		Firmness	BI	ΔE	OAA
Regression					
First-order terms	3	52.43361 [a]	0.344686 [a]	599.9493 [a]	17.32174 [a]
Second-order terms	6	14.43637 [a]	0.069658 [a]	538.2427 [a]	13.30722 [a]
Total	9	66.86998	0.414344	1138.192	30.62896
Residual	10	3.56	0.037	186.9048	5.988967
Lack of fit	5	2.639663	0.037	186.8996	5.939234
Pure error	5	0.920337	0.000045	0.005197	0.049733
Corrected total	19	46.51057	0.26	782.4047	22.61146

[a] Significant at 1% level of significance; df - Degree of freedom; BI - Browning index; ΔE - Change in colour; OAA - Overall acceptability

values of their linear and quadric terms i.e. β_2, β_{22}, β_3 and a β_{33} respectively. There was the good fit for the quadric model with the data because of higher R^2 (0.9235) value. It is stated that, the texture change in the minimal processed also influence enzymatic and non-enzymatic processes at certain level (Van Buren *et al*., 1979.) which also influences the sensory attributes of the minimal processed samples (Saxena *et al*., 2012.). According to Verala *et al*. (2007) keeping the minimal processed apple slices in calcium salt based solution for a while, resulted in prevention in solubilisation of pectin will maintain its textural as well as sensory characteristics. The benefits from the treatments were positive towards the better textural quality and prevention from microbial growth as well. The relationship between independent and dependent variables can be described by the following multiple regression equation.

$$Firmness(N)=0.363+0.43A0.55B+1.09C+0.36AC+0.72B-0.58A^2-0.53B^2-0.12C^2-0.84C^2A-2.32B^2C-0.35BC^2$$

Where,

A= $CaCl_2$ concentration
B= Citric acid concentration
C= treatment time

Influence on browning index (BI)

Koukounaras *et al*. (2008) reported in their study that browning is the important factor which remarkably influences the shelf life and marketing of minimal processed products. The Figure 1(b) shows the response of browning index to independent variables. The browning index varies from 0.035 to 4.595 for various combinations of treatments. From the all the treatment the treatment No. 15 and treatment No. 4 are having the maximum and minimum values for browning index respectively. When consider as one factor the increase in concentration of $CaCl_2$ and treatment time resulted in significant decrease the browning index values of treatments. The interaction effect of concentration of citric acid and $CaCl_2$ at browning index values was highly influencing at higher concentration of citric acid and $CaCl_2$ for longer treatment time resulted in lower browning index ($p>0.05$). The effect of $CaCl_2$ on the browning index was negative and it might be justified with the values for linear and quadric terms ($\beta1$, $\beta11$) of concentration of $CaCl_2$. The linear terms citric acid was resulted in non-significant effect ($p>0.05$). The interaction effect between the concentration of $CaCl_2$ and concentration of citric acid influence the response significantly ($p>0.05$). There was the good fit for the quadric model with the data because of higher R^2 (0.8571) value. Oxidative browning has been reported as very influencing parameter for shelf life of minimally processed fruit and vegetables (Sexena *et al*., 2012). Cocci *et al.* (2006) has been reported the positive effect of citric acid to minimize the browning index and extension of shelf life of minimal processed fruits. The multiple regression equation showed the final reduced model fitted for describing the relationship between the independent and (dependent variable) browning index.

$$Browning\ Index\ (BI) = 0.09-0.14A+0.022B-0.022C+0.021AB+0.022AC+0.013BC+0.065A^2+0.030ABC+0.060A^2C+0.18AB^2$$

Where,

A= $CaCl_2$ concentration
B= Citric acid concentration
C= treatment time

Influence on colour (ΔE)

Change in the colour of minimally processed tender jackfruit slices could properly described by

Table 4(a). Regression coefficients of fitted second-order polynomials model showing the relationship between independent and dependent variables

Coefficients	Firmness	BI	ΔE	OAA
β_0	3.627583[a]	0.089758[a]	2.383419[a]	6.520699[a]
		Linear		
β_1	0.431664[a]	-0.14226	0.503041[a]	0.297302[a]
β_2	-0.54801[a]	0.02205[a]	-0.57713[a]	0.142705[a]
β_3	1.090749[a]	-0.02209[a]	-0.4477	-0.12189[a]
		Interaction		
β_{12}	0.034911[a]	0.021488	-0.33574	0.475
β_{13}	0.362962	0.021554[a]	2.114559[a]	0.4125[a]
β_{23}	0.724055	0.013288	-0.74366[a]	-0.22
		Quadratic		
β_{11}	-0.58114	0.064597	5.257563[a]	-0.75328
β_{22}	-0.53252[a]	-0.00695[a]	2.283985[a]	0.204846[a]
β_{33}	-0.1249[a]	0.000498	1.280005[a]	0.259647[a]
R^2	0.9235	0.8571	0.8611	0.8351

[a] Significant at 5% level of significance; BI-Browning index; ΔE-Change in colour; OAA-Overall acceptability; β_0 – Regression co-efficient of fitted response at centre point; β_1, β_2 and β_3 – Regression co-efficient for linear effect terms; β_{11}, β_{22} and β_{33} – Regression co-efficient for quadratic effect terms; β_{12}, β_{23} and β_{13} – Interaction effect

colour change value (ΔE). The change in colour value graph as dependent to the independent variables been presented in Figure 1(c). The maximum and minimum change in colour value varied from 0.932 to 21.802. Treatment No. 1 reported the maximum value of change in colour, whereas treatment No. 15 was reported with minimum value. The linear and quadratic terms of concentration of $CaCl_2$ (β1, β11), quadratic term of concentration of citric acid (β22) and linear and quadratic terms of treatment time (β3, β33) are having negative effect on change in colour. The lower the value of change in colour, the better the colour quality of tender jackfruit because, it represent that there is least colour changes when compare to the fresh cut samples. The retention of colour is more in case at higher concentration of citric acid and longer treatment time. The coefficient of determination R^2 value is 0.8611, which represent the good fit of quadratic model with the experimental data. In case of minimal processed mangoes the same kind of results were quoted by Robles-Sanchez *et al.* (2009). The retention of colour is because citric acid acts as radial scavenger. The relationship between independent and dependent variables can be described by the following multiple regression equation.

$$Colour=2.38+0.50A-0.58B-0.45C-0.34AB+2.11AC-0.74BC+5.26A^2+2.28B^2+1.28C^2+0.70ABC+0.36A^2B+2.41A^2C$$

Where,

A= $CaCl_2$ concentration
B= Citric acid concentration
C= treatment time

Influence on overall acceptability (OAA)

Figure 1(d) shows the response of overall acceptability with respect to independent variables. The overall acceptability varies from 4.32 to 8.23 for various combinations of treatments. From all the treatment the treatment No. 18 and treatment No. 17 are having the maximum and minimum values for overall acceptability respectively. When consider as one factor the increase in concentration of $CaCl_2$ at certain level will increase the overall acceptability and thus decreases further with increase in concentration of $CaCl_2$. Treatment time and citric acid concentration resulted in no significant change in overall acceptability values of treatments. The interaction effect of concentration of citric acid and $CaCl_2$ on overall acceptability values was highly influencing and with increase in concentration of citric acid and $CaCl_2$ for longer treatment time resulted in higher browning index ($p>0.05$) at certain point and after that point the negative effect was observed. The effect of $CaCl_2$ on the overall acceptability was positive and it might be justified with the values for linear and quadric terms (β1, β11) of concentration of $CaCl_2$. The linear terms citric acid was having no significant effect on OAA ($p>0.05$). The interaction effect between the concentration of $CaCl_2$ and concentration of citric acid influence the response significantly ($p>0.05$). There was the good fit for the quadric model with the data because of higher R^2 (0.8537) value. The sensory values for the texture properties were found positively affected with the concentration of $CaCl_2$, and concentration of citric acid. Similar reports were quoted by Rocha and Morais (2003) but in case of minimal processed apple slices. The multiple regression equation showed the final reduced model fitted for describing the relationship between the independent variables and overall acceptability.

$$OAA=6.52+0.30A+0.14B-0.12C+0.48AB+0.41AC-0.22BC-0.75A^2+0.20B^2+0.26C^2+0.12ABC-0.13A^2B+0.35A^2C+0.078AB^2$$

Where,

A= $CaCl_2$ concentration
B= Citric acid concentration
C= treatment time

Optimization

To optimize the different treatments for minimal processing of fresh cut tender jackfruit the graphical and numerical optimising technique was used. In Table 4(a) Regression coefficients of fitted second-order polynomials model showed the relationship between independent and dependent variables The contour plots were reported that one factor effect and interactive effect of various independent variables on the dependent variables. Overlay contours and 3D plot of dependent were created for any given treatment by plotting between any two independent variables and keeping third independent variable as constant. The desirability plot of concentration of $CaCl_2$ and citric acid was drawn with treatment time at its minimum value. The constant term applied for the curve is treatment time at 3 minute (Figure 1(e)). The desirability curve is concave in nature and desirability ranges from 0.588 to 0.92. From the curve most desirable results can be taken at highest citric acid concentration and concentration of $CaCl_2$ at centre points. The optimum range from the desirability curve and overlay plot were found to be 3.17% Concentration of $CaCl_2$, 1.37% Concentration of citric acid and 6.78 minute treatment time. These parameters were resulted for graphical optimization. When optimization is done for maximum firmness, minimum change of colour (minimum ΔE), minimum browning index and maximum score for overall acceptability. The optimised treatment found were tabulated in table. 4(b). The graphical and numerical optimized conditions were similar to each other. These optimised condition were helpful to find out the best treatment for optimised overall acceptability, which is very important factor to decide the popularity and acceptability of product in the market. Remaining experiments were carried out at given optimized conditions and the results compared with actual and predicted values from the model. From those results it could be concluded that second order polynomial model could be used to determining the quality of minimally processed tender jackfruit slices. Where independent parameters could be concentration of $CaCl_2$, concentration of citric acid and treatment time to the dependent variables such as browning index, overall acceptability, firmness and change in colour. Samples were treated in optimised conditions as mentioned above and kept in refrigerated conditions for 15 days. The treated samples were compared against untreated sample and it was found that untreated samples lasts only for 5 days whereas treated (with optimised treatment) samples were found good for consumption even on 15th day of experiment.

Conclusion

The methodology used to optimising the pre-treatment for minimal processing of fresh cut tender jackfruit was response surface methodology (RSM). Study was conducted with the aim of extension in shelf life of fresh cut tender jackfruit and the results found were very promising and positive. There was increase in shelf life of fresh cut tender jackfruit by 10 to 15 days in refrigerated conditions. With increase in shelf life the quality of tender jackfruit was also retained in terms of colour and firmness. There was no or minimum browning recorded in samples and the overall acceptance of fresh cut tender jackfruit was higher in terms of overall acceptability. The treatment adopted for minimal processing was dipping of fresh cut tender jackfruit slices in solution of different concentration of $CaCl_2$ and citric acid for various time interval. The response variables were browning index, overall acceptability, change in colour and firmness. The model used to determining the optimised conditions for pre-treatment as minimal processing was second order polynomial model. From the experimental data it was found that the model was having good fit with high R^2 (0.942) value. From the model and with the help of RSM the optimised conditions were 3.17% concentration of $CaCl_2$ and 1.37% concentration of citric acid for 6.78 minute treatment time. The optimised conditions for processing ensure maximum retention of quality and longer shelf life. The output from this study could be prove a boon for the industries which deals with processing and packaging of jackfruit.

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