Optimization using Response Surface Methodology on Soy- Cakes by Infrared Microwave Combination

Gomathi Jawahar G., S Elizabeth Amudhini Stephen, Divya P.S., Sandra K. Raju

Abstract: ***Optimization of soy-cake using infrared microwave combination using response surface methodology was studied here ,in which box Behnken method was used .The independent variables used here are the time to bake (8-10 min) ,soy flour concentration(30-50%),DATEM concentration , (0.4-0.8%) .The dependent variables used for this study is weight loss ,texture ,color change .The optimum time for baking ,concentration of soy flour ,DATEM concentration were respectively found as 8.74 mins.36.61%,0.488%.the optimum values for quality characteristics weight loss ,texture ,color measurement are 17.011%,0.2005%,56.83% respectively as per response surface methodology and contour plot.***

Keywords: Response surface methodology, soy-cake, infrared, microwave, DATEM concentration, soy flour, baking time, weight loss, color, texture

I. INTRODUCTION

Baking is cooking of food that uses prolonged dry heat without direct exposure ,in an oven it is series of physical, chemical and biochemical changes in food .(Sakiyan 2007).Baking of cakes are done by microwave energy but in this we use combination of infrared microwave combination. Problems occurred during microwave baking is high moisture loss, crumb hardness, lack of surface color and also one main problem of microwave baking is lack of combination of some ingredients because of short baking period (Summu 2001).So combination of microwave with infrared heating is used to get the browning and crisping nature A formulation study for wheat flour based sponge cake with tapioca starch and Xanthum gum was determined using central composite design with 2 factors and RSM. Determination of specific volume, texture analysis and sensory scores were done. They found normally containing 17 % butter with maximum specific volume, minimum bread microwave baking is hardness ,gumminess and chewiness and maximum overall liking was found to be 11.09 to 11.88 % TS and 0.10 to 0.11 % Xanthium. Benefits of soy, they have high protein content and use as nutritional and a functional food (Dube et .al .2007).As cereals have low protein and imbalanced amino acid content ,so soy protein produces were used as it has essential amino acids to complement cereal proteins RSM was used to optimization of soy cakes. Weight loss, color, texture was determined.

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RSM is a statistical technique for development of products .This methodology was successfully used for baked foods such as cake and bread. The objective is to optimize a response (output variable). which is influenced by several independent variables (input variables)(Sumnu et al. 2000;Sevimli et al. 2005 ;Turabi et al .2008).The work aims to optimize the formulation and processing conditions of infrared microwave combination baked soy cakes

II. MATERIALS AND METHODOLOGY USED

Ingredients Used

100 grams cake flour kept as basis,100grams cake flour ,0.65 grams ash,13.5grams moisture ,soy flour, sugar, non fat dry milk, cake shortening ,salt and baking powder,egg white powder ,emulsifier DATEM are the ingredients used in making of soy cakes

Preparation of Batter

A standard cake batter recipe containing 100 g sugar,2 g fat ,12 g non fat dry milk ,9g egg white powder,3 g salt , g baking powder, 90 g water was used in the experiments .100 g of flour mixture was taken of 100g wheat and soy flour .Emulsifier ,DATEM concentration was added in 0.4 %,0.6%,0.8% .All dry ingredients were mixed, then fat (shortening) is added to the mixture of sugar and egg white and mixed with the blender for 1 minute at low speed (Toastmaster,1779CAN,China) .Then all the dry ingredient and water was added and mixed for 4 minutes

Baking

Adventism oven was used for infrared microwave combination baking .Cavity size of advantium oven was 21cm height, 48 cm length,33 cm width .power of oven is 706 W(Summu et .al 2005).It consists of upper halogen lamps, and lower halogen lamp and a microwave source.For infrared microwave combination baking, power levels of upper halogen was 1500W and lower halogen lamps was 1500 W .And both irradiation source and microwave source was adjusted to 50%.baking of cakes were done at 8,9,10 mins and to maintain humidity in oven 800ml of water were placed(Sevimli et al.2005) .conventional oven was used for baking of control cake at 175 ◦C at 24 mins.

III. DESIGN OF EXPERIMENT

The optimum levels of emulsifier concentration ,concentration of soy flour and baking time were evaluated by response surface methodology using Box Behnken design. Concentration of emulsifier , concentration of soy flour and time taken for baking are the independent variables .emulsifier DATEM was used because of positive effect on baking products(Sehyhun et al.2003).Soy flour was used

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as it has many health benefits and is gluten free. Baking time was selected as independent variable because of effect of quality on final product. The dependent variables chosen for this study is weight loss, color measurement, texture measurement

Table 1: Experimental design using factors and responses

Std	Run	Factor 1 A:soy flour conc... %	Factor 2 B:datem concent... %	Factor 3 C:baking time min	Response 1 weight loss %	Response 2 color measurem...	Response 3 texture N
5	1	30	0.6	8	10.51	56.8	0.165
16	2	40	0.6	9	11.33	57.2	0.18
13	3	40	0.6	9	12.17	55.8	0.243
4	4	50	0.8	9	11.56	59.7	0.172
1	5	30	0.4	9	25.6	56.19	0.169
14	6	40	0.6	9	21.9	59.2	0.189
17	7	40	0.6	9	18.3	57.12	0.213
9	8	40	0.4	8	13.6	55.88	0.22
2	9	50	0.4	9	22.4	57.6	0.25
11	10	40	0.4	10	19.8	58.99	0.213
7	11	30	0.6	10	13.7	56.4	0.178
6	12	50	0.6	8	10.8	59.1	0.193
12	13	40	0.8	10	14.11	55.9	0.222
10	14	40	0.8	8	25.3	58.76	0.248
8	15	50	0.6	10	24.9	59.34	0.197
15	16	40	0.6	9	17.2	57.15	0.219
3	17	30	0.8	9	16.1	55.79	0.238

Weight Loss Determination

Weight of the batter before baking of product (W_1) and weight of cake after baking(W_2) were used to calculate the weight loss and equation is

Weight loss % = W_i -W_f/W_f

Color Measurement

The objective of measuring color is to describe the color effect(chromaticity).minolta colorimeter reader was used to determine the surface color, a*(redness/greenness),b*(yellowness/blueness) by (xaio et. al.2009).

Texture Measurement

The texture testing is a technique for evaluating the mechanical and physical properties of raw ingredients, food structure and designs. Since texture can be measure by sense of touch, mechanical methods in units such as force are done**.** Here, hardness of the cake is determined by texture analyzer. The cake sampled where compressed 25% of its own size with a 50 N force applied .55mm/min was the cross head speed of the analyzer

IV. RESULTS AND DISCUSSION

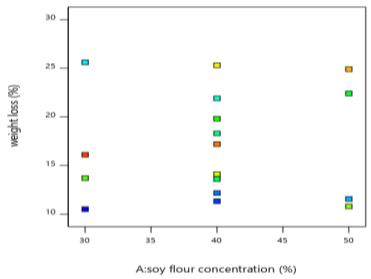
Statistical Analysis

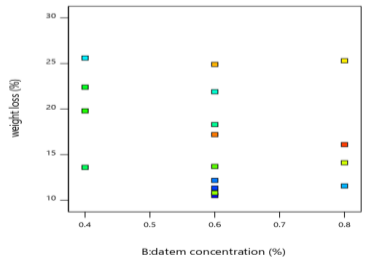
The experimental values and analysis of variance are obtained for concentration of DATEM, concentration of soy flour, baking time are the response variables used in this study. The obtained response surface variables from rsm model are adequate and having no prominent lack of fit.Response value are denoted by R_2.

1.WEIGHT LOSS (Y_1) = $-72.028-2.111\ X_1+103.98\ X_2+20.905\ X_3-0.167\ X_1.X_2+0.272\ X_1.X_3-21.737\ X_2.X_3-0.002\ X_1^2+74.500\ X_2^2-0.957X_3^2$

2.COLOUR MEASUREMENT (Y_2) = $24.488-0.199\ X_1+55.59\ X_2+3.848\ X_3+0.312\ X_1.X_2+0.0160\ X_1.X_3-7.462\ X_2.X_3$

3.TEXTURE (Y_3) = $-0.918+0.031\ X_1+0.352\ X_2+0.084\ X_3-0.018\ X_1.X_2-0.0002-0.0237X_2.X_3-0.002\ X_1^2+0.511\ X_2^2-0.003\ X_3^2$





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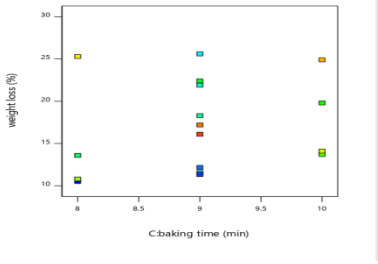

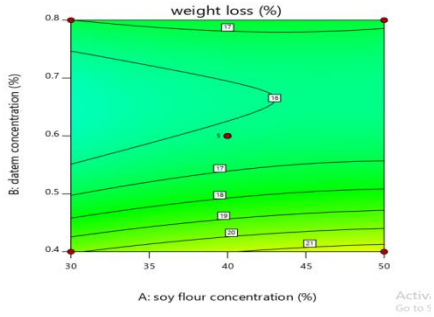

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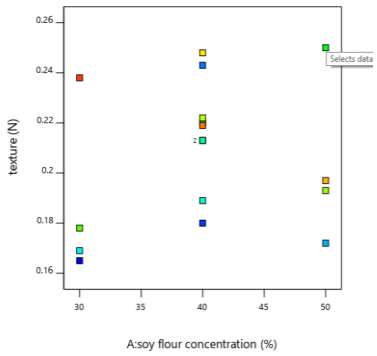
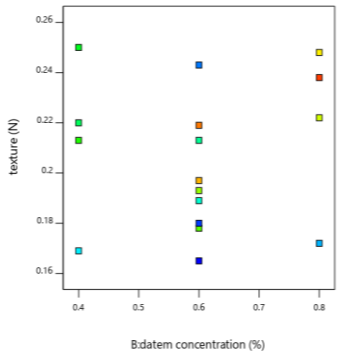
Fig 1. Effect of independent variables Soy, (A)flour concentration(%) Vs weight loss (%), (B)DATEM concentration(%)Vs weight loss(%) , (C)baking time Vs weight loss(%), (D)weight loss increases with increase in DATEM concentration





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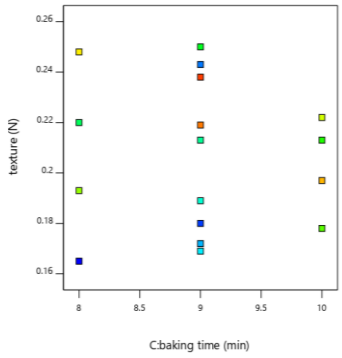

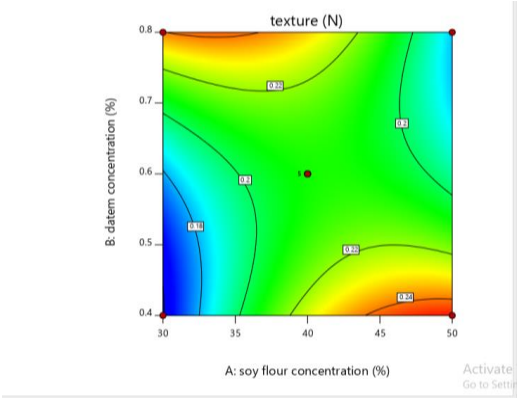

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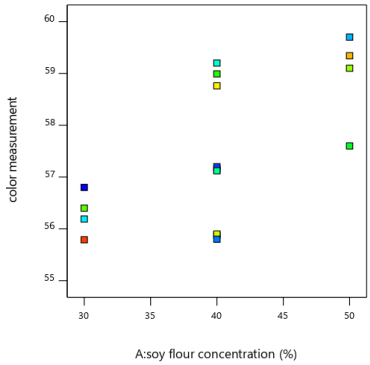
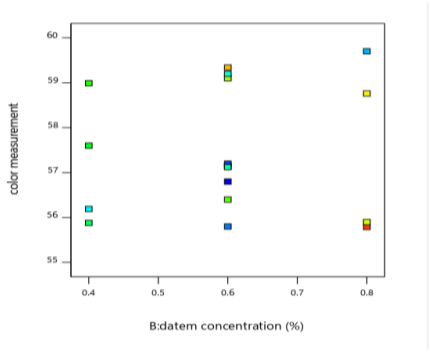
Fig 2.Effect of independent variables (A) soy flour concentration Vs texture,(B) DATEM concentration Vs texture , (C) baking time Vs texture ,(D)with increase inDATEM concentration and soy flour concentration hardness increases





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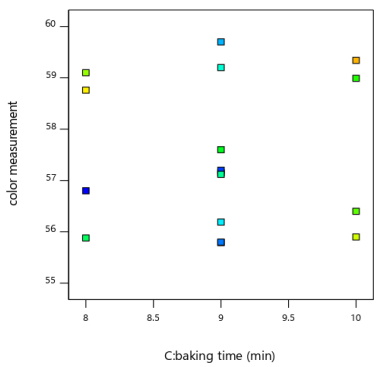

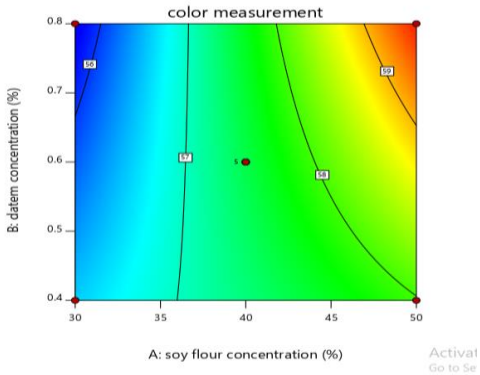

(C)
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Fig 3.Effect of independent variables (A) soy flour concentration Vs color measurement , (B)DATEM concentration Vs color measurement , (C)baking time Vs color measurement , (D)with increase in DATEM concentration and soy flour concentration ,color increases

Here in this study of response obtained weight loss is minimum of 10.51%,texture of minimum 1.625 N,color of maximum value 59.7%.Minimum weight loss is more desirable as more moisture content will cause microbial attack .maximum color is desirable as it is appealing and consumers will prefer these breads.Hardness should be less in baked products. The independent variables are soy flour concentration ranges (30-50%),DATEM concentration value ranges from (0.4-0.8%),baking time value ranges from (8-10%).The optimized result obtained using box –Behnken method is all most similar to the optimized result obtained from CCD.

V. CONCLUSION

Optimization of soy cakes using infrared microwave combination using RSM method was studied here. RSM is a useful method to detect optimal levels of soy flour concentration, DATEM concentration, baking time. The optimum points were found as optimum baking time , concentration of soy flour ,concentration of DATEM were found as 8.74 mins.36.61%,0.488%.corresponding predicted responses were for weight loss 17.011%,hardness 0.2005%,color measurement 56.83% respectively .Thus by, using infrared microwave oven, we can produce high quality soy cakes with shorter baking time

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