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Studies on the Development of Microwave Baked Potato Chips to Optimize Process Parameters

P Naga Deepthi, L Edukondalu, Sivala kumar and Lakshmi J
College of Agricultural Engineering, Bapatla 522 101, Andhra Pradesh

ABSTRACT

The present investigation was to study the development of microwave baked potato chips using response surface methodology to determine the optimum operation conditions of microwave baked potato chips and to analyze the effects of microwave baking processing variables, including thickness (0.5-2.5mm), microwave power (300-900 Watts), baking time (4-12 min). Quadratic polynomial equations were also obtained by multiple regression analysis. The predicted models were adequate based on the lack-of-fit test and coefficient of determination obtained. By superimposing individual contour plots of the different responses, regions meeting the optimum conditions were also derived. Quadratic regression equations describing the effects of these factors on the physico-chemical attributes were developed. It was found that effects of thickness and microwave power were more significant on the moisture, ash, CHO & fat content than baking time. As for protein and browning index, the power level has no significant effect. The microwave baking process was optimized for physico-chemical attributes. The optimum conditions were found to be: thickness of 1.5 mm, microwave power of 600 Watts and baking time of 8min. At this condition the optimum values of moisture, ash, fat, protein and carbohydrate contents were found to be 6.12%, 4.12%, 0.44% and 82.5 g/100 g respectively.

Key words : Microwave baking, Potato chips, Response surface methodology.

Potato (*Solanum tuberos*) is a starchy, tuberous crop of the *Solanaceae* and one of the world's major crops, is consumed daily by millions of people from diverse cultural backgrounds (Pedrschi *et al*., 2005). Potato is semi-perishable in nature, it contains about 80% water and 20% dry matter. A major portion of dry matter is starch and sugar that constitute 16% on fresh wet basis, crude protein content is 2% (Singh *et al*. 2007). Potato chips are thin slices of potato, deep fried or baked until crisp or crunchy. they serve as an appetizer, side dish or snack. Potato chips have been popular salty snacks for 150 years. Traditional potato chips have a high oil content that ranges from 35 to 45 g per 100 g (wet basis), which gives the product a unique texture and flavor to make them appeal to the consumer.

Deep fried potatoes in oils add fat and calories to the product, which may increase risk of gaining weight. Increasing body weight may increase risk of obesity and insulin resistance. In order to reduce the oil content in chips microwave drying has been studied as an alternative method for improving the quality of dehydrated product.

There are a number of advantages of microwave baking in food processing technology like significant reduction in the thermal processing time while making food safe for consumption is the major advantage of microwave sterilization processing, reduction in processing time results in more fresh-like taste and texture, and improves visual appeal of the food. The reduction of processing time may also potentially increase retention of nutrients in the thermally processed foods. Instantaneous turn-on and off of the process allows for a more precise process control, better energy usage, and cleaner working environment in food processing facilities (Chavan *et al.* 2010).

MATERIAL AND METHODS

Experimental Procedure

Selected mature potatoes were washed and peeled. The peeled potatoes were trimmed to remove any discolored region or green area. Then, the potatoes were sliced into different thickness (0.5, 1.0, 1.5, 2.0 & 2.5 mm) and blanched in hot water at 85±5p C for 3 min. The blanched potatoes were baked in micro oven at different powers of

300, 450, 600,700,750 and 900 Watts. The baking was done at different levels of time of 4, 6, 8, 10 and 12 min. After baking, the samples were cooled; packed and further qualitative analysis was conducted.

Experimental design

Response surface methodology (RSM) was adopted in the design of experimental combinations. The main advantage of RSM is the reduced number of experimental runs needed to provide sufficient information for statistically acceptable results. A three-variable (five levels of each variable) Central Composite Rotatable Experimental (CCRE) design was employed. The independent variables included thickness (0.5-2.5mm), microwave power (300-900W), and baking time of (4-12min). The five levels of the process variables were coded as -á, -1, 0, +1, +á and design in coded (x) form and the actual levels are given in Table 1.

Physic-Chemical analysis

Moisture content

Moisture content was determined using approximately 3.0 g of the ground potato chips in a oven at 105ºC until the weight constant (AAOC, 1984).

Ash content

The ash content of potato chips was determined by muffle furnace (AAOC, 1984).

Fat content

The microwave baked potato chips were ground and oven dried. Fat content of potato chips was determined by Soxhlet apparatus using petroleum ether (AAOC, 1984).

Carbohydrate content

The carbohydrate content of microwave baked potato chips was determined by anthrone method (Ranganna, 1986).

Sensory analysis

Sensory analysis was conducted for all the samples. The panelists rated the samples on a Hedonic Rating Test (1-Dislike extremely, 5-Neither like nor dislike and 9-Like extremely) in accordance with their opinion for color, taste, texture, flavour, and overall acceptability.

Statistical Analysis

Data were analyzed using the statistical analysis system software package (Design expert, trial version 9.0.2.0). Analysis of variance was performed by the ANOVA procedure. Mean values were considered significantly different when $P<0.05$. The adequacy of the regression model was checked by R^2, Adjusted R^2, Adequate Precision and F-test. The regression coefficients were then used to make statistical calculation to generate three dimensional plots for the regression model.

RESULTS AND DISCUSSION

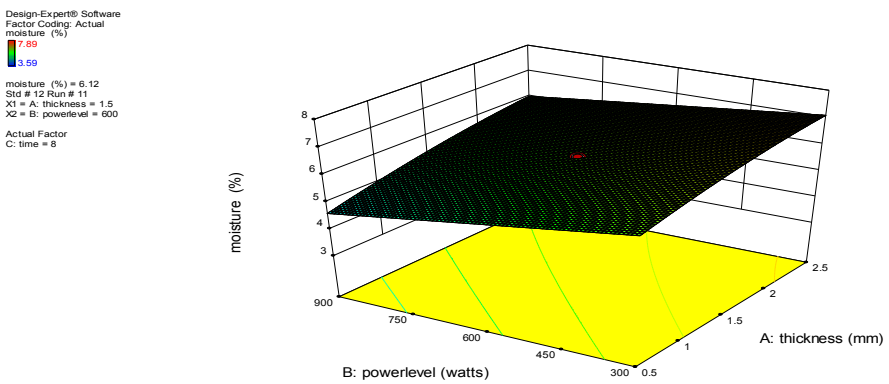
Variations of responses (moisture, ash, fat, and carbohydrate) of microwave baked chips with independent variables (thickness, microwave power and baking time) are shown in Table 2. A complete second order model was tested for its adequacy to decide the variation of responses with independent variables. To aid visualization of variation in responses with respect to processing variables, series of three dimensional response surfaces (Figures 1 to 8) were drawn using design expert software (Statease 9.0).

Moisture Content

Figure 1, and 2, represents the effect of thickness, microwave power, and baking time on the moisture content of potato chips during microwave baking. At constant baking time (8 min), the moisture content increased with increase in thickness, whereas the moisture content decreased with increase in power level. At constant power level (600 W), the moisture content increased with increase in slice thickness, whereas the moisture content decreased with increase in baking time. The reason behind the decrease in moisture content with increase in power level may be due to rapid conversion of moisture within the potato slice into steam which escaped from the slices and prevented the gelatinization resulting in hardening of a starch layer on the exterior surfaces of the slice.

Ash Content

It was predicted from the figures 3&4 that at constant baking time (8 min), the ash content decreased with increase in thickness, whereas the ash content increased with increase in power level. At constant power level (600 W), the ash content decreased with increase in slice thickness, whereas


Design-Expert® Software
Factor Coding: Actual
moisture (%)
7.89
3.59
moisture (%) = 6.12
Std # 12 Run # 11
X1 = A: thickness = 1.5
X2 = B: powerlevel = 600
Actual Factor
C: time = 8
moisture (%)
8
7
6
5
4
3
900
750
600
450
300
B: powerlevel (watts)
0.5
1
1.5
2
2.5
A: thickness (mm)