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Niman Bodra
Department of Agricultural Engineering Birsa Agricultural University, Ranchi, Jharkhand, India

IA Ansari
Department of Agricultural Engineering Birsa Agricultural University, Ranchi, Jharkhand, India

Correspondence
Niman Bodra
Department of Agricultural Engineering Birsa Agricultural University, Ranchi, Jharkhand, India

Optimization of blanching treatments of green chilli

Niman Bodra and IA Ansari

Abstract
Blanching is a thermal treatment that is usually carried out prior to food processes such as drying, freezing, and canning. It is an essential unit operation to preserve the product quality attributes during the long-term storage because it inactivates the enzymes and reduces microbial load. In this study, sample of green chilli was used for blanching treatment to increase the shelf life with acceptable quality attributes. The experiments were conducted according to Central Composite Rotatable Design (CCRD). The blanching treatment conditions were optimized by using response surface methodology. The samples of green chilli were treated with concentration of potassium metabisulphite (0.5-1.5%) at blanching time of 0.5 to 2.5 min in boiling water before drying. The drying of green chilli was carried out at 60 °C for all samples. The response variables taken were rehydration ratio and visual color. The optimum values of concentration of potassium metabisulphite and blanching time were found to be 0.7 % and 1.5 min respectively at a desirability value of 0.60. The optimized values of pre-treatment conditions could be utilized for dehydration of green chilli to get better quality of dehydrated green chilli.

Keywords: green chilli, dehydration, blanching, response surface methodology, optimization, rehydration ratio, visual colour

Introduction
Green chillies are one of the most valuable crops of India and their cultivation and consumption has increased substantially due to their commercial importance and nutritional values. It is known for its sharp acidic flavor and colour. It is used in India as a principle ingredient of various curries and chutneys. It is also used for vegetable spices, condiments, sauces and pickles. Chillies are excellent source of vitamin A, B, C and E with minerals like molybdenum, manganese, folate, potassium, thiamine and copper. Green chillies are highly perishable and sometimes farmers get very less profit due to the glut in the market during the main seasonal harvests. A huge amount of green chillies is found to be wasted due to lack of proper preservation techniques (Shanmughavelu, 1989) [4]. Microbial, enzymatic and chemical reaction, discolouration, textural changes are the factors which lower their quality and thus influences the consumers decision of acceptance. Fresh green chillies (*Capsicum annuum* L.) undergo high postharvest losses due to poor postharvest handling during transportation and storage. The drying of chilli is essential to enhance keeping quality and making available round the year. Pretreatment of green chilli before drying is very important operation as it improves the quality attributes of products. The main reasons for treating the produce before drying is to stop enzymatic action, to improve flavour, colour, to minimize the nutrient loss, to stop decomposition by the microbes, to ensure even drying. Conducted an experiment on drying characteristics and color retention of red chilli by applying pre-treatments. They reported that blanched sample had highest drying rate and color retention than control. Blanching is a thermal treatment that is usually performed prior to food processes such as drying, freezing, frying, and canning. Blanching involves heating vegetables and fruits rapidly to a predetermined temperature and maintaining it for a specified amount of time, typically 1 to less than 10 min. Blanching has several advantages as it reduces drying time, inactivates the enzyme that bring undesirable changes, expulses air from the tissue and retains minerals and acids (Cruess, 1997) [1]. The optimum blanching treatment condition for green chilli is essential for getting the quality of end product with minimum changes during subsequent storage period. The main objective of this study to determine the optimum conditions for blanching treatment of green chilli.

Material and Methods

Raw material and sample preparation

Fresh green chilies were obtained from local market of Kanke, Ranchi and stored at 4 to 5 ^{0}C temperature in a refrigerator. Prior to experiments, green chillies were thoroughly washed to remove the sticking soil particles and graded to eliminate the variations in sizes. The size of desired length were obtained by carefully cutting the green chillies with a sharp knife. Potassium metabisulphite were obtained from market. The different concentration of sodium metabisulphite (w/v) and different blanching time were used for pre-treatments.

Determination of moisture content

Moisture content of the fresh green chilli sample was determined by drying the samples in an oven at 104 ^{0}C for 24 hours. The amount of moisture evaporated was calculated and moisture content was expressed as % (w. b.). The initial moisture content of the green chilli used for this study was in range of 86- 90 % (w. b.).

Experimental procedure for blanching treatment

For carrying out pre-drying treatment of green chilli, 100 to 200g of sample was poured in boiling water with potassium metabisulphite. Green chilli samples were thoroughly mixed by stirring. The treatment was conducted with different combinations of concentrations of potassium metabisulphite and blanching time as per experimental design. After draining the excess solution, the samples were kept on strainer for some time to remove the water. All samples treated for different treatment combinations were dried in a hot air oven using drying air temperature of 60±1 °C.

Visual colour (VC)

The visual color evaluation of dried samples was carried out by a panel of 10 untrained judges. The panelists were given a Proforma for color evaluation of each sample. The evaluation was performed using 5-point Hedonic scale with 10 panel members. The Hedonic scale rating used are as follows: Excellent: 1, Good: 2, Fair: 3, Poor: 4 and Very poor: 5.

Calculation of rehydration ratio (RR)

The rehydration experiments were carried out for dried samples. Dried green chillies were weighed (approx. 2g) and soaked in boiling water. The samples were weighed at every 15 min. intervals after draining excess water until constant weight was attained.

The equation used for calculation of rehydration ratio was as given below:

$$rehydration\ ratio = \frac{weight\ after\ rehydration}{weight\ before\ rehydration}$$

Experimental plan and design

Rehydration ratio and color are the two important qualities attributes of dehydrated green chilli and these properties depend on concentration of potassium metabisulphite and blanching time. For optimization of pre-drying treatment conditions of green chilli, the independent variables taken were concentration of potassium metabisulphite (C) and blanching time (T_b). The independent variables and their levels were selected based on data available in published literature and some preliminary pre-drying treatments. Thirteen experiments were conducted according to second order Central Composite Rotatable Design (CCRD) with two variables and five levels of each variable. Levels of independent variables are coded using following equations:

$$x_i = \frac{\varepsilon_i - central\ value}{\text{int}erval\ between\ successive\ levels} \quad \ldots\ldots\ldots\ldots (1)$$

Where,

x_i = Coded value of the independent variable

ε_i = Actual value of the factor

The independent variables, coded variables and their levels combinations for a 2-factor CCRD are presented in Table 1. The experimental data were fitted in second order regression equation as given in equation 2.

$$y = a + bx_1 + cx_2 + dx_1^2 + ex_2^2 + fx_1x_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Analysis of data and response surface method

Analysis of variance (ANOVA) was conducted for fitting the models represented by equation (2) and to examine the statistical significance of the model terms. The adequacies of the models were determined using R^2 (coefficient of determination). The R^2 is defined as the ratio of the explained variation to the total variation, and is a measure of the degree of fit of the model (Haber and Runyon, 1977). The response surface method produces a mathematical model that can be used to predict a response. The model equation describes the effect of the independent variables on the responses, determine interrelationships among independent variables and represent the combined effect of all independent variables on the response. The response surface plot was plotted for response variables RR and VC against independent variables (concentration of potassium metabisulphite and blanching time) using regression equation after deleting the non significant terms.

Optimization of blanching treatment conditions

Numerical optimization technique of the Design-Expert software was used for simultaneous optimization of the multiple responses. The desired goals for each factor and response were chosen. All the independents factors were kept within range while the responses were either maximized or minimized.

Results and Discussion

Effect of process parameters on Rehydration Ratio (RR)

The experimental values of RR and VC for various experimental conditions are presented in Table 1. A second order polynomial equation (2) was fitted to experimental data. The regression model obtained for RR as a function of concentration of potassium metabisulphite (C) and blanching time (T_b) is presented in equation 3. The equation was obtained using step down regression method by eliminating the non-significant factors. The model was tested for adequacy by analysis of variance. The regression model for RR was found to be highly significant with a coefficient of determination as 0.87and F value of 9.06.

$$RR = 5.27+0.0365*C-0.0178*T_b+0.1175*C*T_b-0.2199*C^2-0.1799*T_b^2 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Table 1: Five level two factors experimental design for optimization of pre-drying treatments conditions of green chilli and responses

Experiment No.	Potassium metabisulphite C (%)	Blanching Time (T_b, min)	Actual value of responses	
	Level of variable [(coded) actual]	Level of variable [(coded) actual]	RR	VC
1	−1(0.65)	−1(0.8)	4.93	1.9
2	1(1.35)	−1(0.8)	4.65	2.1
3	−1(0.65)	1(2.2)	4.73	1.7
4	1(1.35)	1(2.2)	4.92	1.8
5	−1.414(0.5)	0(1.5)	4.75	1.6
6	1.414(1.5)	0(1.5)	5.02	1.8
7	0(1)	−1.414(0.5)	5.04	2.1
8	0(1)	1.414(2.5)	4.89	1.9
9	0(1)	0(1.5)	5.28	1.9
10	0(1)	0(1.5)	5.35	1.85
11	0(1)	0(1.5)	5.25	2.0
12	0(1)	0(1.5)	5.3	2.1
13	0(1)	0(1.5)	5.15	1.95

The effect of independent variables concentration of potassium metabisulphite (C) and blanching time on RR using regression model is shown in Fig 1. It is clear from the Fig.1 that by increasing the concentration of potassium metabisulphite, there is increase in rehydration ratio (RR) but in some cases at lower value of concentration, RR increases.

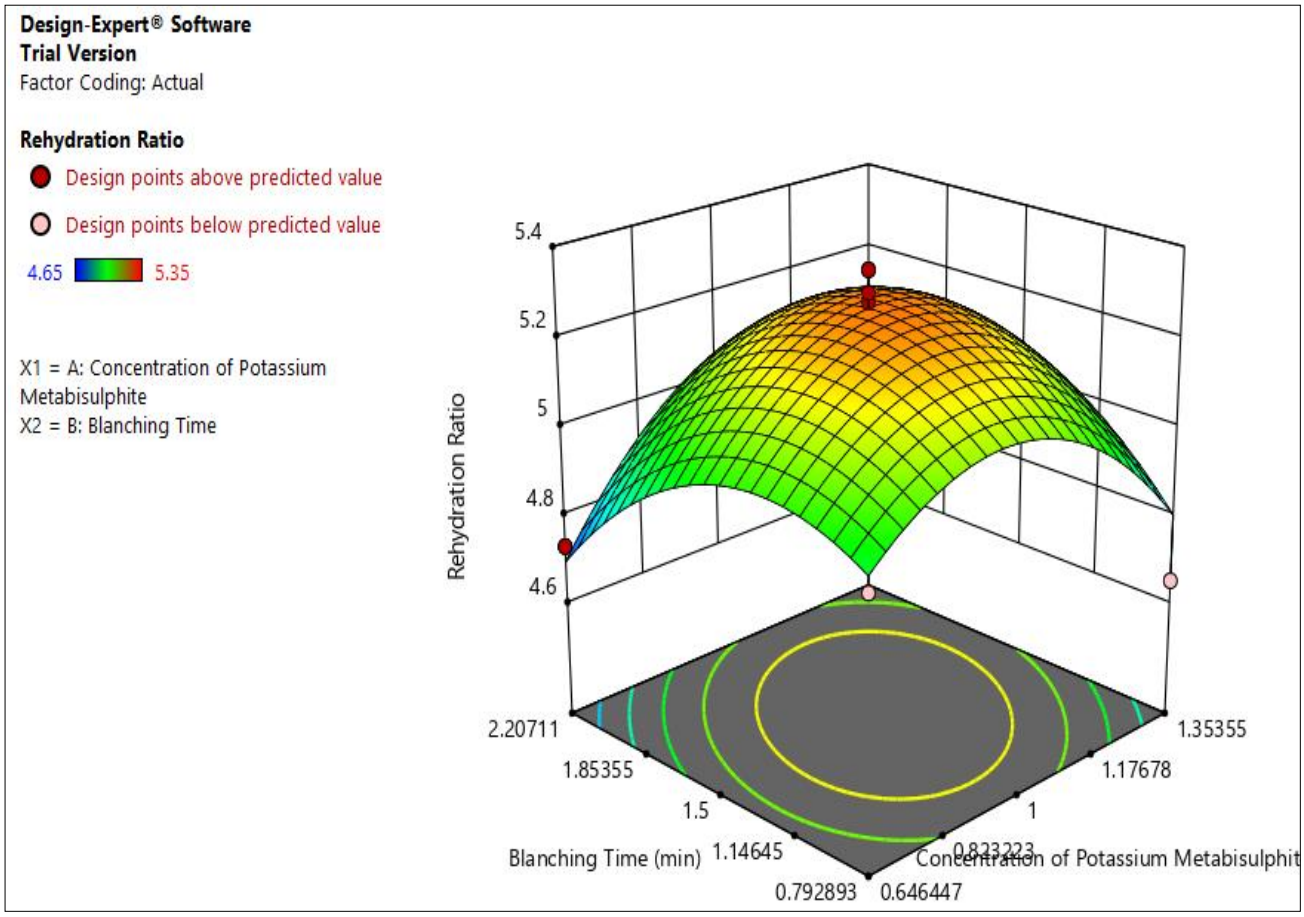

Fig 1: Effect of concentration of potassium metabisulphite and blanching time on rehydration ratio

Effect of process parameters on Visual Colour (VC)

The regression analysis of the experimental data was done to obtain second order polynomial equation. Regression coefficients of the proposed model and statistical significance of all the main effects of response were obtained and effects being not significant ($p>0.05$) were stepped down from models without damaging the model hierarchy. The model was tested for adequacy by analysis of variance. The regression model for VC was found to be highly significant with a coefficient of determination 0.85 and F value of 7.63. The developed regression equation is given in equation 4.

$$VC=1.96+0.0729*C-0.0979*T_b-0.0250*C*T_b-0.1237*C^2+0.0262*T_b^2 \quad \text{……..(4)}$$

The effect of independent variables concentration of potassium metabisulphite (C) and blanching time (T_b) on VC using regression model is shown in Fig 2. The VC of dehydrated samples increased in some case while in some case with increase in concentration and blanching time, VC decreased.

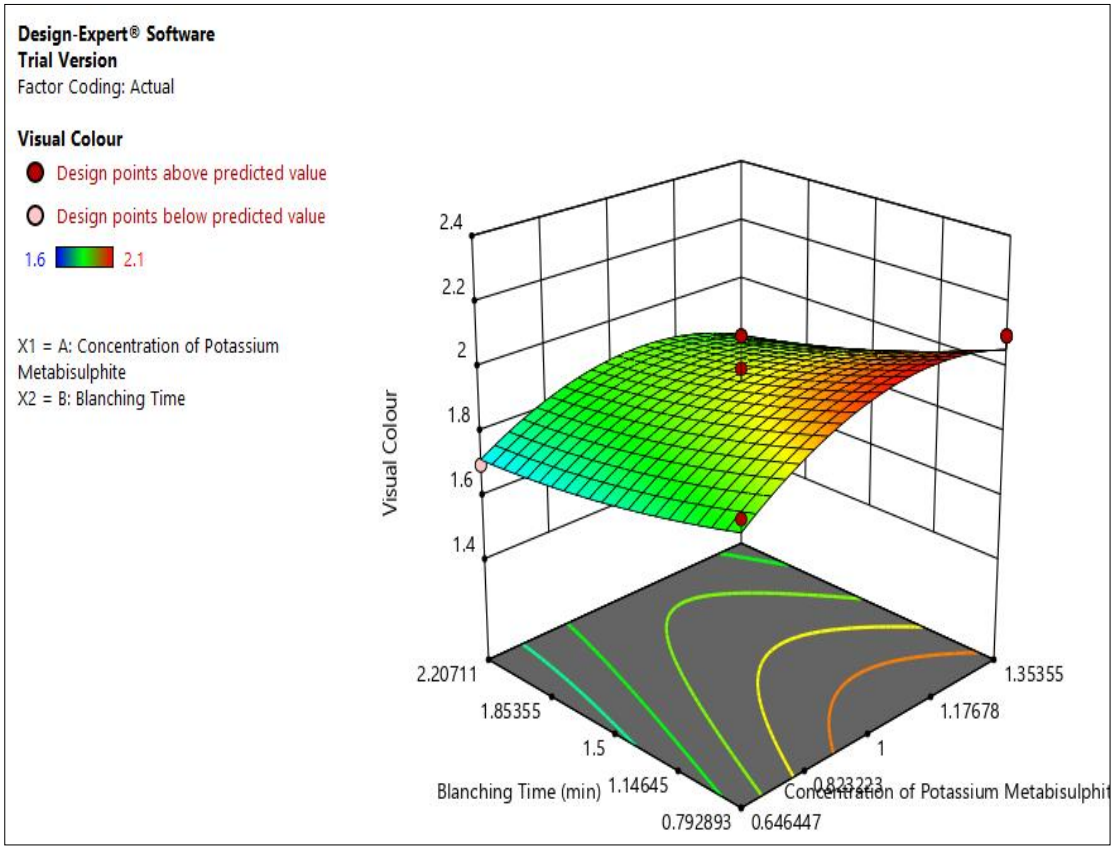

Fig 2: Effect of concentration of potassium metabisulphite and blanching time on visual colour

Optimization of process parameters

The numerical optimization technique (Design-Expert software) was used to get the optimum values of the independent variables i.e. concentration of potassium metabisulphite and blanching time. The optimum condition was optimized by maximizing the rehydration ratio and minimizing visual colour. The values of independent variables were kept within the range. The optimized value of concentration of potassium metabisulphite and blanching time were found to be 0.7% and 1.5 min respectively at desirability value of 0.60. At this optimum condition, the value of rehydration ratio and visual colour were found to be 5.1 and 1.8 respectively. Similar results were reported by Giri and Prasad 92007. These optimums values could be used for blanching of green chilli before dehydration.

Conclusion

Blanching is an essential pretreatment before dehydration as it offers consistent quality attributes of end packed product with minimum changes during storage. In this study, optimization of operating conditions of blanching of green chilli was carried out using response surface methodology. The independent variables taken were concentration of potassium metabisulphite and blanching time while response variables taken were rehydration ratio and visual color of dehydrated green chilli. The samples of green chilli were treated with concentration of potassium metabisulphite (0.5-1.5%) at blanching time of 0.5 to 2.5 min in boiling water before drying. All treated samples were dried at a fix temperature of 60 °C. The optimum values of concentration of potassium metabisulphite and blanching time were found to be 0.7 % and 1.5 min respectively at a desirability value of 0.60. The optimized values of pre-treatment conditions could be utilized for dehydration of green chilli to get better quality of dehydrated green chilli.

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