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ORIGINAL ARTICLE

Optimization of colour parameters and drying efficiency in osmotically pretreated microwave assisted drying of yellow sweet pepper (*Capsicum annum* L.) using Response-Surface Methodology

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Abstract

Yellow sweet pepper (*Capsicum annum.* L*)* were dried in a microwave-assisted drying system with four levels of microwave power (0.35, 0.70, 1.05, 1.4 W/g) and three levels of air temperature (30, 45 and 60^{o}C) at constant air velocity of 1.5m/s. Color parameters *viz.* Total Colour Difference (TCD), Browning Index (BI) and Total Carotenoid (TC), along with drying efficiency and sensory score of dehydrated capsicum were analyzed by means of response surface methodology. Analysis of variance showed that a second-order polynomial model predicted well to the experimental data. The system microwave power level strongly affected quality attributes of dehydrated capsicum. The result showed that a power level of 180 (0.90W/g) at a process temperature of 60^{o}C were sufficient to draw optimum product.

Keywords: Microwave-assisted drying, optimization, browning index, drying efficiency, response surface methodology (RSM).

1. Introduction

Drying has been used for centuries to enhance the shelf-life of fruits and vegetables to be available out of season (Baysal *et al.*, 2003; Nicoleti *et al.*, 2001). It is now an important unit operation in modern food industries to occupy their positions in processing capability. The increasing demand for high-quality shelf-stable dried vegetables requires the design, simulation and further optimization of the drying process with the purpose of accomplishing not only the efficiency of the process but also the final quality of the dried products using different drying techniques (Pardeshi *et al.*, 2014; Srivastav and Kumbhar, 2014; Giri *et al.*, 2014; Kamble *et al.*, 2013; Nema et al., 2013). Sweet pepper (*Capsicum annuum L.*), as other vegetables, is a good source of antioxidant substances such as carotenoids (pro-vitamin A) and vitamin C, which confer protection against carcinogenic components and delay the aging process (Howard *et al*., 1994; Simonne *et al*., 1997; Mendiratta *et al.*, 2013). It is one of the most important vegetable spices, cultivated worldwide due to its nutritional value, delicacy and flavor. Its quality being determined mainly by color and their contents are related to varietal and technological factors.

Demand for sweet peppers are continued to increase in the market day-by-day due to consumer's willingness to eat raw, minimally processed vegetable products, as part of healthier food habits. Colour is an important attribute because it is usually the first property the consumer observes (Saenz *et al*., 1993). At the point of sale, the first impact made by a consumer on a food is its visual appearance. Maintenance of naturally colored pigments in thermally processed and stored foods has been a major challenge in food processing. However, during processing such as drying, vegetables undergo physical, structural, chemical, organoleptic and nutritional changes that cause quality degradation (Crapiste, 2000). Major disadvantages of hot air drying of foods are low energy efficiency, long drying times and the problem of case hardening etc. during the falling rate period. The use of high drying temperatures results in degradation of the quality parameters of the product such as colour, nutritional value and taste etc. (Feng and Tang, 1998). In recent years, Microwave has been investigated as a potential method for obtaining high-quality dehydrated food products (Nema *et al.,* 2014). However, the independent parameters affecting the response variables (e.g. nutritional value, qualities, energy use efficiency, carotenoid, Vit-C etc.) could be optimized to ensure an acceptable quality product and a high throughput capacity for particular dryer. On the other hand, the process parameters to be optimized include temperature, flow rate of drying air, microwave power intensity, pressure, retention time, slice thickness, speed of machine and many other related criteria for various methods of drying. Response Surface Methodology (RSM) is a useful technique for investigation of several input variables that influence the performance measures or quality characteristics of the product or process under investigation. It is also an effective and frequently used tool for optimization studies. Several authors have employed RSM to optimize various unit operation processes resulting in acceptable responses (Smith *et al*., 1977; Lah *et al.*, 1980; Floros *et al*., 1987; Mudahar *et al*., 1989; Rustom *et al*., 1991; Madamba *et al*., 2001; Giri *et al*., 2007; Chauhan and Srivastava, 2009).

The objective of the present work was to study the effect of microwave assisted drying parameters such as microwave power level, drying temperature on process parameters (drying rate, browning index, total colour difference, total carotenoid, drying efficiency(η) and sensory score and to determine the optimum microwave drying conditions for production of high quality dried Sweet pepper).

2. Materials and Methods

Material

Fresh yellow sweet pepper samples were procured from the Center of Protected Cultivation Technology, Indian Agricultural Research Institute, New Delhi. The samples were washed and stored at 7±0.5 ºC in the cold storage until analysis. Before drying the pepper samples were removed from the cold storage and sliced to uniform size of approximately, 60 (L) × 6 (B) × 4 (W) mm^3. Initial moisture content was measured by taking 30 g samples, dried in an oven at 70^{o}C for 24 hours and calculated as 10.2±0.37 (gram water/gram solid). Then the sliced pepper samples were osmotically dehydrated as a pre-treatment using parameters, such as salt, sucrose, revolution per minute (RPM), solution to sample ratio (SSR) and time, inside the incubator shaker by using Central Composite Rotatable Design (CCRD). These were optimized based on the objective requirements of weight loss, moisture loss and solid gain and optimized dehydrated samples (the results not shown here) containing 2.22±0.54% (gram water/gram solid) moisture were taken for microwave drying.

Drying equipment and drying method

Drying experiments were performed in a laboratory scale microwave-convective dryer (consists of four subsystems: air supply unit, heating unit, drying unit and control unit) available in the Division of Post-Harvest Technology, Indian Agricultural Research Institute, New Delhi. The blower (0.24 HP, 50 H_Z, continuous single phase) blows the air in to the heating section, where the temperature was regulated by thermostat before entering the microwave oven. The thermostat (Multispan, MDC-2901) was mounted over the blower to adjust the air temperature, which can be operated manually using the regulator unit. The microwave oven (WP700L17.3 MW Oven, LG make, 17 L Capacity) with technical features of ~230 V, 50 Hz and 700 W with a frequency of 2450 MHz has dimensions of 295, 458 and 370 mm and consisted of a 270 mm diameter turn table at the base of the oven and it also operates in pulsed mode. The microwave oven has the capability of operating at ten different microwave output powers between 70 and 700 W measured using the IMPI-2 L test (12). The adjustment of microwave power level and processing time is done with an analogue controller. The dryer was operated for about 30 min to set the desired drying conditions before each drying experiment. Air velocity was measured usinga hot wire anemometer (least count of 0.1 m/s, Model No : AM-4204, Make: LT Lutron, Taipei, Taiwan). Preliminary experiments of microwave-hot air drying of red sweet pepper resulted in charring of the product towards the end of drying at power level higher than 280 W. So, the combined microwave-hot air drying experiments were conducted starting at a continuous microwave power of 280 W and then at step down intervals of 70 W, in conjunction with hot air at 30, 45 and 60 ^{o}C temperatures at constant air velocity of 1.5 ms^{-1}.

About 200 g of osmotically-dehydrated pretreated red sweet pepper was arranged in a single layer on the rotating glass plate and placed in the centre of the oven and the drying process was started for different combinations of microwave power and air temperature. Then, the samples were removed from the oven periodically and moisture loss was measured by weighing on the digital balance (Panacea GX 4000, Germany) with 0.01 g precision. Three replications of each experiment were performed according to pre-set conditions and the data given are an average of these results. The reproducibility of the experiments was within the range of ±5%. Drying process continued until the moisture content of samples reached about

0.06 (gram water/gram solid). All weighing processes were completed in <10 s during the drying process.

Experimental Design

The variables chosen for microwave drying experiments were microwave power level (P) and air temperature (T). The variable levels were selected on the basis of preliminary drying experiments. Table 1 gives the levels of variables in coded and actual units and Table 2 indicates Twenty-four experiments were performed using Factorial Design taking two replications. Response surface methodology was used to determine the relative contributions of P and T to various responses under study such as drying time, drying rate, browning index (BI), total colour difference (TCD), total carotenoid (TC) and energy use efficiency (η) of dehydrated capsicum. The second-order polynomial response surface model (Eq. (1)) was fitted to each of the response variables (Yk).

$$Y_k - b_{k0} + \sum_{i=1}^{2} b_{ki} X_i + \sum_{i=1}^{2} b_{kii} X_i^2 + \sum_{i \neq j=1}^{2} b_{kij} X_i X_j \qquad (1)$$

Where, b_{k0}, b_{ki}, b_{kii} and b_{kij} are constant, linear, quadratic and cross-product regression coefficients of the model, respectively, Xi and X_i^2 represent the independent variables.

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Measurement of Quality Attributes and Drying Parameters

Drying rate

It is defined as the amount of moisture evaporated per unit time under certain condition of MW power and air temperature, expressed in (g. of water/g. solid.)

$$Drying rate = \frac{M_{t+dt} - M_t}{M_t} \qquad (2)$$

Where, M_t and M_{t+dt} are the moisture content (kg/kg d.b.) at drying time t and t+dt (min), respectively.

Colour

Colour measurements of the samples were carried out using a Hunter-Lab Colorimeter (Miniscan® XE Plus 4500 L). The instrument ($45^o/0^o$ geometry, D 65 optical sensor, 10^o observer) was calibrated with black and white reference tiles through the tri-stimulus values X, Y, Z, taking as standard values those of the white background (X=79.01, Y=83.96, Z=86.76) tile. The colour values were expressed as L, (whiteness or brightness/ darkness) a (redness/greenness) and b (yellowness/blueness) at any time respectively. A glass cell containing the MW treated samples was placed above the light source and post-processing L, a, b values were recorded. Color measurements were taken in triplicate and average values were taken for calculation. Using above three values, browning index (Eq. 3), total colour difference (Eq. 4) were calculated as follows.

Browning Index (BI)

It represents the purity of brown color and is reported as an important parameter in drying processes where enzymatic and non-enzymatic browning takes place (Maskan, 2001; and Barreiro *et al.*, 1997). It is given by the formula:

$$BI = \frac{[100(x - 0.31)]}{0.17} \qquad (3)$$

Where

$$x = \frac{(a + 1.75L)}{(5.645L + a - 3.012b)}$$

Total Colour Difference (TCD)

It indicates the degree of overall color change of a sample in comparison to color values of an ideal sample having color values of L_o, a_o and b_o, is given by the formula:

$$TCD = [(L_o - L)^2 + (b_0 - b)^2 + (a_0 - a)^2]^{0.5} \qquad (4)$$

Total Carotenoid

It is that constituent which recognizes the consumer's acceptability of the product on the basis of respective judgments of colour. It was measured by a modified method of one described by Rangana (1986). A known weight of the sample was ground with acetone in a pestle and mortar. The extract was decanted in to a conical flask and continued till the residue was colourless. The collected extracts were then transferred in to a separating funnel and 25 to 30 ml of stabilized petroleum ether containing 0.1% BHT

Table 1: Independent variables with different levels in microwave assisted drying

Variable	Name(Unit)	Level			
P	Power(W/g)	0.35	0.70	1.05	1.4
T	Temperature(^oC)	30	45	60	
V	Air velocity(m/s)	1.5			

Table 2: ANOVA for different models

		F-Values					
Variables	DF	Drying rate	BI	TCD	Tc	η	SS
Model	5	215.20***	69.45***	37.82***	29.42***	7.68***	9.66***
X1	1	1011.25***	230.08***	162.76***	140.84***	3.07*	46.04***
X2	1	34.20***	110.23***	24.17***	4.40*	13.41***	2.15
X1X2	1	6.98**	0.080	2.14	0.14	0.015	0.048
X_1^2	1	22.55***	6.74**	0.045	1.43	21.08***	0.000
X_2^2	1	1.13	0.13	0.0003	0.26	0.082	0.080
Residual	18						
Lack of fit	6	11.33***	0.75	0.15	2.61	78.73***	2.70
Pure error	12						
Total	23						

Significant at $p<0.01^{***}$, $p<0.05^{**}$, $p<0.1^{*}$

was added with 5-10 ml of 5 percent sodium sulphate. Petroleum ether was repeatedly used until all the colour got transferred in to a petroleum ether layer. It was transferred into a volumetric flask and the volume was made up to 50 mL with the petroleum ether. Absorbance was measured at 450 nm using ether as blank.

$$\text{Total Carotenoids}\left(\frac{\text{mg}}{100\text{gm}}\right) = \frac{3.87 \times \text{O.D} \times \text{Volume mde up} \times 100}{\text{Weight of thr sample} \times 1000} \quad (5)$$

Drying Efficiency (DE)

Drying efficiency, defined as the energy required to evaporate unit mass of water from the sample, is given by the following equation (Yongsawatdigul *et al.*, 1996).

$$\text{DE}\left(\frac{\text{MJ}}{\text{kg}}\right) = \frac{t \times P(1-m_f) \times 10^{-6}}{M_i(m_i - m_f)} \quad (7)$$

Where, t is the time (s), P is microwave input power (W), Mi is initial mass of sample (kg), m_i is initial moisture content (fraction) and m_f is final moisture content (fraction).

Sensory Score (SS)

Sensory evaluation of the dried capsicum slices was carried out to obtain preliminary information on consumer preference. A panel of 4 semi-trained judges using hedonic rating test, usually conducted to measure the consumer acceptability of food product (Ranganna, 1986). The panelists were given a specimen evaluation card for sensory evaluation and asked to rate the accept, ability of the dried samples subjected to designed application of MW power based on the quality attributes of color, flavor, texture, taste and buying intention. The sensory rating of the products was done on a scale of 9 points, ranging from ‘‘extremely desirable’’ (9 points) to ‘‘extremely undesirable’’ (1 point). Individual scores of each panel member for overall acceptability of different samples were averaged and represented as the sensory score of the products.

Analysis of Data

Response surface analysis of the experimental data was carried out using a commercial statistical package Design Expert, version 7.1.6 (Stat Ease Inc., Minneapolis, MN). The data are entered using Historical design analysis, where one has to enter the data according to the experiments actually conducted to the above software. Regression analysis and analysis of variance (ANOVA) were conducted for fitting the model represented by Eq. (1) to the experimental data and to examine the statistical significance of the model terms. The adequacies of the models were determined using model analysis, lack-of-fit test, and R^2 (coefficient of determination) analysis as outlined by Lee *et al*. (2000) and Weng *et al*. (2001). If there is a significant lack of fit as indicated by a low probability value, the response predictor is discarded. Response surfaces were generated and numerical optimization was also performed by Design Expert software 7.1.6.

Optimization Technique

Numerical optimization technique of Design Expert 7.1.6 was used for simultaneous optimization of the multiple responses. The desired goals for each factor and response were chosen based on the importance of each parameter for quality products.

3.0 Results and Discussion

The ANOVA of model terms are given in Table 2 and the estimated regression coefficients of the quadratic polynomial models (Eq. (1)) for various responses and the corresponding R^2 and Coefficient of Variation (CV) values are given in Table 3. A high proportion of variability (R^2>0.87) was explained for the response surface models of drying rate, Browning Index(BI), Total Colour Difference (TCD), Total Carotenoid (TC), Rehydration Ratio(RR), Total Soluble Solid (TSS). This function show that over 87% of the total variation was accounted for or the three response surface models fitted the data well and were adequately explained. The coefficient of variation (CV) describes the extent to which the data were dispersed. The CV's for the above six responses along with water activity (Aw) and sensory score (SS) were within acceptable range. However, CV for drying efficiency (η) and total carotenoid were beyond the acceptable range of 10%. A high CV indicates that variation in the mean value was high and did not satisfactorily develop an adequate response model (Batalon, 1998). Analysis of variance (ANOVA) revealed that the models are highly significant at $p \leq 0.01$. The lack of fit did not result in a significant F-value in case of Browning Index (BI), Total Colour Difference (TCD), Total Carotenoid (TC), drying efficiency and Sensory Score(SS) indicating that the models are sufficiently accurate for predicting these responses. However, for drying rate and drying efficiency, the lack of fit was significant and R^2 values were low, indicating that a high proportion of the variability was not explained by the data.

Effect of Microwave Power and air temperature on Drying Parameters and Quality Attributes

Drying rate

The drying rate ranged between 1.103 to 4.557. The following regression equations, describing the effect of process variables on drying rate (Eq. 8) in terms of actual levels of the variables.

$$\text{Drying rate(gm/min)} = 1.47023 - 0.37912P - 0.030201T + 0.01835PT + 1.29047P^2 + 3.33752\times10^{-04}T^2 \quad (8)$$

From ANOVA (Table 2), it could be concluded that only linear model for drying rate is significant at $p \leq 0.01$ with coefficient of determination (R^2) > 0.98 for process temperature, where as both linear and quadratic model are significant ($p \leq 0.01$) for MW power. Microwave power and air temperature were both positively affected drying rate, although the former was dominant as evident from corresponding regression coefficients and F-values (Table 3). The positive effect of both the independent factors suggested a higher drying rate at a higher level of these factors (Fig 1). At higher microwave power levels, the drying rates were higher due to the generation of more heat at greater depths, resulting in escape of water vapor vigorously at a faster rate than at lower levels without causing much collapse in the cellular structure of capsicum, leads to less shrinkage ratio. Similar type of findings were also reported by (Giri and Prasad, 2007) and (Chauhan and Srivastava, 2009).

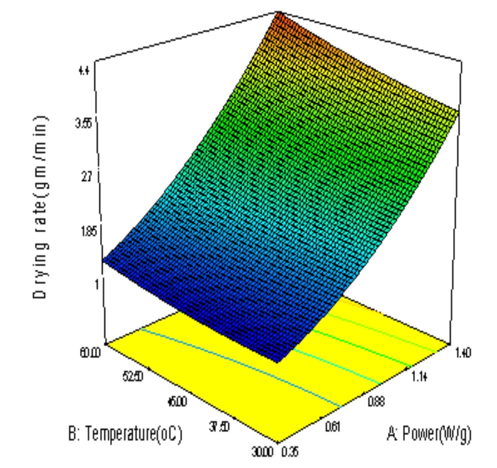

Fig 1: Effect of microwave power level and air temperature on drying rate

Colour

Browning Index (BI): It ranged from 65.77 to 77.05 which significantly affected by MW power and process temperature. The regression equations describing the effect of the process variables on browning index (Eq. 9) in terms of actual levels are given as:

$$\text{Browning Index(BI)} = 70.56360 - 12.68612P + 0.21069T - 0.010214PT + 3.67279P^2 - 5.90833\times10^{-004}T^2 \quad (9)$$

It could be observed from ANOVA (Table 2),

Table 3: Regression coefficients of the second-order polynomial model for the response variables (in actual units)

	Dependent parameters					
Variables	Drying rate	BI	TCD	Tc	η	SS
Constant	2.17	71.16	26.24	25.90	5.02	6.88
X1	1.42	-3.53	3.54	-10.29	0.23	0.95
X2	0.24	2.23	1.25	-1.66	-0.44	0.19
X1X2	0.14	-0.080	0.50	0.40	-0.02	0.038
X_1^2	0.36	1.01	-0.099	1.74	-1.04	0.000
X_2^2	0.075	-0.13	-0.008	-0.70	-0.06	-.062
R2	0.9835	0.9507	0.913	0.891	0.881	0.828
CV	6.76	1.20	2.50	11.99	11.02	7.48

that both linear as well as quadratic effects are significant at $p \leq 0.01$ and $p \leq 0.05$ respectively with coefficient of determination, $R^2 > 0.95$ in terms of MW power, where as only linear effect is significant at $p \leq 0.01$ in terms of process temperature. Thus, it may be concluded that of MW power had more impact on browning index as also evident from its F-value and regression co-efficient (Table 3). Again, in terms of level of significance, linear model (significant at $p \leq 0.01$) gives greater effect than quadratic model (significant at $p \leq 0.05$). Power levels exerted a greater negative effect on BI values than the process temperature (Fig 2). The reason may be the dominating effect of the former in such a way that suppressed the narrow range effect of the later.

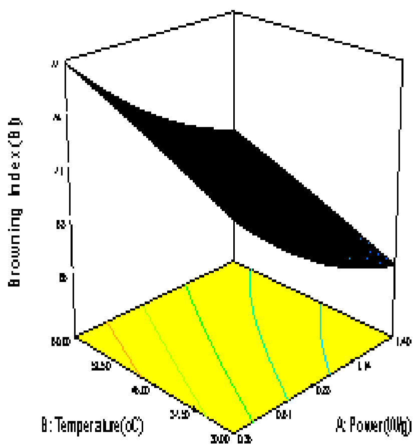

Fig 2: Effect of microwave power level and air temperature on browning index

Total Color Difference (TCD): It varied from 21.86 to 31.88 for all conditions of process variables, which suggested that capsicum were prone to change their colour during MW heating. The following regression equations, describing the effect of process variables on total colour difference (Eq.10) in terms of actual levels of the variables.

$$TCD= 18.74528+4.52949P+0.031032T+0.063170\ PT-0.35965\ P^2-3.65635\times10^{-5}\ T^2 \quad (10)$$

From ANOVA (Table 2), only linear effect is significant in terms of both MW power and process temperature. Hence, it may be concluded that TCD had less affected by process variables that above two parameters (Drying and BI). MW power was main factor affecting colour as predicted from F-value and corresponding regression coefficient. With the increase in MW power and air temperature, the product gradually lost its colour parameters like L-, a- and b-value causing high TCD at highest level of power and temperature as shown in Fig3. This finding is in consistent with the previous work by Lin *et al*. (1998) and Sunjka *et al*. (2004).

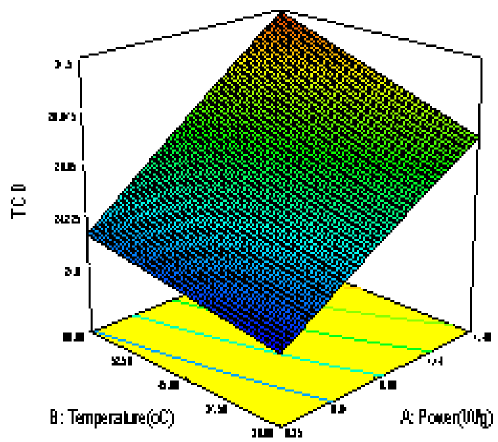

Fig 3: Effect of microwave power level and air temperature on total colour difference (TCD)

Total Carotenoid

It significantly affected by the process variables. It ranged from 16.34 to 37.14. The regression model relating the process variables are given as:

Total Carotenoids = $48.54375-32.94571P+0.12600T+0.051238PT+6.31293P^2-3.12778\times10^{-3}T^2$ (11)

Power level and process temperature are negatively correlated with carotenoid contents (Fig 4) but former had major effect with the rate of carotenoid degradation as revealed from F-value (Table 2) and regression coefficient (Table 3). Thus, it is advisable to dry the product at low power level to keep the above parameter to be maximum. From ANOVA, it is observed that the linear effect of power is significant at $p\leq0.01$ but, the same is only significant at $p\leq0.1$ in terms of process temperature. Thus, process temperature had no significant effects regarding carotenoid degradation. So, it could be concluded carotenoid degradation was mostly influenced by MW power than dried air temperature in the range of 30-60^{o}C.

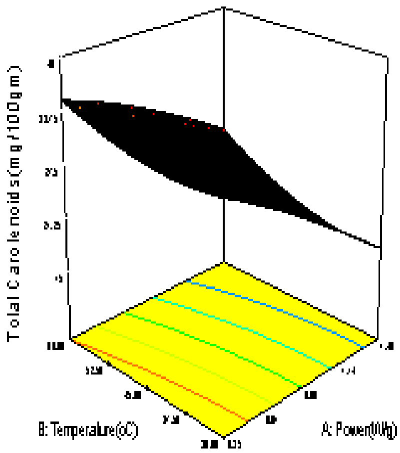

Fig 4: Effect of microwave power level and air temperature on total carotenoid

Drying Efficiency (η)

It ranged from 3.319 to 6.079(MJ/kg). The regression equations in terms actual levels of process variables are given as:

Drying efficiency(MJ/Kg) = $2.43018+7.16529P-3.36000\times10^{-3}T-2.51077\times10^{-3}PT-3.77670P^2-2.67077\times10^{-4}T^2$

From ANOVA (Table 2), it is found that drying efficiency was mainly depends on process temperature for the linear effect (significant at $p\leq0.01$) and on MW power level for the quadratic effect (significant at $p\leq0.01$) in comparison to process temperature, where it is only significant at $p\leq0.01$ for the linear effect. From Fig 5, it is observed that microwave power had a positive effect on drying efficiency upto certain level and then gradually decreased. A possible reason may be that increasing power level within the experimental range did not result in considerable reduction in drying time after a certain level, thereby decreasing the efficiency.

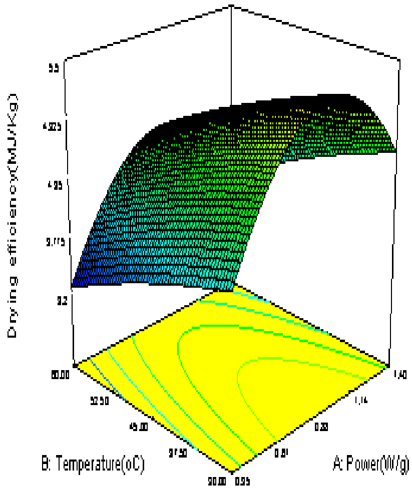

Fig 5: Effect of microwave power level and air temperature on drying efficiency

Sensory Score (SS)

When consumed in the dried state, dried samples dried for high levels of power and temperature received significantly higher ratings for texture, color, aroma/flavour and overall acceptability, which may be due to the excellent structural retention. The sensory evaluation of dried samples was carried out by a panel of untrained judges. A 9-point hedonic rating was employed for all the attributes evaluated, where 9 denoted ''liked extremely'' and 1 indicated ''disliked extremely''. The regression equations relating the sensory score to the actual levels of the process variables are

Sensory Score = $4.35417+1.59524P+0.033333T+4.76190\times10^{-3}PT+3.14498\times10^{-15}P^2-2.77778\times10^{-4}T2$. (13)

From ANOVA, it could be concluded that sensory score mainly depends on the power levels as seen from F-value and corresponding regression coefficient. Again, only linear effect is significant at ($p\leq0.01$) but process temperature did not have any effect. Both power level and process temperature were positively correlated with the sensory score (Fig 6). Samples dried at higher power levels were lighter in color and there was less shrinkage in these products, resulting in better appearance. Therefore, these products received higher scores and were highly accepted by the panel.

Table 4: Optimization criteria for different factors and responses

Factors/ responses	Goal	Lower limit	Upper limit	Importance
Power(W/g)	In the range	0.35	1.4	3
Temperature(^{o}C)	In the range	30	60	3
Drying rate	Maximize	1.10258	4.55733	4
Browning Index	Maximize	64.58	77.05	5
TCD	Minimize	21.86	31.88	4
Tc	Maximize	16.34	37.55	5
η	Minimize	3.25662	6.079	4
SS	Maximize	6	8	5

Table 5: Solution for optimum conditions

Solution no.	Power(W/	Temp(^{o}C	Drying rate (gm/min)	BI	ΔE	Tc	DE	SS	Desirability
1	0.90	60	2.54391	72.10	27.64	23.13	4.52	7.04	**0.766**
2	0.91	60	2.58321	72.02	27.74	22.90	4.52	7.06	**0.756**

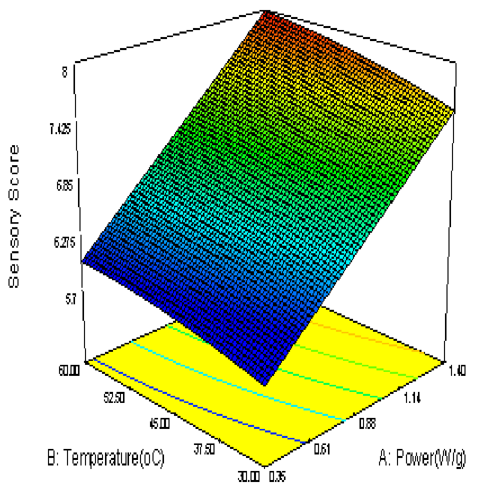

Fig 6: Effect of microwave power level and air temperature on sensory

4. Optimization of MD for Capsicum

The desired goals for each factor and response were chosen and different importance was assigned to each goal (Table 4). The assignment of goals to responses was based on their desirability in the dehydrated product and the assignment of importance was based on their relative preferences. Because browning index, total carotenoid, rehydration ratio and sensory score are relatively more important responses compared to others, they were assigned an importance value of 5 and remaining were assigned values ranging from 3 to 4. Assigning relative values of importance to responses. However, is subjective and therefore may be perceived differently. Two solutions were obtained with the desirability values as given in Table 5. Solution no. 1 was chosen because it had a higher number of responses having optimum values slightly closer to goal values. The optimum values of all the responses corresponding to optimum drying conditions were found to be within the range of experimental values.

5. Conclusions

Under the present study of investigation, the MW power level had most pronounced effect on the drying characteristics and quality attributes of dehydrated yellow and red capsicum than system temperature. The second-order polynomial model was well fitted to predict the experimental data for most responses with high values of R^2 (>0.9) for most of the desired variables. The optimum condition was found to be 0.90W/g (180 W) of microwave power and 60^{o}C of process temperature. The experimental response values were found in close proximity to the predicted values from fitted models. The response surface methodology is a useful tool for analyzing the effect of microwave-assisted drying parameters on product quality and for optimizing the process.

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