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Effect of drying parameters on quality attributes of green chilli

Iftikhar Alam and Khan Chand

Abstract
Chilli (*Capsicum annuum* L.) is one of the most important commercial spice crops, widely used universal spice, and is virtually an indispensable item in the kitchen for everyday cooking. Green Chilli powders have many practical applications for use with many food adjuncts in place of fresh green chillies. The drying of chilli was carried in two stages: microwave drying for initial moisture reduction (60%wb) and tray drying for final product. Each sample sizes (100, 125, 150, 175 and 200 g) was dried in microwave at constant power 160W for 14min, second stage of drying was conducted in tray dryer after 14min over temperature ranges of 55, 60, 65, 70 and 75^{0}C inside the tray dryer.The results were found that quality parameters like carotene content 0.377 µg/100g and dehydration ratio (16.02) are significantly affected by drying temperature (60^{0}C) while sample size(125g) was found to affect the carotene of final dried product. It is concluded that the best drying time was found 180min to dry 125g chilli at 60^{0}C temperature.

Keywords: Green chilli, dehydration ratio, tray dryer and chlorophyll content

Introduction
About 1057 million tonnes of vegetables are grown all over world, and nearly one third of that, 378 million tonnes, are produced in China. India, with a production of 134 million tonnes of vegetables produced annually, tops the list of a major producer in South Asia. During 2010-11, India produced around 12.43 lakh tonnes of chillies from an estimated area of 7.65 lakh hectares with productivity of 1826 kg/ha. Andhra Pradesh, Karnataka, Maharashtra, Orissa, Tamil Nadu and West Bengal are leading in chilli cultivation (FAO, 2010) [4]. Chilli is the universal spice of India belongs to family solanaceae. Chillies are native of Central and Southern America and were introduced to India by Portuguese in the later part of sixteenth century. Its cultivation became popular in the 17th century. Though chilli is an introduced crop in India, due to its suitable growing climate, India stands first in chilli cultivation in the world covering 45 per cent of the total hectare (Reddy and Sadashiva, 2001) [6].The chilli is taken with food stimulates our taste buds and thereby increases the flow of saliva which contains amylase enzyme that helps in digestion of starchy or cereal foods. Green chillies have a characteristic delicate flavour that cannot be replaced by red chilli powders. Dehydration of green chilies using recirculatory tray dryer was studied by Srivastav *et al.* (2006) [7] while the dehydration of whole green chillies studied by Luhadiya and Kulkarni (1978) [3]. A traditional food adjunct with onion and red chilli chutney recipe was standardized (Balaswamy *et al.* 2004) [1]. The drying of green chilli is thus important to preserve the natural instinct. The characteristic colour plays an important role in assessing product quality. The most common change that occurs during the drying of green spice-vegetables is the conversion of chlorophylls to pheophytins, causing a change from bright green to olive-brown**.** Therefore, the colour loss during thermal processing could be used as a basis to evaluate the quality of green chilli drying. There is a great need to improve the drying in order to improve the quality of dried chilli.

Methodology
Experiments were conducted to study the microwave assisted tray drying characteristics of green chilli at a constant input power was given in microwave. The five levels of temperature and sample weight were taken into account in tray dryer. Moisture loss data were recorded periodically and each sample was dried upto the safe moisture content reached. The dried green chilli was packed in double polythene bag for quality analysis. For the present study preliminary trials were done to select range of experiment parameters. The process variables were considered microwave power 160 W, air temperatures (55, 60, 65, 70 and 75^{o}C) and sample weight (100, 125, 150, 175 and 200 g) treated with (0.3 % NaMS + 1 % $CaCl_2$),

to avoid the undesirable changes during drying and to preserve quality of dried green chilli.

Assessment of quality

Carotene content

Total chlorophyll was measured following the method described by (Lichtentaler and Wellburn, 1985). In this method accurately weighed 5-10 g sample of chilli was grounded to fine powder by use of mortar and pestle followed by addition of 50 ml acetone per gram of fine powder of chilli. The result and mixture was homogenised in a homogeniser operated at 100 rpm for 1 min. the homogenised solution was filtered through a two layer cheese cloth followed by centrifugation at 200 rpm for 10 min the clean homogenised supernatant was then transferred to 100 ml volumetric flask for spectrophotometric analysis to measure chlorophyll content. For measurement of chlorophyll content two clean matched cuvettes were taken and ensured that they give same reading with acetone. In, one acetone was taken as blank, and in other diluted 100% acetone extract of chlorophyll content (mg/g). The readings were recorded at 470, 645, 662 and 666 nm for each unknown solution.

$$C_a = 11.75A_{666} - 2.350A_{645}$$

$$C_b = 18.61A_{645} - 3.960A_{662}$$

$$C_x + C = \frac{[1000A_{470} - 2.270C_a - 81.4C_b]}{227}$$

Where, A_x = absorbance at specific wave length (X), C_a = chlorophyll-a (mg/g), C_b = chlorophyll-b (mg/g) and C_x + C = carotene (mg/g)

Dehydration ratio

Dehydration ratio was calculated by taking the weights of fresh and dried sample according to the method of Pawar *et al.*, (1988) [5]. The dehydration ratio shows the bulk reduction in the weight of sample.

$$\text{Dehydration ratio} = \frac{\text{weight of sample before drying,g}}{\text{weight of sample after drying,g}}$$

Results and Discussion

Quality characteristics of dried chilli were determined in terms of chlorophyll content and dehydration ratio. The effect of independent variables on quality parameters was analysed after tray drying and mathematical models were developed. The adequacy of these models was tested using coefficient of determination (R^2) and standard error of estimation (SEE) in different sections.

Carotene

The temperature and sample size of dried chili was found to have a significant effect on carotene content at 1% level of significance shown in Table 1. The maximum carotene content of 0.377 µg/100g was observed for a sample size of 150 g at temperature of 75^{0}C while the minimum (0.139 µg/100g) was observed for a sample size of 100 g at a temperature of 55^{0}C. A second order regression model was developed between carotene and independent variables using MS-EXCEL software. This model analyses the effect of temperature and sample size on carotene of dried chili. The regression analysis of the model resulted in a coefficient of determination (R^2) 99.3% indicating the minimum variability in the experimental data of carotene and standard error of estimation 0.041 shows the well fitted data in the mathematical model (1).

$$C_a+C=0.265+0.054T+0.003w-0.0012T^2-0.00053w^2-.0437Tw\ldots \quad (1)$$

Positive coefficients at linear level in the regression equation indicate increase in carotene content with increase in the level of temperature and sample size. While negative coefficients at quadratic level, decreased the carotene content with increase the both the variables as well as interactive level also. After the analysis of variance, Table 1 shows that the effect of temperature on carotene content of dried chilli was found highest in comparison to sample size because of higher F-calculated value than F-tabulated value.

Table 1: ANOVA for carotene

Source	df	SS	MS	F-cal	F-tab
Temperature	4	0.142	0.036	4693.0904	3.006
Sample weight	4	0.000	0.000	15.7102	3.006
Error	16	0.000	0.000		
Total	24	0.143			

The figure 1 shows a relationship between drying parameters and responses. The effect of temperature on the carotene content was found significant as compared to sample weight of dried green chillies. It indicates that carotene content (0.13 to 0.37 µg/100g) was increasing with the increasing of temperature (55 to 75 ^{0}C) and sample size (100 to 200g), the microbial activity was reduced in the sample which was safe for use.

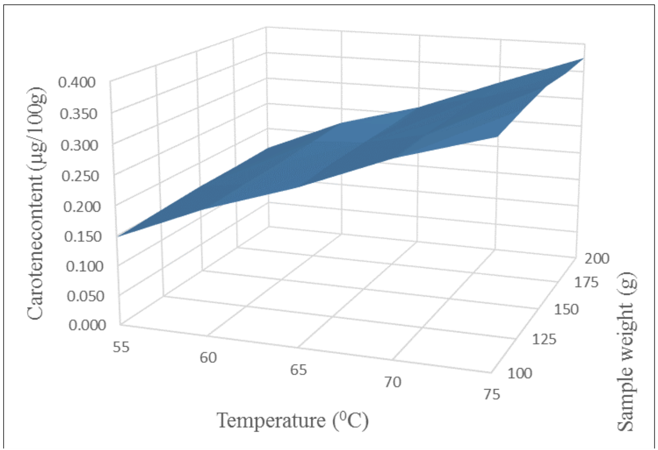

Fig 1: interactive effect of temperature and sample size on carotene content of dried green chilies

Dehydration Ratio

The dehydration ratio shows the bulk reduction in the weight of sample. The maximum and minimum values for dehydration ratio were 14.87 and 19.03, respectively. The corresponding conditions of temperature and product size for maximum dehydration ratio were 60^{o}C and 150 g and for minimum 70^{o}C and 200g. The table 2 shows that temperature and sample size were found individually non-significant in their effect on dehydration ratio. A second order mathematical model for dehydration ratio of dried chili was developed rehydration ratio and independent variables data using MS-EXCEL software. Model analyses the effect of temperature and sample size on dehydration ratio. The regression analysis of the model resulted in a coefficient of determination (R^2) 98.21% which shows the minimum residual error present in the experimental data while standard error of estimation was present 1.10 also indicates well fitted data of dehydration ratio in the model. Therefore second order model was adequate in describing effect of variables on dehydration ratio. The dehydration ratio could be predicted by the following equation (2).

$$\text{Dehydration ratio} = 16.711+0.103T + 0.042w- 0.005T^2 - 0.012w^2 - 0.032Tw \quad \dots (2)$$

The equation 2 indicates that at linear level, the positive coefficient of temperature and sample size reveals that increase in both temperature and sample size provides an incremental effect on dehydration ratio results the dried chilli is safe from the attack of microbes due to not availability of moisture content. Table 2 shows the very less effect of temperature and sample size on dehydration ratio.

Table 2: ANOVA for dehydration ratio

Source	df	SS	MS	F-cal	F-tab
Temperature	4	2.602	0.650	0.6604	3.006
Sample weight	4	0.461	0.115	0.1171	3.006
Error	16	15.758	0.985		
Total	24	18.821			

As discussed Figure 2 which indicates the dehydration ratio (16 to 19) was increasing with the increasing of temperature (55 to 75 ^{0}C) and sample size (100 to 200g) but there was no change in colour of dried green chillies.

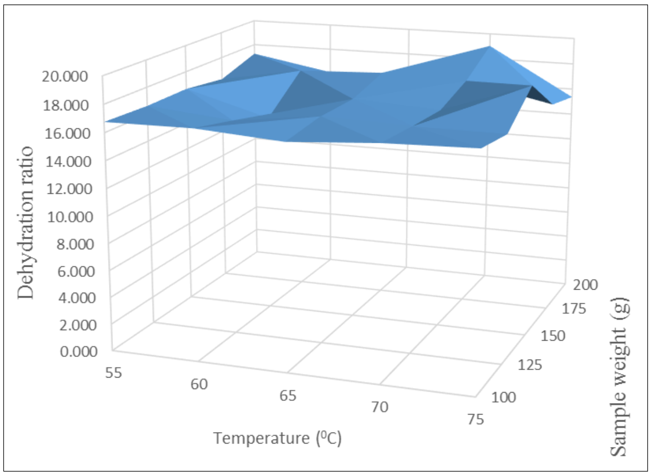

Fig 2: Interactive effect of temperature and simple size on dehydration ratio of dried green chilies

Optimization

Optimization is a process of making compromises between responses to achieve a optimum target. Numerical optimization was carried out with the help of Design-Expert 8.0.7.1 statistical software. The goal was fixed to be in the range for independent variable (drying temperature and sample size) and maximum or minimum for response. All the independent variables and response were given similar importance. The optimum values of drying temperature and sample weight for drying time were obtained as 60^{0}C and 150 g.

Conclusion

The conclusion was drawn to the study of drying parameters on quality attributes of dried chillies. Two quality parameters were discussed and analysed statistically in details, found that temperature and sample size of dried chillies increased with the increase of carotene content and dehydration ratio. The quality in the sense of colour not much changed with these parameters.

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