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OPTIMIZATION OF BLANCHING PROCESS FOR CARROTS, BY RESPONSE SURFACE METHOD

MYTHRI R[1], ASHWINI N GANGURDE[2] & S. ELIZABETH AMUDHINI STEPHEN[3]

[1,2]Department of Food Processing & Engineering, Karunya University, Coimbatore, TamilNadu, India

[3]Associate Professor, Department of Mathematics, Karunya University, Coimbatore, TamilNadu, India

ABSTRACT

Aim is to study the effects of selected blanching treatments, on the quality of carrots over a temperature range of 80–100°C. The blanching treatments selected were steam, water, 0.05 N acetic acid solution and 0.2% calcium chloride solution. These blanching treatments were optimised with respect to the maximum yield of carrot juice and minimal loss of β-carotene, by using Response Surface Method. The most effective blanching treatment was 5.6 min in hot water at 91.4°C and yields for 55.334% of carrot juice and minimal loss in β-carotene content.

KEYWORDS: Blanching, Optimisation, Yield & β-carotene

INTRODUCTION

Carrots (Daucus carota), one of the important root vegetables, are known for their nutrient contents viz. b-carotene besides appreciable amount of vitamins and minerals. Carrots are well known for their sweetening, antianemic, healing, diuretic and sedative properties. The enzymes commonly found to have deteriorative effects in carrots are peroxidises (PODs) and catalase. In order to minimize deteriorative reactions, fruits and vegetables are heat treated or blanched to inactivate the enzymes. Blanching of fruits and vegetables are done either in hot water, steam or selected chemical solutions. Blanching in calcium chloride solution is used to increase the firmness of fruits and vegetables, because of the activation of pectinmethylesterase when immersed in hot calcium chloride solution (Quintero-Ramos et al. 2002). The variables, such as temperature and time of treatment, and concentration and nature of the acid or salt in the blanching solution, determine the effectiveness of the blanching process (Quintero-Ramos et al. 2002; Sever in iet al. 2004a).

Blanching is an important unit operation before processing fruits and vegetables for freezing, pureeing or dehydration. The findings of this study would be useful in determining the process parameters for blanching carrots with maximal retention of nutrients. The enzyme residual activity curve indicates the destructive effect of heat on the affected enzymes. A successful modelling will enable the processors to modulate their process, according to different time–temperature combinations. Over the years, low- temperature long-time blanching, compared to the conventional high-temperature short-time blanching for better quality retention, has been emphasized. Low-temperature long time blanching, in comparison to high temperature short time, enhances the firmness and reduces the nutritional and flavor losses of the product (Taylor et al. 1981; Canet and Hill 1987). Blanching carrots to 93°C before milling reduced juice yields, but improved color compared to heating carrots after milling (C. A. SIMS et al.1993).

The objective of this work was to determine the optimum blanching conditions for carrots in terms of yield of carrot juice and β-carotene using Response Surface Method. Response Surface Methodology (RSM) has been successfully applied in optimizing food processing operations by several investigators (WALDE et al. 1992).

MATERIALS AND METHODS

Process of Blanching

Fresh carrots were used for the study and washed in tap water or process water to remove the extraneous water from the surface, peeled manually using stainless steel knife. Peeled carrots are cut into small uniform pieces (1 in.). These slice where blanched in hot water at 80-100°C for 1-10 min.

β-Carotene Content

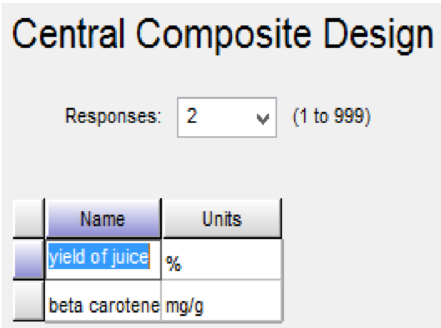
The β -carotene content was determined using the spectrophotometric method as described by Ranganna (1991). The sample (2 g) was extracted in a separating funnel using petroleum ether diluted with acetone (3:1, v/v) containing a few crystals of sodium sulphate (Na2SO4), until it became colourless. Ether layer containing b-carotene was separated. After the dilution with petroleum ether, the b-carotene content (milligram per 100 g) was measured by measuring the absorbance of the extract at 452 nm using a UV visible spectrophotometer

Yield

The blanched carrot slices were taken for juice extraction immediately after blanching and for the removal of external moisture on the surface by tissue paper. The yield was measured by the amount of juice extracted from blanched carrot sample. After the extraction of the juice the carrot juice was passed through a muslin cloth and weighed. In this paper, we have considered the main factors taken are temperature (°C) and time (minutes) and response as Yield % of juice and β-carotene content.

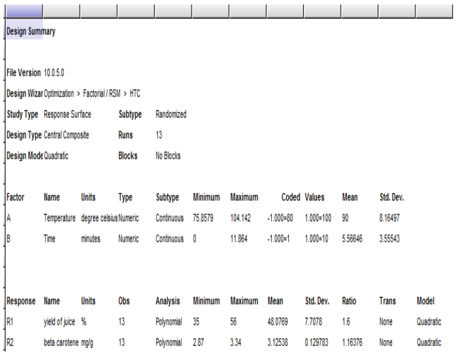
RESULTS AND DISCUSSIONS

Effect of Blanching Treatments on the Yield of Carrot Juice



Std	Run	Factor 1 A:Temperature degree celsius	Factor 2 B:Time minutes	Response 1 yield of juice %	Response 2 beta caroten... mg/g
9	1	90	5.5	55	3.18
5	2	75.8579	5.5	42	3.07
2	3	100	1	35	3.21
13	4	90	5.5	56	3.18
10	5	90	5.5	55	3.18
12	6	90	5.5	55	3.18
11	7	90	5.5	55	3.18
1	8	80	1	38	3.01
8	9	90	11.864	47	2.98
3	10	80	10	52	3
6	11	104.142	5.5	51	2.87
4	12	100	10	37	3.25
7	13	90	0	47	3.34

Summery



Design Summary

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Design Wizar Optimization > Factorial / RSM > HTC

Study Type	Response Surface	Subtype	Randomized
Design Type	Central Composite	Runs	13
Design Mode	Quadratic	Blocks	No Blocks

Factor	Name	Units	Type	Subtype	Minimum	Maximum	Coded	Values	Mean	Std. Dev.
A	Temperature	degree celsius	Numeric	Continuous	75.8579	104.142	-1.000=80	1.000=100	90	8.16497
B	Time	minutes	Numeric	Continuous	0	11.864	-1.000=1	1.000=10	5.56646	3.55543

Response	Name	Units	Obs	Analysis	Minimum	Maximum	Mean	Std. Dev.	Ratio	Trans	Model
R1	yield of juice	%	13	Polynomial	35	56	48.0769	7.7078	1.6	None	Quadratic
R2	beta carotene	mg/g	13	Polynomial	2.87	3.34	3.12538	0.129783	1.16376	None	Quadratic

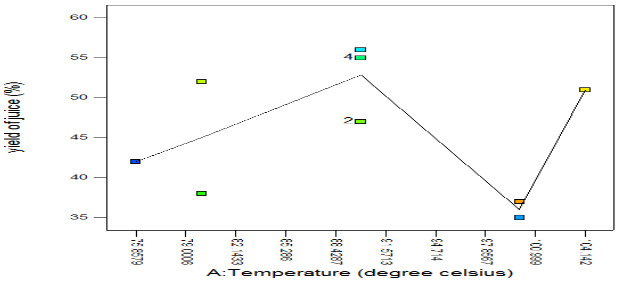


Figure representing the yield of juice Vs temperature Equation developed for yield is y=55.46-0.66A+2.83B-3AB-5.71A^2-6.78B^2

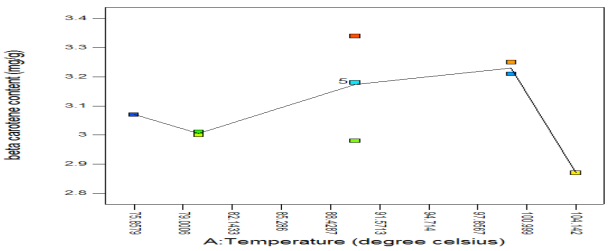
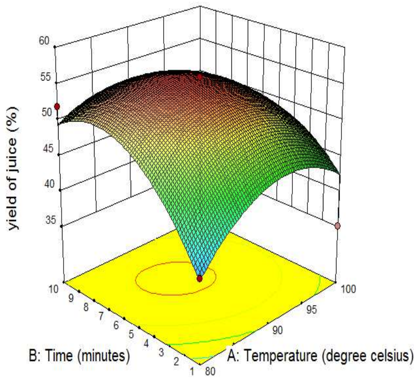
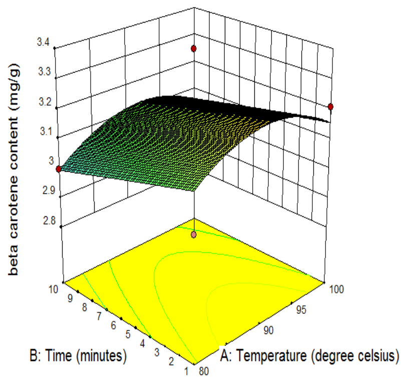


Figure representing beta carotene content Vs temperature Equation developed for beta caroteneis y=3.18+0.021A-0.060B+0.013AB-0.093A^2-9.218E-004B^2

The yield of un-blanched carrot juice was 59%, and it decreased after the blanching treatment because the texture of whole carrots became soft, thus making juice extraction difficult, and because of the leaching loss during the blanching process (Bao and Chang 1994). The heated, whole carrots had softened to some extent, which made juice expression, by pressing through a cloth more difficult. The yield of carrot juice was found to be maximum, i.e., 55.334% in water blanching at 95°C for 5.6 min. There is a minimal loss in β-carotene.

Variation in the β -carotene content of carrot slices at blanching treatments. It may be inferred that the β -carotene concentration was maximum at 95°C during blanching in water.





CONCLUSIONS

Blanching is important for the processing of carrot as it improves the quality and shelf life of the product. The process was optimized on the basis of the maximum yield of carrot juice and minimum loss of beta-carotene. The best blanching treatment for carrots based on these process parameters was 95°C for 5.6min in water. At this time–temperature combination, both POD and catalase enzyme were inactivated 55.334% yield of carrot juice and minimal β-carotene content were lost. By using RSM, maximum yield (55.334%) is obtained at 91.4 degree Celsius for 5.6min. According to non linear regression by Statistica method, at 95degree Celsius for 5min, the blanched carrot will give maximum yield (55%) and β- carotene content 3.18mg/100g.

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