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MAXIMIZATION OF PERFORMANCE RATIO OF OSMOTIC DEHYDRATION OF PINEAPPLE CUBES

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ABSTRACT

The concentration gradients resulting from dipping in a hyper concentrated solution cause the fruit to loose water and gain solids. The solid gain results in undesirable sensory changes. The aim of this work was to maximize the performance ratio (PR: defined as the ratio of water loss to solid gain) of osmotic dehydration of pineapple cubes. The experiment was performed according to a Central Composite Design, CCD (RSM), varying temperature (30, 35, 40, 45 & 50°C), processing time (30, 60, 90, 120 & 150 min) and concentration of osmotic solution (40, 45, 50, 55 & 60°B). The maximum PR values of 3.49 were observed, at 40°C, 30 min & 50°B.

KEY WORDS:
Performance ratio, osmotic dehydration, pineapple.

INTRODUCTION

Osmotic dehydration, a technique adequate to produce high moisture fruits, involves immersing fruit pieces in a hypertonic solution. The main objective of the process is the water loss, although a solid gain occurs also, promoting sensory changes in the product (Azoubel & Murr, 2000). So, a maximum dehydration combined with minimum sensory changes may be obtained by maximizing the performance ratio (PR), defined by Camirand et al. (1992) as the ratio of water loss to solid gain. Some process variables affect water loss and solid gain. A temperature increase favors the dehydration kinetics (Lenart & Lewicki, 1990); however, temperatures higher than 50oC may promote browning and flavor deterioration (Videv et al., 1990). The mass transfer, particularly water loss, is also affected by concentration of osmotic solution (Rahman & Lamb, 1990). The objective of this work was to evaluate

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the effects of temperature, concentration & processing time of osmotic solution on mass transfer during osmotic dehydration of pineapple cubes, as well as to maximize the performance ratio of the process.

MATERIALS AND METHODS

RAW MATERIALS

Fresh, good quality Kew variety Pineapple (ripe) were procured from the local market Allahabad on daily basis prior to each set of experiment.

EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

Response surface methodology (RSM) was used to estimate the main effects of osmotic dehydration process on water loss (WL) and Solid gain (SG) in pineapple. A central composite design was used in temperature (30, 35, 40, 45 & 50°C), processing time (30, 60, 90, 120 & 150 min), sugar concentration (40, 45, 50, 55 & 60°B) & sample to solution ratio kept constant (1:10) being the independent variables Table 1. For the generated 30 experiments, RSM was applied to the experimental data using design expert 6.0.10.

OSMOTIC DEHYDRATION PROCESS

The pineapple was peeled and cut into 15 mm^3 cubes. The prepared samples were subjected to osmotic dehydration according to the experimental design shown in Table 2. The temperature was controlled using a constant temperature water bath. The ratio of sample to solution was maintained at 1:10 in order to ensure concentration of the osmotic solution did not change significantly during the experiment.

EXPERIMENTAL DESIGN FOR OPTIMIZATION OF OSMOTIC DEHYDRATION OF PINEAPPLE

Response Surface Methodology was applied to the experimental data using a commercial statistical package (Design expert, trial version 6.0.10) for the generation of response surface plots and optimization process variables. The experiments were conducted according to Central Composite Rotatable Design (CCRD) (Khuri and Cornell, 1997). Five levels of each variable were chosen for study, including 2 centre points and 2 axial points. A factorial study was used to study the effects of temperature (X1), processing time (X2) sugar concentration (X3) of the pine apple cubes.

In order to follow adequately the osmotic dehydration kinetics, individual analysis for each sample were carried out and from these weight reductions (WR), solid gain (SG) and water loss (WL) data were obtained according to the expressions.

$$WR = \left(\frac{Mo - M}{Mo}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$WL = (Wo - Wt) + St - So) \times 100/W \cdot \quad (5)$$

$$SG = \left(\frac{St - So}{Wo}\right) \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$PR = \frac{\mathrm{WL}}{\mathrm{SG}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

Where Mo- initial mass of sample (g), M- mass of sample after dehydration (g), Wo is the initial weight taken for osmotic dehydration at any time (g), So is the initial dry matter (g), St is the dry matter of after osmotic dehydration for any time (g), PR is performance ratio.

RESULTS AND DISCUSSION

The responses obtained from the experiments are presented in Table 3, and the regression coefficients of the coded models in Table 4. According to the models, temperature, processing time & sugar concentration affected water loss, weight reduction and solid gain positively whereas, the performance ratio was affected negatively. The positive effects of all the variables on weight reduction and water loss confirm results reported by other authors (Beristain et al. 1990; Heng et al. 1990; Lenart and Lewicki, 1990; Fernandez et al. 1995).

CONCLUSION

It can be concluded from this study that solution temperature and sugar concentration were the most pronounced factors affecting solid gain and water loss of pineapple cubes during osmotic dehydration followed by immersion time. The maximum PR values of 3.49 were observed, at 40°C, 30 min & 50°B and the minimum performance ratio 1.303 were observed at 50°C, 150 min and 40°B.

REFERENCE

- Azoubel, P.M., and F.E. Murr. (2000). Mathematical modeling of the osmotic dehydration of cherry tomato. Cie. Tecn. Alim., 20(2): (pp.228- 232).
- Beristain, C.I., Azuara, E., Cortes, R., and Garcia, H.S. (1990). Mass transfer during osmotic dehydration of pineapple rings. Int. J. Food Sci. Techn., 25(5): (pp.576-582).
- Camirand, W., Krochta, J.M., Pavath, A.E., Wong, D. and Cole. M.E. (1992) Properties of some edible carbohydrate polymer coatings for potential use in osmotic dehydration. Carbohydrate Pol., 17(1): (pp. 39-49).
- Fernandez, D., Velezmoro, C. and Zapata, C. (1995). Determinacion de la difusividad efectiva de la sacarosa en papaya (Carica papaya L.) inmersa en soluciones azucaradas. Cie. Tecn. Alim., 15(3): (pp.246-250).
- Heng, K., Guilbert, S. and Cuq, J.L. (1990). Osmotic dehydration of papaya: influences of process variables on the product quality. Sci Alim., 10(4): (pp.831-848).
- Khuri, A.I., & Cornell, J.A. (1997). Secondary Design considerations for Minimum Bias Estimation. "Commun. Statist., A6, (pp. 631-647).
- Lenart, A., and Lewicki, P.P. (1990). Osmotic dehydration of apples at high temperature. In: Mujumbar, A.S. (ed.) Drying 89. Bristol: Hemisphere.
- Rahman, M.S., and Lamb, J. (1990). Osmotic dehydration of pineapple. J. Food Sci. Techn., 27(3): (pp.150-152).
- Videv, K., Tanchev, S., Sharma, R.C. and Joshi, V.K. (1990). Effect of sugar syrup concentration and temperature on the rate of osmotic dehydration of apples. J. Food Sci. Techn., 27(5): (pp. 307-308).

Table 1 Process variables and their levels of experimental design

		Range and levels				
Symbol	Independent Variables	-2	-1	0	+1	+2
X1	Temperature °C	30	35	40	45	50
X2	Immersion time (min)	30	60	90	120	150
X3	Sugar concentration °B	40	45	50	55	60

$$X1 = \frac{\text{temperature - 40}}{5} \qquad X2 = \frac{\text{immertion time -90}}{30} \qquad X3 = \frac{\text{sugar concentration - 50}}{5}$$

Table 2 Observed values of dependent variables for different runs of optimization experiments

	Actual Values			Coded Values		
Design	X_1	X_2	X_3	X_1	X_2	X_3
1	40	90	50	0	0	0
2	45	60	45	1	-1	-1
3	35	60	55	-1	-1	1
4	40	90	50	0	0	0
5	45	60	45	1	-1	-1
6	40	90	60	0	0	2
7	45	60	55	1	-1	1
8	35	120	45	-1	1	-1
9	50	90	50	2	0	0
10	45	120	45	1	1	-1
11	40	90	40	0	0	-2
12	30	90	50	-2	0	0
13	40	150	50	0	2	0
14	35	120	55	-1	1	1
15	40	90	60	0	0	2
16	35	60	45	-1	-1	-1
17	45	120	55	1	1	1
18	35	120	45	-1	1	-1
19	40	90	40	0	0	-2
20	45	120	45	1	1	-1
21	40	30	50	0	-2	0
22	35	60	45	-1	-1	-1
23	40	30	50	0	-2	0
24	35	60	55	-1	-1	1
25	35	120	55	-1	1	1
26	40	150	50	0	2	0
27	45	60	55	1	-1	1
28	45	120	55	1	1	1
29	50	90	50	2	0	0
30	30	90	50	-2	0	0

Table 3 Responses resulting from osmotic dehydration of pineapple cubes

Design	WL	WR	SG	PR
1	21.91	8.57	7.15	3.064
2	20.88	8.07	8.81	2.370
3	24.01	11.52	12.48	1.923
4	23.55	10.71	12.84	1.834
5	26.93	16.16	11.78	2.286
6	27.97	16.86	11.11	2.517
7	31.44	17.92	13.51	2.327
8	26.44	14.15	20.29	1.303
9	29.91	10.17	13.73	2.178
10	28.91	10.97	13.48	2.144
11	26.44	14.15	20.29	1.303
12	29.72	14.41	20.80	1.428
13	28.66	23.37	9.29	3.085
14	26.43	23.70	7.73	3.419
15	34.15	23.30	22.81	1.497
16	34.46	19.99	21.42	1.608
17	29.24	7.91	10.32	2.833
18	31.31	8.05	10.09	3.103
19	36.56	20.83	20.82	1.756
20	29.72	20.04	16.67	1.782
21	20.89	7.91	5.99	3.487
22	20.42	7.71	7.66	2.665
23	33.17	28.26	15.91	2.084
24	35.52	28.63	12.89	2.755
25	30.53	20.74	13.80	2.212
26	27.65	19.21	8.74	3.163
27	34.94	19.20	15.75	2.218
28	36.23	21.12	24.15	1.500
29	30.75	15.85	14.89	2.065
30	29.78	20.30	14.58	2.042

Table 4 Regression coefficients of the coded models referring to responses obtained from osmotic dehydration of pineapple cubes

Variants	WL	WR	SG	PR
Intercept	30.83	18.49	14.60	2.12
X1	1.03	1.84	3.3	-0.43
X2	2.83	4.99	1.24	-0.015
X3	2.08	1.34	2.23	-0.14
X1X2	0.90	-1.11	0.93	-0.082
X1 X3	0.19	-0.062	1.30	-0.13
X2 X3	-0.86	0.90	-1.40	0.21
X12	-0.27	-1.95	0.10	0.019
X22	-1.76	-0.56	-1.27	0.15
X32	-0.021	0.13	0.50	-0.011
R2 (%)	73.82	83.63	81.69	62.92
F- Value	6.27	11.35	9.91	3.77
Adequate precision	8.447	10.088	9.014	5.746

Figure1. Contour plots of the performance ratios of osmotic dehydration of pineapple cubes