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Studies on the Effect of Process Parameter on the Textural Characteristics of Osmotically Dehydrated Papaya (Var. Red lady) Cubes

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Abstract

The papaya (*Carica papaya. L*) is a very nutritious fruit and a good source of provitamin A, vitamin C, folate and dietary fiber. India is second largest producer of papaya, due to the post harvest storage and handling effects, the texture of the fruit changes and becomes undesirable. To reduce the losses osmotic dehydration (OD) can be a better alternative. In this aspect studies were conducted in two phases. In the first phase, OD was carried out with sucrose solution with variation in process parameters - sample to solution ratio, heating time, soaking time, with and without agitation, followed by tray drying. In the second phase, wtih the view to imrove quality characteristics, experiments were carried out using 4 different osmotic solutions namely; i) sucrose, ii) sucrose:liquid glucose (70:30), iii) sucrose:invert sugar (50:50), iv) sucrose with 0.2M LA+0.2M $CaCl_2$ and v) sucrose with 2% citric acid along with the optimized process parameters. The efficiency of OD was judged by calculating water loss, solid gain and conducting sensory analysis on the osmotically dehydrated papaya cubes. The samples were packed in low density poly ethylene (LDPE) and stored at room temperature for 45 days. The colour, texture, moisture content of dehydrated papaya cubes were periodically evaluated. Results showed that storage time has significant effect on the product texture, colour and moisture content. With respect to texture the treatment dehydrated using combination of sucrose and invertsugar (50:50) showed better results.

Keywords : Papaya, Osmotic Dehydration, invert sugar, liquid glucose, citric acid.

1. Introduction

The papaya is the fruit of the plant *Carica papaya*, genus *Carica* of the plant family Caricaceae. India is the leading papaya producer, with a 38.61 percent share of the world production during 2008–2010, followed by Brazil (17.5%) and Indonesia (6.89%). The susceptibility of papaya fruit (Carica papaya L.) to several diseases is a major reason for extensive postharvest losses during handling and storage. (Paull et al., 1997). In order to reduce the postharvest losses, papaya is osmotically dehydrated and studies were done on its textural chracteristics.

The osmotic dehydration (OD) is a process that partially removes water from food material by means of food immersion in a hypertonic solution (i.e. sugar and salt). It is one of the most important food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decrease the energy costs (Devic et al.,2010 ; Mundada et al., 2011). Fruits and vegetables are perishable due to their high moisture content. Drying, a process of moisture removal, is one of the processes used for preservation. Osmotic dehydration is used with other drying methods such as freezing and deep fat frying to make available better quality final product (Behsnilian and Speiss, 2006).

2. Materials and Methods

The Papaya fruits (Var.Red Lady) were purchased from a farmer, hailing from tuticorin district, Tamilnadu, India. Semi ripe fruits were washed, manually peeled, deseeded and cut into 2 cm cubes. The work was done in two phases. In *phase I* – optimization of process parameter was done in sucrose solution. The process parameters include i) sample to solution ratio (1:0.75 – 1:1.25), ii) heating time (6-12 min), iii) soaking time (2-4 hr), iv) with and without agitation. Water loss and solid gain were calculated. The process paramete in this phase was optimized by considering maximum water loss and solid gain. *In phase II* the optimized parameter from *phase I* were considered along with 4 different types of osmotic solution viz i) sucrose, ii) sucrose:liquid glucose (70:30), iii) sucrose:invert sugar (50:50), iv) sucrose with 0.2M LA+0.2M $CaCl_2$ and v) sucrose with 2% citric acid, with the view to improve the textural characteristics of the osmotically dehydrated papaya. After the OD, papaya pieces were drained to remove excess solution and rinsed with water. Then, osmodehydrated fruits were subjected to the conventional drying using a hot air circulation tray dryer at 45ºC and air velocity of 1.5 m/s, until the product reached the final moisture content of approximately 13% (wet basis). The dried papaya were packed with LDPE to avoid the moisture gain and stored at room temperature. During the shelf life study, the fruits were evaluated for its texture, colour and moisture content. Experiments were conducted in triplicates.

2.1. Analytical Methods

Water loss and solid gain were calculated by the formula,

Water Loss (WL) = $\frac{wx-wx}{w} X100$

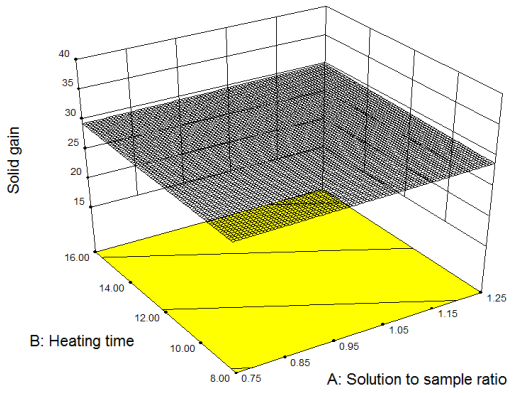
Solid Gain (SG) = $\frac{w(1-x)-w(1-x)}{w} X100$

W□ - Initial mass of papaya cubes (g)
W□ - Mass of cubes after time θ (g)
X □ - Water content as a fraction of Initial mass of papaya cubes (g)
X □ - Water content as a fraction of mass of papaya cubes at time θ (g).

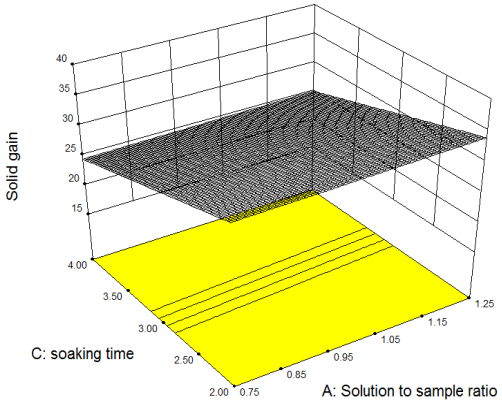
Moisture content was determined using hot air oven method (AOAC, 2006). Colour was measured using a hunterlab colorimeter (coloeQuest – XE D18) with scale (L*, a*, and b*). The texture was evaluated with a Universal Testing Machine (TA.XT2i Texture Analyzer, Stable Micro Systems, England), using a needle set probe (HDP/BSK) and a platform HDP/90.

The experimental data were analysed using Design expert 2008 software to study the effect of process parametr on the water loss and solid gain.

3. Results and Discussion



1A



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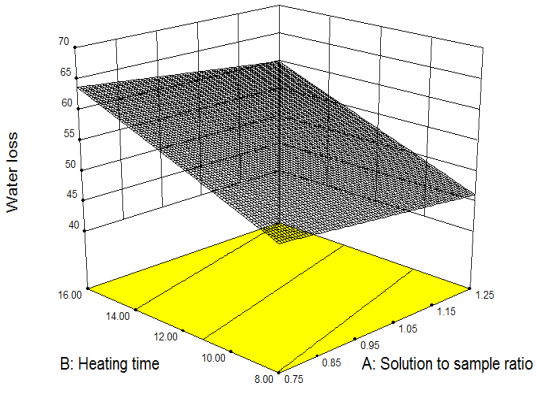

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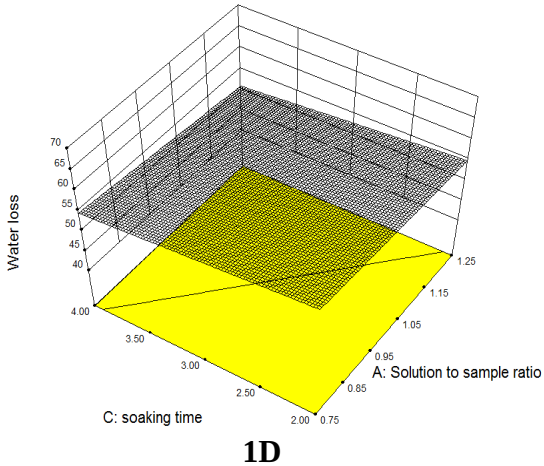
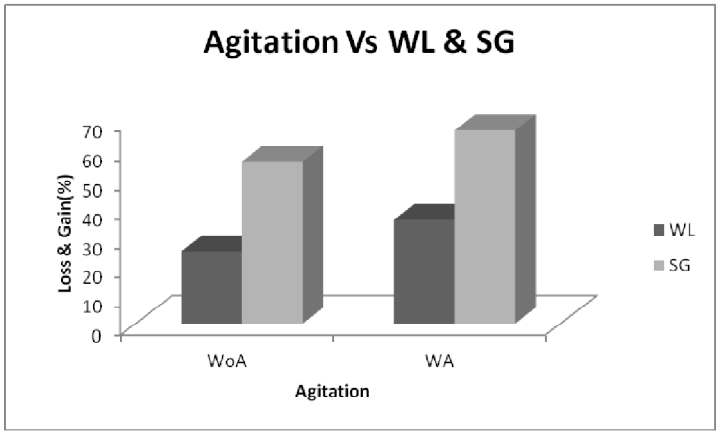


1D



1E

WoA- With out agitation, WA- With agitation.

The statistical analysis shows linear effect on water loss and solid gain with respect to heating time, soaking time and agitation. Longer heating time showed higher water loss and solid gain (fig 1a and 1c). The soaking time did not have much influence on water loss and solid gain (fig 1b and 1d). In order to make the process rapid the soaking time with 2 hour was selected. Agitation showed increase in water loss and solid gain with agitation when compared to without agitation. (fig1e). The sample to solution ratio of 1:1.25 showed the better results of solid gain in the study (fig1a) .

3.2. Effect of storage on the quality of dehydrated cubes

Moisture content (Table.1) of dried papaya varied around 2% along the storage, remaining in the range of 13±2 %. Statistical analysis shows that there is no significant difference in T_2 and T_3. T_0, T_1 and T_4 showed significant difference in the study. Fig.2 represents the force required to penetrate the papaya cubes during its various period of 45 days.

Table .1 Moisture content (db%) of treatments from 0^{th} to 45^{th} day.

MC (db%) / Time (days)	T_0	T_1	T_2	T_3	T_4
0	13.89	13.17	13.50	13.16	13.77
15	12.02	12.78	13.87	14.11	12.81
T-value initial Vs 15^{th} day	0.01 S	0.04 S	0.11 Ns	0.35 Ns	0.01S
30	11.86	12.02	13.64	14.40	12.37
T-value initial Vs 30^{th} day	0.01 S	0.03 S	0.17 Ns	0.13 Ns	0.04 S
45	11.69	11.20	13.49	14.17	12.32
T-value initial Vs 45^{th} day	0.01 S	0.02 S	0.83 Ns	0.30 Ns	0.01 S

Ns: Not Significant, S: Significant

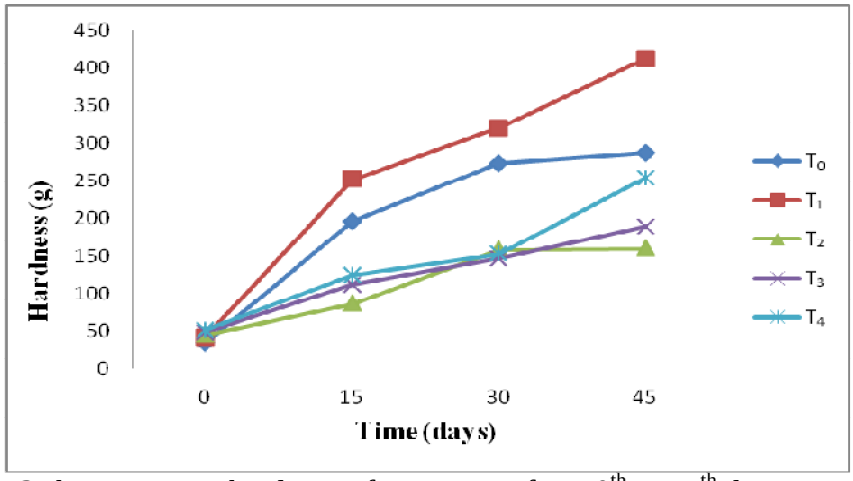


Fig.2 shows texture hardness of treatments from 0th to 45th day.

Hardness of papaya cubes were on bar with treatment T_2,T_3, & T_4 upto 30 days and T_2 showed a better retention of textural softness upto 45 days. The chromaticity values (a^* and b^*) during storage time was studied in hunter lab calorimeter. From the T-test satistical analysis, Chromaticity values did not show any significant difference in the storage time of 45 days other than T_0. The changes in chromaticity is shown below in Table 2.

Table 2: Show the chromaticity values of the treatments during storage time 0-45th day

Time (days)	T_0		T1		T2		T3		T4	
	a*	b*	a*	b*	a*	b*	a*	b*	a*	b*
0	11.28	14.92	11.1	13.47	7.44	4.74	14.12	6.5	5.9	10.65
15	10.31	8.55	12.82	11.48	8.93	6.16	11.25	8.11	7.48	7.6
T- value initial vs 15th day	0.49 Ns	0.33 Ns	0.23 Ns	0.18 Ns	0.27 Ns	0.43 Ns	0.11 Ns	0.20 Ns	0.45 Ns	0.59 Ns
30	9.5	9.22	11.48	11.18	8.44	5.96	11.03	7.79	7.48	8.84
T-value initial Vs 30th day	0.41 Ns	0.34 Ns	0.47 Ns	0.42 Ns	0.51 Ns	0.56 Ns	0.40 Ns	0.54 Ns	0.57 Ns	0.46 Ns
45	7.79	11.97	11.17	15.65	22.93	10.44	8.25	5.95	7.17	10.63
T- value Initial Vs 45th day	0.34 Ns	0.001 S	0.94 Ns	0.30 Ns	0.57 Ns	0.088 Ns	0.42 Ns	0.50 Ns	0.70 Ns	0.99 Ns

Ns: Not Significant, S: Significant

4. Conclusions

The parameter study on osmotic dehydration of papaya showed linear effect, water loss and solid gain increases with heating time. The optimized parameter is with the sample to solution ratio 1:1.25, heating time 16 min, soaking time 2 hr and with

agitation. The OD process carried out with different osmotic soultions resulted in better maintenance of texture, in comparison to the treatment performed only with sucrose solution. Storage period had significant effect on the product texture over the time. The treatment T_1 and T_4 resulted in texture hardness and loss of moisture of dried papaya during the storage time, meaning that the use of these additives was not effective in OD of papaya. Comparitively, the treatment T_3 better preserved the fruit texture, T_3 and T_4 reatined moisture of the dehydrated papaya. The result from the study shows that T_3 is the better way to preserve the texture of the fruit.

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