Research Paper

Volume : 3 | Issue : 8 | Aug 2014 • ISSN No 2277 - 8179

Effect of Hurdle Technology on the Quality and Stability of Minimally Processed Papaya

Food Science

KEYWORDS : hurdle technology, osmotic dehydration, sucrose

Ankita	M.Tech Food Tech.(Food Safety& Standards), Sam Higginbottom Institute of Agricultural Engineering and Technology
Singh Rongen	Assistant Professor, Department of Food Process Engineering, Vaugh School of Agricultural Engineering and Technology, Sam Higginbottom Institute of Agricultural Engineering and Technology, Allahabad-211007
Nayansi	M.Tech Food Tech. (Food Quality Management), Sam Higginbottom Institute of Agricultural Engineering and Technology

ABSTRACT

The present investigation aimed to study the combined effect of blanching, osmotic dehydration and preservatives on the quality and stability of minimally processed papaya .Osmotic dehydration of Papaya using sucrose solution at mild temperature (25ºC) was investigated. Different sucrose solution (50%, 55%, 60%, 65% and 70% w/v) were employed for osmotic dehydration process. Physico-chemical analysis (TSS, water activity and ascorbic acid) and microbial quality along with a sensory analysis were measured at regular intervals throughout the storage period. During storage for 30 days, a decrease in water activity, ascorbic acid (g/kg), firmness (N), color (L value) and sensory characteristics was observed.From the results it were revealed that the papaya slices obtained showed a good overall acceptability upto 30 days of storage at refrigerated temperature.*

1. INTRODUCTION

Papaya (Carica papaya L.), one of the most important fruit crops of the world (Ali et al., 2011), is a climacteric tropical fruit and is known to have a very short postharvest life due to the loss of weight, rapid pulp softening and the presence of microbial growth (Fabi et al., 2007; Gonzalez-Aguilar et al., 2009). It is a good source of vitamin A, lycopene, polysaccharides and proteins. Preparation of fresh-cut fruit and vegetables causes increase in respiration rates and ethylene production rates. It also induces synthesis of secondary metabolites, membrane disruption and activation of defence mechanisms (Brecht et al., 2004). Hence, fresh-cut produce is extremely perishable and even more susceptible to spoilage than intact fresh produce. Minimally processed fresh-cut papaya provides convenience, uniqueness and nutritional quality which could create marketing opportunities (Wall et al., 2010).

Osmotic dehydration, a technique used to produce high moisture products, involves immersing pieces of food in a hypertonic solution allowing the adjustment of the physicochemical properties of food by reducing water content and incorporating simultaneously ingredients or additives with antioxidant or other preservative properties into the food. This process promotes stabilization of colour parameters, reducing non-enzymatic browning reactions and often improves fruit product colour (Krokida, Karathanos, & Maroulis,2000).

Three basic problems confront the extension of shelf life of fresh cut fruits and vegetable products. First is the intermixing of polyphenol oxidase with phenolics due to peeling and cutting which undergo enzymatic browning to produce an undesirable brown color and second tissue wounding induces a high respiration rate which triggers faster tissue deterioration and third is the faster growth of microorganisms .

The shelf life of peeled, sliced and polyethylene packed papaya slices when stored at room when kept at 8–10 C, do not stay more than 8–10 days. Therefore, many alternate approaches were followed for papaya preservation. The blanching treatment for microbial reduction and browning inhibition affects freshness and taste. Cut papaya undergoes enzymatic browning which can be inhibited by dipping in sodium bisulfite solution. Citric acid is used to reduced the pH content. Restaino et al. (1982) reported that citric acid increases the inhibitory properties of potassium sorbate at pH 5.5 against several common deteriorative microorganisms. Huhtanen et al. (1983) reported an increase of inhibitory properties of potassium sorbate against Clostridium botulinum in the presence of this acid.

The objective of this work was to develop a shelf stable high moisture papaya by hurdle technology and to increases the shelf-life of the product. This process is based on mild heat treatment (blanching), osmotic dehydration and the use of preservatives which helps in slight reduction of a_w, a decrease in pH.

2. MATERIAL AND METHOD

2.1 Sample preparation

Fresh quality papaya were chosen from the local market of Allahabad for the preparation of minimally processed papaya. Fruit was washed to remove dirt and surface microflora to prevent contamination during preparation of minimally processed papaya. Washed papaya was peeled ,cut into slices of equal sizes using a knife. The papaya slices were blanched with hot water for 1-2 min. Osmotic solution was prepared using commercial grade sucrose and distilled water. Syrup were prepared at concentrations (50%, 55%, 60%,65%, and 70% w/v).Three different preservatives were added in the syrup.Citric acid added at different level of (3%, 4%, 5%, 6%, 7%).Potassium sorbate added at concentration of (900, 950, 1000, 1050, 1100 ppm) and sodium bisulphite added at different concentration of (50,100,150,200,250 ppm).TSS was measured by using hand refractometer .The blanched fruit pieces was immersed in sucrose solution in the ratio of 1:10 at different concentration. Osmotic dehydration was carried upto 10 days at ambient temperature (25^0C). Then the samples removed from the syrup and rinsed quickly with distilled water to eliminate the solution from the surface and carefully blotted with tissue paper to remove the excess surface water. Finally prepared papaya slices were packed in polyethylene (HDPE) and stored at refrigerated temperature.

2.2 Physico-chemical analysis

The weight and moisture content of samples before and after the osmotic process were determined and used to calculate the variables water loss (WL), weight reduction (WR) and solid gain (SG) of minimally processed papaya. Water Activity

can be measured by using a water activity meter. Total soluble solids (TSS), and ascorbic acid content were determined by (Ranganna, 1986) The surface color of the Papaya was measured by using a colorimeter (XY COLOUR LAB) Color was expressed as the CIE: L* a* b* uniform color space, where L* indicates lightness, a* corresponds to chromaticity on a green (-) to red (+) axis and b* the coloration on a blue (-) to yellow (+) axis (Francis 1980). Firmness of Papaya was measured by using a texture analyzer.

For microbiological assessments, samples were examined for total plate count (TPC), Yeast and Mold count (Y&M), and total coliforms and Salmonella as as per the procedure described by Vanderzant and Splittstoesser (1992).All the counts were done in triplicate and the results were reported as log cfu/g.

2.3 Sensory analysis

A panel of semi-trained panelists assessed sensory attributes according to general appearance, color, flavor, texture and overall acceptability on a 9-point hedonic scale

2.4 Statistical analysis

Statistical analysis was done on the data by analysis of variance (ANOVA) on Surface Response Methodology. RSM were used for multivariative variance analysis test at ($p<0.05$). Whenever ANOVA indicated a significant, a pair-wise comparison of means by least significance difference (LSD) was carried out.

3. RESULT AND DISCUSSION

3.1 Effect of sucrose concentration on weight reduction, solid gain and water loss.

In minimally processed papaya the percentage of weight reduction and water loss increases with increase in sucrose concentration . The maximum weight reduction and water loss percentage was found to be 34.10% and 45.97% in treatment T_5 (70 ^{0} brix) and minimum percentage found to be 18.11% and 28.37% in treatment T_1 (50 brix). The water loss was favored by higher solution concentrations, due to the increase of the osmotic gradient between the food material and the osmotic solution. The presence of a large amount of solute causes a higher osmotic pressure that makes the WL easier. These results corroborate those obtained by Ito et al. (2007) in the PVOD of cantaloupe cylinders and mango slices.

But in sugar gain the maximum percentage found to be 9.26% in T1 (50 brix) and minimum percentage found to be 6.56% in treatment T_5 (70 ^{0} brix).The concentrated solutions may have promoted the formation of a dense layer of solutes at the surface of the osmodehydrated papaya. This layer acts as a barrier against penetration of the solutes into the food and makes solutes mass transfer more difficult, which results in a lower solids uptake in fruits tissue. Diluted solutions penetrate better into the fruit tissue than concentrated solution. With increased sugar concentration, the osmotic solution becomes more viscous, that makes the solutes penetration more difficult. Similar behavior was also observed by Mastrantonio et al. (2005).

3.2 Water activity

The water activity of control sample (fresh fruit) was found to be 0.996 which is higher than treated sample. Water activity of treated sample reduced due to osmotic dehydration of papaya at different sucrose concentration. It can be concluded that the value of water activity (a_w) decreases with increase in sugar concentration. Since the sucrose hydrolysis reduced the water activity aw more than the desired,which was an additional safety factor for the preservation of minimally processed papaya. Reducing the water activity of samples also decreases the non-enzymatic browning reaction (Krokida et al., 2000). But during storage there is slight increase in the value of water activity.

3.3 Ascorbic Acid

In fresh fruit Ascorbic Acid content (mg/100g) is 56.4 which is reduced to 34.2.From the result it can be concluded that the major ascorbic loss in minimally processed papaya occur during processing and first month of storage .It can be observed that the vitamin losses was not only due to degradation reaction but also diffusion in syrup. These findings were similar to Alzamora et.al., (1989). During storage ascorbic acid content decreases in large amount. There is no effect of ascorbic acid loss at different sugar concentration.

3.4 Colour Analysis

Color is an attribute of food quality which initially being judged by a consumer at the point of purchasing food products. Loss of color during osmotic dehydration process is one of the most significant changes (Osorio et al., 2007). Initially the value Lightness(L), redness (a), yellowness (b), of fresh cut papaya were 44.20, 14.47, and 26.6 respectively. The maximum value of lightness (L) for papaya was found to be 57.70 in treatment T1 (50 brix) and minimum value were found to be 47.21 in T5 (70 brix) and during storage lightness decreases upto 30 days of storage. The a value also decrease as the sucrose concentration increases. The b value of papaya increases from T1 to T5 ranged from 27.12 to 30.34.So it was concluded that an increase in yellowness (b*) coordinate and a decrease in lightness (L*) and redness (a*) was achieved as the sucrose concentration increased. Higher decreases in L* values of non-treated sample (control sample) compared to treated samples showed that blanching, osmotic dehydration, chemical treatments the combined effect preserved the natural color of the minimally processed papaya during storage. The a* value, which indicates redness when positive or greenness when negative, also showed a decreasing trend during storage. A significant reduction of the b* value, yellowness when positive or blueness when negative, was also observed during storage. During storage chroma value decreases and hue angle inceases. Findings of present investigation were in close conformity with values described by(Waghmare and Annapure 2013). The decrease in L value for Papaya may be attributed to brown pigment formation during process due to high levels of reducing sugars and air loss of osmodehydrated papaya (Moreno et al., 2000). Generally, "L*" and "a*" parameters are well correlated to browning reaction . Enzymatic and non-enzymatic reactions are the most important reason of browning development in fruits and vegetables during dehydration. This reduction of lightness values could also be attributed to the shrinkage of plant tissue which leads to increase in samples opacity. The changes of redness and yellowness are clear and seem to be relevant to alteration of fruit pigments and solids uptake (Falade and Igbeka, 2007)

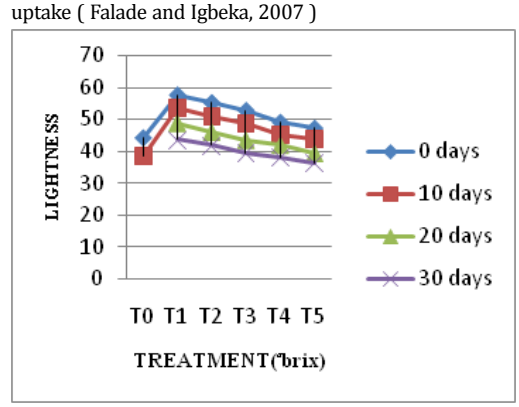

Fig.3 Graph of Lightness for minimally processed papaya packed in HDPE stored at 4^{0}C.To (control sample-fresh fruit) , T_1 (Treatment consists of 50^0 brix solution),T_2

Volume : 3 | Issue : 8 | Aug 2014 • ISSN No 2277 - 8179

(Treatment consists of 55⁰ brix solution), T_3 (Treatment consists of 60 ⁰ brix solution), T_4 (Treatment consists of 65⁰ brix solution) and T_5 (Treatment consists of 70⁰ brix solution).

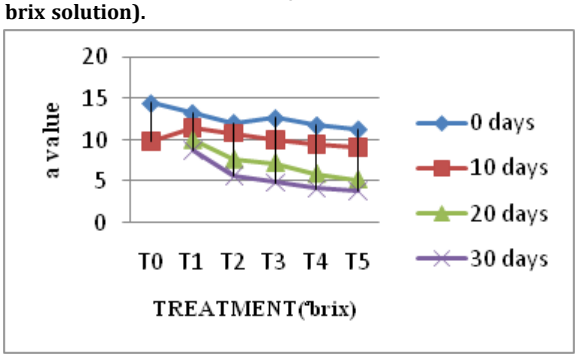

Fig.4 Graph of a value for minimally processed papaya packed in HDPE stored at 4⁰C.To (control sample-fresh fruit) , T_1 (Treatment consists of 50⁰ brix solution),T_2 (Treatment consists of 55⁰ brix solution), T_3 (Treatment consists of 60 ⁰ brix solution), T_4 (Treatment consists of 65⁰ brix solution) and T_5 (Treatment consists of 70⁰ brix solution).

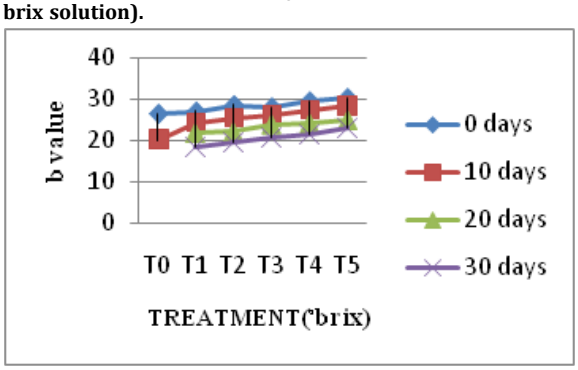

Fig.5 Graph of b value for minimally processed papaya packed in HDPE stored at 4⁰C.To (control sample-fresh fruit) ,T_1 (Treatment consists of 50⁰brix solution),T_2 (Treatment consists of 55⁰ brix solution), T_3 (Treatment consists of 60⁰ brix solution), T_4 (Treatment consists of 65⁰ brix solution) and T_5 (Treatment consists of 70⁰ brix solution).

3.5 Texture Analysis

Texture is a significant quality attribute of fruits and vegetables. During osmotic dehydration, the textural properties of osmo-dehydrated products are changed due to physical and chemical modifications occuring in the cell structure (Lewicki, 1998). Puncture force is usually used to measure the textural properties of dehydrated products which is the measure of the hardness of the product surface, and presents the extent of case hardening during drying (Lin et al., 1998). The hardness value for fresh papaya was found to be 0.206 N.Maximum force found at treatment T_5 (70 brix solution) and minimum force found in treatment T_1 (50 brix solution). Force increases as sugar concentration increases. It was found that osmosed samples were considerably softer than untreated samples.From the result it can be concluded that firmness decreases during storage. Firmness changes during storage may be a consequence of water loss and cellular breakdown, due to both microbial growth and biochemical activity

3.6 Microbial Analysis

Initially microbial load of fresh papaya was found to be 5.6 cfu/gm which is higher than the treated sample.The total plate count of papaya at T1 to T5 decreases from 5.5 to 3.6 cfu/gm. Microbial load increases upto 30 days of storage. Yeast and Mould count were found in T1 which contain 2.44 cfu/gm and minimum were found in T5 which contain 1.90 cfu/g. From the table it can be observed that total plate count and yeast and mold count was found to be less than 10 cfu/gm in papaya slices. The results obtained were comparable with the results of reported by Lopez-Malo et.al (1994). No coliforms and salmonella were detected in any of the samples during the whole storage period. It was concluded that the combined effect of blanching, osmotic dehydration and the use of chemical preservatives decreased the microbial load upto 30 days of storage at refrigerated temperature. It indicating that the selected condition were capable of assuring the microbial stability of the product.

3.7 Sensory Analysis

Changes in sensory attributes such as color, flavor, texture and overall acceptability of minimally processed papaya influenced by various treatments were evaluated during storage for 30 days Color scores for papaya decreased during storage. The loss of color scores was due to the development of browning in minimally processed papaya. This can be confirmed by decrease in L* value of the papaya. Appearance and texture scores were also found to decrease during 30 days of storage. It could be observed that overall acceptability of sample is found to be acceptable. But overall acceptability are goes decreasing with no. of days increasing during the storage. In conclusion, the shelf-life was based on the score of overall acceptability and the combined application of blanching, osmotic dehydration and preservatives result in successful storage of minimally processed papaya for 30 days with little loss of sensory quality.

CONCLUSION

In current research Papaya can be minimally processed by hurdle technology and their shelf life can be extended by the combined effect of blanching, osmotic dehydration and the use of preservatives which can be packed in polyethylene (HDPE). From the results it was revealed that the higher values of solution concentration resulted in higher flow of water and solids and loss of weight through the Papaya slices. Microbiological study showed the acceptable level for TPC, yeast & mold, growth to the all dilutions. Coliform and Salmonella were not detected in any of the sample during storage. From color measurement it was showed that an increase in yellowness (b*) coordinate and a decrease in lightness (L*) and redness (a*) was achieved as the sucrose concentration increased. Finally, from texture analysis it was found that osmosed samples were considerably softer than untreated samples and force increases as sugar concentration increases. A shelf life of 30 days is observed, which was microbiologically and organoleptically stable at refrigerated temperature.

ACKNOWLEDGMENT

I would like to thank my supervisor Prof. Rongen Singh for him active guidance, valuable advice and statistical analysis. I am grateful to Er. Avanish Kumar, Er. Kailash Chandra Yadav, Er. K. Lakshmi, Bala for their warm assistance.

I would like to thank Prof. (Dr.) ir. D. M. Dennis, Dean and Prof. (Dr.) B. R. Shakya, HOD Vaugh School of Agricultural Engineering & Technology, Sam Higginbottom Institute of Agricultural, Technology and Sciences (Deemed – To-Be-University), Allahabad, for making it possible for me to attend this programme and their careful help for his careful help.

I would also like to thank all the people of the Department of Food Process Engineering and fellows for their contribution to my learning and life in Allahabad

REFERENCE

[1] Ali, A., Muhammad, M.T.M., Sijam, K., Siddiqui, Y., (2011). Effect of chitosan coatings | on the physicochemical characteristics of Eksotika II papaya (Carica papaya L.) fruit during cold storage. Food Chem. 124, 620–626. | | [2] Alzamora, S. M., Gerschenson, L. N., Cerrutti, P., Rojas, A. M. (1989). Shelf-stable pineapple for long-term non-refrigerated storage. Lebensm. Wissu. Technol., 22, 23336. | | [3] AOAC. (1995). In official methods of analysis. Washinton DC, USA: Association of Official Analytical Chemists. | | [4] Brecht, J.K., Saltveit, M.E., Talcott, S.T., Schneider, K.R., Felkey, K., Bartz, J.A., (2004). Fresh-cut vegetables and fruits. Hortic. Rev. 30, 185–251. | | [5] Fabi, J.P., Cordenunsi, B.R., de MattosBarreto, G.P., Mercadante, A.Z., Lajolo, F.M., Oliveira do Nascimento, J.R., (2007). Papaya fruit ripening: response to ethylene and 1- methylcyclopropene (1-MCP). J. Agric. Food Chem. 55, 6118–6123. | | [6] Falade, K. O., Igbeka, J. C., Ayanwuyi, F. A. (2007). Kinetics of mass transfer and colour changes during osmotic dehydration of watermelon. Journal of Food Engineering 80, 979–985 | [7] Gonzalez-Aguilar, G.A., Valenzuela-Soto, E., Lizardi-Mendoza, J., Goycoolea, F., Martinez-Tellez, M.A., Villegas-Ochoa, M.A., Monroy-Garcia, I.N., Ayala-Zavala, J.F., (2009). Effect of chitosan coating in preventing deterioration and preserving the quality of fresh-cut papaya 'Maradol'. J. Sci. Food Agric. 89, 15–23. | | [8] Huhtanen, C. N., Feinberg, J., Trenchard, H., Philips, J. G. (1983). Acid enhacement of Clostridium botulinum inhibition in jam and bacon preparations with potassium sorbate and sorbic acid. J. Food Protect., 46, 807-10. | | [9] Ito AP, Tonon RV, Park KJ, Hubinger MD. (2007). Influence of process conditions on the mass transfer kinetics of pulsed vacuum osmotically dehydrated mango slices. Drying Technology: An International Journal 25(10):1769 - 1777. | [10] Krokida, M. K., Karathanos, V. T., Maroulis, Z. B. (2000). Effect of osmotic dehydration on color and soption characteristics of apple and banana. Drying Technology, 18(4–5), 937–950. | | [11] Lewicki PP.(1998) Effect of pre-drying treatment, drying and rehydration on plant tissue properties: A review. International Journal of Food Properties 1(1):1-22. | [12] Lin TM, D. Durance T, Scaman CH. (1998) Characterization of vacuum microwave, air and freeze dried carrot slices. Food Research International 31(2):111-117. | [13]LopezMalo.A;Palou.E;Welti.J;Corte.P;Argaiz.A(1994) Shelf-stable high moisture papaya minimally processed by combined methods. Food Research international Vol 27,545-553. | [14] Mastrantonio, S. D. S., Pereira, L. M. and Hubinger, M. D. (2005) Osmotic dehydration kinetics of guavas in maltose solutions with calcium salt. Alimentos e Nutrição 16: 309–314. | [15] Moreno, J., Chiralt, A., Escriche, I. and Serra, J. A. (2000) Effect of blanching/osmotic dehydration combined methods on quality and stability of minimally processed strawberries. Food Research International 33: 609-616. | [16] Osorio, C., Franco, M. S., Castaño, M. P., González-Miret, M. L., Heredia, F. J. and Morales, A. L.(2007) Colour and flavour changes during osmotic dehydration of fruits. Innovative Food Science and Emerging Technologies 8: 353–359. | [17] Ranganna, S. (1986). Handbook of analysis and quality control for fruit and vegetable products. New Delhi: Tata McGraw-Hill Publishing Co. | | [18] Restaino, L., Komatsu, K. K., Syracuse, M. J. (1982). Effects of acids on potassium sorbate inhibition of food related microorganism in culture media. J. Food Sci., 47, 134-8, 143. | | [19] Vanderzant, C., and Splittstoesser, D. F. (1992). Compendium of methods for the microbiological examination of foods (3rd ed.). Washington: American Public Health Association. | | [20] Waghmare, R.B., Mahajan, P.V., Annapure, U.S., (2013) Modelling the effect of time and temperature on respiration rate of selected fresh-cut produce. Postharvest Biol. Technol. 80, 25 30 | | [21] Wall, M.M., Nishijima, K.A., Fitch, M.M., Nishijima, W.T., (2010) Physicochemical, nutritional and microbial quality of fresh-cut and frozen papaya prepared from cultivars with varying resistance to internal yellowing disease. J. Food Qual. 33, 131–149. |