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DEVELOPMENT OF FUNCTIONAL SAPODILLA FLAKES WITH NEUTRACEUTICAL AND HEALTH REGULATORY COMPONENTS AND THEIR QUALITY CHARACTERISTICS DURING STORAGE

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Enrichment of fruits with bioactive components for improving the nutritional, functional and health beneficial qualities is a major goal for the food processing industries. The composition of the infusion media for osmotic dehydration of sapodilla (Manilkara zapota) was formulated by enhancing the incorporation of neutraceutical herb Ocimum bacilicum (basil leaves) and partially substituting maltodextrin for sucrose at different concentrations. Optimization of the process parameters viz., syrup concentration (40, 60 and 80° Brix) and process time (2, 4 and 6 hr) was also investigated. The flakes prepared with binary solute systems of malto dextrin and sucrose (50:50, 70: 30) and infusion of 0.5% basil herb scored high on various sensory attributes. Further, flakes were analyzed for their chemical, microbial and antioxidant properties at different periods of storage. Among all the treatments, mixed solute systems with incorporation of herb remained chemically and biologically safe during storage and there was better retention of nutrients and antioxidants in the product.

Keywords: Osmotic dehydration, Sapodilla, Binary solute system, Basil leaf

INTRODUCTION

Changing life styles and values have affected eating habits considerably and there is a strong demand for usage of convenience foods. Modern food industries adopt many different types of food processing and preservation techniques to obtain stable and safe foods. Hurdle technology advocates the use of different techniques in combination (Leistner, 1996). Selection and magnitude of hurdle plays an important role in achieving microbial stability without impeding the vital nutrients and sensory properties of multi target preserved products (Jayaraman and Gupta, 1995). At present, there is an increasing interest in exploiting fruits and vegetables to obtain potentially bioactive products (Rozek *et al.*, 2010). Sapodilla (*Manilkara zapota*) belongs to the family *sapodillaceae* and assigned for various properties in the traditional system of Indian medicine. Sapodilla remains as most unexplored fruit, although research has been reported on various aspects of its postharvest treatment.

Osmotic treatment, also known as dewatering-impregnation soaking, involves immersing a solid food in a hypertonic aqueous solution leading to the loss of water and a solute transfer from the solution into the food. Osmotic dehydration has been reported as a feasible treatment for incorporating physiologically active compounds into plant tissues without destroying the initial food matrix (Alzamora *et al.*, 2005). Osmotic dehydration, include significant changes in the dehydrated material such as volume reduction, membrane alteration or lysis, membrane separation from the cell wall or cell wall deformation

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(Alzamora *et al.,* 2000). All these structural changes greatly affect the sample mechanical and textural properties which define consumer acceptability of the product (Castello *et al.,* 2009). Current technologies employ sucrose for osmotic dehydration of fruit. However, in terms of health consumption of such fruit products is not ideal because of the high glycemic index of sucrose and increased chances of developing type II diabetes.

Infusion of fruits with neutraceutical and health regulatory components enhance the functionality of the product. A study on osmotic dehydration of coconut slices with the impregnation of mint extract has been conducted by Sivasakthi and Narayanaswamy (2012) and reported to have favorable results in increasing the storage and shelf life of the product with in desirable stand and limits. A similar study on infusion of fruits with neutraceutical components to enhance the functionality of the pineapple product has been reported (Jissy *et al.,* 2012). Most of the work on sapodilla is related to the nutritive value of the fresh fruit and its preserved products viz., jams, jellies, etc., but little information is available regarding the dehydration of fruits and storage quality of dried sapodilla. Hence, the study was undertaken with a work objective of optimizing the selected process parameters, developing sapodilla flakes using different formulations of infusion media and evaluating the quality characteristics during storage.

MATERIALS AND METHODS

Sapodillas (*Manilkara zapota*) were obtained from local market. To ensure homogeneity of sample, they were selected according to their quality attributes such as uniform degree of maturation, size and free from defects. The fruits were washed with clean water, manually peeled and cut in slices of 2.5 mm thickness for osmotic dehydration.

Osmotic Treatment

An acqueous sucrose and maltodextrin solutions were used as dehydrating agents. Osmotic solutions were prepared by blending different combination of solutes. To enrich the medium, basil leaves (*Ocimum bacilicum*) at 0.5% concentration were introduced into the media. The prepared fruit slices (2.5 mm) were immersed in the mentioned infusion media at 30 °C temperature. The weight ratio of solution to fruit was 1:2, to avoid the dilution of the medium. The beaker was covered with a sheet of aluminium film to prevent evaporation of syrup. The system was maintained at the selected temperature by immersion in a constant temperature water bath. The flakes were prepared using 100% sucrose solution (control), 100% maltodextrin solution, 50:50 and 30:70 proportions of sucrose and maltodextrin respectively with and without the infusion of 0.5% of basil leaves and were coded as A_1, A_2, B_1, B_2, C_1, C_2, D_1 and D_2.

Optimization of Process Parameters

Preliminary infusion process was conducted at 30 °C in 40° Brix, 60° Brix and 80° Brix solutions at different osmosis periods (2 h, 4 h and 6 h). The solutions were stirred at an interval of 15 minutes to stimulate an ongoing osmotic process. Samples were withdrawn from the osmotic solution after the determined time, drained and dried with filter papers to remove adhering solution from the surface of the slices. The weight of the samples (i.e., slices) and volume of the osmotic solution were measured prior to immersion and after the specified time.

Preliminary quantitative analysis was carried out to determine the moisture content of the samples. After the analysis, 4 hrs soaking time with 60° Brix concentration were found best to obtain the fruit with desirable characteristics and further used for the development of sapodilla flakes. Sapodilla flakes were prepared by convective air drying of the osmotically dehydrated sapodilla slices. The sapodilla flakes prepared from the selected treatments were stored in LDPE pouches and qualitative, microbial and sensory analysis were conducted periodically at different storage periods.

Mass Transfer Mechanism

The overall mass transport data namely, mass reduction, water loss, sugar gain and soluble solid concentration were used to indicate the overall exchange of solute and water between sapodilla slices and infusion media. Weight Loss (WL), Solid Gain (SG) and Mass Reduction (MR) of the samples were done by using the method given by Panagiotou *et al.* (1998). The amount of water loss, solid gain and mass reduction after infusion and oven drying of sapodilla was calculated as follows:

$$Water\ loss(\%) = \frac{(M_0 - m_0) - (M - m)}{M_0} \times 100$$

$$Mass\ reduction(\%) = \frac{M_0 - mass\ at\ time(T)}{M_0} \times 100$$

$$Solid\ gain(\%) = \frac{(m - m_0)}{M_0} \times 100$$

where, M_0 is the initial weight of fruit before infusion (g), M is the weight of fruit after infusion (g) and m_0, m are the dry matter content of untreated fruits (g) and infused fruits.

Quality Analysis

Moisture content of the sample was determined by the method given by Jissy *et al.* (2012). Dehydration and rehydration ratio of the samples were determined using the method given by Ranganna (2002). TSS was determined by using the method given by Jissy *et al.* (2012) using digital refractometer (Atago, Model PAL-1 Japan make) having range of 0-53°Brix. The increase in absorbance of sample extract at 440 nm was taken as a measure of non enzymatic browning (Berwal *et al.*, 2004). The titrable acidity of samples were analyzed by the method developed by Ranganna, (2002). Reducing sugars and total sugars were estimated by Lane and Eynon method (Rajarathnam and Ramtake, 2011).

For antioxidant assays, samples (1 g) were crushed using a mortar and pestle and transferred into a 25 ml volumetric flask and made up the volume to 25 ml with methanol. The mixture was shaken manually and was kept overnight and filtered under suction. The filtrate was transferred to a 50 ml volumetric flask and made up the volume up to the mark. Vitamin C content was estimated by the method given by Ranganna (2002). Total phenol content was determined by Folin-Ciocalteu's method given by Singleton and Rossi (1965). The yeast and mold count of the fruit was determined by pour plate method using Potato Dextrose Agar (PDA) as a media as described by Aneja (2001) and expressed as log cfu/g of sample.

Statistical Analysis

The data were reported as average of triplicate observations. To investigate the significant differences amongst the average values of treatment and duration, ANOVA and Duncan's Multiple Range Test (DMRT) were applied using SPSS VERSION 18.0 package.

RESULTS AND DISCUSSION

Mass Transfer Mechanism in Sapodilla

Changes in Water Loss (%WL) and Solid Gain (%SG)

Mass transfer in osmotic dehydration is a combination of simultaneous water loss and solute uptake. Sucrose, maltodextrin and combination of the both in different proportions, with and without the addition of basil leaves as a means of dewatering showed a significant effect on water loss and solid gain (Table 1). Over all infusion process for all the treatments resulted in removal of half the moisture content of fresh sapodillas (60-70%). Maximum reduction in water content (%WL) was observed in sucrose medium (A_1 and A_2). It was observed that the water loss was lowest in maltodextrin infused samples (B_1). A significant influence of solutes were observed in solid gain (SG%) of sapodilla slices. Maximum solid gain was observed in sucrose infused samples (A_1 and A_2) and minimum in combined infusion medium of sucrose and maltodextrin (C_2 followed by D_2).

The results indicated that the solute uptake was a function of water content in the fruit, and also the type of solutes and its concentration. Studies reported that temperature has a significant influence on the rate of osmosis. However, in the present study this factor had not been taken into consideration and the infusion process was carried out at constant 30 °C temperature. From the study, it can be noted that the reduction in the moisture content of the infused fruits may be attributed to large osmotic driving force difference between the cell sap of the fruit and the surrounding hypertonic infusion medium. Similar observation was noted for osmotic dehydration of watermelon fruit (Falade *et al.*, 2007).

Table 1: Effect of Osmotic Dehydration on % Mass Transfer Mechanisms of Sapodilla Slices

Treatment	WL (%)	MR (%)	SG (%)
A_1	43.4	40.6	2.8
A_2	37	34.7	2.3
B_1	26.3	29.5	-3.2
B_2	28.1	32.1	-4
C_1	31.2	30	2
C_2	34.9	39.8	-4.9
D_1	28.9	29.2	-0.3
D_2	32	33.6	-1.6

Note: Values are mean±S.D, n = 3.

Dehydration Ratio

Dehydration ratio studies on the developed sapodilla flakes with different treatments revealed a significant difference among the treatments which could be due to the use of different solutes in different proportions and added additive in the infusion media (Table 2).