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Development of Value Added Product from Cashew Apple using Dehydration Processes

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Cashew apple, rich in Vitamin C is known as unconsumed product because of its astringent and acrid principles. Heavy toll of Cashew apple are being wasted annually because the focus was on nuts alone. This unconsumed product was processed into value added product with improved consumer acceptability by osmo-dehydration of them in a50% sucrose solution (fruit: syrup ratio 1:4) fortified with 2% $CaCl_2$ for 12 hrs at 30°C and drying in a hot air dryer for 48 hrs below 60°C.The dried product packed under vacuum in a nylon packaging, showed shelf life of 6 and 10 months at 30°C±2 and 4°C respectively. Phosphorus, ash, fiber content and total acidity of dried product found to be remained almost the same as the original. Retained ascorbic acid contents were nearly 63%. The estimated medians for color, taste, aroma, crispness and overall acceptability above 6 in 7-point Hedonic scale.

Keywords: Cashew Apple, Improved Consumer Acceptability, Longer Shelf Life, Osmo-Dehydration, Value Added Product

Introduction

Cashew apple (*Anacardiumoccidentale L.)* is rich in Vitamin C and minerals (i.e., Ca, P, Fe). Despite its high nutritive values and economic potential, it has been known as a virtually unconsumed product, due to its astringent and acrid principles[1]. Processing this unconsumed waste product into a value added product with improved consumer acceptability and longer shelf life, can generate healthy profit with minimum investment cost. In this regard, osmo-dehydration is highly beneficial and effective technique which facilitates the processing of preserving its initial colour, aroma and nutritional compounds[2, 3, 4]. The objective of this work was to optimize the conditions for osmotic dehydration to improve consumer acceptance of cashew apple removing its astringent and acrid properties and to establish the drying, packaging and storing condition in order to obtain a longer shelf life.

Material and methods

Cashew apple (half ripen) freshly obtained from a local fruit garden, washed thoroughly under running water, followed by distilled water and cut into 0.5cm thick slices with average diameter of ~ 5 cm. Commercial sucrose was purchased from local market. All the experiments were done twice in triplicate. Mean and the Standard deviation were calculated.

Optimization of conditions for osmotic dehydration process

Effect of the concentration of hypertonic solution and the immersion time

Pre- weighed slices were immersed in different concentration of sucrose solutions ranging from 30% to 70% for different immersing times (3, 6, 9 and 12 hrs) maintaining the ratio of the fruit samples to sucrose solution at 1:4 (v/v). After the due immersion times slices were removed, drained and washed under running water for 2 min. to eliminate the excess syrup and dried with blotting papers. Weight of the fruit samples were recorded and dried in an oven at 105°C until, the weight became constant.

Effect of ratio of fruit samples: osmotic solution on osmo-dehydration process

Fruit slices were immersed in 50% sucrose solution for 12 hrs at different ratio of fruit samples: osmotic solution 1:1, 1: 2, 1:3, 1:4 and 1:5 v/v. All the Other treatments were exactly as above.

Effect of mechanical treatment on the osmotic dehydration process

Two shapes of samples were prepared. - disk shape 0.5cm thickness diameter ~ 5cm and Cube shape

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average thickness 0.4cm length 1.5cm. Disk shape samples -3 sets prepared. Set I -control (no any other mechanical treatment). Set II with ten pin holes evenly, set III cut into two (half disk shape). Pre-weighed fruit samples were immersed in 50% sucrose solution 12 hrs (ratio of fruit samples: osmotic solution 1:4). After 12 hrs of osmo-dehydration, all the other treatments were exactly as above.

Composition of the hypertonic solution

Composition of the hypertonic solution (40% sucrose) was changed by adding NaCl and $CaCl_2$ as follows.5 sets were prepared. Set I –control (no NaCl or $CaCl_2$) Set II and III- 40% sucrose with 1% and 2%NaCl (w/v) respectively.Set IV and V 40% sucrose with 1% and 2% $CaCl_2$ (w/v) respectively. Pre- weighed the fruit slices were fully immersed in each solution for 12 hrs maintaining the ratio of fruit samples: osmotic solution at 1:4. All the Other treatments were exactly as above. Experiments were repeated in the same way under the same condition with sucrose 50% and 60%.

Drying of the osmo-dehydrated products

Samples were osmo-dehydrated under optimized conditions (immerse in 50% sucrose solutions, with and without $CaCl_2$, 2%for 12 hrs). To obtain self stable product, osmo-dehydrated products were further dried by two methods, freeze drying and hot air drying for 48 hrs .Hot air dryer temperature ~ 60°C speed of the fan inside the dryer is ~1200rpm.

Packaging

Four sets of Samples were placed in nylon packaging bag, sealing two sets under vacuum and other two under nitrogen. Out of two sets sealed under vacuum one set stored at room temperature at 30°C and other set at 4°C.Similarly, for the two sets sealed under nitrogen one set stored at room temperature 30 °C and other set at 4 °C. In the same way another four sets of samples were placed in an Aluminum foil laminated low density poly ethylene bag packaging and storing were done as above.

Chemical analysis

Chemical analysis were done for all type of samples. All the experiments were done in triplicate. Moisture content, ascorbic acid content, total ash, crude fiber content and total acidity were determined following AOAC methods.

Determination of moisture content

Fruit samples was dried for 1 hr in the oven at 105°C until the constant weight was obtained, cooled in a desiccators and measured the weight (AOAC method 934.06).

Determination of total ash content

Fruit sample was heated at temperature near 105°C until moisture expelled. Then transferred to furnace and heated at 550°C until the ash is visibly free from carbon particles (AOAC method 940.26).

Determination of crude fiber

Fruit sample (2.00 g) transferred to a 500 ml beaker which contained H_2SO_4 (1.25%, 200 ml) and boiled for 30 min over a hot plate. Distilled water (200 ml) was added. The hot solution was filtered; residue was washed with hot water and transferred to a 500 ml beaker which contained NaOH (1.25%, 200 ml). Content in beaker was boiled as quickly as possible and gentle ebullience was maintained for 30 min. It was filtered through filter paper and residue was transferred by washing with HCl (1%) followed by distilled water and small amount of rectified alcohol and diethyl ether. Residue was transferred quantitatively to a tarred crucible, dried in an oven, cooled and weighed. Then it was incinerated at 550°C and cooled and weighed (AOAC method 962.09).

Determination of Calcium content (AOAC 984.27)

HCl (10%, 1.00 ml) and distilled water (10.00ml) were added to the ash. Then the solution was filtered, filtrate was transferred to a 100 ml volumetric flask and top up to 100.00 ml .Series of standard solutions (1, 2, 3 and 4 mgL^{-1}) were prepared for calibration. Calcium in fruit samples were quantified by Atomic Absorption Spectrometer (GBC 932 plus, Germany).

Determination of phosphorus content

Working standard solutions changing from 10 to 60 μg/ml were prepared by diluting $NaH_2PO_4$1mg/ml stock solution. Molybdovanadate reagent (5.00 ml) was added to 10.00ml of each working standard solution immediately and the absorbance was measured at 400 nm after 10 min. The ash obtained in above step was dissolved in HCl (3M, 10.00 ml),diluted up to 100 ml and the absorbance was measured at 400 nm after treating with molybdovanadate reagent (5.00 ml) as above. The concentration of phosphorus was calculated using the calibration curve (AOAC method 970.39).

Determination of total acidity (titratable)

Fruit sample (10.00 g) was well pulped and mixed in blender. Distilled water (25.00 ml) was added and then boiled. After 5 min, distilled water (10.00 ml)

was added to the content and transferred it into 100 ml volumetric flask, cooled and diluted up to the 100 ml mark. Prepared solution (25.00 ml) was taken in to the titration flask and few drops of phenolphthalein were added and titrated with NaOH (0.1 M) until the pink color was persisted (AOAC method 942.15).

Determination of ascorbic acid (AOAC method 967.21)

Sample assay solution (1.00g) was dissolved in Metaphosphoric acid - acetic acid solution (5.00 ml) and titrated with the indophenol solution until the color changed to pink. Same experiment was repeated with Ascorbic acid standard (200 µg/ml) solution (1.00 ml).

Microbial Analysis

Bacterial count and Yeast and mold count were analyzed by - pour plate technique separately

Fruit sample (1.00 g) was homogenized with sterile peptone salt (9.00 ml) by using stomacher for 2 min. The suspension (1.00 ml) was transferred in to 9.00 ml of peptone salt diluents. Dilution series up to 10^{-2} was prepared. Exactly 1.00 ml of each dilution was transferred medium. For the bacteria, the inoculums were mixed with plate count agar (PCA), allowed to set and incubated for 1 day at room temperature. For fungi the inoculums were mixed with potato dextrose agar (PDA), allowed to set and incubated for 3 days at room temperature.

Sensorial evaluation

Quality of dried samples (hot air dried, freeze dried and hot air dried sample with $CaCl_2$ and control were analyzed by 20 panelists. A structured 7- point hedonic scale was used to evaluate the acceptance of the product with respect to attribute of aroma, flavor, texture, color and overall acceptance. Evaluators were requested to give marks from 1 to 7 considering 1 is the lowest mark can be given and 7 are the highest. 1: Dislike extremely2: Dislike very much3: Dislike slightly4: Neither like nor dislike 5: Like slightly6: Like very much7: Like extremely

Results and Discussion

Effect of osmo-dehydrating conditions on mass transfer

Analysis of mass transfer indices i.e. water loss, (WL) and solid gain indicated that concentration of osmotic solution and immersion time has a significant influence on the loss of water and solid gain. Mass transfer during osmotic-dehydration is affected by several factors. They are temperature and concentration of the osmotic solution, type of osmotic agent, agitation of the osmotic solution, time duration, geometry (size) of the food material, variety of the food material, osmotic solution and the food mass ratio, physico-chemical properties of the food and operating pressure[4]. Increase in solute concentration resulted an increase in osmotic pressure gradients hence higher water loss and higher solid gain can be observed through the osmosis period[3, 4, and 5]. In the present study also, percentage of water loss and solid gain increases with increasing concentration of osmotic solution (Figure. 1 and 2). But at higher solute concentration for eg. at 60% -70% concentration rate of water loss has been slowed down, this could be due to dense solute-barrier layer formed at the surface of the food material. As presented in Figure.1 highest water loss was observed at 60% and 70% sucrose concentration which immerse for 12 hrs. However, the products obtained at 60% and 70% sucrose concentration were found to be too sweet than one in 50%. Hence, 50% sucrose concentration was selected as the suitable concentration for the study. The water loss that observed during 3hr time period in the present study is well consistent with the work done by Akbarian *et al*[3] and Yadav and Singh[4]. Sucrose is

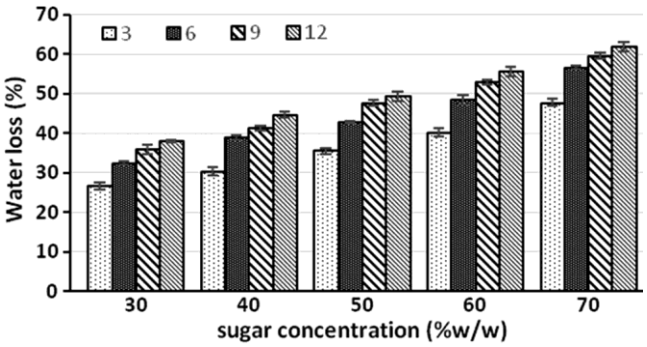

Fig. 1—Water loss under different sugar concentration and the immersion time

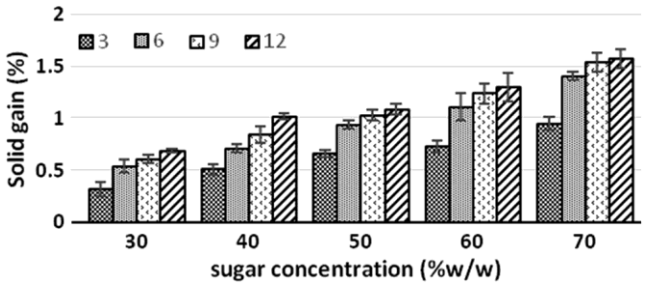

Fig. 2—Solid gain under different sugar concentration and the immersion time

cheap and provides better consumer acceptance than the other osmotic agents such as corn, and fructose syrup. Hence sucrose was selected as the osmotic agent. Studies with different fruit: syrup ratio (by volume) indicated that fruit: syrup ratio 1:4 provide higher water loss (results not shown) retaining the quality of the product. Akbarian *et al*[3]also revealed 1:4 or 1:3 is the better ratio for mass transfer during the osmotic process. Studies on mechanical pre-treatment method also revealed that maximum water loss can be seen in cube and half disk shapes. This may be due to higher surface area exposed to hypertonic solution.

Effect of the composition of hypertonic solution on the osmotic dehydration process

Sugar and salt solutions proved to be the best choices based on effectiveness, convenience and flavor. Hence effect of NaCl as well as the effect of $CaCl_2$ on the water loss, crispiness and consumer acceptance of the final product was investigated. Osmo-dehydration in a 50% sucrose solutions supplemented with 1-2%NaCl as well as with 1-2% exhibit higher water loss than the control (Figure. 3 and Figure. 4).Samples immersed in 50% sucrose solution supplemented with $CaCl_2$provide crispiness and better consumer acceptance than the samples in the solution treated with NaCl. Previous reports also indicate that dipping in 1% $CaCl_2$ contribute to crispiness and helps to maintain textural properties of osmo-dehydrated food[6]. In all samples, Moisture content of hot air dried samples were found to be less than freeze dried sample (Table 1) Phosphorus, ash and fiber content and total acidity of dried products found to be very similar to that of fresh fruit. Retained moisture and ascorbic contents of hot air dried samples fortified with $CaCl_2$were (table 1) nearly 8% and 62% respectively. Ascorbic acid content of freeze dried samples was little less (~5%) than fresh fruit. Moisture and ascorbic contents of hot air dried samples treated with Ca and non-treated with Ca were closely resemble to each other. Retained ascorbic acid content in the present study is nearly 63%. This value is very close to that reported in Da Silva *et al*.[7]. At temperatures, above 40°C loss of ascorbic acid is reported to be high. At low temperature, ascorbic acid losses may be attributed to the leaching of vitamin C from product to the osmotic solution. At higher temperature, chemical degradation as well as the diffusion to the osmotic solution seemed to be most significant phenomena. Hence, maintaining low temperature during the osmotic process help to retain nutritional quality of the product minimizing nutrition lost[5, 8]. Ca content of the final hot air dried fortified with $CaCl_2$ product is ~ 22mg/100g which is well below than the recommended daily intake. Recommended daily intake of Ca ~ 1.0-1.2g. Therefore, Ca content of the final product is in the safe level. Microbiological analysis revealed that microbial count of hot air dried vacuum packed samples were negligible and dried product was microbiologically safe for direct consumption.

Sensory Evaluation

As the data given table 2 highest overall acceptance score is received for the hot air dried samples treated with $CaCl_2$, owing to its crispiness, aroma and improved color and the taste.

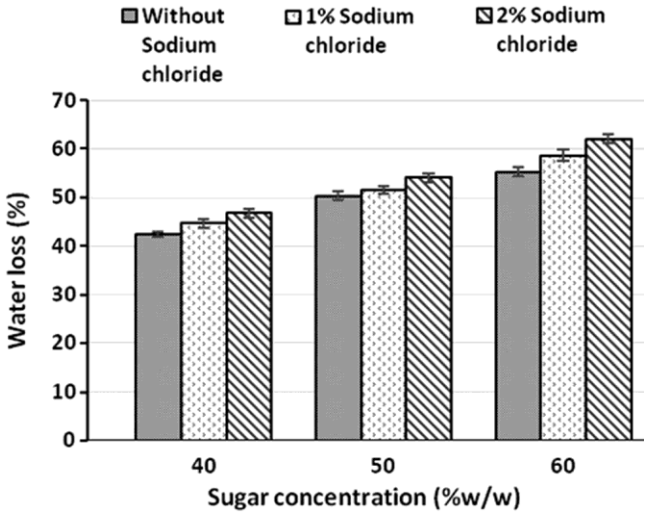

Fig. 3—Water loss during 12 hr immersion period for different concentrations of sucrose solutions supplemented with different level of NaCl

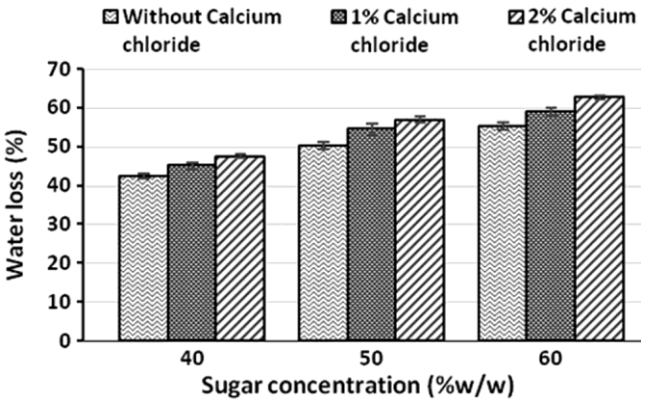

Fig. 4—Water loss during 12 hr immersion period for different concentrations of sucrose solutions supplemented with different level of CaCl2

Table 1—Moisture, ash, calcium, fiber, ascorbic acid, phosphorous contents and total acidity of dried cashew sample

	Fresh fruit	Osmo-dehydrated fruit	Freeze - dried fruit	Hot air - dried fruit	Hot air - dried fruit with $CaCl_2$
Moisture content (%)	79.29±1.13	21.39±0.96	9.73±0.25	7.58±0.30	6.39±0.35
Ash content	0.5320±0.0207	0.4757±0.0251	0.3847±0.0151	0.4298±0.0307	0.4796±0.0127
Total acidity	2.85±0.26	2.40±0.11	2.80±0.12	2.65±0.18	2.45±0.14
Calcium content (mg/100 g)	1.914±0-144	1.825±0.131	1.977±0.078	1.725±0.152	22.630±1.117
Ascorbic acid content(mg/100 g)	111.17±1.55	104.50±1.10	105.22±1.11	69.87±0.50	68.79±0.61
Phosphorus content(mg/100 g)	111.17±1.55	104.50±1.10	105.22±1.11	69.87±0.50	68.79±0.61
Fiber content	0.5320±0.0207	0.4757±0.0251	0.3847±0.0151	0.4298±0.0307	0.4796±0.0127

Table 2—Means obtained in the Sensory Evaluation Testing.

Treatment	Color	Texture	Aroma	Taste
A	1.90 [a]	1.35 [a]	3.40 [a]	2.90 [a]
B	4.55 [b]	4.35 [b]	3.10 [a]	3.75 [a]
C	6.90 [c]	6.60 [c]	6.75 [b]	6.85 [b]

[a, b, c] Means with the same exponent in the same column are not different (Mean differences are not statistically significant at 95% confidence level – p value greater than 0.05). Analysis Method: One-way Repeated Measures ANOVA.A –Hot air dried sample B-Freeze dried sample C-Hot air dried sample with calcium chloride.

Conclusion

Osmo-dehydration in 50% sucrose containing 2% $CaCl_2$and subsequent hot air drying can be improved overall acceptance and self stability of Cashew apple. Samples packed under vacuum found to posse's higher self stability than the samples packed under nitrogen. Freeze dried samples, packed under vacuum retained nearly 4 month shelf life. Product obtained from hot air drying can be preserved up to 6- 10 months depending on the packaging material and storage condition. The hot air dried product packed under vacuum in a nylon packaging, showed shelf life of 6 and 10 months at 30 °C±2 and 4 °C respectively.

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