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INFLUENCE OF OSMOTIC AGENTS ON DRYING BEHAVIOR AND PRODUCT QUALITY OF GUAVA FRUIT

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Abstract

Fruits and vegetables are very perishable due to their high water content. Water content is removed by the osmotic dehydration process from low concentration to higher concentration, which increases the shelf life of fruits and vegetables. Osmotic dehydration has better retention properties like flavor, taste and vitamins and mineral than others that is why it is a preferable process to increase the shelf life of fruits and vegetables. This present study was carried out to find out the effects of solutions type and concentration on the osmotic dehydration of guava. In this study, sucrose (40, 50 and 60°B); salt (5, 10 and 15%) and sucrose: salt (combine) solutions (40°B:10%, 50°B:10% and 55°B:10%) were used. Among different solution concentration and 6 hrs contact time 55°B: 10% (T_9) at 50°C gave highest, water loss 89.7%, solid gain 13.79% and normalized solid content 2.43%. It was also found that there is not very much difference between mineral content, a slight increase in acidity and degradation in ascorbic acid content on the storage at ambient temperature after 45 days. It can be concluded from this study that solution type and concentration were the pronounced factors affecting solid gain, water loss and normalized solid content of guava slice during osmotic dehydration. Sensory analysis showed that product obtained after osmotic dehydration with sucrose: salt (combine) solution (55°B: 10 %) was best followed by sucrose 50°B and 10% salt solution.

Key words : Normalized solid content, Osmotic dehydration, Water loss, Guava.

Introduction

Guava (*Psidium guajava* L.) is one of the most common and popular fruit with high dietary fiber and nutritional value. Guava is a native of tropical America and guava growing countries are Cuba, Brazil, Mexico, Southern China, India and Malaysia (Pedapati and Tiwari, 2014). India is one of the largest producers in the world. Guava is acommon fruit crop of India and called the ‘Apple of the Tropics” (Surendar *et al*., 2016). In India, the total production of guava was 36.67 lakhtones in 2014-15 and major producing states are Maharashtra, Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal, Punjab, Gujarat & Karnataka. Allahabad Safeda, Lucknow 49, Chittidar, Nagapur Seedless, Bangalore, Dharwar, AkraM-ridula, ArkaAmulya, Harijha, Hafshi, Allahabad Surkha CISHG1, CISHG2, CISHG3 are the main cultivars cultivated in India (NHB database, 2014).

Guava contains 74–87% moisture, 13–26% dry matter, 0.5–1% ash, 0.4–0.7% fat and 0.6–1.5% protein (Bashir and Abu-Goukh, 2003). It is a rich of ascorbic acid, at levels far higher than most imported and local fruits. Some other vitaminssuch as vitamin B complex are also found in the fruit. Additionally, it also contains adequate amount of phosphorous, calcium, iron, potassium and sodium (Kwee and Chong, 1990). Guava, as in many other fruits and vegetables, is also rich in antioxidants that help to reduce the incidence of degenerative diseases such as arthritis, arteriosclerosis, cancer, heart disease, inflammation, and brain dysfunction. Antioxidants were reported to retard ageing besides preventing or delaying oxidative damage of lipids, proteins and nucleic acids caused by reactive oxygen species (Feskanich *et al.*, 2000; Gordon, 1996; Halliwell, 1996).

Guava is a seasonal fruit with very short shelf life therefore, it is required to make a self-stable value added products by using simple drying technology. There are several techniques of preservation or processing available for fruits and vegetables that can increase their self life

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like drying, freezing, canning and osmotic dehydration. Teles *et al*. (2010) reported that the osmotic dehydration represents a technological alternative to reduce post-harvest losses of fruit. It involves dehydration of fruits slices in two stages, removal of water using as an osmotic agent and subsequent dehydration in a dryer to make the product shelf-stable (Yadav and Singh, 2014). In this process, the solutes used are generally syrup and /or brine solution. In this process, water flow from fruits or vegetables to solution and along with water some component of fruits or vegetables such as minerals, vitamins and fruit acids etc. also moves towards solution. It results in quality improvement in terms of color, texture, flavor, product stability and prevention from microbial spoilage (Tiwari, 2005). However, product quality were influenced by factors like pretreatment, nature and concentration of osmotic solution, quality of raw material, maturity of fruits, shape and size of slices, duration of osmosis, sample to syrup ratio, agitation, temperature and additives added (Yadav and Singh, 2014).

So, the present study focus on application of two osmotic agents like sugar and salt with different concentration and combination of themon Guava fruitand the quantification of the changes occurred with respect to the water loss, moisture content, sugar gain, normalized solid content, ascorbic acid and their sensorial effect on guava.

Materials and Methods

Materials

Guava cultivars (Safeda and Chittidar) were collected in January 2017 from Khushrobagh Allahabad Uttar Pradesh, India. The fruits were selectedat maturity according to their resemblance in color, size. Fruits were washed, peeled and then cut into 2-2.5 cm slices manually using stainless steel knife. All chemicals were of analytical grade and all water used was deionized.

Osmosis of guava slices

For the osmotic dehydration the prepared guava samples were weighed approximately 100 gm for each experiments and immersed in sucrose and salt solution *i.e.* T_1 (40°B), T_2 (50°B), T_3 (60°B) sucrose T_4 (5%), T_5 (10%), T_6 (15%) salt and of T_7 (40°B/10%), T_8 (50°B/10%), T_9 (55°B/10%) sucrose-salt combined solution in a 500 ml conical flask. The flasks were placed inside the shaking water bath at 50^{0}C. Samples were removed from water bath after 6 hours, and were immediately washed with running water and placed on tissue paper to remove the surface moisture before weighing. And then these guava slices were oven dried for better results at 40^{0}C for 3 hrs (Alam, Islam and Islam, 2013)

Physico-chemical characteristics

Total soluble solids of fresh and osmotic dehydrated guava were done by refractometer (Rangana, 2000). Moisturecontent fresh andosmotic dehydrated guavas were analyzed by hot air oven method (AOAC, 2016). Ascorbic acid content was estimated by 2, 6 dichloroindophenol titration method (AOAC, 2016). Acidity was determined by titrametric method and expressed as percent citric acid (AOAC, 2016), whereas iron, phosphorus and calcium content of fresh and dried guava samples were performed by spectroscopic and titration method, respectively (Rangana, 2000).

Characteristics of osmotic dehydrated guava slices

Osmotically dehydrated guava slices were taken from each solution and analyzed for water loss (WL), solids gain (SG) using the following equations:

Solid gain (g/g) = $(M_f\text{-}S_o)/S_o$ (Eq.1)

Water loss = $[(M_o\text{-}S_o) - (M_{od}\text{–}Mf)]/\ M_o\text{-}S_o$ (Eq.2)

Where, M_o = Initial sample weight before osmotic dehydration (g); M_{od} = Sample weight after osmotic dehydration at time (g); M_f= Final weight of dried sample (g); S_o = Initial solid content (g).

Normalized solid content of the samples do affect the final weight of the sample and it is calculated by mass of total solid at any time divided by initial mass of total solid (Hawkes and Flink, 1978).

Rehydration ratio and dehydration ratio

Rehydration ratio and dehydration ratio of osmotic dehydrated samples was done. For rehydration sample was cooked in a beaker 1:10 (dehydrated sample: water) for 20 minutes and then allowed it to cool at room temperature and computed by following equation:

Rehydration ratio = Weight of reconstituted sample/ Weight of dehydrated sample. (Eq.1)

Dehydration ratio was calculated by taking the weights of sample before drying and the weight of sample after drying and calculated by mass of sample before drying/mass of sample after drying (Rangana, 2000).

Sensory analysis

Sensorial effect of osmotic dehydration was done by 9 point hedonic test. The sensory evaluations for assigning scores for sensoryattributes of samples were conducted by a panel of five judgesand the recipes were rated on a 9- point hedonic scale for color, flavor and texture (Mudita *et al*., 2015). The products were stored at ambient condition and the shelf life was judged.

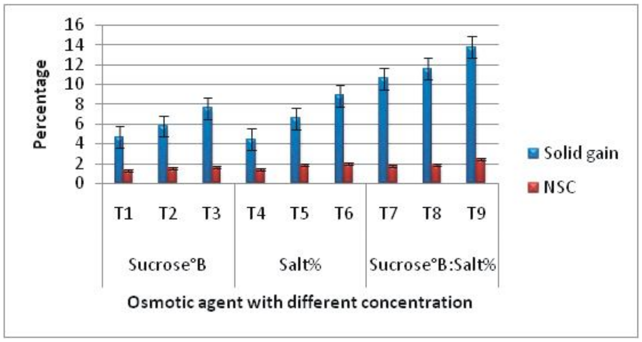

Fig. 1 : Change in solid gain and normalized solid content (NSC) of guava slice different osmotic solutions after 6 hrs.

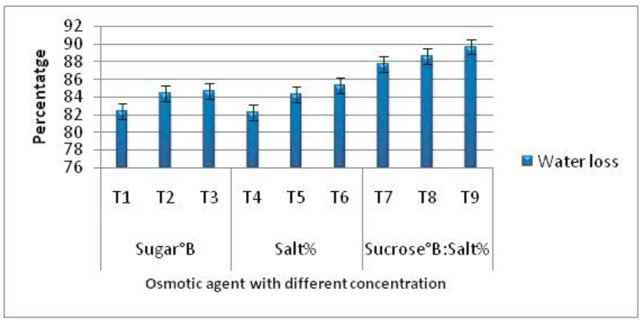

Fig. 2 : Change in water loss of guava slice different osmotic solutions after 6 hrs.

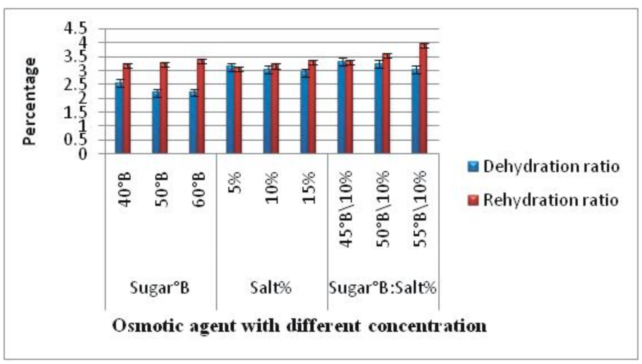

Fig. 3 : Change in dehydration and rehydration ratio of guava slice different osmotic solutions after 6 hrs.

Statistical analysis

The influence of osmotic agents and their concentration (sucrose and salt) on water loss, sugar gain, mass reduction, acidity and ascorbic acid content were analyzed. All the experiments were carried out in replicate.

Results and Discussion

Moisture, total soluble solids, ascorbic acid, mineral contents (Calcium, Iron and phosphorous) and acidity of fresh guava are as follows; 83.51%, 8.4%, 378.6 mg/100g, (50.15 mg/100g, 15.6mg/100g, 30.45 mg/100g), 0.9g/100g in terms of citric acid, respectively.

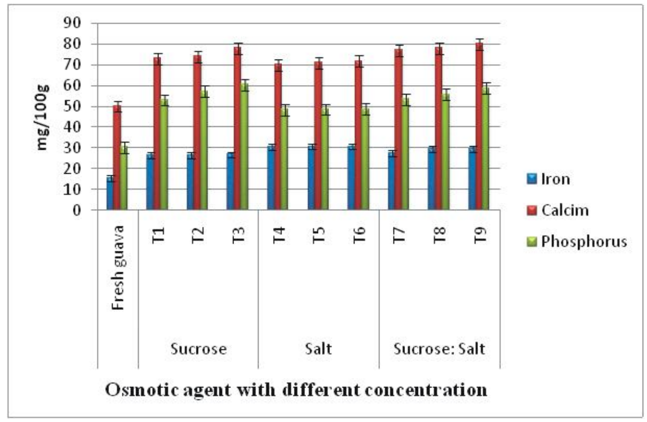

Fig. 4 : Mineral content of fresh and osmosed guava slices with different osmotic solutions after 6 hrs.

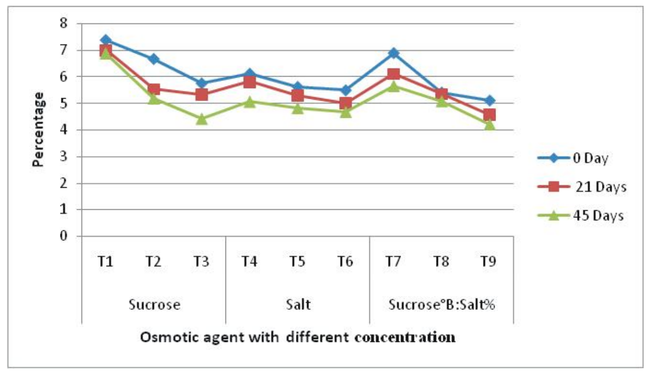

Fig. 5 : Degradation in moisture content of osmosed guava slices after 45 days storage at ambient temperature 25±2^{0}C.

Effect of solution concentration on water loss, solid gain, normalized solid content, rehydration and dehydration ratio

The effect of all the solutions and their concentrations on the percent of solid gain, water loss andnormalized solid content (NSC) has been shown in figs. 1 and 2. It is found that theconcentration of sucrose have positive effect on the percent water loss (WL). Simultaneously, percentsolid gain (SG) also showed the same pattern with increased concentration of sugar.After 6 hrs of osmosisperiods the highest water loss (89.7%), NSC (2.43%) and solid gain (13.79%) are given by T_9 i.e. 55^{0}B:10% sucrose: salt solution and is closely followed by T_8solution with 88.6% WL, NSC (2.27) and 12.58% SG, while the lowest water loss (81.3%), NSC (1.06) and solid gain (4.45) are shown in5% solution followed by 40°Brix sucrose solution. Similar trends in results were also found by Falade, Akinwale and Adedokun (2003) and Alam, Islam and Islam (2013). Tsamo *et al*. (2005) reported that a binary solution of sugar: salt showed the highest dehydration capacity with high proportion of water elimination and gain of solutes more than solute loss.

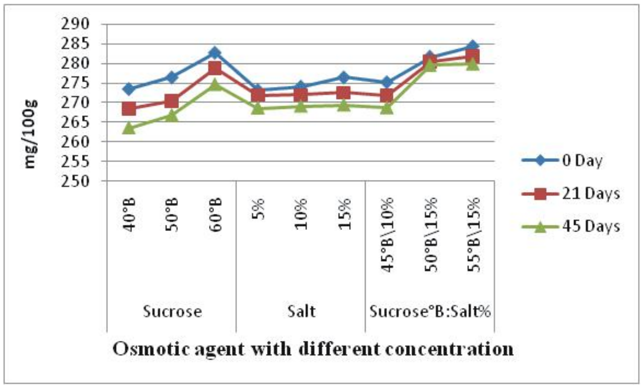

Fig. 6 : Degradation in ascorbic acid content of osmosed guava slices after 45 days storage at ambient temperature 25±2^{0}C.

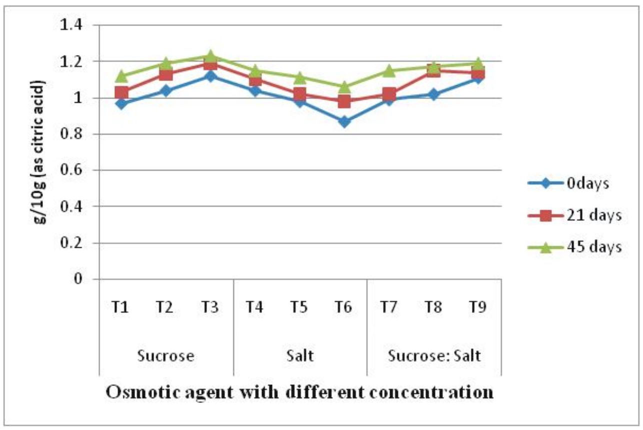

Fig. 7 : Degradation in titratable acidity of osmosed guava slices after 45 days storage at ambient temperature 25±2^{0}C.

Rehydration ratio increased as the concentration of sugar increases but the mixed solution of sucrose: salt at 55^{0}B:10% (T_9) showed best results (3.91%) followed by T_8 solution. Dehydration ratio shows contradictory results with concentration of solution. It is seen that minimum dehydration ratio was found in T_9 (sucrose: salt) solution (fig. 3). After osmosis the content of iron, calcium and phosphorus in guava slices increased and it was found that iron content maximum in treatment T_6 following T_5 and T_4. While in calcium and phosphorus content T_9 shows maximum results followed by T_3 and T_7, respectively (fig. 4).

Physicochemical changes of osmotic dehydrated guava slices during storage

Effect of storage on moisture content

Moisture content of osmotic dehydrated guava slices ranges between 4.21 to 7.38%. Dehydrated guava slices were stored for 45 days at 25±2^{0}C and the tests were performed in the interval of 0 days, 21 days and 45 days storage. Effect of storage on osmotic dehydrated samples shows a clear decline with days. Fig. 5 shows that the

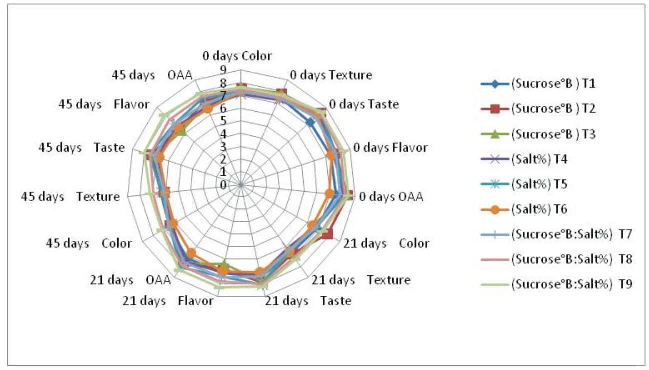

Fig. 8 : Sensory Profile of Osmotic dehydrated guava slices.

maximum moisture loss was found at the binary solution of sucrose: salt at 55^{0}B:10% sucrose solution followed by 60^{0}B sucrose solution. The moisture content in the sample reduces due to evaporation during storage (Kumar *et al*., 2016) and it can be reduces by appropriate packaging material.

Effect of storage on titratable acidity and ascorbic acid

Fresh guava fruit is a good source of ascorbic acid *i.e.* 378.6 mg/100g. The average ascorbic acid content in dehydrated slices of guava decreased after osmosis and minimum degradation was found in the solution of 55^{0}B:10%. During the storage of osmotic dehydrated guava slices maximum loss of ascorbic acid content shown by 40^{0}B sugar solution followed by 50^{0}B sugar solution. Among the brine solution the highest vitamin C content was found in 15% brine solution and maximum loss during 45 days storage at ambient temperature 25±2^{0}C showed in the same *i.e.* from 276.5mg/100g to 269.43mg/100g (fig. 6). According to El-Gharably *et al.* (2014), the main mechanism of the loss in vitamin C appears to be due to water solubility, mass transfer, heat sensitivity and enzymatic oxidation ascorbic acid to dehydro-ascorbic acid followed by further degradation to 2,3-diketogulonic acid and finally to furfural compounds. Similar reductions in ascorbic acid content have also been reported in guava beverages (Baramanray *et al*., 1995; Pandey and Singh, 1998; Pandey, 2004). Titratable acidity content of samples was seen to increase during storage and as an apparent process, the corresponding pH showed a marked decline. The change in acidity during storage might be due to ascorbic acid degradation, formation of organic acidsor hydrolysis of pectin (Chauhan *et al*., 1997). The acidity in dehydrated guava slices increased in all thetreatments during storage. At the end of osmosis process the acidity of guava slices increased from 0.90 g/100g to 1.11 g/100g. Among the all treatments maximum increase in acidity was found in

T_7 followed by T_1 (fig. 7).

Similar trends have been found in the guava jelly bar (Kuchi, Gupta and Tamang, 2014) and guava (Pandey, 2004) osmotic dehydrated guava (Surendar *et al*., 2016).

Sensory analysis

Organoleptic evaluation of the osmosed guava slices over an interval of time 0, 21, and 45 days has been represented in fig. 8. There were significant differences amongst different treatmentsat different storage durations. Treatment 9 comprising of sucrose and salt in the ratio of 55:10 was found to be the most accepted treatment for all the parameters judged followed by T_8. In this ratio of the degradation of the ascorbic acid contentwas found to be good. The product prepared using T9 concentration received maximum ratings at all three durations.

Conclusion

The osmotic dehydration method is very useful as it results in high quality product by retaining the color and flavor. The overall energy requirement in drying process is reduced substantially. In current research, the effects of sucrose concentrations on mass transfer in terms of water loss and solid gain were investigated during osmotic dehydration of guava. It was revealed that the higher values of solution concentration resulted in higher flows of water and solids and loss of weight through the guava slices. It was concluded that an increase in syrup concentration increased weight loss, moisture loss and solid gain in slices. The osmosed slices prepared by almost all the solutions have good overall acceptability. Osmotic treatment (T_9) that is ^{0}B:10% syrup for 6 hrs showed the best results in terms of highest yield and lowest drying ratio.

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