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EFFECT OF SUCROSE BRIX, DRYING METHOD AND PACKAGING MATERIAL ON PHYSICO-CHEMICAL AND ORGANOLEPTIC PROPERTIES OF OSMOTICALLY DEHYDRATED GUAVA (*PSIDIUM GUAJAVA* L.) SLICES

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Abstract–An experiment was conducted during 2012-13 and 2013-14 at laboratory of SHUATS, Prayagraj, U. P, to study the effect of sucrose brix, drying method and packaging material on physico-chemical and organoleptic properties of somatically dehydrated guava slice. The experiment was laid out in three factorial completely random design (CRD), consisting of 24 treatments in factor (a), *viz.*, SB_0: Control, SB_1: 50 ^{0}Brix, SB_2: 60 ^{0}Brix and SB_3: 70 ^{0}Brix, factor (b) DM_1: Vacuum dryer, DM_2: Hot Air oven dryer and DM_3: Solar dryer, and factor (c) PM_1: LDPE (Low density polyethylene) and PM_2: HDPE (High density polyethylene), respectively. Pooled data of experiment in treatment sucrose brix (70^0) significant and maximum moisture content (29.364 %), total soluble solid (21.85 %) and reducing sugar (5.000 %) were recorded compare to the other sucrose treatment, respectively. Analysis data of colour (7.444), flavor (7.39), overall acceptability (7.38), texture and taste (7.42), significantly the highest were recorded in the treatment SB_2: 60 ^{0}Brix, respectively. Drying method applied by the vacuum dryer treatment significantly the highest was found the physico-chemical observation *viz.*, total soluble solid (21.36 %). Further, drying method applied by the vacuum dryer treatment significantly the highest were found the organoleptic observations *viz.*, colour (7.617), flavor (7.21), overall acceptability (7.63), texture (7.77), taste (7.76) and appearance (7.43), respectively. Packaging material PM_2: HDPE (High density polyethylene) was recorded significantly the highest moisture content (28.031 %) and total soluble solid (21.07 %), respectively. Further, drying method applied by the vacuum dryer treatment significant and maximum was found the organoleptic observations *viz.*, colour (7.407), flavor (7.18), overall acceptability (7.27), texture (7.30), taste (7.36) and appearance (7.00), respectively.

INTRODUCTION

In India, the guava (*Psidium guajava* L.) is regarded as the most well-liked fruit and is referred to as an apple or a tropical fruit. After mango, banana, and citrus this is the fourth fruit, which is most important in area and production. Guava is now regarded as a fruit that makes a great commerce item. Most fruits are particularly perishable due to their higher water content, which causes postharvest losses in handling, storage, and transportation as well as monetary losses. Therefore, transformation into a stable product is required, either by canning, freezing, or drying.

The principle of osmosis is meant for removal of water, which has been known for a long time. However, the application of osmotic treatments to food can be considered among the new or improved techniques in which the main characteristics of the materials that are exposed to

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minimal thermal stress are not changed and get processed. In most of the cases, it is applied in combination to get better result of treatments and processing technique. Hence, osmotic treatments have been studied in combination with air, vaccum, freeze and sun drying pasteurizing, canning, freezing or addition of preservatives. Dehydration is the process of water removal from the food under controlled conditions like temperature, relative humidity and air flow etc. The main objective of dehydration is to reduce the bulk weight and to reduce water activity. This process is best suited for developing countries with poor thermal processing facilities.

Osmotic dehydration has received greater attention in recent years as an effective method preservation for fruits and vegetables. Being a simple process, it facilitates processing of fruits like banana, sapota, mango and pineapple, etc. with retention of their initial fruit characteristics *viz.*, colour, aroma and nutritional compounds. Osmotic dehydration is a process of water removal from fruits, because cell membrane is semi-permeable and allows water to pass through them more rapidly than sugar (Chavan *et al.*, 2010).

In the recent years interest in osmotic treatments arised primarily because of the need to get better quality product, larger storage and economics. Quality improvement is meant for removal of water without any thermal stress and also impregnation of solutes takes place with the correct choice of solutes, controlled and equilibrated ratio of water removal and impregnation process. Therefore, it is possible to enhance natural flavour and colour retention of fruit products. Osmo- dehydrated products are also called as intermediate moisture products. There is limited research work carried out in India on osmotic dehydration of Guava.

A considerable cost reduction occurs in packaging and distribution of osmotically dehydrated product due to the simple nature (reduction in product weight and volume) of osmotically dehydrated products resulting in easier handling and transportation to market. Additionally, all types of fruits and vegetables could be made available throughout the year addressing the problem of fruit glut seasons. Biswal *et al.*, (1991) stated that osmotic dehydrated fruit and vegetables prior to freezing saves packing and distribution costs. The product quality is comparable with that of conventional products. The process is referred to as "dehydrofreezing".

MATERIALS AND METHODS

Moisture content (%)

A standardization procedure was used to estimate the moisture content of guava slices. The moisture content of the sample was computed using the following equations (Sharma and Yadav, 2017).

Moisture content (Wet basis) = M_1-M_2/M_1*100

Where M_1 is the weight of sample before oven drying (g), M_2 is the weight of sample after oven drying (g) and M.C. is the moisture content of sample (% w.b). Total soluble solids (^{0}Bx)

The total soluble solid (TSS) of guava slices was measured by using an hand Refractometer and expressed as percentage after necessary corrections.

Reducing sugar (%)

Representative samples from each treatment were ground to a fine powder and preserved in 80 per cent alcohol in a refrigerator. These samples were used for the estimation of reducing, non-reducing and total sugars. The sugars from the powdered guava fruits was extracted with 80 per cent alcohol using a centrifuge at 4000 rpm and the alcohol free extract was used for the estimation of sugars as per the Dinitro-salicylic acid method (Manasa, 2018). The values obtained were expressed as percentage on dry weight basis.

Reducing sugar (%) = Factor × dilution × 100/Titre × wt. or volume of sample × 100

Factor for Fehling solution = Titre × 2.5/1000

Titrable Acidity (%)

Titrable acidity was calculated by titration in terms of citric acid with 0.1 N NaOH where 10 ml of sample was taken and dissolved to prepare the volume upto 100 ml with water. The solution was filtered through muslin cloth and 10 ml of the prepared aliquot was titrated against 0.1 N NaOH using few drops of 1% phenolphthalein indicator till the pink colour end-point persist. Result for percent anhydrous citric acid was calculated as given below:

Acidity (%) = Titre × Normality of alkali × volume made up × eq. wt. of acid × 100/Volume of sample taken for estimation × wt. / volume of sample × 1000

Sensory evaluation

The sensory evaluation for assigning scores for the samples were conducted by a panel of five judges and the product was rated on a 9 - point Hedonic scale (Manasa, 2018). The judges were kept same.

The 9-point hedonic scale is given below

9 Like extremely, 8 Like very much, 7 Like moderately, 6 Like slightly, 5 Neither like nor dislike, 4 Dislike slightly, 3 Dislike moderately, 2 Dislike very much, 1 Dislike extremely.

The overall final rating was obtained by calculating the average of the marks. "Liked moderately" rating was considered for acceptability of the products.

Statistical analysis

ANOVA was used to assess the effects of sucrose brix, drying method and packaging material on physico-chemical and organoleptic properties of somatically dehydrated guava slice. To compare the means, Fisher's least significant difference test was performed (LSD). The data collected throughout the inquiry were subjected to statistical analysis using the analysis of variance approach (Fisher, 1950).

RESULTS AND DISCUSSION

Effect of sucrose brix (Factor A)

Based on the two year pooled data (Table 1) sucrose brix (70^0) significantly the highest moisture content (29.364 %) and total soluble solid (21.85 %) were recorded compare to the other sucrose treatment, respectively. Further, significantly higher value of sucrose brix reducing sugar (5.000) was recorded. Increased solution concentration resulted in increase in the osmotic pressure gradients and higher moisture (Gani and Kumar, 2013; Manasa, 2018).

Analysis data (Table 2) of colour (7.444), flavor (7.39), overall acceptability (7.38), texture and taste (7.42), significantly the highest were recorded in the treatment SB_2: 60 ^{0}Brix, respectively. However, non significantly the highest data of appearance (6.99) was recorded under the treatment SB_2: 60 ^{0}Brix. This is due to prevention of enzymatic and oxidative browning as the fruit cubes were surrounded by sugar thus making it possible to retain good colour. Colour score of osmo dehydrated guava cubes had declined with the advancement of storage period. It may be due to absorption of atmospheric moisture, carmalization of sugar present in the product resulting brown colour of the product which effects on compositional status and it was reflected in colour acceptability (Manasa, 2018; Ahmed and Choudhary, 1995; Chavan *et al.*, 2010; Relekar, 2010, Naik, 2013). Taste score had decreased with advancement of storage period because of moisture increase and there by dilution of sugars and change in acidity in product (Chavan *et al.*, 2010; Relekar, 2010, Naik, 2013). Flavour score showed decreasing trend during storage which might be due to increase

Table 1. Effect of sucrose brix, drying method and packaging material on physico-chemical of osmotically dehydrated guava (*Psidium guajava* L.) slices

Treatments	Moisture content (%)	Total soluble solid (%)	Reducing Sugar (%)	Acidity (%)
Factor: A (Sucrose Brix)				
SB_0: Control	26.736 c	20.52 d	4.643 b	1.055
SB_1: 50 ^{0}Brix	26.840 c	21.10 b	4.869 a	1.082
SB_2: 60 ^{0}Brix	27.792 b	20.57 c	4.811 a	1.055
SB_3: 70 ^{0}Brix	**29.364 a**	**21.85 a**	**5.000 a**	1.113
F-test	S	S	S	NS
SEm±	0.175	0.076	0.086	0.023
CD (P=0.05)	0.498	0.027	0.245	-
Factor: B (Drying Method)				
DM_1: Vacuum dryer	27.915	21.36 b	4.957	1.087
DM_2: Hot Air oven dryer	27.521	20.79 c	4.759	1.063
DM_3: Solar dryer	27.614	20.88 a	4.776	1.079
F-test	NS	S	NS	NS
SEm±	0.152	0.023	0.075	0.020
CD (P=0.05)	-	0.066	-	
Factor: C (Packaging Material)				
PM_1: LDPE (Low density polyethylene)	27.335 b	20.95 b	4.822	1.063
PM_2: HDPE (High density polyethylene)	28.031 a	21.07 a	4.839	1.089
F-test	S	S	NS	NS
SEm±	0.124	0.019	0.061	0.016
CD (P=0.05)	0.352	0.054	-	-

in moisture level and decrease in taste and colour score as well as oxidation of ascorbic acid during storage (Ahmed and Choudhary, 1995; Chavan *et al.,* 2010). Texture score had decreased during storage period of four months which might be due to the absorption of moisture and hygroscopic nature of osmo-dehydrated cubes which soften the tissue in pulp (Chavan *et al.,* 2010; Relekar, 2010, Naik, 2013). The decrease in overall acceptability score may be due to absorption of atmospheric moisture, dilution of sugars and changes in acidity, oxidation of ascorbic acid, and hygroscopic nature of osmo-dehydrated cubes as well as changes in biochemical constituents of cubes.

Effect of drying method (Factor B)

Vacuum dryer (Table 1) treatment recorded highest value of physico-chemical characteristics *viz.,* total soluble solid (21.36 %). It might of due to the materials are dried in containers or enclosures, average drying temperature is much lower than the standard dryers, drying action becomes faster as heat is easily transferred throughout the body of the dryers, due to its large surface area, drying large moisture as compared to normal dryers, quality of dries material is better than that of the normal dryers (Anon. 2016).

Further, drying method applied by the vacuum dryer (Table 2) treatment significantly the highest were found the organoleptic observations *viz.,* colour (7.617), flavor (7.21), overall acceptability (7.63), texture (7.77), taste (7.76) and appearance (7.43), respectively.

Effect of packaging material (Factor B)

Packaging material PM_2: HDPE (High density polyethylene) was recorded significantly the highest moisture content (28.031 %) and total soluble solid (21.07 %), respectively. High density polyethylene products are safe and are not known to transmit any chemicals into foods or drinks, making this plastic a low health risk variety, according to chemical safety facts. This might be due to the fact that high density polyethylene packaging acted as barriers for smooth passage or diffusion of moisture to the atmosphere. The high density polyethylene packaging reduces moisture loss and respiratory activities and maintains turgidity which helps in lower the reducing sugar. The increase in total soluble solid might be due to the renovation of starch and other insoluble carbohydrates into sugars and also due to the loss of moisture content that tends to increase total soluble solid (Phimpharian *et al.,* 2011; Pravinkumar, 2012; Shakoor *et al.,* 2015).

Table 2. Effect of sucrose brix, drying method and packaging material on organoleptic properties of osmotically dehydrated guava (*Psidium guajava* L.) slices

Treatments	Colour	Flavor	Overall Acceptability	Texture	Taste	Appearance
Factor: A (Sucrose Brix)						
SB_0: Control	7.170 b	6.79 c	6.97 c	7.05 b	7.03 c	6.81
SB_1: 50 ^{0}Brix	7.291 b	7.19 b	7.03 c	7.08 b	7.15 b	6.82
SB_2: 60 ^{0}Brix	7.444 a	7.39 a	7.38 a	7.27 a	7.42 a	6.99
SB_3: 70 ^{0}Brix	7.418 a	7.20	7.22 b	7.12 b	7.25 b	6.83
F-test	S	S	S	S	S	NS
SEm±	0.030	0.031	0.046	0.024	0.056	0.059
CD (P=0.05)	0.086	0.088	0.130	0.069	0.160	-
Factor: B (Drying Method)						
DM_1: Vacuum dryer	7.617 a	7.21 a	7.63 a	7.77 a	7.76 a	7.43 a
DM_2: Hot Air oven dryer	7.096 c	7.02 b	6.83 c	6.74 c	6.89 b	6.53 b
DM_3: Solar dryer	7.279 b	7.19 a	6.99 b	6.88 b	6.99 b	6.63 b
F-test	S	S	S	S	S	S
SEm±	0.037	0.027	0.039	0.021	0.049	0.051
CD (P=0.05)	0.106	0.076	0.112	0.060	0.139	0.146
Factor: C (Packaging Material)						
PM_1: LDPE (Low density polyethylene)	7.254 a	7.10 b	7.04 b	6.97 b	7.07 b	6.73 b
PM_2: HDPE (High density polyethylene)	7.407 a	7.18 a	7.27 a	7.30 a	7.36 a	7.00 a
F-test	S	S	S	S	S	S
SEm±	0.122	0.022	0.032	0.017	0.040	0.042
CD (P=0.05)	0.043	0.062	0.092	0.049	0.113	0.119

The moisture content was found to rapidly increase in the material stored in high density polyethylene packaging which can be due to the lesser thickness of packaging material which allowed rapid moisture absorption. This is because of the easy movement of air between the samples and ambient atmosphere through the spaces of the carton boxes and so the material could easily absorb moisture from the atmosphere.

Further, drying method applied by the vacuum dryer (Table 2) recorded higher values of organoleptic parameter *viz.,* colour (7.407), flavor (7.18), overall acceptability (7.27), texture (7.30), taste (7.36) and appearance (7.00), respectively. Higher drying temperature and low moisture level in the product resulted in better texture. The texture of fruit leathers is mostly affected by their moisture content and drying temperatures (Cheman *et al.,* 1997)**.** High temperatures and long drying times are related with lower moisture content and rigid texture. Differences in texture of leathers might also be due to variations in genetic makeup of the fruit, rate of water immersion from the surroundings and protein content of the fruit amongst others (Babalola *et al.,* 2002). Overall acceptability generally related to all sensory attributes. It is stated that the suitability of fruits and vegetables is influenced by their aroma by (Karmas and Harris, 1998). Texture values tend to decrease as there is an increase in moisture content while on storage. The samples stored in high density polyethylene packaging maintained the texture properties for a longer duration followed by gunny bags. Due to increase in shearing forces mechanical properties show greater values during storage period for better packaging.

Fig. 1. (A) Osmotically dehydrated guava (*Psidium guajava* L.) slices, (B) Advisory committee check the osmotically dehydrated guava (*Psidium guajava* L.) slices in lab of SHUATS, Prayagraj

CONCLUSION

The guava dehydration was more appreciable at 70 ^{0}B solution concentration, vaccum dryer and high density polyethylene on the basis of physico-chemical properties. Further, the organoleptic observations *viz.*, colour, flavor, overall acceptability, texture, taste and appearance content were found the best in 60 ^{0}B solution concentration, compared to other sucrose brix.

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