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Study On dehydration of Papaya Slices Using Osmotic Dehydration Mediated Hot Air Oven Drying

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Abstract: *Fruits and vegetables are rich source of minerals and vitamins. India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits and vegetables production in the world, after China.Among all despite large acreage of land devoted to papaya the fruit loss is reported to be between 40-100% of total annual produce.Alone in Andhra Pradesh the total production of fruit is 1173.6 thousand MT.Post-harvest losses are attributed to mechanical damage, rapid flesh softening, decay, physiological disorders, pest infestation, and improper temperature management and storage which results in greater loss.To reduce these losses many methods were discovered among which Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits and vegetables which is being a simple process, facilitates processing of fruits and vegetables with retention of initial fruit characteristics viz., colour, aroma, texture and nutritional composition.*

Hence, the present work is undertaken to study the influence of osmotic dehydration aided with subsequent dehydration in dryer on the rehydration property of papaya slices.

The study was carried out with treatment of papaya slices with sucrose solution as osmotic agent at 50,55,60°brix at 50°C temperature with immersion timing 30min followed by further dehydration in dryer at 70°C temp.

The result obtained showed that a product osmo- treated at 60°brix at 50°C temp shows the better rehydration property along with better nutrient retention, texture, colour, taste and overall acceptability.

I. Introduction

Papaya (*Carica papaya*)is a tropical fruit having commercial importance because of its high nutritive and medicinal value.Total annual world production is estimated at 6 million tonnes of fruits. India leads the world in papaya production with an annual output of about 3 million tones.Alone in Andhra Pradesh the total area under cultivation is 11.2 thousand hectare and productivity is 100 MT/Hactare. Despite large acreage of land devoted to papaya the fruit loss is reported to be between 40-100 per cent of total annual produce(*Source : Database of National Horticulture Board, Ministry of Agriculture , Govt. of India*).

Since, ancient time, dehydration has been one of the most common natural and reliable methods for food preservation.Among various dehydration techniques osmotic dehydration which is a traditional process applied to food dewatering which leads to attractive products that are ready to eat or can be applied as a pre-treatment to the next process such as drying or freezing(Phisut2012) is more popular and cost effective than other techniques.Being a simple process, it facilitates processing of fruits and vegetables such as banana,papaya, sapota, fig, guava, pineapple, apple, mango, grapes, carrots, pumpkins, etc. with retention of initial fruit characteristics viz., colour, aroma, texture and nutritional composition. It is less energy intensive than air or vacuum drying process because it can be conducted at low or ambient temperature(Chavan and Amarowicz 2012).

Hence, the present study was undertaken to"Study the dehydration of papaya slices using osmotic dehydration mediated hot air oven drying" with the following objectives:

1. To study the rehydration features of osmotically dehydrated fruit slices.
2. To study the effect of osmotic dehydration on nutritional quality of fruit slices.

Fruit slices are treated with sucrose solution as osmotic agent at 50,55,60°brix at 50°C temperature with immersion timing 30min followed by dehydration in dryer at 70°C temp. The responses of experimental design were moisture content,reconstitution ratio and reconstitution coefficient.

The result obtained showed that a product osmo treated at 60°brix at 50°C temp shows the better rehydration property along with better texture colour and taste.

II. Review Of Literature

Anoar *et al* (2006) studied on the Influence of osmotic agent on osmotic dehydration of papaya and reported that the value obtained for weight reduction water loss and Solid gain for dehydration in sucrose solution were higher than those obtained in corn syrup solution due to their high viscosity and polysaccharide content.

Chavanand Amarowicz (2012) studied on the osmotic dehydration process for preservation of fruits and vegetables and reported that it has potential advantage for the processing industry to maintain the food quality to preserve the wholesomeness of food.

Fasogbon *et al* (2013) studied on the Osmotic Dehydration and Rehydration Characteristics of Pineapple Slices and found out Osmotic dehydration enhanced solid gain water loss drymatter loss and rehydration capacity.

Graziella *et al* (1998-2004) studied on the osmotic dehydration of carica papaya L Influence of process variables and reported that increase of variables (temperature concentration and geometry of sample) leads to an increase in water and weight loss.

Giraldo *et al* (2003) studied on the influence of sucrose concentration on kinetics and yield during osmotic dehydration of mango and reported that the water transfer rate increased when the concentration of sucrose increased upto 45°brix,whereas this effect didn't appear between 55° brix and 65° brix,the rate constant being slightly greater for the treatment at 55°brix.A case hardening effect could be responsible for the mass transfer reduction at the highest sucrose concentration.

Kephas *et al* (2004) studied on the osmotic dehydration of banana slices as a pre-treatment for drying process and mass transfer properties as water loss solid gain and weight reduction during osmotic dehydration were investigated and reported that longer treatment time in high concentration of sucrose resulted in very soft product unsuitable for further drying and most efficient water removal occurred between 0.5-4 hr .

Konapacka *et al*(2008) studied on the effect of different osmotic agents an the sensory perception of osmo-treated dried fruit and concluded that osmotic solutions significantly influenced the taste and texture profile of dehydrated fruit and affect their sensory acceptability.

Moazzam (2012) studied on the osmotic dehydration technique for fruit preservation and reported that osmotic dehydration is an operation used for the partial removal of water from plant tissue by immersion in an osmotic solution.

Nutthanun *et al* (2013) studied on the effect of osmotic dehydration time on hot air drying and microwave vacuum drying of papaya and reported that an increase in osmotic dehydration time for 1-4 hours followed by hot air drying and microwave vacuum drying at 70°C.

Patricia *et al* (2008) studied on the optimization of Osmotic dehydration of Tommy Atkins mango fruit and reported that optimum conditions to obtain water removal less 25% with solid uptake lower than 6% could be obtained by using a 44% sucrose solution concentration temperature up to 38°C and immersion time up to 80 minutes.

Patricia *et al(*2009) studied on the effect of osmotic dehydration on the drying kinetics and quality of cashew apple and reported that osmotic pretreated samples showed the highest vitamin–c losses and the lowest water activity and the sample treated with sucrose solution had the highest acceptance.

Phisut (2012) studied on the factors affecting mass transfer during osmotic dehydration of fruits and reported that osmotic dehydration is a traditional process applied to food dewatering.

III. Material And Methodology

This chapter deals with the material procurement and methodology of dehydration of papaya slices.

3.1 Procurement of raw Materials:

Fresh Papaya of good and uniform quality were obtained from a local market (Bapatla). The average initial moisture content was 80.2% w⁄w and soluble solids content was 15° Brix. The fruits were hand peeled and cut into slices (3.0 ×5.0 × 0.5 cm) using cutters designed for this purpose.

3.2 Osmotic dehydration treatment:

The osmotic agent used was sucrose and the osmotic solution was prepared by dissolving the required quantity of sugar in distilled water to make 50,55,60°brix solution.

Papaya fruit slices, previously weighed and identified, were immersed in the osmotic solution of given concentration (50%, 55%, and 60 %, w⁄w) and temperature (50 °C) during a given immersion time (30 min).

The weight ratio of osmotic medium to fruit samples was 4:1 to avoid significant dilution of the medium and subsequent decrease of the driving force during the process. After removed from the sugar solution, samples were drained and the excess of solution at the surface was removed with absorbent paper for

posterior weight. The moisture content of the samples was gravimetrically measured using a vacuum oven at 70 ^{o}C for 24 h.

3.3 Air drying of the samples:

The osmotically dehydrated papaya slices were arranged in a tray and placed in the hot air oven (MRC Oven/Incubator, Model DP/DK 500/600/800, made by MRC Ltd. Hahystadnit) at 60°C for 24 hr to obtain dried products. The dried samples were stored in an airtight polythene bag for further use.

Flow Chart:

SEMI RIPEN PAPAYA FRUIT

↓

WASHING/PEELING/SLICING(3.0 × 5.0 ×0.5 cm)

↓

OSMOTIC TREATMENT (at 50,55,60^{0}brix and 50^{0}C temp respectively)

↓

AIR DRYING(at 70^{0}C temperature for 24 hr)

↓

PACKAGING(in polyethylene sheets)

Samples Prepared Using Different Brix Of Sucrose

Fig 3.1:Samples prepared using different brix of sucrose

3.4 Evaluation of Dehydrated Papaya Slices:

Samples of different formulations of papaya slices were evaluated for the following parameters :

1. Organoleptic evaluation. 2. Proximate analysis 3.Rehydration Test 4. Microbiological analysis.

3.4.1 Organoleptic Evaluation of Dehydrated Papaya Slices:

Organoleptic evaluation of dehydrated papaya slices prepared and evaluation was carried out in this experiment. The 9 point Hedonic Scale was used to compare the control with the formulated samples.Sensory evaluation was conducted in sensory evaluation laboratory, Department of Food Technology. The panellists were selected solely on the basis of interest, time available and lack of allergies to food ingredients used in study.

On every occasion, the panellists were provided with coded disposable paper cups containing the sample beverage under investigation. Sensory evaluation was carried out under ambient conditions. A comfortable area without distractions (isolated booths) under fluorescent lighting and controlled temperature was used. Water was supplied to clean the pallets between the evaluations of two samples.

Samples were tested for different parameters like colour, taste, texture, flavour, and overall acceptability. All these tests including the testing for consumer acceptance was done by sensory panellist according to 9 point hedonic scale for sensory evaluation as described by Peryac and Giradot (1952) .

Sensory Evaluation Score Card

Product: Osmotically treated papaya slices.
Name of the Panel Member:
Date:

You have been given four (4) samples made from papaya treated at different brix 50°,55°,60° of sucrose solution. Kindly, taste the samples and rate them based on your personal feel as given in the table below. Please try to make an honest expression your feeling in order to help us make the product better suited for the target consumer.

Hedonic Rating Scale:

Sl. No.	Feeling/Attribute	Rating
1.	Like Extremely	9
2.	Like Very Much	8
3.	Like Moderately	7
4.	Like Slightly	6
5.	Neither Like Nor Dislike	5
6	Dislike Slightly	4
7.	Dislike Moderately	3
8.	Dislike Very Much	2
9.	Dislike Extremely	1

Scorecard:

Attribute	Score			
	1	2	3	4
Taste				
Colour				
Texture				
Overall Acceptabiliy				

Signature

3.4.2 Proximate Analysis of Dehydrated Papaya Samples:

The osmo-treated papaya slices were evaluated for following chemical parameters:
Estimation of Moisture.
Estimation of Fat.
Estimation of Protein.
Estimation of Total Carbohydrates.
Estimation of Energy.
Estimation of Total Ash.

Estimation of Crude Fibre.
Estimation of Calcium
Estimation of Potassium
Estimation of vitamin A.
Estimation of Vitamin C.

Estimation of Moisture:

Moisture content (Wb.) of the osmotically treated papaya slices was determined according to oven method (AOCC, 1969). 1 g of sample was accurately weighed into a clean dry petri dish and dried in an oven at 105 ^{0}C for 6 - 8 hrs. It was then cooled in a desiccator and weighed. This was repeated till a constant weight was obtained. The moisture content was expressed as % of sample mix.

% Moisture (Wb.) = $\frac{W1-W2}{W1-W0} \times 100$

Where,

W0 = Weight of petri dish (g),
W1 = Weight of petri dish + sample (g),
W2 = Weight of petri dish + dried sample (g).

Estimation of Fat:

Fat was determined by Soxhlet Method (AOAC, 1990). 3 g of the sample was accurately weighed into a dry cellulose thimble and extracted using petroleum ether (60° - 80 ^{0}C b.p) as solvent in a Soxhlet's Apparatus. The solvent was allowed to flow until it touched the bottom of the beaker. The stopper was opened to ensure whether the rate of condensation of solvent and the delivery of the solvent are at equilibrium. At the end of this rinsing stage, the stopper was closed and solvent was recovered from the extractor. The beaker along with fat was removed from the apparatus and kept on a hot plate for some time. The weight of the beaker was then taken and the fat content calculated. The fat content of the samples were expressed as g /100 g of sample. The amount of fat present in sample mix were calculated using the following equation,

$$\textbf{g of fat / 100g of sample} = \left(\frac{\textbf{Final wt of beaker} - \textbf{empty wt of beaker}}{\textbf{weight of sample}} \times \mathbf{100}\right)$$

Estimation of Protein:

Protein estimation of sample was carried out using kjeldhal method (AOAC,1990). The kjeldhal method can conveniently be divided into three steps: Digestion,Neutralization and Titration.

Reagents required:

- Conc. H_2SO_4
- Digestion mixture: 100 g of K_2SO_4, and 20 g of $CU_2SO_4.5H_2O$ was weighed and mixed uniformly.
- Mixed indicator: 0.1% bromocresol green and 0.1% methyl red indicator in 95% ethanol were prepared separately. 10 ml of bromocresol green was mixed with 2 ml of methyl red solution in a bottle provided with a stopper, which will deliver about 0.05 ml per four drops.
- NaOH (40% solution): 40 g NaOH is dissolved in 100 ml of distilled water.
- Boric acid (2% solution): 50 mg of boric acid is dissolved in 100 ml of distilled water.
- Ammonium sulphate (1 mg/ml solution): 50 mg of ammonium sulphate is dissolved in 50 ml of distilled water.
- HCl (N/70 solution) : 1.2315 ml of concentration HCl is made up to one liter volume with distilled H_2O.

Procedure:

0.1 g of sample was weighed into a kjeldhal flask 0.2 g of the digestion mixture as added and digested in kelplus – kjeldhal digester with 20 ml of conc.H_2SO_4 until all the organic matter was oxidized and uniform greenish – blue digest was obtained. The digest was cooled and volume was made up to 100 ml distilled water. An aliquot of 5 ml was taken for steam distillation in kelpus distillation unit with excess of 40% NaOH solution (10 ml). the liberated ammonia was observed in 100 ml of 2% boric acid containing a few drops of mixed indicator. This was titrated against N/70 HCl. A simultaneous standard (Anhydrous ammonium sulphate) was done to estimate the amount of nitrogen taken up by N/70 HCl. From the nitrogen content of the sample, the protein content of different samples was calculated by multiplying by a factor of 6.25.

$$\textbf{\% of } N_2 \textbf{ present in given sample} = \frac{(\textbf{sample titer value} - \textbf{blank titer value}) \times \textbf{normality of HCl} \times 14}{\textbf{sample weight} \times 10000} \times \mathbf{100}$$

Estimation of total carbohydrate

Estimation of carbohydrates in the samples was carried out by Anthrone Method (AOAC, 1990).

Reagents Required:

1. 2.5 N HCl.
2. Anthrone Reagent: Dissolve 200 mg of Anthrone in 100 ml of ice cold 95% H_2SO_4.
3. Stock Standard Glucose Solution: Dissolve 100 mg of glucose in 100 ml of distilled water (1 mg/ml).
4. Working Standard Solution: Dilute 10 ml of stock standard solution to 100 ml with distilled water (1 ml / 100 mg)

Procedure:

1. Weigh 100 mg of sample and place it in boiling test tube.
2. Hydrolyze by keeping it in a boiling water bath for 3 hrs. with 5 ml 2.5 N HCl and cool to room temperature.
3. Neutralize it with solid Na_2CO_3 until the effervescence ceases.
4. Make up the volume to 100 ml and then centrifuge and filter.
5. Collect the supernatant and take 0.5 ml and 1 ml aliquots from the supernatant.
6. Prepare the standards by taking 0.2 ml, 0.4 ml, 0.6 ml, 0.8 ml, 1 ml and run a blank simultaneously.
7. Make up the volume in all the tubes to 1 ml with distilled water.
8. Then add 4 ml of Anthrone Reagent.
9. Heat for 8 min. in a boiling water bath.
10. Cool the tubes under tap water and read the green color at wave length 630 nm.
11. Draw a standard curve by plotting concentration of standard on X-axis and absorbance on Y-axis.
12. From the graph calculate the amount of carbohydrates present in the sample.
13. **Amount of carbohydrates present (%)** $= \left(\frac{\textbf{mg of carbohydrate}}{\textbf{volume of the sample}}\right) \times \mathbf{100}$

Estimation of Energy:

The energy value was estimated using an iso-thermal oxygen bomb calorimeter.

Reagents Required**:**

1. Benzoic Acid (Heat of Combustion - 6.318 Kcal/g). This reagent is used to calculate water equivalent of 2000g of water.
2. Standard Alkali Solution (Na_2CO_3) N/10. This solution is used to titrate the total acid produced due to burning of food sample and the reading of N/10 Sodium Carbonate is used for acid correction.
3. Methyl Orange Indicator.

Procedure:

Filling of the Bomb: 0.5 g of the sample was taken in a metal crucible and the crucible was placed in the crucible stand of the Bomb Calorimeter. The platinum wire (10 cm) was taken and the crucible was placed in the crucible stand of the bomb. The thread (20 cm) is tied to the wire and carried to the sample in the crucible. About 10 ml of distilled water was added to the bomb. The control valve was closed on the filling connection and the oxygen tank was opened. The filling connection valve was opened slowly, and the gauge was monitored allowing the pressure to rise slowly until 30 atmospheres was reached and then the control valve was closed.

Water Bucket Adjustment**:** Two litres of distilled water was added to the calorimeter bucket. The bucket was adjusted with water inside the calorimeter.

Assembling of the Calorimeter:The bomb was placed inside the calorimeter with the help of the handle provided on the bucket. The terminal point is attached to the bomb electrode. The cover is placed on the jacket. The thermometer reading is adjusted to 1-20 ^{0}C and immersed in the water bucket. Vibrator is started to achieve homogeneous temperature of water bucket inside.

Temperature Observations**:**The motor is run for 5 min. The initial temperature is noted when the thermometer reading is constant. The button on the ignition unit is pressed to fire the charge. After firing, mercury starts rising. Final temperature is noted when the temperature reading is again constant.

Dissembling the Calorimeter**:** Once the thermometer is removed and covered with insulation, the bomb is lifted out of the bucket and all residual pressure inside the bomb is relieved. The screw cap is removed. The bomb head is lifted out and examine the wire left un-burnt. All interior surfaces of the bomb and crucibles are washed with distilled water. The washings are collected in a beaker for the estimation of H_2SO_4 and HNO_3 formed from Sulphur and Nitrogen present in the test sample. It is titrated with standard alkali solution using mixed indicator. Total value of standard alkali is noted.

Determination of Water Equivalent: Benzoic Acid is used as a standard material. It has a heat of combustion of 6318cal/g. Water equivalent of one calorimeter is computed from the following equation:

$$W = \frac{HM+C1+C2+C3}{t}$$

Where,
W = Water equivalent of calorimeter in cal/g.
H = Heat of combustion of benzoic acid in cal/g = 6318 cal/g.
M = Wt. of benzoic acid in g.
t = Rise in temperature of water in the bucket.
C1 & C2 = Correction of combustion (cal) of H_2SO_4 and HNO_3 respectively.
C3 = Correction of combustion of fuse wire and thread.
The combustion of thread fuse wire may be taken as 3962 cal/g & 1400 cal/g respectively.
Calculations:

Gross heat of combustion (cal/g) $= \frac{t \times W-(C1+C2+C3)}{M}$

Where,
t = Rise in temperature.
W = Water equivalent.
M = Wt. of substance.

Estimation of Total Ash:

The ash content was estimated according to the method described by AOAC. 5 g of samples were accurately weighed into cleaned, dried, weighed, tare silica crucible (W2). The initial ashing was carried out over a low flame to char the sample. The crucible was then transferred to a muffle furnace maintained at 500-550 ^{0}C to get ash. The crucible was then cooled until a constant weight (W1) was achieved and expressed as g/100 g of sample.

% ash content = $\left(\frac{weight\ after\ ashing}{weight\ before\ ashing}\right) \times 100$

W1 = Weight of sample + crucible before ashing (gm)
W2 = Weight of sample + crucible after ashing (gm)

Estimation of Crude Fibre:

2 g of fat free sample was weighed in triplicate and digested with 200 ml of 1.25% sulphuric acid by gently boiling in a water bath for half an hour. The contents were filtered through a filter paper and then transferred to the same beaker. To this 200 ml of sodium hydroxide was added. The contents were then digested again for half an hour, filtered and washed free of alkali using hot distilled water. The residue obtained was dried in a hot air oven over night at 130±2 ^{0}C. The dried residue was then weighed and placed in a muffle furnace at 600±15°C for 30 minutes. The loss in weight after ignition represented the crude fiber content of the sample in the sample.

% Crude Fiber = $\frac{W2-W1}{W0} \times 100$

Where,
W0 = weight of the sample (g).
W1 = weight of empty crucible (g).
W2 = weight of crucible +residue (g).

Estimation of Calcium:

Calcium content of the samples was estimated using some amount of ash obtained after the estimation of total ash in the sample. The calcium present in the sample ash was selectively reacted with ammonium oxalate to form calcium oxalate. The calcium oxalate formed was precipitated and titrated against 0.1 N $KMnO_4$. Thus, the calcium content was then estimated using the titer value and expressed as mg of calcium 100 g of sample .

Reagents Required**:**

1. Conc. HCl.
2. Sulphuric Acid.
3. 0.1N $KMnO_4$.
4. Oxalic Acid (Saturated Solution).
5. Dilute Ammonium Hydroxide.

Procedure:
Take the ash prepared from the estimation of total ash and add 5 ml HCl. Boil and add about 50 ml of water and continue heating for few minutes. Transfer to 100 ml volumetric flask, make to volume, mix and filter through Whattman No. 1 filter paper. Take 25 ml of filtrate in a beaker in duplicate, dilute to 50ml with water. Add few drops of Methyl Red Indicator. Make it alkaline by adding dil. NH_4OH (yellow color). Heat the solution to boil, add 10 ml of Ammonium Oxalate drop by drop by constant stirring. Complete the precipitation by adding few ml of dilute NH_4OH. Remove the beaker from hot plate and make it acidic by adding dil. HCl (pink color) and leave the beaker for 4 hours to make complete precipitation of Calcium Oxalate. Filter the contents and wash the beaker and precipitate with hot water until the filtrate is free from oxalate. Warm and titrate immediately against standard 0.1 N $KMnO_4$ solution to a pink end point.

$$\text{mg calcium /100g} = \frac{2}{X} \times \frac{100}{25} \times \frac{100}{W}$$

Where,
X = Volume of 0.1 N $KMnO_4$ (ml).
W = Weight of sample (mg).

Estimation of potassium:

In acid solution,potassium is precipitated as the yellow double cobalt nitrite salt which is dissolved in hot dilute acid and titrated with standard potassium permanganate.Since the end point is indeterminate,a standard quantity of sodium oxalate is added at the end of the titration to produce a sharp end point.
Reagents:

1. 40% sodium acetate solution.
2. Sodium cobalt nitrate solution.
3. i)Dissolve 140gm sodium nitrate in 210ml water.Slowly add water.Slowly add the solution to (i)bubble air through solution for 3hrs.filter and store in refrigerator.Aerate solution for 15min and filter,if necessary,before using.
4. 12%sulphuric acid(v/v): add acid to water slowly,stirring constantly,cool, and make up to volume.
5. Acetone-water mixture.300ml water+100ml acetone.
6. Dry acetone:add anhydrous sodium carbonate to acetone in the proportion of 10gm per liter and store in this condition.
7. 0.01N sodium oxalate solution:Heat the sodium oxalate overnight at 105 degree centigrade and cool in a desiccator.Dissolve 0.67gm in water and dilute to 1litre.
8. Potassium permanganate.
9. 0.1N stock solution:Dissolve 3.16gm in water and make to a volume of 1litre.Store in a darkcoloured bottle.
10. 0.01N standard solution:Dilute 10ml of stock solution to 100ml with water.Prepare fresh before using.Standardize by titrating against sodium oxalate solution acidified with 15ml diluted H_2SO_4.Heat to 80 degree centigrade before titrating.

$$\text{Normality of } KMnO_4 = \frac{g\ of\ Na2\ C2\ O4}{ml\ KMnO4 \times 0.067}$$

1ml of 0.01N $KMnO_4$=0.07mg K approximately.

Procedure:

Measure 1ml of ash solution into a 15ml centrifuge tube .add 3ml of water,1ml sodium acetate solution,the last being added drop by drop.mix and allow to stand for 2hr at 5 degree centigrade.Centrifuge at 1000g for 15min and decant the supernatent liquid.add 5ml of a acetone-water mixture,mix,centifuge for 15min and decant the wash solution.repeat the washing procedure using acetone.evaporate the acetone by allowing the precipitate to stand for a few minutes.add a little standard pottasium permanganate from the burette,then add 2ml of dil H_2SO_4.complete the reaction by adding permanganate from the burette with the tube set in a container of boiling water and with constant shaking,always maintaining an excess of permanganate.when the precipitate is completely dissolved and a permanent pink colour is obtained,add 2ml of sodium oxalate solution and titrate to an end point.

True titration value=ml of 0.01N $KMnO_4$ solution_ml of 0.01N $Na_2C_2O_4$ solution.

Determination of Vitamin –C by Titration:

In the absence of interfering substances that may reduce the dye or oxidize ascorbic acid during sample preparation,the capacity of a sample to reduce a standard dye solution,as determined by titration,isdirectltly proportional to the ascorbic acid content.

Reagents:

i) Metaphosphoric acid solution (3%)

ii) Dye solution : Dissolve 50mg of 2,6-dichlorophenol-indophenol in approximately 150ml of hot distilled water containing 42mg of sodium bicarbonate.cool and dilute with distilled water to 200ml.Store solution in brown bottle in a refrigerator at about 3 degree centigrade,Standardize every day and prepare afresh every week.

iii) Standard ascorbic acid solution:Dissolve 100mg of L-ascorbic acid in a small volume of 3% metaposphoric acid solution and make up to 100ml with same solution.Dilute 10ml this of stock solution to 100ml with 3%metaphosphoric acid (0.1 mg ascorbic acid per ml). i)Standardisation of Dye:

Dilute 5ml of standard ascorbic acid solution with 5ml of 3% meta-phosphoricacid.Titrate with dye solution till pink colour persists for 10sec.Calculate the dye factor as follows:

Dye factor(D.F) = $\frac{0.5}{\text{Titre}}$

In case of liquid or juice sample,take 10 ml sample and make upto 100ml with 3%HPO_3 and then make up to 100ml and filter.Pipette 10 ml of filterate into a conical flask and titrate with the standard dye to a pink end point.If a sample contains sulphur dioxide which reduces the dye and thus interferes with the ascorbic acidestimation,the following procedure is followed.

Take 10 ml of filterate,add 1ml of 40%formaldehyde and 0.1ml of HCl,allow to stand for 10 minutes and then titrate.

Ascorbic acid(mg/100g)=$\frac{titrate \times dye\ factor \times volume\ made\ up \times 100}{volume\ of\ filtrate\ taken \times weig\,ht\ of\ volume of\ sample\ taken}$

Estimation of Vitamin A:

Reagents : Acetone, Anhydrous sodium sulphate, Petroleum ether.

Procedure:-

Take 5 gm of fresh sample and crush in 10-15ml acetone, adding a few crystals of anhydrous sodium sulphate, with the help of pestle and mortar. Decant the supernatant into a beaker. Repeat the process twice and transfer the combined supernatant to a separatory funnel, add 10-11ml petroleum ether and mix thoroughly. Two layers will separate out on standing. Discard the lower layer and collect upper layer in a 100 ml volumetric flask,make up the volume to 100 ml with petroleum ether and record optical density at 452nm using petroleum as blank.

Calculations:

β-carotene = $\frac{OD \times 13.9 \times 10000 \times 100}{Wt\ of\ sample \times 560 \times 1000}$

Vitamin-A= $\frac{beta-carotene(^{\mu g}/_{100})}{0.6}$

3.4.3 Microbial Analysis:

Microbial Limit Test (MLT) was done to analyse the sample for its microbial quality (both bacterial and fungal). The procedure given in the Food Safety Act, 1990 (Govt. of United Kingdom) was followed for this purpose. The test was performed at two stages. In the first stage all the raw materials to be used in the preparation of the millet based malt beverage mix were tested for microbial quality. The raw materials procured from the market were stored at 0 - 5°C (refrigerated conditions) until the microbial analysis was done. The raw materials were processed further only after affirming their microbial quality. In the second stage after the preparation of the malt beverage mix, the final product including the various samples and control formulations were finally tested for their microbial safety.

Bacterial Limit Test:

Requirements:

Medium**:** Nutrient Agar Medium was prepared for the purpose of bacterial limit test. 28 g of media was dissolved in 1000 ml of distilled water. This was later sterilised by autoclaving at 15 lbs pressure and 121°C for 15 minutes.

Diluent Solution**:**0.1% peptone water solution was prepared by dissolving 100 mg of peptone in 100 ml of distilled water. This was also sterilised by autoclaving at 15 lbs pressure and 121°C for 15 minutes.

Technique Adopted**:** Pour Plate Technique.

Incubation Temperature: 37°C.

Incubation Period : 48 hours.

P^H Adjustment: The pH of the sample is adjusted to 7 (neutral pH) by using 1N NaOH or 1N HCl as required.

Procedure**:**

1. Transfer 1 ml. of diluted neutral sample (1 g in 10 ml of sterilized peptone diluent) into sterile petri plates.
2. Transfer 15 – 20 ml the sterilized media into the petri plate and allow it to solidify. Close the lids after the medium solidifies.
3. Incubate the solidified plates in an inverted position in an incubator for 48 hrs. at 37°C.
4. After 48 hrs. count the number of colonies and record the result.

Calculation:

No. of colonies (CFU/g), $N = A \times D$

Where,

N = Number of colonies (CFU/g)

A = Average count of colonies in petri plates,

D = Dilution factor (D = 10 as 1:10 dilution of sample was taken).

Fungal Limit Test:

Requirements:

Medium:Sabouraud Dextrose Agar Medium was prepared for the purpose of fungal limit test. 65 g of media was dissolved in 1000 ml of distilled water. This was later sterilised by autoclaving at 15 lbs pressure and 121°C for 15 minutes.

Diluent Solution: 0.1% peptone water solution was prepared by dissolving 100 mg of peptone in 100 ml of distilled water. This was also sterilised by autoclaving at 15 lbs pressure and 121°C for 15 minutes.

Technique Adopted: Spread Plate Technique.

Incubation Temperature: 22 - 25°C.

Incubation Period: Upto 5 days.

P^H Adjustment: The pH of the sample is adjusted to 7 (neutral pH) by using 1N NaOH or 1N HCl as required.

Procedure:

1. Transfer 15 – 20 ml the sterilized media into the sterilized petri plate and allow it to solidify.
2. Transfer 1 ml of diluted neutral sample (1 g in 10 ml of sterilized peptone diluent) into the petri plates. Close the lids after evenly spreading the sample on the medium.
3. Incubate the solidified plates in an upright position in an incubator for upto 5 days at 23°C.
4. After 5 days count the number of colonies and record the result.
5. Calculation:

No. of colonies (CFU/g), $N = A \times D$

Where,

N = Number of colonies (CFU/g)

A = Average count of colonies in petri plates,

D = Dilution factor (D = 10 as 1:10 dilution of sample was taken)

3.4.4 Rehydration test:

Procedure :

Weigh 2 to 10gm of the dry material. Place in 500ml beakers,Add 80 to 150 ml of distilled water,cover each with a watch glass, bring to a boil within 3 min on an electric heater, and boil for 5 min. The precise amount of water will vary with the material ,time and rate of boiling excessive amount of water should not be used. Remove from the heater and dump in to a 7.5 cm buncher funnel which is covered with a coarsely porous whatmann no.4 filter paper.Apply gentle suction and drain with careful stirring for half to one min until the drip from the funnel has almost stopped. Do not dry by long suction. Remove from the funnel and weigh.Set the drained sample aside ina covered porcelain evaporating dish for quality tests.Repeat this test,and then rehydrate six. Other 10gm samples,boiling two for 10 min,two for 20 min,and two for 30 min.It will be necessary to use 20 to 30 ml more of water for the last two tests than for the shorter boiling,first tests.Only small pieces will rehydrate in 5min Calculation:

Results in term of "rehydration ratio",coefficient of rehydration",and "per cent of water in the rehydration material", as given below:

Rehydration ratio = weight of dehydrated sample:drained weight of rehydration sample

Coefficientof Rehydration:

$$\frac{\text{drained wt of dehydrated sample} \times [100 - \text{moisture content of sample before drying}]}{[\text{wt of dried sample taken for rehydration} - \text{amount of moisture content present in dried sample taken for rehydration}] \times 100}$$

Percentage of water in rehydrated sample=

$$\frac{\textit{Drained wt of rehydrated material} - \textit{Dry matter content in the sample taken for rehydration}}{\textit{drained wt of rehydrated material}} \times 100$$

IV. Results And Discussions

This chapter deals with the presentation of results obtained from present work.

4.1. Microbial Analysis:

The formulated product is evaluated for the presence of microbial count. Here, we analyzed one sample microbially. The results obtained is given in table below which shows that the colony count for both bacterial and fungal is below the permissible count.

Table 4.1:Bacterial Count in (CFU/gm)

Permissible	Actual
50	15

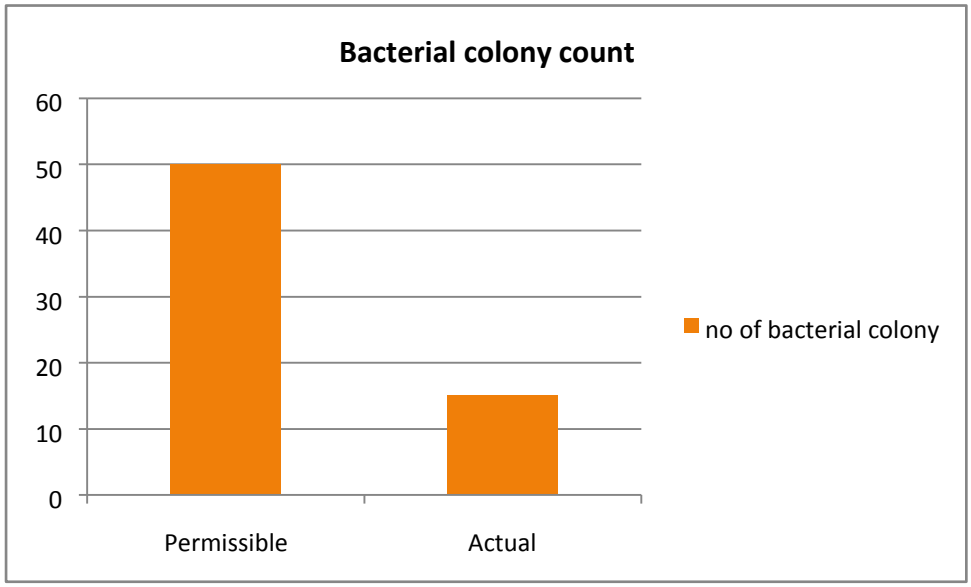


Fig:4.1:-Bacterial Count

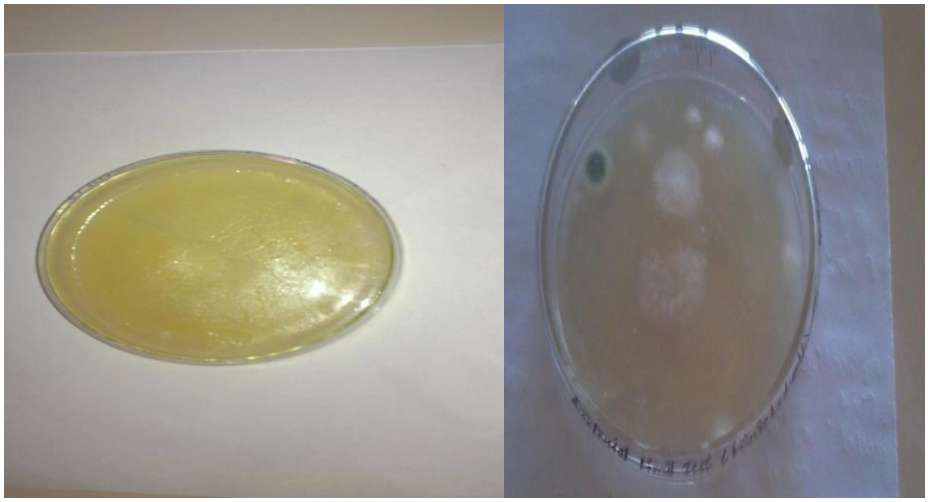


Plate 4.1.1:- Bacterial count for control andtest sample(60^{o}brix)

Table 4.2:Fungal Count in (CFU/gm)

Permissible	Actual
30	10

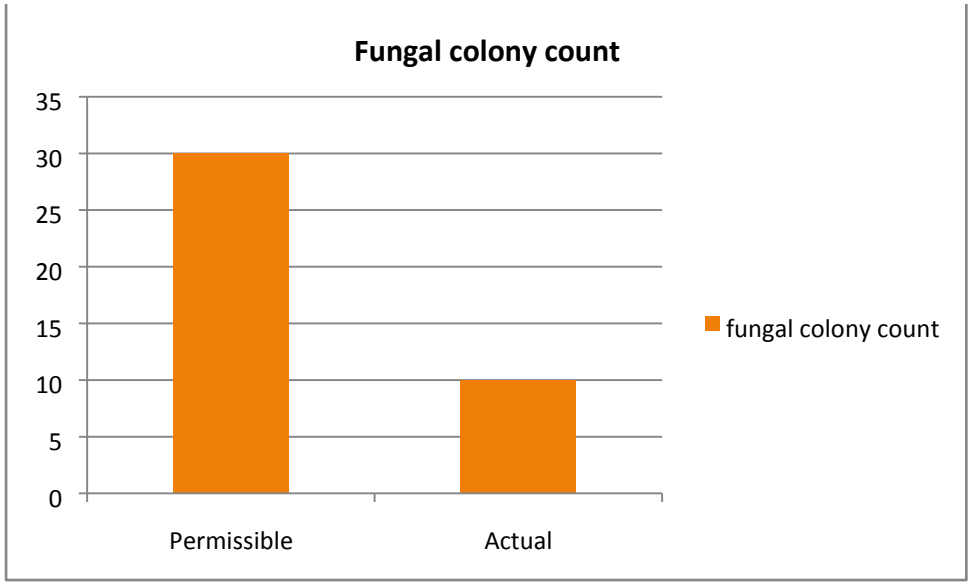


Fig:4.2:-Fungal Count

Plate 4.2.1:- Fungal count for control and test sample(with 60°Brix)

4.2. Organoleptic Evaluation:

Sensory evaluation for the osmotically dehydrated papaya slices was conducted using 4 test samples treated at different brixes and temperatures. These samples were tested with the help of a 10 member panel and the results are furnished below in table and sensory analysis chart.

Table 4.3. Sensory analysis data

Attributes	Control	50°Brix	55°Brix	60°Brix
Colour	7.1	8.3	8.5	9
Texture	7.3	7.5	8	8.2
Taste	5	7.4	7.9	8
Overall acceptability	7	8.0	8.4	9

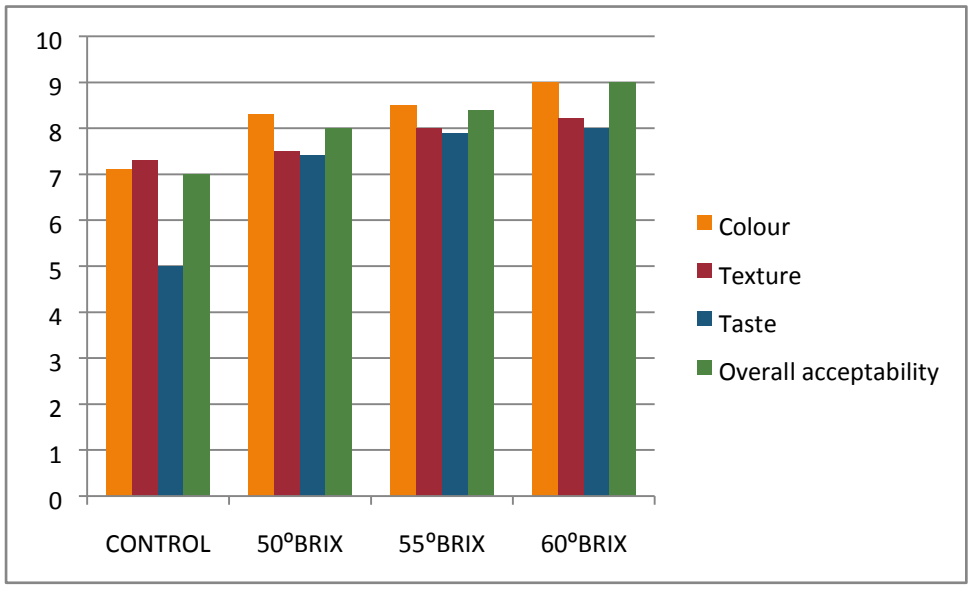


Fig 4.3: Sensory Evaluation Chart.

From the sensory evaluation analysis, it is clearly understood that in terms of color sample of 60°brix is best, in terms of texture and taste sample of 60°brix and finally in terms of overall acceptability sample of 60° brix is accepted. Hence, at the end of sensory evaluation it can be conclude that sample of 60°brix is having better edge over the other samples.

4.4. Proximate Analysis:

Table:4.4 Nutritional value of Raw papaya

Nutritional value per 100 g (3.5 oz)(RAW PAPAYA)

Nutritional composition	Amount present
Moisture content	**80%**
Fibre	**1.8g**
Protein	**0.61g**
Carbohydrate	**10.82g**
Fat	**0.14g**
Energy	**39Kcal**
Vitamin-A	**47µg**
Vitamin-C	**62mg**
Potassium	**182mg**
Calcium	**30.3mg**

Table:4.5: Proximate Analysis data

Results obtained after proximate analysis of different samples are following:

S.NO	EXPERIMENT	CONTROL	500 BRIX	550 BRIX	600 BRIX
1	Moisture content	1.9%	1.52%	1.51%	1.49%
2	Ash content	13.75%	13.88%	16%	23.25%
3	Fibre(per 100g)	2.7g	2.79g	2.81g	2.812g
3	Protein(per 100g)	0.59g	0.54g	0.53g	0.522g
4	Carbohydrate(per 100g)	14.94g	19.32g	20.2g	23.33g
5	Fat(per 100g)	0.145g	0.147g	0.147g	0.148g
6	Energy(Kcal per 100g)	59	60	62.5	63.3
7	Vitamin A(IU per 100g)	1.3783	1.3543	1.3542	1.3541
8	VitaminC(mg/100g)	48	45	44.8	44.6
9	Potassium(mg/100g)	240mg	255mg	255.6mg	258mg
10	Calcium(mg/100g)	34	38	48.5	50.5

4.4.1. Estimation of moisture content:

The moisture content of prepared sample is found to be higher in control(1.9%) followed by other, in 50°brix(1.52%),55°brix(1.51%),and 60°brix(1.49%) as shown in figure 4.4 and table 4.6.

Table 4.6. Analysis of moisture content(%)

Parameters	Moisture content(%)
Control	1.9
50°brix	1.52
55°brix	1.51
60°brix	1.49

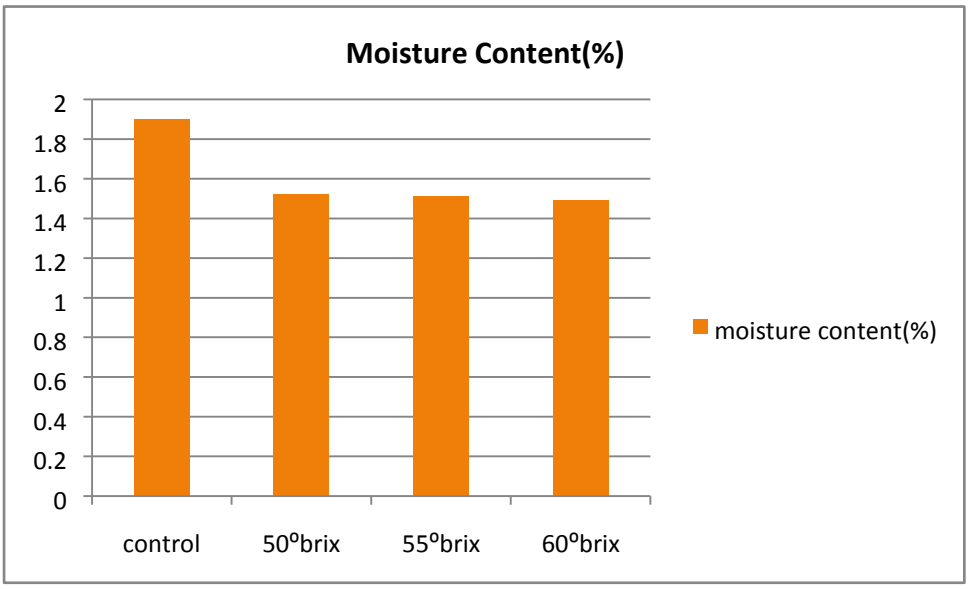


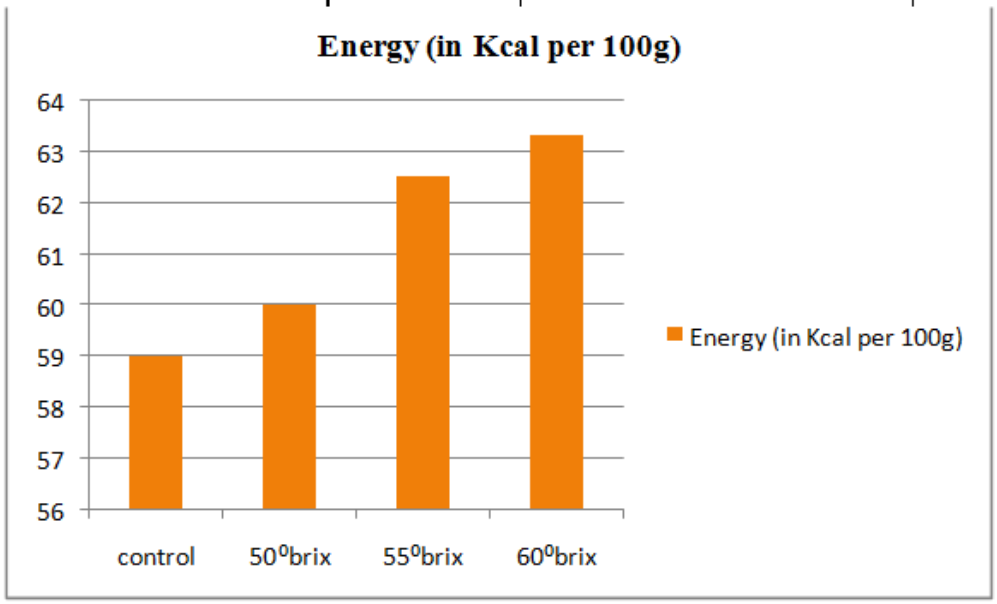
Fig 4.4: Analysis of moisture content(%)

4.4.2 Estimation of energy:

The energy of prepared sample is found to be higher in sample of 60°brix (63.3Kcal) followed by other, in sample with 55°brix (62.5Kcal), sample with 50°brix (60Kcal) and control sample(59 Kcal) which can be shown by following data and graph.

Table 4.7: Analysis of energy (kcal/100g)

Parameters	Energy (in Kcal per 100g)
control	59
50°brix	60
55°brix	62.5
60°brix	63.3



4.4.3 Estimation of carbohydrate:

As shown in the fig and table below the carbohydrate of prepared sample is found to be higher in sample of 60°brix (23.33g) followed by other, in sample with 55°brix (20.2g), sample with 50°brix (19.32g), and control sample(14.94g). This can be shown by following data and graph.

Table 4.8: Analysis of carbohydrate(%).

Parameters	Carbohydrate (in g per 100g)
Control	14.94
50°brix	19.32
55°brix	20.2
60°brix	23.33

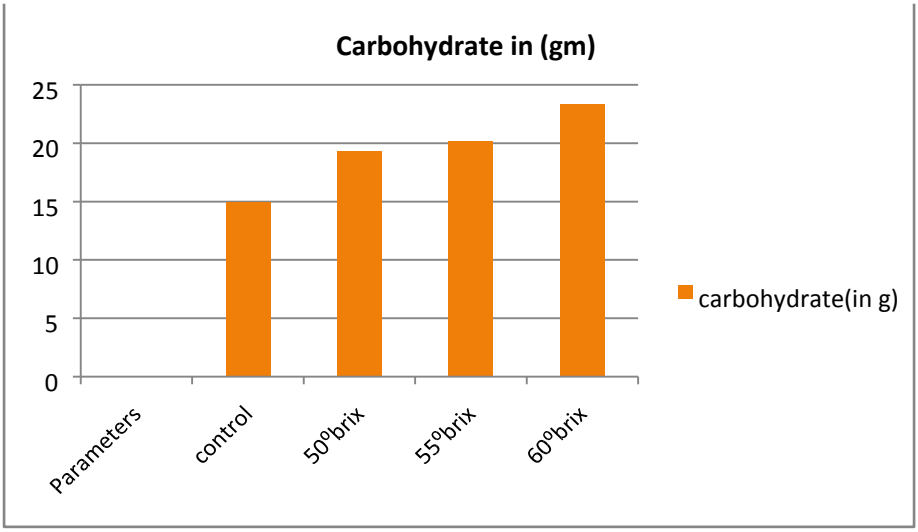


Fig 4.6 Analysis of Carbohydrate

4.4.4 Estimation of fat:

The fat of prepared sample is found to be higher in 60°brix(0.148g), followed by 55°brix(0.147g),50°brix(0.147g) and control sample(0.145g). This can be shown by following data and graph.

Table 4.9 Analysis of fat (%)

Parameters	Fat (in g per 100g)
Control	0.145
50°brix	0.147
55°brix	0.147
60°brix	0.148

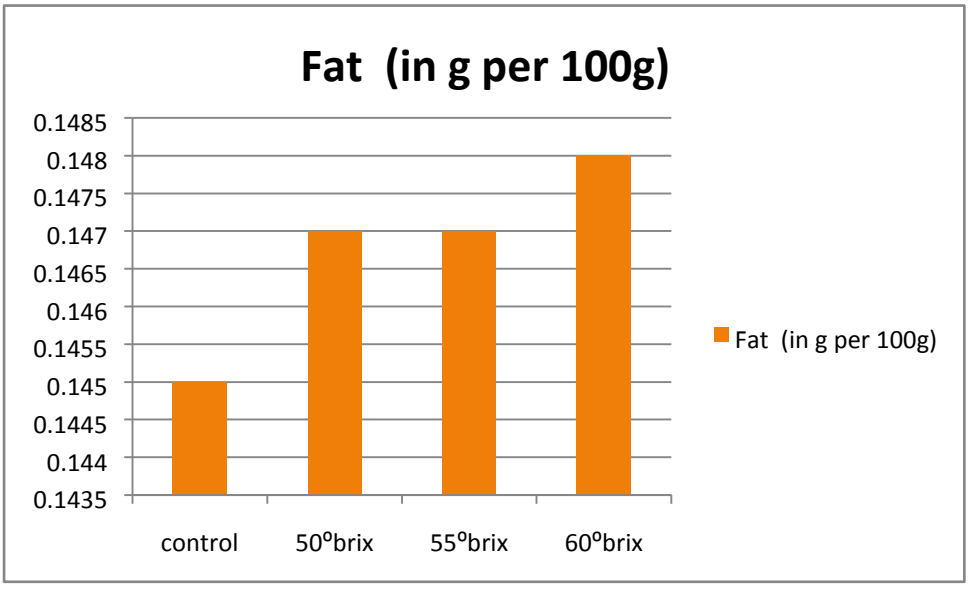


Fig 4.7: Analysis of Fat

4.4.5 Estimation of protein:

The protein of prepared sample is found to be higher in control sample (0.59g) followed by 50°brix(0.54g),55°brix(0.53g) and 60°brix(0.522g) which can be shown by following data and table.Decrease in protein content may be explained by loss of water soluble proteins during various processing steps.

Table 4.10: Analysis of protein (%)

Parameters	protein (in g per 100g)
control	0.59
50°brix	0.54
55°brix	0.53
60°brix	0.522

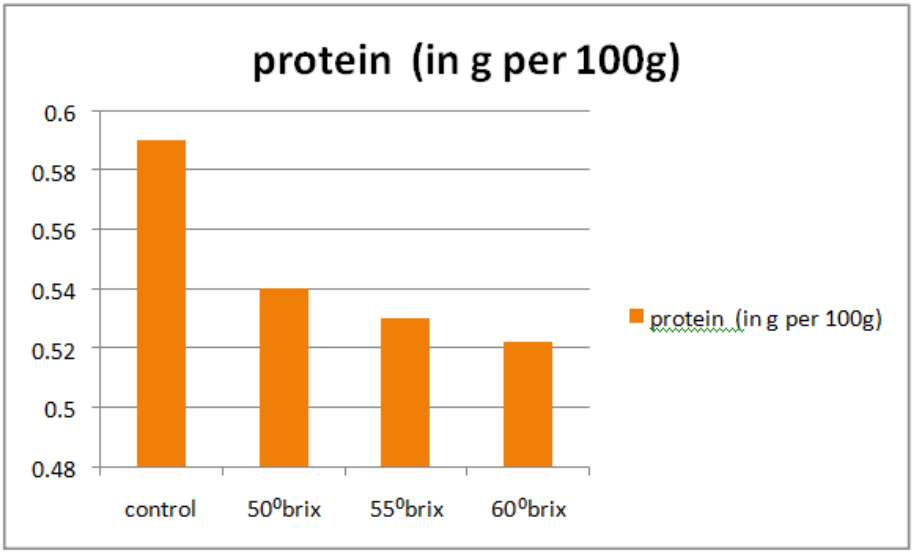


Fig 4.8: Analysis of Protein

4.4.6 Estimation of total ash:

The total ash of prepared sample is found to be higher in sample of 60°brix (23.25%) followed by other, in sample with 55°brix (16%), sample with 50°brix (13.88%), and control sample(13.75%) which can be shown by following data and table.

Table 4.11: Analysis of total ash(%)

Parameters	Total ash (%)
control	13.75
50°brix	13.88
55°brix	16
60°brix	23.25

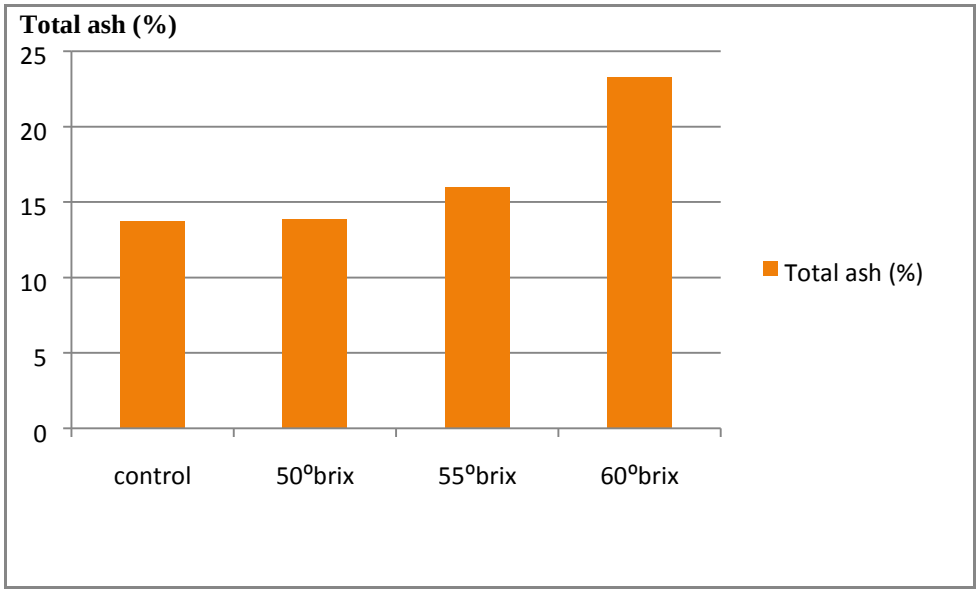


Fig 4.9. Analysis of Ash

4.4.7.Estimation of total fibre:

The Total fibre of prepared sample is found to be higher in 60°brix(2.812g) followed by 55°brix(2.81g), 50°brix(2.79g) and control sample (2.7g) which can be shown by following data and chart.

Table 4.12: Analysis of total fibre

Parameters	Total fibre (per 100g)
Control	2.7
50°brix	2.79
55°brix	2.81
60°brix	2.812

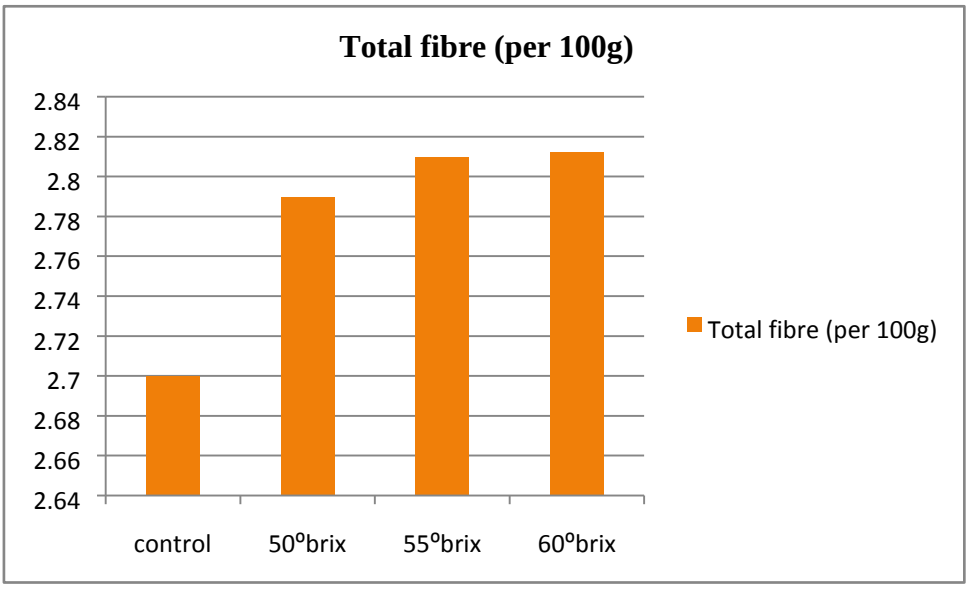


Fig 4.10: Analysis of total fibre

4.4.8.Estimation of Vitamin A:

As shown in the fig and table below the Vitamin A of prepared sample is found to be higher control sample(1.3783) followed by 50°brix (1.3543), 55°brix (1.3542),60°brix (1.3541) .It can be shown by following data and graph.

Table 4.13: Analysis of Vitamin A

Parameters	Vitamin A (in IU per 100g)
Control	1.3783
50°brix	1.3543
55°brix	1.3542
60°brix	1.3541

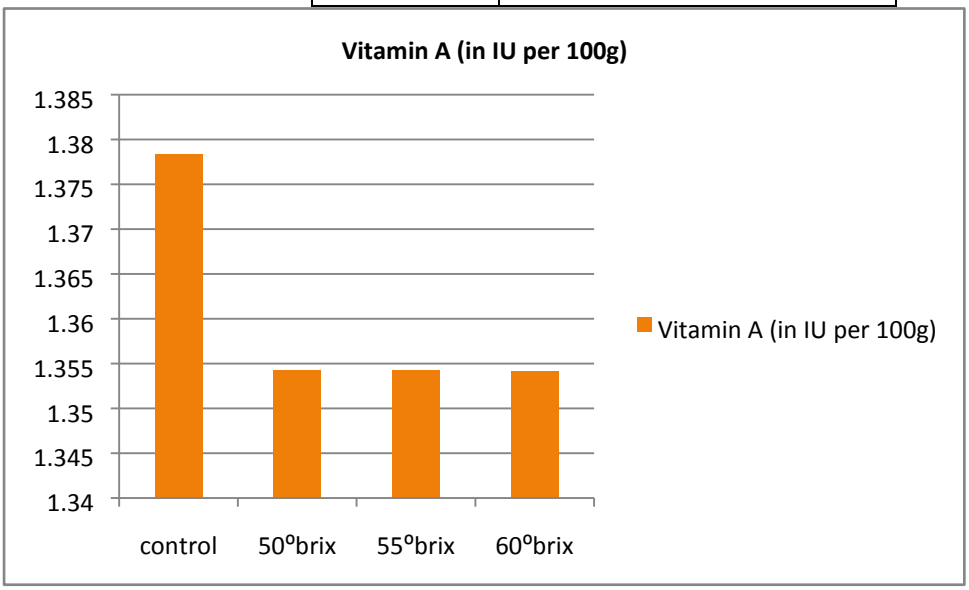


Fig 4.11:Analysis of Vitamin A

4.4.9.Estimation of Vitamin C:

As shown in the fig and table below the Vitamin C of prepared sample is found to be higher in sample of control (48 mg) followed by other, in sample with 50°brix (45 mg), sample with 55°brix (44.8mg), and 60°(44.6mg) which can be shown by following data and graph.

Table 4.14 :Analysis of Vitamin C

Parameters	Vitamin C (in mg per 100g)
Control	48
50°brix	45
55°brix	44.8
60°brix	44.6

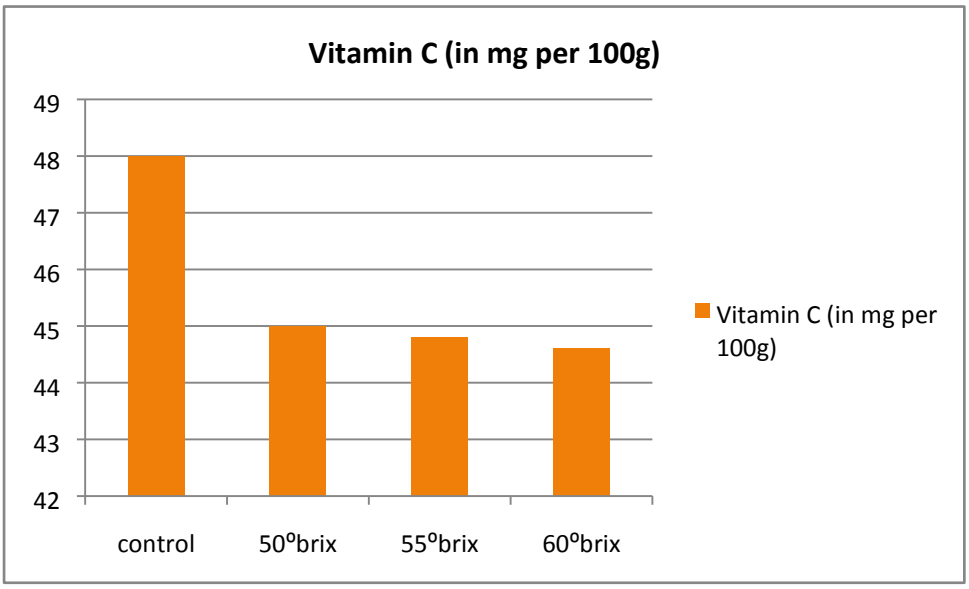


Fig 4.12:Analysis of Vitamin C

4.4.10.Estimation of potassium:

The potassium content of prepared sample is found to be higher in 60°brix(258mg) followed by 55°brix(255.6mg), 50°brix(255.mg) and control sample (240mg) which can be shown by following data and graph.

Table 4.15: Analysis of potassium

Parameters	Potassium (in mg per 100g)
Control	240
50°brix	255
55°brix	255.6
60°brix	258

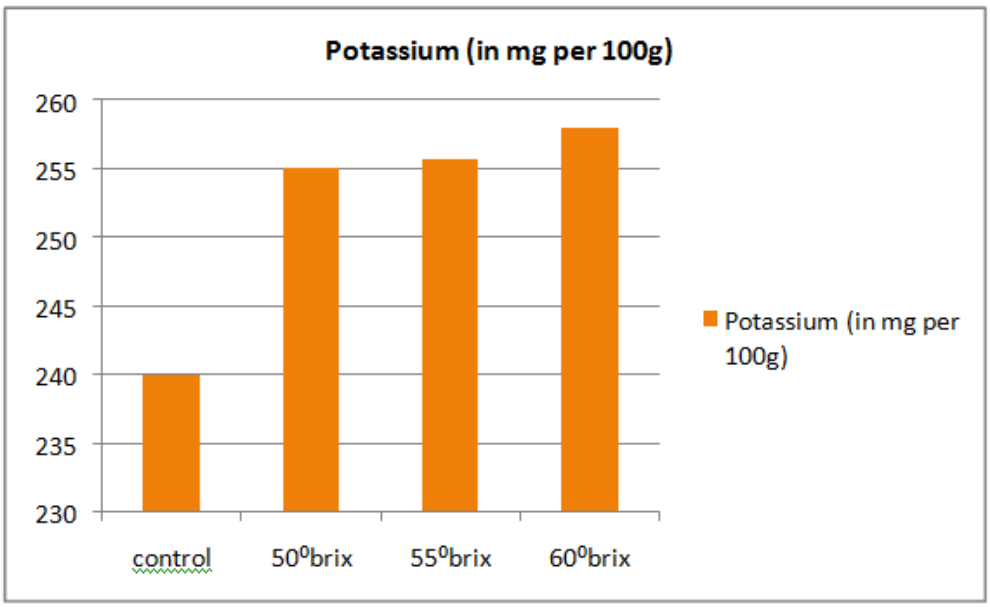


Fig 4.13: Analysis of Potassium.

4.4.11.Estimation of calcium:

The potassium content of prepared sample is found to be higher in 60°brix(50.5mg), followed by 55°brix(48.5mg), 50°brix(38mg) and control sample (34mg) which can be shown by following data and graph.

Table 4.16 :Analysis of Calcium

Parameters	Calcium(in mg per 100g)
Control	34
50°brix	38
55°brix	48.5
60°brix	50.5

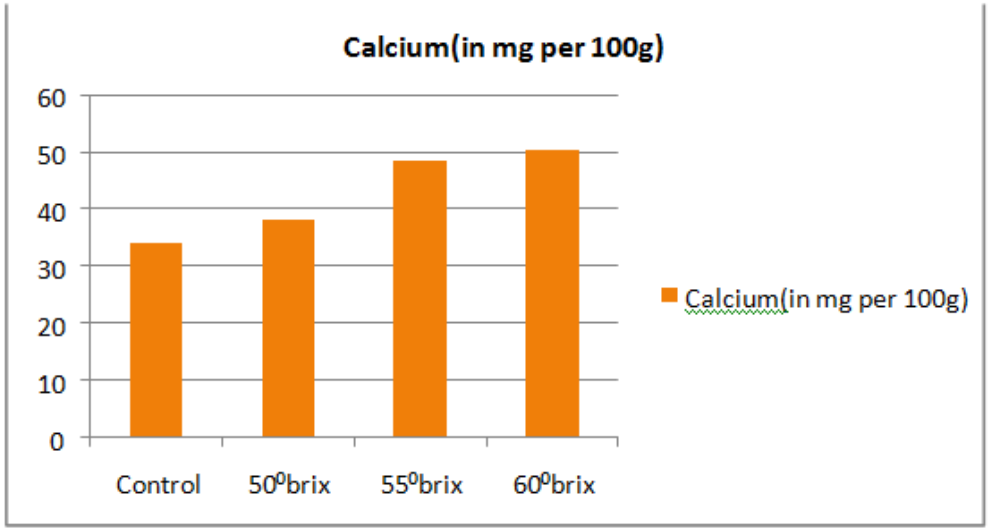


Fig 4.14: Analysis of Calcium

4.5. Rehydration Test:

Table 4.17: Rehydration test

Parameters	Rehydration ratio	Coefficient rehydration of	% of Water in rehydrated sample
Control	2/4.59	0.255	56.42
50°Brix	2/5.18	0.66	61
55°Brix	2/5.56	0.688	64.02
60°Brix	2/5.8	0.715	65.5

4.5.1.Rehydration ratio:

From rehydration test it was analysed that Rehydration ratio of control sample was 2/4.59, 50°brix was 2/5.18,55°brix was 2/5.56 and 60°brix was 2/5.8.

Table 4.18:Rehydration ratio of samples

Parameters	Rehydration ratio
Control	2/4.59
50°Brix	2/5.18
55°Brix	2/5.56
60°Brix	2/5.8

4.5.2. Coefficient of rehydration:

From rehydration test it was analysed that coefficient of Rehydration of 60°brix(0.715) was highest followed by 55°brix(0.688), 50°brix(0.662), and control(0.255) which can be shown by following data and graph.

Table 4.19:coefficient of rehydration of different samples

Parameters	Coefficient rehydration of
Control	0.255
50°Brix	0.662
55°Brix	0.688
60°Brix	0.715

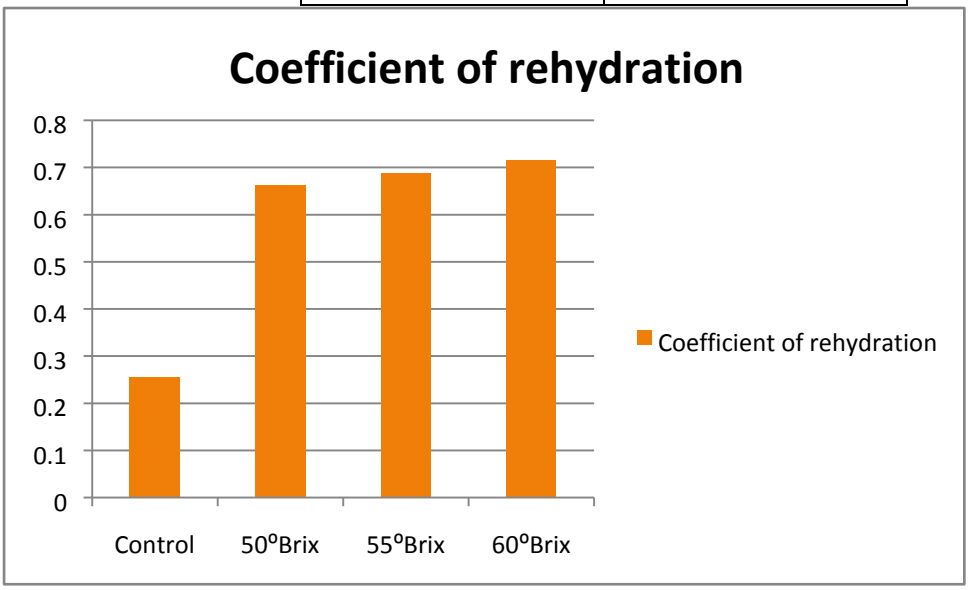


Fig 4.15 : coefficient of rehydration

4.5.3. Percentage of water in rehydrated sample:

From rehydration test it was analysed that percentage of water in rehydrated sample of 60°brix was highest(65.5%),followed by 55°brix(64.02%),50°brix(61%) and control(56.42%) shown by following data and graph.

Table 4.20 Percentage of water in rehydrated sample

Parameters	% of Water in rehydrated sample
Control	56.42
50oBrix	61
55oBrix	64.02
60oBrix	65.5

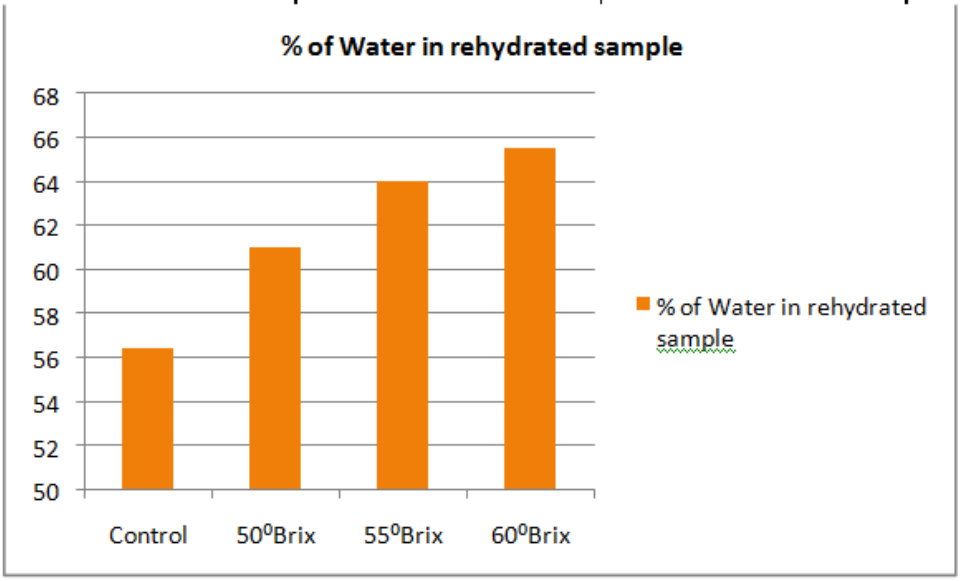


Fig 4.16:Variations in percentage of water in rehydrated samples

According to proximate analysis sample of 60°brix contain good amount of carbohydrates, fibres, ash content,minerals like potassium and calcium, as well as energy content.But, at the same time protein contents decreased with increase in brix because water soluble proteins are lost during various processing steps. Control sample have significantly high amount of protein. From sensory evaluation results it can be concluded that sample of 60°brix has good acceptability to that of other samples in terms of taste, colour and texture.From rehydration test results it can be concluded that water rehydration capacity of 60°brix sample is maximum as compared to others as well as rehydration ratio of 60 °brix sample is good as comparared to others.From moisture content analysis results it can be estimated that the moisture content of control sample is highest as compared to other.

V. Summary And Conclusion

Osmotic dehydration is being a simple process, facilitates processing of tropical fruits and vegetables such as banana, sapota, pineapple, mango, guava, carrot, pumpkin, papaya etc with retention of initial fruit characteristics viz., colour, aroma and nutritional compounds. In preservation of fruits and vegetables osmotic dehydration process add value to the finished product, which is wholesome, nutritious and available round the year.

In this study on osmotic dehydration of papaya, papaya was treated at different brix of sucrose at 50°,55°,60° brix at 50°C temperature for 1hr along with hot air drying at 70°C temperature and different analysis was carried out like proximate analysis, organoleptic analysis and rehydration test and different conclusions are drawn .

And from this study , it can be concluded that the slices which are treated with 60°brix sucrose solution at 50°C temperature and cabinet drying at 70°C temperature shows the better rehydration characteristics, organoleptic characteristic along with nutritional compounds retention.

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