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Effect of process parameters on quality of honey osmosed dehydrated Aonla

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Abstract
Experiments were carried out to study the effect of immersion time and different osmotic solution temperatures on the quality of dehydrated aonla in honey. Optimum conditions for making honey osmosed dehydrated aonla were found as 78.5% honey concentration, 5:1 solution to fruit ratio, 35 ^{0}C osmotic solution temperature, with 80.01% water loss, 13.99% solid gain with process time of 180 minutes.

Keywords: parameters, honey osmosed, aonla

1. Introduction
Indian Gooseberry (*Emblica officinalis*) known as Aonla is an important fruit and is highly valued for its nutritional and medicinal properties. It is one of the richest sources of ascorbic acid (500-1500 mg/100 g) used as a strong rejuvenator in Indian pharmacopoeia (Pathak and Ram 2007) and is very popular for its medicinal properties in Ayurvedic and Unani system of medicines in India. Aonla fruits are not consumed in fresh form because of its acidic and bitter taste and therefore not popular as a table fruit. It has an excellent nutritive and therapeutic values and great potential for processing into several quality products.
Drying is a method to increase shelf life of aonla fruits. Studies have been carried out to prepare dried whole fruit (Verma and Gupta 2004), slice (Alam *et al*. 2010) [4], supari (Damame *et al*. 2002) [10], shreds (Sagar and Kumar 2006) [30] and powder (Sharma *et al*. 2002; Alam and Singh 2005) [31, 2]. Drying is the most energy consuming and the least understood unit operation, consisting of a stimulation heat and mass transfer process Osmotic dehydration is an operation used for the partial removal of water from plant tissues by immersion in a hyper-tonic osmotic solution. Water removal is based on the natural and non-destructive phenomenon of osmosis across cell membranes. The driving force for the diffusion of water from the tissue into the solution is provided by the higher osmotic pressure of the hyper-tonic solution. The diffusion of water is accompanied by the simultaneous counter diffusion of solutes from the osmotic solution into the tissue. Since the cell membrane responsible for osmotic transport is not perfectly selective, solutes present in the cells (organic acids, reducing sugars, minerals, flavors and pigment compounds) can also be leached into the osmotic solution, which affect the organoleptic and nutritional characteristics of the product. Keeping in view all the aspects, the present study was planned to get a ready to eat osmotically dehydrated aonla in honey giving a health food with longer shelf life. The objective of the study was to see the effect of immersion time and osmotic solution temperatures and storage period on the quality of dehydrated aonla.

2. Materials and Methods
The experiments were carried out to study the effect of osmotic solution temperature, dipping time on the quality of osmotically dehydrated aonla samples such as color, texture and TSS value. Three levels of osmotic solution temperatures i.e .25, 35 and 45 degree centigrade and three levels of immersion time i.e. 60, 120 and 180 minutes and solution to fruit ratio was taken as 5:1.

2.1 Preparation of samples
The fresh AONLA fruit was procured from New Orchard, PAU, Ludhiana. The fruit was washed with fresh water to remove dust and unwanted materials.

The fruit was sorted to remove under and oversize to get aonla fruit of uniform size and color. The fruit was cut into equal size pieces of six each. The color, texture and initial moisture content of fresh aonla sample were determined. The graded aonla were subjected to hot water blanching to inactivate enzymatic activity. Sample was wrapped in muslin cloth and dipped for 5 min in boiling water. The blanched samples were then kept on sieve for 10 min for draining of water followed by wiping of surface with blotting paper. Honey was used as osmotic solution. The concentration of osmotic agent was found as of 71%.

2.2 Osmotic dehydration of Aonla

Osmotic dehydration of blanched aonla was done taking into process variables osmotic solution temperature (25 ^{0}C, 35 ^{0}C, 45 ^{0}C) and immersion time of 60 minutes interval. The temperature of osmotic solution was maintained by shaking cum DOD incubator. The rpm was set as 150. Glass beakers containing osmotic solution in required ratio were kept in shaking incubator. After the attainment of the desired temperature of the solution, the aonla fruit of known weights were put into the beakers (500 ml). Three beakers were used for each experiment taking one sample out after designated times of 60, 120 and 180 minutes. The weight of the samples was recorded manually at 60 minutes interval to calculate the moisture content. After osmosis, the samples were removed from the osmotic solution and rinsed immediately with running water to remove the adhered solute to fruit surface. Then the osmosed sample was spread on absorbent paper to remove the free water from the outer surface. The fruit was then put in the pre –weighed petri dish for the determination of dry matter by oven method. The water and solute gain was measured. During experimentation, it was assumed that the amount of solid (Sugar, acid and vitamins) leaching out of the product into the medium, although recognized the organoleptic and nutritional characteristics of the product was considered negligible (Biswal and Bozorgmehr 1992).

2.3 Convective dehydration of aonla

The convective dehydration of osmotically dehydrated samples at 45 ^{0}C was carried out in tray drier. The samples were placed on perforated sieves and were convectively dehydrated with hot air having temperature of 60 ^{0}C. The preatreated osmotically dried samples of aonla were convectively dried in laboratory tray drier at air temperature of 60 ^{0}C. The desired temperature was set by an automatic digital control and stablilized by keeping the dryer running about 15 min without any load. The weight of the samples was recorded manually at 30 min interval and moisture content was calculated. The texture obtained on convective drying was very hard was not acceptable thus later the experiment was stopped and sample was allowed to remain in osmotic solution to measure further quality parameters.

2.4 Moisture content

The moisture content of aonla samples were done using method (AOAC, 2000).

2.5 Water loss calculation

The mass transfer parameters i.e water loss (WL) reflecting one of the quality attributes of aonla were determined by the following equation (Pokhrakar and Prasad, 1998).

$$\text{Water loss (\%)} = \frac{\mathbf{Wi.Xwi - Wo.Xwo}}{\mathbf{Wi.Xwi}} \times 100$$

Where, Wi = Initial mass of aonla, grams
Xw i= Water content as a fraction of initial mass of aonla
Wo = Mass of aonla after time 't'
Xwo= Water content as a fraction of mass of aonla of mushroom at time 't'

2.6 Solid gain during osmotic dehydration

The solid gain was calculated using the formula:

$$\text{Solid gain (\%)} = \frac{Wi.(1 - Xwi) - Wo(1 - Xwo)}{wi} \times 100$$

Where, Wi = initial mass of aonla, grams
Xw i=water content as a fraction of initial mass of aonla
Wo = mass of aonla after time 't'
Xwo=water content as a fraction of mass of aonla of mushroom at time 't'

2.7 Weight reduction

Weight reduction = Water loss – Solid gain

2.8 Quality evaluation

Color measurement

Color is the most important parameter for the acceptability of the product. The color properties of the fresh and osmosed sample were measured using Miniscan XE plus Hunter Lab Colorimeter (USA), Model No. 45/0-L. The color was measured in terms of 'L', 'a', 'b' and color difference in reference to fresh aonla (ΔE) was obtained. For determination of color, the sample was completely filled in petri dish provided that no light is allowed to pass during the measuring process. The 'L', 'a', b' values were recorded at D 65/10^0 and were compared. In hunter scale L measures lightness (Whiteness or darkness). The chromatic portion of the solid is defined by +a (red),-a (green), +b (yellow),-b (blue).
Color change was calculated from 'L', 'a', 'b' readings

$$\text{Color change, } (\Delta E) = \sqrt{\{(L-L_0)^2 + (a-a_0)^2 + (b-b_0)^2\}}$$

Where L_0, a_0, b_0 represents the respective readings of fresh sample.

Total soluble solids (TSS)

Digital refractometer having range of 0-91% was used to measure the total soluble solids of sample.

Texture analysis using XT Plus texture analyser

The textural properties of fresh and osmotically dehydrated aonla samples were measured with the help of texture analyser The TPA test was conducted to determine the textural characteristics of osmosed samples i.e hardness, cohesiveness, springiness, chewiness, fracturability and gumminess.

Physio-organoletic evaluation

The osmosed samples were examined by a panel constituted for the purpose of sensory evaluation. This panel was selected on the basis of gender and age and briefly acquinted with the sensory characteristics that were to be judged and also with the available scales according to which the samples were to be rated each member was provided with sensory evaluation rating scales based on which rating was given to various samples. The average value of ratings given by all members were then calculated and used for further analysis. The score

cards of Physico – organoleptic properties were evaluated in terms of appearance, flavor, color, texture and overall acceptability.

3. Results and Discussion

The value of moisture content, water loss, solid gain and other quality parameters were obtained and are presented in below tables.

Table 1: Moisture content (%db), Water loss (WL %), Solid gain (SG%) in aonla during osmotic dehydration at different temperatures

Time (min)	Osmotic Agent Temperature(^{0}C)								
	25			35			45		
	M.C (%)	W.L (%)	S.G (%)	M.C (%)	W.L (%)	S.G (%)	M.C (%)	W.L (%)	S.G (%)
60	122.22	40.95	21.5	62.15	59.96	26.54	33.33	42.36	58.73
120	100.00	43.16	34.82	36.35	73.27	25.4	30.42	45.98	51.08
180	71.40	53.35	37.9	49.99	80.01	13.99	27.55	46.62	42.59

TSS value =70 Fruit ratio = 5:1 Shaking frequency = 150 rpm

Table 2: Moisture content of osmotically dehydrated aonla at 45 ^{0}C during convective drying

Time (min)	30	60	90	120	180	240
Moisture content (%db)	67.47	52.25	45.44	33.39	25.373	19.63

Table 3: TSS value of samples

Time(min)	Just after osmosis			After 7 days of osmosis			After 14 days of osmosis			After 21 days of osmosis		
	Osmotic Solution temperature (^{0}C)											
	25	35	45	25	35	45	25	35	45	25	35	45
60	68.7	67.6	64.3	67.3	64.2	63.3	65.4	62.9	61.9	64.5	61.5	61.4
120	70.5	67.1	63.2	66.7	63.7	62	64.1	62.8	62.3	60.8	61.2	62.1
180	70.9	64	64.2	62.6	63.2	63.8	61.5	62	63.4	60.8	61	63.2

Table 4: Texture analysis (Hardness) of aonla

Time(min)	After one week of osmosis			After 2 weeks of osmosis			After 3 weeks of osmosis		
	Osmotic Solution Temperature(^{0}C)								
	25	35	45	25	35	45	25	35	45
60	451.455	10.371	10.234	450.83	10.15	10.16	455.286	10.001	9.86
120	416.371	9.867	9.378	410.28	9.43	9.28	410.28	9.43	9.28
180	409.12	9.378	8.936	408.10	96.31	8.7	408.10	96.31	8.7

Table 5: Effect of Osmotic dehydration parameters on color of aonla after one week of osmosis

Time (min)	Osmotic solution temp =25 ^{0}C								Osmotic solution temp =35 ^{0}C								Osmotic solution temp =45 ^{0}C							
	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3	W1	W3
	L	L	a	a	b	b	ΔE	ΔE	L	L	a	A	b	b	ΔE	ΔE	L	L	a	a	b	b	ΔE	ΔE
60	41.7	39.8	-1.9	-0.9	4.3	5.2	14.59	15.74	44.5	41.5	4.2	-2.7	12	12	11.283	11.721	41.4	35.5	-0.6	-1.5	0.9	0.9	11.285	21.56
120	44.1	41.2	-1.9	-2.2	4.2	3.6	12.868	16.66	47.9	36.1	-2.6	1.0	3.6	3.6	15.694	20.00	39.1	40.2	1.1	-0.8	8.7	8.7	15.69	13.29
180	42.6	40.4	-1.6	-1.7	4.4	2.5	13.98	16.74	37.5	37.6	-1.5	-2.1	2.5	4.7	14.59	17.784	45.1	44.6	-0.2	-1.4	4	4	19.062	13.71

L_o=53.15, a_o = -2.93, b_o=13.2

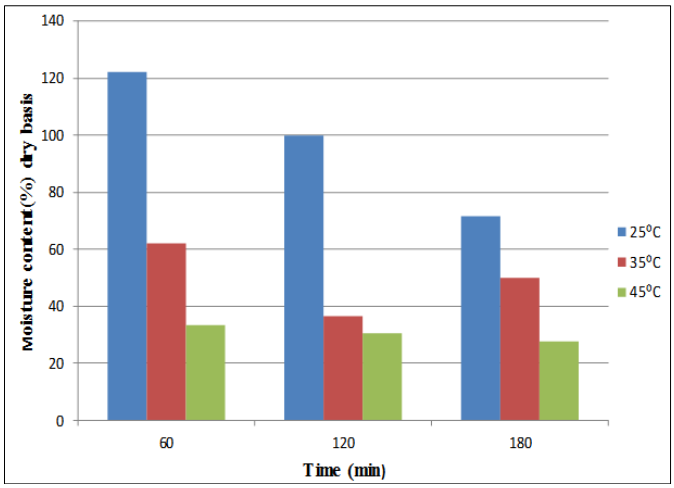

Fig 1: Comparison of moisture content on dry basis with temperature

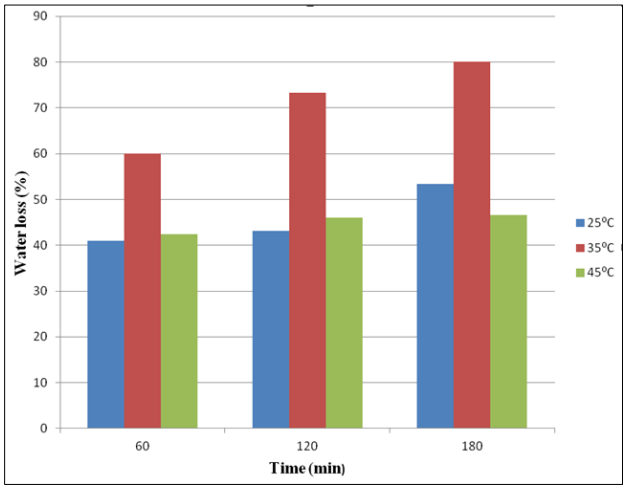

Fig 2: Comparison of water loss with time and temperature

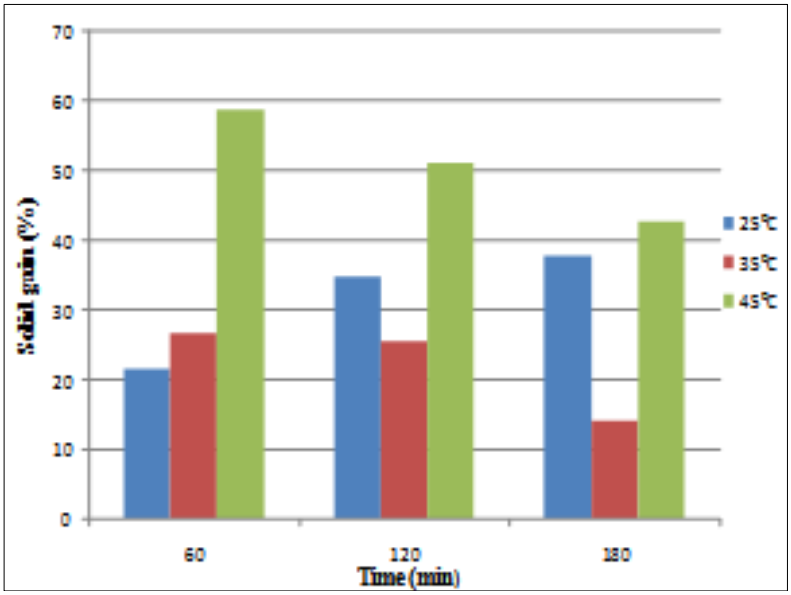

Fig 3: Comparison of solid gain with time and temp

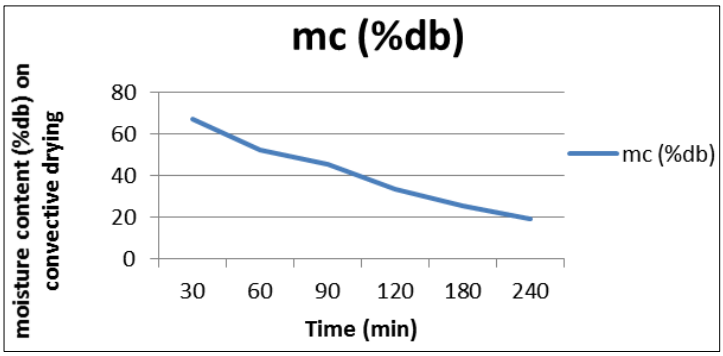

Fig 4: Moisture content of osmotically dehydrated aonla @ 45 ºC during convective drying.

3.1 Effect of solution temperature and immersion time on moisture content

The trends of change in moisture content with drying time, osmotic drying temperature are presented in fig1.It was observed that moisture content decreased with the period of drying as well with increase in osmotic during temperature. There was very quick removal of water in the initial drying. Thereafter the removal of water slowed down. The high removal of moisture initial stages was due to higher moisture differences between moisture content of aonla and honey concentration resulting in higher driving forces. Similar results were reported by Alam and Singh (2008) [3] for aonla. The moisture content decrease was maximum at the temperature of 45 ^{0}C due to larger diffusion time and temperature.

3.2 Effect of solution temperature and immersion time on water loss

The effect of solution temperature on water loss is presented in fig 2. It is clear that water loss showed increasing trend with increase in solution temperature. This is very well illustrated that water loss increased from 40.95 to 59.96% with increase in temperature from 25 ^{0}C to 45 ^{0}C. It showed increasing trend from 40.95 to 43.16% with increase in immersion time. The water loss was higher in the initial phase of osmosis than the later period. Similar results were reported by Kar and Gupta (2001, 2003) [13, 14]; Alam *et al.* (2010) [4] for peas.

3.3 Effect of solution temperature and immersion time on solid gain

The effect of solution temperature on solid gain is presented in fig 3. The solid gain showed increasing trend with increase in solution temperature. The effect of immersion time on solid gain is also shown which also increasing trend with increase in immersion time. The solid gain was higher in the initial phase of osmosis.

3.4 Convective drying of aonla

When the moisture content in the osmotic dehydration became constant the aonla were dried in the tray drier at temperature of 60 ^{0}C. The data has been presented in the fig4. Drying rate in the initial stages was fast as compared to later stages. Whole of the drying took place in falling rate period. There was quick removal of water in the initial stage of drying. Thereafter, removal of moisture slowed down and after sometime very little or no moisture removal was observed.

3.5 Effect of solution temperature on color change

The color of osmotically dried aonla was measured with the help of Hunter Colorimeter. The results have been presented in fig 5 and 6 shows that minimum color change was observed at temperature of 35 ^{0}C after 60 minutes of osmosis and maximum color change was at the temperature of 45 ^{0}C, too after 60 minutes of osmosis

3.6 Effect of solution temperature and immersion time on TSS value

It is observed from fig 7 that for the same time period of 60 min, the TSS value started decreasing with passing days of osmosis. Later on the effect with time was studied and it was reported that with immersion time the TSS value decreased. It is clear from the fig 8 and 9 that with increase in the incubator temperature the TSS value increased keeping all the parameters same.

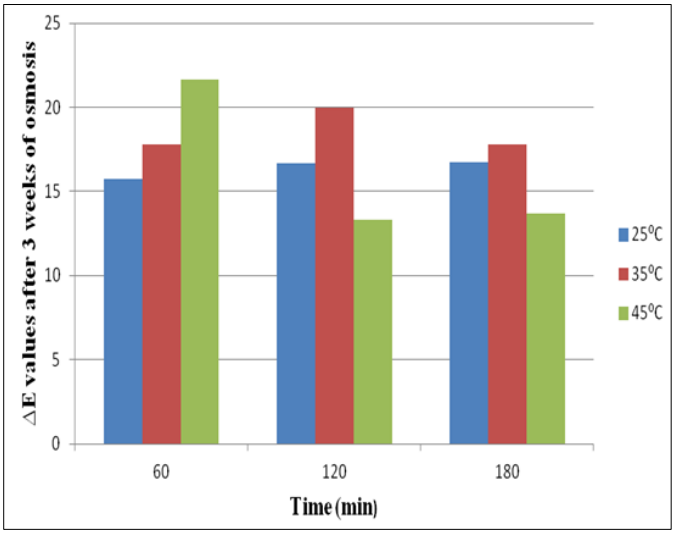

Fig 5: ΔE values at different temperatures

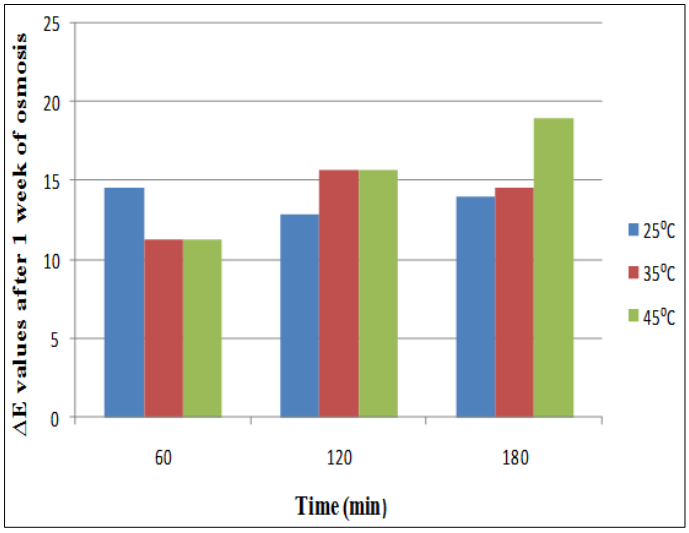

Fig 6: ΔE values at different temperatures

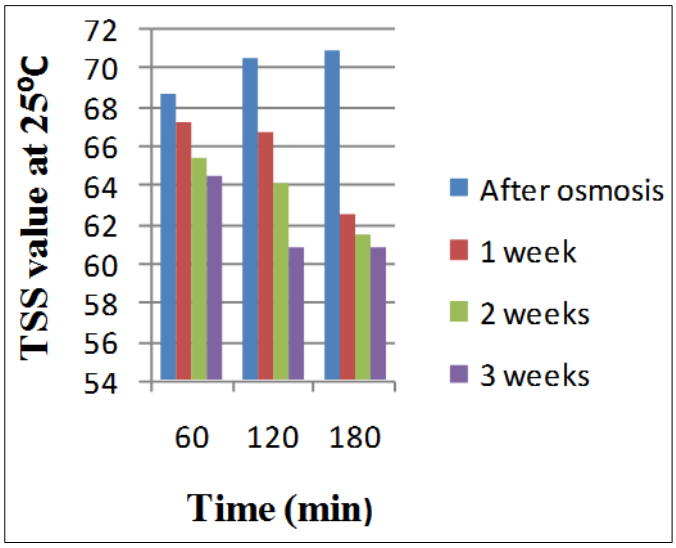

Fig 7: TSS value at 25 ^{0}C

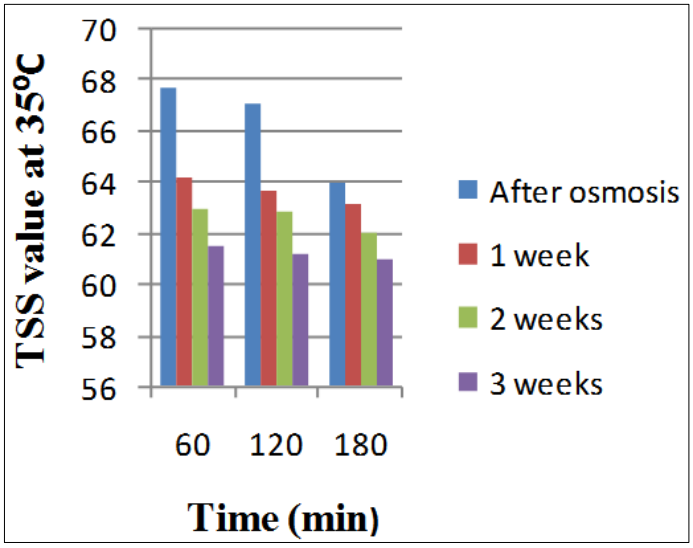

Fig 8: TSS value at 35 ^{0}C

3.7 Effect of temperature and immersion time on Texture of Aonla

The initial values of fresh aonla sample were as: Hardness=10647.909 kg-f, fracturability = 12.026, adhesiveness = -6.676, springiness =0.754, cohesiveness =0. 514 and gumminess = 5471.196.

Hardness of the samples decreased with increase in immersion time for the same incubation temperature as compared to initial values of sample. Also with the temperature the hardness showed decreasing trend. Fracturibility of the samples decreased with increase in immersion time for the same incubation temperature. Also with the temperature the fracturibility showed decreasing trend. Adhesiveness of the samples decreased with increase in immersion time for the same incubation temperature. Also with the temperature the adhesiveness showed decreasing trend. Springiness of the sample increased with increase in immersion time and immersion temperature. Cohesiveness of the sample increased with increase in immersion time and immersion temperature. Gumminess decreased with increase in temperature**.** Chewiness decreased with increase in immersion time and also increased with the temperature.

3.8 Physio –Organoleptic characteristics

A panel of five judges evaluated the physio- organoleptic qualities like color, appearance, texture, flavor and overall acceptibility. Each judge critically examined each sample of osmotically dried sample dipped in honey and assigned scores by using 9 – point hedonic scale.

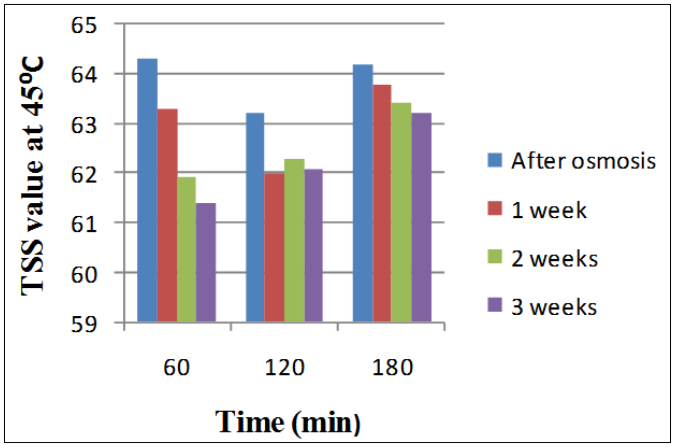

Fig 9: TSS value at 45 ^{0}C

4. Summary and Conclusion

Optimum conditions were found as 78.5% honey concentration, 5:1 solution to fruit ratio, 35 ^{0}C osmotic solution temperature, with 80.01% water loss, 13.99% solid gain with process time of 180 minutes for making honey osmosed dehydrated aonla.

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