International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 1722-1730

Received: 19-05-2018
Accepted: 27-06-2018

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Effect of different osmotic dehydration treatments on quality parameters of water melon rind candy during storage

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Abstract
The present investigation was aimed to utilize leftover water melon rind for the preparation of candy and to study the effect of different osmotic treatments on quality parameters of water melon rind candy during storage. Experiment was conducted for preparation of water melon rind candy using different levels of osmotic treatments *viz.* O_1-50 g sugar/100g rind, O_2-75 g sugar/100 g rind, O_3-100 g sugar/100g rind, O_4-100 g 60°Brix syrup/100 g rind and O_5-100 g 70°Brix syrup/100 g rind (Factor 1) and acidity *viz.* A_1 - 0.10 %, A_2-0.20 % and A_3-0.30 % (Factor 2). The results of the present investigations indicate that water melon rind candy prepared by mixing 100 g sugar per 100 g water melon rind along with 0.20 per cent acid from was rated as the best treatment (O_3A_2) on the basis of higher sensory score as well as nutritional composition and also exhibited minimum changes in nutritional as well as sensory quality during six month storage. Thus, developed technologies can commercially be explored by food processing industry for utilization of leftover rind for the preparation of candy after preparation of water melon beverages to ensure better returns to growers and processors as well.

Keywords: Water melon rind, osmotic dehydration, rind candy, quality and sensory parameters

Introduction
Water melon [*Citrullus lanatus* (Thunb.) Mastu and Nakai] is an important vegetable *vis-a-vis* fruit belonging to Cucurbitaceae family. Fruits comprised of three main components *viz.* flesh, rind and seeds. Water melon constitutes approximately 64% flesh, 33% rind and 2% seeds of the total weight (Kumar, 1985). The sweet, juicy pulp of ripe fruits is eaten fresh throughout the tropical and subtropical region. The fleshy part of water melon is being used for preparation of RTS drink or sweetened juice on small scale without any specific standard recipes and procedures. During the process of juice extraction nearly one third of fruit consists of rind which is usually discarded (Ahmed, 1996) [2]. The disposal of rind invites various problems for food industrialist due to overcoming pressures of pollution control agencies. However, the rind of water melon nearly constituting one third weight of fruit is known to be rich source of carbohydrates (3.80%), proteins (0.98%), minerals (0.20%) and fibers (Bhatnagar, 1991) [6] and possess several health beneficial effects. At present, the left over rind after juice extraction is not being utilized for value addition and thereby making it available for dumping as solid waste like municipal waste (Gontero *et al.*, 2010) [7]. So, there is urgent need to utilize left over rind for preparation of value added products. The water melon rind can be used for preparation of candy and thus can help in reducing waste generation, besides better remuneration to farmers, food processors and more importantly reduces the bad environmental impacts.

Candy is produced from fruits and vegetables by osmo dehydration process in which sugar is the main preservative. Osmotic dehydration (OD) is a technique applied to fruit and vegetable products to reduce their moisture content and increase soluble solids content. In osmotic dehydration, the raw material is immersed in hypertonic solution having a high osmotic pressure, thus resulting mass transfer from the region of higher concentration to the lower concentration (Khan, 2012) [8]. However, at present there is no standard process available for the preparation of water melon candy by osmotic dehydration technique. The maintenance of texture, taste and aroma are major problems in preparation of candy. Thus, there is urgent need to standardize the process for preparation of candy from the water melon rind.

Further, the quality of water melon nectar and rind candy also need there evaluation before going for commercialization of products.

Materials and Methods

Mature fully ripe water melon fruits of local cultivar were procured from Navsari fruit market, Navsari and brought to Department of Post-Harvest Technology, ASPEE College of Horticulture and Forestry, NAU, Navsari, Gujarat during April-2014. Water melon fruits rind were analyzed for various physico-chemical characteristics and used for preparation of rind candy.

The fruits of water melon were weighed and washed thoroughly in clean water. Then fruits were cut into halves and quarters manually using stainless steel knife. The seeds and white rind along with the peel were separated from juicy pulp. The green portion of rind was peeled using stainless steel knife and white edible portion cut into cuboids (1.5 cmx1.5 cm) having thickness of 1.0 -1.50 cm. Then prepared cuboids were used for candy preparation by osmotic dehydration.

Experiment was conducted for preparation of water melon rind candy using different levels of osmotic treatments *viz.* O_1 -50 g sugar/100g rind, O_2-75 g sugar/100 g rind, O_3-100 g sugar/100g rind, O_4-100 g 60°Brix syrup/100 g rind and O_5-100 g 70°Brix syrup/100 g rind (Factor 1) and acidity *viz.* A_1 - 0.10 %, A_2-0.20 % and A_3-0.30 % (Factor 2).

The rind of water melon was collected, washed and outer green skin was peeled. The white peeled rind was cut into cuboids of 1.5 cm x 1.5 cm. Then water melon rind cuboids were blanched in boiling water for 5 min. Simultaneously, sugar syrup of 60°B and 70°B was prepared by adding table sugar to hot water and strength of sugar syrup was measured using hand refractometer. After that freshly prepared syrup/direct sugar was mixed with blanched rind cuboids as per treatments for osmotic dehydration. Then required quantity of citric acid (0.10%, 0.20% and 0.30%) and potassium metabisulphite (350 ppm) was mixed in syrup containing cuboids. The cuboids were left overnight in syrup. After 24 hours, syrup was drained out, TSS and weight of syrup was recorded. Then TSS of drained out syrup was raised 10°Brix by adding table sugar and cuboids were again kept in syrup for overnight. The process was repeated till the TSS of syrup reached to 70°Brix. Then candy cuboids were rinsed in boiling water for 5 to 10 seconds. Then cuboids were air dried in cabinet drier at temperature of 60°C for 8 hours. After air dehydration, 50g samples of water melon rind candy were packed in polypropylene bags (300 guage), sealed airtight and stored at room temperature. Principal steps used for candy preparation are illustrated in Figure 1.

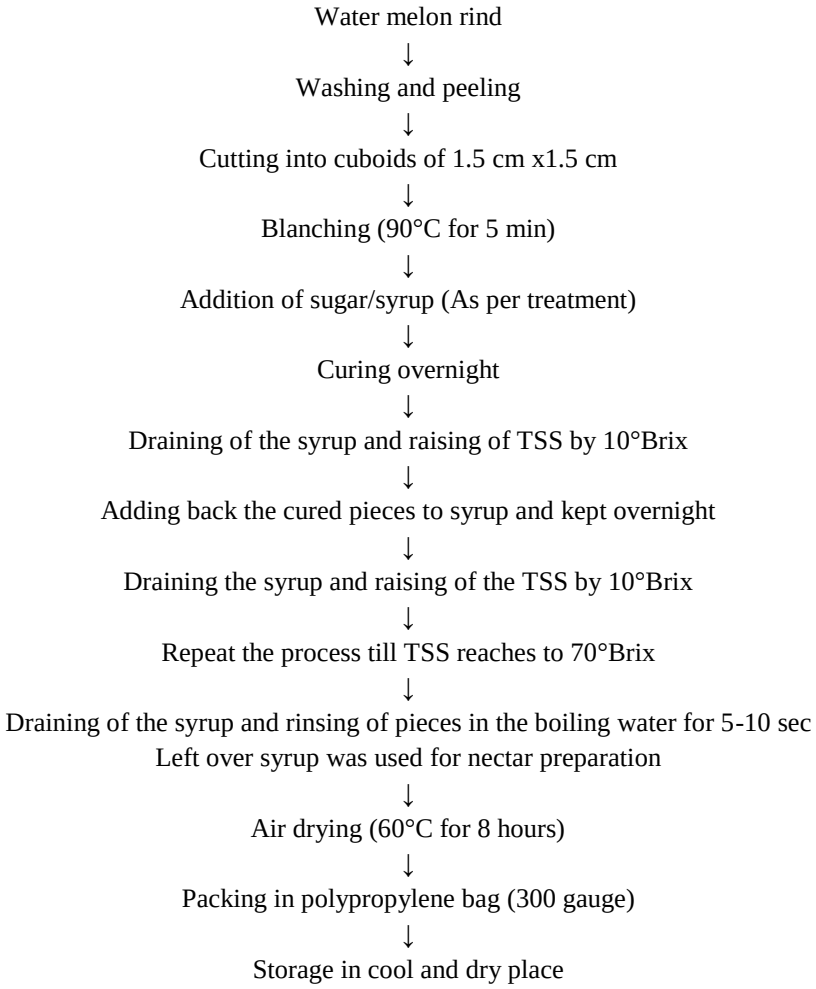

Fig 1: Principal steps used for candy preparation

Ten water melon fruits were selected randomly from the whole lot for determining the physical characteristics. The recovery of water melon rind candy was calculated by osmotic dehydration of water melon rind of known weight. After dehydration, the weight of rind candy was measured and expressed in per cent. Ash contents of samples was

determined gravimetrically then calculated and expressed as per cent on fresh weight basis (AOAC, 1984) [4]. The mass transfer-in was calculated on the basis of solids gain (g) in the candy during osmotic dehydration and mass transfer-out was calculated on the basis of amount of moisture removed (g) from the rind during osmosis and the results were expressed as per cent mass transfer-in and per cent mass transfer-out. The moisture was estimated by drying the weighted samples in hot air oven at 70±2°C to a constant weight (AOAC, 1984) [4]. The total soluble solids (TSS) of the samples were determined with the help of hand refractometer and expressed as °Brix (Ranganna, 1997) [17]. The titratable acidity were determined by the method as detailed by Ranganna (1997) [17]. Proteins content of samples were determined by Lowry's method as detailed by Sadasivam and Manickam (1996). The rind candy was evaluated for sensory qualities on the basis of overall acceptability by a panel of 7-10 judges on a 9-point Hedonic scale (Amerine *et al.*, 1965) [3]. The data pertaining to physico-chemical characteristics of candy were analyzed statistically by following completely randomized design (Panse and Shukhatme, 1967) [12].

Result and Discussion

The physico-chemical characteristics of fresh water melon fruits which were used for the preparation candy are given in Table 1. Results for physico-chemical parameters are in line with the observations made by Kumar (1985) [9], Saini and Bains (1994) [19], Ahmed (1996) [2], Yau *et al*. (2010) [24] and Adedeji and Oluwalana (2013) [1].

Table 1: Physico-chemical parameters of fresh water melon fruits

S. No	Parameters	Mean±S.Em.
Physical parameters		
1	Weight of fruit (kg)	5.00±0.26
2	Length (cm)	27.00±1.83
3	Breadth (cm)	24.50±1.34
4	Juice (%)	61.84±1.48
5	Rind (%)	32.80±0.80
	a. Edible white portion (%)	28.00±0.70
	b. Green peel (%)	4.80±0.17
6	Seed (%)	3.68±0.15
Chemical parameters of pulp		
1	Moisture (%)	90.50±0.86
2	Total soluble solids (°Brix)	8.90±0.12
3	pH	5.6±0.15
4	Titratable acidity (%)	0.12±0.02
5	Reducing sugars (%)	6.16±0.10
6	Non-reducing sugars (%)	1.45±0.13
7	Total sugars (%)	7.69±0.18
8	Ascorbic acid (mg/100 g)	10.10±0.14
Chemical parameters of rind		
1	Moisture (%)	89.20±0.18
2	Total soluble solids (°Brix)	2.80±0.07
3	Titratable acidity (%)	0.04±0.001
4	Reducing sugars (%)	1.84±0.02
5	Non-reducing sugars (%)	0.50±0.01
6	Total sugars (%)	2.37±0.04
7	Ascorbic acid (mg/100 g)	1.24±0.20
8	Ash (%)	1.60±0.15
9	Protein (%)	3.10±0.25

Physico-chemical characteristics of candy

Recovery: The perusal of data pertaining to recovery of water melon rind candy has been presented in Table 2. Data shows that among different osmotic treatments the recovery of water melon rind candy varied from 67.67 per cent to 68.83 per cent, with minimum recovery in candy prepared by osmotic treatment using 100 g sugar per 100 g rind (O_3) and maximum in candy prepared by using 50 g sugar per 100 g rind (O_1). However, non-significant differences were observed in recovery of candy. Further, it was observed that recovery of candy varied from 67.90 per cent to 68.90 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum recovery in candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.30 per cent citric acid (A_3). However, non-significant differences were observed in recovery of candy. Further, recovery of water melon rind candy was found minimum (67.00 per cent) in candy prepared by using 100 g of sugar per 100 g of rind and 0.10 per cent citric acid (O_3A_1) and maximum (70 per cent) in candy prepared by using 50 g of sugar per 100 g of rind and 0.30 per cent citric acid (O_1A_3).

***Ash content*:** The perusal of data pertaining to ash content of water melon rind candy has been presented in Table 2. Data shows that among different osmotic treatments the ash content of water melon rind candy varied from 1.870 per cent to 1.900 per cent, with minimum ash content in candy prepared by osmotic treatment using 100 g sugar per 100 g rind (O_3) and maximum in candy prepared by using 50 g sugar per 100 g rind (O_1). However, non-significant differences were observed in ash content of candy. Further, it was observed that ash content of candy varied from 1.888 per cent to 1.902 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum ash content in candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.20 per cent citric acid (A_2). However, non-significant differences were observed in ash content of candy. Further, ash content of water melon rind candy was found minimum (1.860 per cent) in candy prepared by using 100 g of sugar per 100 g of rind and 0.10 per cent citric acid (O_3A_1) and maximum (1.920 per cent) in candy prepared by using 100 g of syrup (60°Brix) per 100 g of rind and 0.20 per cent citric acid (O_4A_2).

***Mass transfer-in*:** The perusal of data pertaining to mass transfer-in for water melon rind candy has been presented in Table 2. Data shows that among different osmotic treatments the mass transfer-in for water melon rind candy varied from 40.33 per cent to 40.67 per cent, with minimum mass transfer-in for candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1) and maximum in candy prepared by using 100 g syrup (60°Brix) per 100 g rind (O_4). However, non-significant differences were observed in mass transfer-in for candy. Further, it was observed that mass transfer-in for candy varied from 40.30 per cent to 40.72 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum mass transfer-in for candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.30 per cent citric acid (A_3). However, non-significant differences were observed for mass transfer-in of candy. Further, mass transfer-in for water melon rind candy was found minimum (40.10 per cent) in candy prepared by using 50 g of sugar per 100 g of rind and 0.10 per cent citric acid (O_1A_1) and maximum (40.90 per cent) in candy prepared by using 100 g of syrup (60°Brix) per 100 g of rind and 0.30 per cent citric acid (O_4A_3) and 100 g of sugar per 100 g of rind and 0.30 per cent citric acid (O_3A_3).

***Mass transfer-out*:** The perusal of data pertaining to mass transfer-out for water melon rind candy has been presented in Table 2. Data shows that among different osmotic treatments the mass transfer-out for water melon rind candy varied from 61.12 per cent to 62.10 per cent, with minimum mass transfer-out for candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1) and maximum in candy prepared by using 100 g sugar per 100 g rind (O_3). However, non-significant differences were observed in mass transfer-out for candy. Further, it was observed that mass transfer-out for candy varied from 61.52 per cent to 61.65 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum mass transfer-out for candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.30 per cent citric acid (A_3). However, non-significant differences were observed in mass transfer-out of candy. Further, mass transfer- out for water melon rind candy was found minimum (61.00 per cent) in candy prepared by using 50 g of sugar per 100 g of rind and 0.10 per cent citric acid (O_1A_1) and maximum (62.20 per cent) in candy prepared by using 100 g of sugar per 100 g of rind and 0.30 per cent citric acid (O_3A_3).

Table 2: Effect of different treatments on recovery, ash content, mass transfer-in and mass transfer-out of water melon rind

Parameters	Acid concentration (A), %	Osmotic treatments,* (O)					Mean	$CD_{0.05}$
		O_1	O_2	O_3	O_4	O_5		
Recovery (%)	A_1 - 0.10	68.00	68.00	67.00	68.00	68.50	67.90	O= NS
	A_2 - 0.20	68.50	68.00	68.00	68.50	68.50	68.30	A=NS
	A_3 - 0.30	70.00	69.00	68.00	69.00	68.50	68.90	O×A=NS
	Mean	68.83	68.33	67.67	68.50	68.50	68.37	
Ash content (%)	A_1 - 0.10	1.900	1.890	1.860	1.890	1.890	1.888	O= NS
	A_2 - 0.20	1.910	1.900	1.890	1.920	1.900	1.902	A=NS
	A_3 - 0.30	1.880	1.870	1.900	1.880	1.890	1.884	O×A=NS
	Mean	1.900	1.886	1.870	1.890	1.893	1.888	
Mass transfer- in (%)	A_1 - 0.10	40.10	40.40	40.40	40.30	40.30	40.30	O=NS
	A_2 - 0.20	40.30	40.50	40.60	40.80	40.40	40.52	A=NS
	A_3 - 0.30	40.60	40.70	40.90	40.90	40.50	40.72	O×A=NS
	Mean	40.33	40.53	40.63	40.67	40.40	40.51	
Mass transfer- out (%)	A_1 - 0.10	61.00	61.30	62.00	61.50	61.80	61.52	O= NS
	A_2 - 0.20	61.20	61.40	62.10	61.60	61.80	61.62	A=NS
	A_3 - 0.30	61.15	61.45	62.20	61.55	61.90	61.65	O×A=NS
	Mean	61.12	61.38	62.10	61.55	61.83	61.60	

* O_1 – 50g sugar/100 g of rind, O_2 – 75g sugar/100 g of rind, O_3 – 100g sugar/100 g of rind, O_4 – 100g syrup (60°Brix)/100 g of rind, O_5 – 100g syrup (70°Brix)/100 g of rind

Moisture content: The perusal of data pertaining to moisture content of water melon rind candy has been presented in Table 3. Data shows that among different osmotic treatments the grand mean (O) moisture of water melon rind candy varied significantly from 17.12 per cent to 17.72 per cent, with minimum moisture content in candy prepared by osmotic treatment using 100 g syrup (60°Brix) per 100 g rind (O_4) and maximum in candy prepared by using 100 g syrup (70°Brix) per 100 g rind (O_5). Data depicts that storage of candy resulted significant decrease in grand mean (S) moisture content from initial value of 17.80 per cent to 17.35 per cent after two months of storage followed by significant increase in moisture from 17.35 per cent to 17.44 per cent after six months storage. The decrease in moisture content during first two month might be due to low relative humidity in the storage area. The increase in moisture during 4^{th} and 6^{th} months might be attributed to increase in relative humidity in the atmosphere due to continuations of rainy monsoon. Similar observations were reported by Sivakumar (2013). The decrease in moisture during six months storage was observed minimum (17.39 per cent to 17.09 per cent) in candy prepared by osmotic treatment using 100g syrup (60°Brix) per 100 g rind (O_4) and maximum (17.85 per cent to 17.32 per cent) in candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1). Further, it was observed that grand mean (A) moisture content of candy varied significantly from 17.37 per cent to 17.66 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum moisture in candy prepared using 0.2 per cent citric acid (A_2) in hypertonic solution and maximum in 0.3 per cent citric acid (A_3). Among different concentrations of citric acid, minimum decrease in moisture content from 17.93 per cent to 17.62 per cent was observed in water melon rind candy prepared by using 0.3 per cent citric acid (A_3), whereas maximum decrease in moisture from 17.80 per cent to 17.39 per cent was observed in candy prepared by 0.10 per cent citric acid (A_1) after six months of storage. Further, significant decrease of moisture content in water melon rind candy during six month storage was found minimum (18.15 per cent to 17.96 per cent) in candy prepared by using 100 g of sugar per 100 g of rind and 0.30 per cent citric acid (O_3A_3) and maximum (17.77 per cent to 17.06 per cent) in candy prepared by using 50 g of sugar per 100 g of rind and 0.10 per cent citric acid (O_1A_1). The decline in moisture content might be attributed to evaporation of moisture from the candy. The decrease in moisture content during storage in the present investigation are in line with the observation reported by Tripathi *et al.* (1988) [23] and Nayak *et al.* (2012) [11] for *aonla* candy.

Table 3: Effect of different treatments on moisture content of water melon rind candy during storage period of 6 month

Storage (S)	Acid concentration (A), %	Moisture content (%)						
		Osmotic treatments*, (O)					Grand Mean (S)	Grand Mean (A)
		O_1	O_2	O_3	O_4	O_5		
0 Month (S_1)	A_1 - 0.1	17.77	18.02	17.60	17.50	18.10	**17.80**	**17.47**
	A_2 - 0.2	17.73	17.94	18.03	17.22	17.43	**17.67**	**17.37**
	A_3 - 0.3	18.05	17.55	18.15	17.45	18.46	17.93	17.66
	Mean	17.85	17.84	17.92	17.39	18.00	17.80	
2 Month (S_2)	A_1 - 0.1	17.02	17.78	17.06	17.01	17.73	17.32	
	A_2 - 0.2	17.16	17.54	17.64	16.83	16.90	17.21	
	A_3 - 0.3	17.60	17.01	17.85	17.05	18.08	17.52	
	Mean	17.26	17.44	17.52	16.96	17.57	17.35	
4 Month (S_3)	A_1 - 0.1	17.05	17.80	17.08	17.10	17.77	17.36	
	A_2 - 0.2	17.19	17.60	17.67	16.96	16.98	17.28	
	A_3 - 0.3	17.67	17.05	17.90	17.11	18.16	17.58	
	Mean	17.30	17.48	17.55	17.06	17.64	17.41	
6 Month (S_4)	A_1 - 0.1	17.06	17.82	17.10	17.15	17.80	17.39	
	A_2 - 0.2	17.20	17.64	17.68	16.99	17.05	17.31	
	A_3 - 0.3	17.70	17.10	17.96	17.14	18.20	17.62	
	Mean	17.32	17.52	17.58	17.09	17.68	17.44	
	Grand Mean (O)	17.43	17.57	17.64	17.12	17.72		17.50
* O_1 – 50g sugar/100 g of rind			O_2 –75g sugar/100 g of rind			O_3 – 100g sugar/100 g of rind		
O_4 – 100g syrup (60°Brix)/100 g of rind			O_5 – 100g syrup (70°Brix)/100 g of rind					
$CD_{0.05}$	O= 0.025 A= 0.200 S= 0.023		O×A= 0.0.040 O×S= 0.050 A×S= 0.040			O×A×S= 0.089		

***Total Soluble Solids (TSS)*:** The perusal of data pertaining to TSS of water melon rind candy has been presented in Table 4. Data shows that among different osmotic treatments the grand mean TSS of water melon rind candy (O) ranged from 72.54°Brix to 73.14°Brix, with minimum TSS in candy prepared by osmotic treatment using 100 g sugar per 100 g rind (O_3) and maximum in candy prepared by using 100 g syrup (60°Brix) per 100 g rind (O_4). However, differences were found non-significant. Data depicts that storage of candy resulted significant increase in grand mean TSS content (S) from initial value of 71.05°Brix to 74.93°Brix after six months of storage. The increase in TSS during storage might be attributed to conversion of polysaccharides into reducing sugars and evaporation of moisture content. Similar observations were reported by Mishra *et al.* (2013) [10] and Pawar *et al.* (2013). The increase in TSS during six months storage was observed minimum (71.13°Brix to 74.58°Brix) in candy prepared by osmotic treatment using 75g sugar per 100 g rind (O_2) and maximum (71.18°Brix to 75.33°Brix) in candy prepared by osmotic treatment using 100 g syrup (70°Brix) per 100 g rind (O_5). Further, it was observed that grand mean TSS of candy (A) varied significantly from 72.41°Brix to 73.48°Brix in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum TSS in candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.30 per cent citric acid (A_3). Among different concentrations of citric acid, minimum increase in TSS from 71.77°Brix to 75.47°Brix was observed in water melon rind candy prepared by using 0.30 per cent citric acid (A_3), whereas maximum increase in TSS from 70.85°Brix to 74.84°Brix was observed in candy prepared by 0.20 per cent citric acid (A_2) after six months of storage. The increase in TSS during storage might be attributed to conversion of organic acids to sugars (Babariya *et al.* 2014). Further, increase of TSS in water melon rind candy during six month storage was found minimum (71.80°Brix to 74.83°Brix) in candy prepared by using 75 g of sugar per 100 g rind and 0.30 per cent citric acid (O_2A_3) and maximum (70.50°Brix to 75.03°Brix) in candy prepared by using 100 g of syrup (60°Brix) per 100 g rind and 0.20 per cent citric acid (O_4A_2). The increase in TSS might be due to reduction of moisture content in product during storage. The increase in TSS during storage in the present investigation are in line with the observation reported by Singh and Gautam (2010) for pineapple candy, Nayak *et al.* (2012) [11] for *aonla* candy, Priya and Khatkar (2013) for *aonla* preserve. However, non-significant differences were observed in TSS among interactions of osmotic treatments and citric acid concentrations during six months of storage.

Table 4: Effect of different treatments on TSS of water melon rind candy during storage period of 6 months

Storage (S)	Acid concentration (A), %	TSS (°Brix)						
		Osmotic treatments,* (O)					Grand Mean (S)	Grand Mean (A)
		O_1	O_2	O_3	O_4	O_5		
0 Month (S_1)	A_1 - 0.1	70.57	70.93	70.07	70.43	70.60	70.52	72.41
	A_2 - 0.2	71.03	70.67	70.67	70.50	71.40	70.85	72.70
	A_3 - 0.3	71.53	71.80	71.13	72.87	71.53	71.77	73.48
	Mean	71.04	71.13	70.62	71.27	71.18	71.05	
2 Month (S_2)	A_1 - 0.1	71.80	71.87	71.23	71.50	71.40	71.56	
	A_2 - 0.2	71.97	71.20	71.63	71.73	72.33	71.77	
	A_3 - 0.3	72.27	72.63	72.40	73.53	72.40	72.65	
	Mean	72.01	71.90	71.76	72.26	72.04	71.99	
4 Month (S_3)	A_1 - 0.1	73.13	73.53	72.47	73.13	73.07	73.07	

	A_2 - 0.2	73.37	73.03	73.07	73.53	73.63	73.33	
	A_3 - 0.3	73.63	73.80	74.13	74.77	73.87	74.04	
	Mean	73.38	73.46	73.22	73.81	73.52	73.48	
6 Month (S_4)	A_1 - 0.1	74.53	74.63	73.67	74.53	75.03	74.48	
	A_2 - 0.2	75.07	74.27	74.43	75.03	75.40	74.84	
	A_3 - 0.3	75.27	74.83	75.60	76.07	75.57	75.47	
	Mean	74.96	74.58	74.57	75.21	75.33	74.93	
	Grand Mean (O)	72.85	72.77	72.54	73.14	73.02		72.86
* O_1 – 50g sugar/100 g of rind			O_2 –75g sugar/100 g of rind			O_3 – 100g sugar/100 g of rind		
O_4 – 100g syrup (60°Brix)/100 g of rind			O_5 – 100g syrup (70°Brix)/100 g of rind					
$CD_{0.05}$	O= NS A= 0.357 S= 0.412		O×A= NS O×S= NS A×S= NS			O×A×S= NS		

***Acidity*:** The perusal of data pertaining to acidity of water melon rind candy has been presented in Table 5. Data shows that among different osmotic treatments the grand mean acidity (O) of water melon rind candy varied significantly from 0.207 per cent to 0.223 per cent, with minimum acidity in candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1) and maximum in candy prepared by using 100 g sugar per 100 g rind (O_3). Data depicts that storage of candy resulted significant increase in grand mean acidity (S) from initial value of 0.143 per cent to 0.290 per cent after six months of storage. The pectin substance is mainly responsible to increase of acidity in candy. Degradation of pectic substances into soluble solids during storage might have contributed towards increase in acidity. Similar observations were reported by Nayak *et al.* (2012) [11] and Mishra *et al.* (2013) [13]. The increase in acidity during six months storage was observed minimum (0.157 per cent to 0.289 per cent) in candy prepared by osmotic treatment using 100 g sugar per 100 g rind (O_3) and maximum (0.123 per cent to 0.284 per cent) in candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1). Further, it was observed that grand mean acidity (A) of candy varied significantly from 0.134 per cent to 0.295 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum acidity in candy prepared using 0.10 per cent citric acid (A_1) in hypertonic solution and maximum in 0.30 per cent citric acid (A_3). Among different concentrations of citric acid, minimum increase in acidity from 0.072 per cent to 0.198 per cent was observed in water melon rind candy prepared by using 0.10 per cent citric acid (A_1), whereas maximum increase in acidity from 0.204 per cent to 0.381 per cent was observed in candy prepared by 0.30 per cent citric acid (A_3) after six months of storage. Further, increase of acidity in water melon rind candy during six month storage was found minimum (0.170 per cent to 0.280 per cent) in candy prepared by using 100 g sugar per 100 g rind and 0.20 per cent citric acid (O_3A_2) and maximum (0.180 per cent to 0.384 per cent) in candy prepared by using 50 g of sugar per 100 g rind and 0.30 per cent citric acid (O_1A_3). However, non-significant differences were observed in acidity among interactions of osmotic treatments and citric acid concentrations during six months of storage. The increase in acidity could also be associated with formation of pectic acid during storage. The increases in acidity during storage in the present investigation are in the line with the observation reported by Singh and Gautam (2010) [20] for pineapple candy and Pawar *et al.* (2013) [13] for *aonla* candy.

Table 5: Effect of different treatments on acidity of water melon rind candy during storage period of 6 months

Storage (S)	**Acid concentration (A), %**	**Acidity (%)**						
		Osmotic treatments*, (O)					**Grand Mean (S)**	**Grand Mean (A)**
		O_1	**O_2**	**O_3**	**O_4**	**O_5**		
0 Month (S_1)	A_1 - 0.1	0.060	0.070	0.080	0.070	0.080	0.072	0.134
	A_2 - 0.2	0.130	0.150	0.170	0.150	0.160	0.152	0.218
	A_3 - 0.3	0.180	0.200	0.220	0.200	0.220	0.204	0.295
	Mean	0.123	0.140	0.157	0.140	0.153	0.143	
2 Month (S_2)	A_1 - 0.1	0.120	0.130	0.120	0.110	0.120	0.120	
	A_2 - 0.2	0.200	0.210	0.230	0.200	0.210	0.210	
	A_3 - 0.3	0.280	0.290	0.290	0.290	0.280	0.286	
	Mean	0.200	0.210	0.213	0.200	0.203	0.205	
4 Month (S_3)	A_1 - 0.1	0.130	0.140	0.150	0.150	0.150	0.144	
	A_2 - 0.2	0.220	0.220	0.230	0.210	0.220	0.220	
	A_3 - 0.3	0.310	0.310	0.320	0.300	0.310	0.310	
	Mean	0.220	0.223	0.233	0.220	0.227	0.225	
6 Month (S_4)	A_1 - 0.1	0.181	0.203	0.203	0.203	0.203	0.198	
	A_2 - 0.2	0.288	0.299	0.280	0.288	0.299	0.291	
	A_3 - 0.3	0.384	0.373	0.384	0.363	0.400	0.381	
	Mean	0.284	0.292	0.289	0.284	0.300	0.290	
	Grand Mean (O)	0.207	0.216	0.223	0.211	0.221		0.216
* O_1 – 50g sugar/100 g of rind			O_2 – 75g sugar/100 g of rind			O_3 – 100g sugar/100 g of rind		
O_4 – 100g syrup (60°Brix)/100 g of rind O_5 – 100g syrup (70°Brix)/100 g of rind								
$CD_{0.05}$	O= 0.005 A= 0.004 S= 0.004		O×A= NS O×S= 0.011 A×S= 0.008			S×O×A= NS		

***Proteins*:** The perusal of data pertaining to protein content of water melon rind candy have been presented in Table 6. Data shows that among different osmotic treatments the grand mean protein content (O) of water melon rind candy varied significantly from 2.21 per cent to 2.26 per cent, with minimum protein content in candy prepared by osmotic treatment using 100 g syrup (60°Brix) per 100 g rind (O_4) and maximum in candy prepared by using 100 g sugar per 100 g rind (O_3). Data depicts that storage of candy resulted significant decrease in grand mean protein content (S) from initial value of 2.41 per cent to 2.05 per cent after six months of storage. The decrease in protein content during storage might be due to breakdown of protein to free amino acids (Raj, 2004) [16]. The decrease in protein content during six months storage was observed minimum (2.40 per cent to 2.14 per cent) in candy prepared by osmotic treatment using 100g sugar per 100 g rind (O_3) and maximum (2.40 per cent to 1.99 per cent) in candy prepared by osmotic treatment using 100g syrup (60°Brix) per 100 g rind (O_4). Further, it was observed that grand mean protein content (A) of candy varied significantly from 2.23 per cent to 2.25 per cent in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum protein content in candy prepared using 0.30 per cent citric acid (A_3) in hypertonic solution and maximum in 0.20 per cent citric acid (A_2). Among different concentrations of citric acid, minimum decrease in protein content from 2.41 per cent to 2.09 per cent was observed in water melon rind candy prepared by using 0.20 per cent citric acid (A_2), whereas maximum decrease in protein content from 2.42 per cent to 2.01 per cent was observed in candy prepared by 0.30 per cent citric acid (A_3) after six months of storage. Further, significant decrease of protein content in water melon rind candy during six month storage was found minimum (2.38 per cent to 2.15 per cent) in candy prepared by using 100 g of sugar per 100 g of rind and 0.20 per cent citric acid (O_3A_2) and maximum (2.45 per cent to 1.98 per cent) in candy prepared by using 100 g of syrup (60°Brix) per 100 g of rind and 0.30 per cent citric acid (O_4A_3). The decline in proteins during storage could also be associated with an increase of proteolytic enzyme activity (Raj, 2004) [16].

Table 6: Effect of different treatments on proteins content of water melon rind candy during storage period of 6 month

Storage (S)	Acid concentration (A), %	Proteins (%)						
		Osmotic treatments,* (O)					Grand Mean (S)	Grand Mean (A)
		O_1	O_2	O_3	O_4	O_5		
0 Month (S_1)	A_1 - 0.1	2.40	2.43	2.36	2.35	2.43	2.39	2.24
	A_2 - 0.2	2.45	2.42	2.38	2.40	2.38	2.41	2.25
	A_3 - 0.3	2.40	2.35	2.45	2.45	2.45	2.42	2.23
	Mean	2.42	2.40	2.40	2.40	2.42	2.41	
2 Month (S_2)	A_1 - 0.1	2.30	2.32	2.26	2.28	2.30	2.29	
	A_2 - 0.2	2.32	2.35	2.28	2.30	2.28	2.31	
	A_3 - 0.3	2.30	2.28	2.32	2.25	2.35	2.30	
	Mean	2.31	2.32	2.29	2.28	2.31	2.30	
4 Month (S_3)	A_1 - 0.1	2.20	2.18	2.16	2.23	2.20	2.19	
	A_2 - 0.2	2.22	2.25	2.20	2.20	2.20	2.21	
	A_3 - 0.3	2.18	2.20	2.25	2.12	2.28	2.21	
	Mean	2.20	2.21	2.20	2.18	2.23	2.20	
6 Month (S_4)	A_1 - 0.1	2.03	2.10	2.11	1.99	2.07	2.06	
	A_2 - 0.2	2.10	2.12	2.15	2.01	2.08	2.09	
	A_3 - 0.3	1.97	1.95	2.15	1.98	2.01	2.01	
	Mean	2.03	2.06	2.14	1.99	2.05	2.05	
	Grand Mean (O)	2.24	2.25	2.26	2.21	2.25		2.24
* O_1 – 50g sugar/100 g of rind			O_2 – 75g sugar/100 g of rind			O_3 – 100g sugar/100 g of rind		
O_4 – 100g syrup (60°Brix)/100 g of rind			O_5 – 100g syrup (70°Brix)/100 g of rind					
$CD_{0.05}$	O= 0.008 A= 0.006 S= 0.007		O×A= 0.015 O×A= 0.017 A×S= 0.013			O×A×S=0.030		

Sensory characteristics of candy

***Overall Acceptability*:** The perusal of data pertaining to overall acceptability of water melon rind candy has been presented in Table 7. Data shows that among different osmotic treatments the grand mean overall acceptability (O) score (9 point Hedonic scale) of water melon rind candy varied significantly from 7.25 to 7.97, with minimum overall acceptability score in candy prepared by osmotic treatment using 100 g syrup (70°Brix) per 100 g rind (O_5) and maximum in candy prepared by using 100 g sugar per 100 g rind (O_3). Data depicts that storage of candy resulted significant decrease in grand mean overall acceptability (S) score from initial value of 7.88 to 7.29 after six months of storage. The decrease in overall acceptability score during six months storage was observed minimum (7.88 to 7.31) in candy prepared by osmotic treatment using 50 g sugar per 100 g rind (O_1) and maximum (8.26 to 7.65) in candy prepared by osmotic treatment using 100g sugar per 100 g rind (O_3) but still possess higher sensory score for overall acceptability during entire period of storage. Even, changes were observed non-significant. Further, it was observed that grand mean overall acceptability (A) score of candy varied significantly from 7.37 to 7.95 in water melon rind candy when hypertonic solution contains different concentrations of citric acid, with minimum overall acceptability score in candy prepared using 0.30 per cent citric acid (A_3) in hypertonic solution and maximum in 0.20 per cent citric acid (A_2). Among different concentrations of citric acid, minimum decrease in overall acceptability score from 8.21 to 7.64 was observed in water melon rind candy prepared by using 0.20 per cent citric acid (A_2), whereas maximum decrease in overall acceptability score from 7.66 to 7.06 was observed in candy prepared by 0.30 per cent citric acid (A_3) after six months of storage. Further, decrease of overall acceptability score in water melon

rind candy during six month storage was found minimum (7.55 to 7.01) in candy prepared by using 100 g syrup (60°Brix) per 100 g rind and 0.10 per cent citric acid (O_4A_1) and maximum (7.71 to 7.07) in candy prepared by using 75 g sugar per 100 g rind and 0.30 per cent citric acid (O_2A_3). However, during entire storage period, the sensory score for overall acceptability was found highest in candy prepared using 100g sugar per 100g rind with 0.20 per cent citric acid (O_3A_2). Further, non-significant differences were observed in overall acceptability score among interactions of osmotic treatments and citric acid concentrations during six months of storage. The decrease in score of overall acceptability during storage could be correlated to change in colour, texture, taste and flavour of water melon rind candy. However, under room condition the quality was maintained to more than six months of storage (Nayak *et al.,* 2012, Pawar *et al.,* 2013 [11, 13], Mishra *et al.,* 2013 and Babariya *et al.,* 2014) [11, 5].

Table 7: Effect of different treatments on overall acceptability of water melon rind candy during storage period of 6 months

Storage (S)	Acid concentration (A), %	Overall acceptability (9 point Hedonic scale)						
		Osmotic treatments,* (O)					Grand Mean (S)	Grand Mean (A)
		O_1	O_2	O_3	O_4	O_5		
0 Month (S_1)	A_1 - 0.1	8.07	7.63	7.79	7.55	7.84	7.77	7.49
	A_2 - 0.2	7.90	8.57	8.90	8.48	7.20	8.21	7.95
	A_3 - 0.3	7.67	7.71	8.09	7.26	7.56	7.66	7.37
	Mean	7.88	7.97	8.26	7.76	7.53	7.88	
2 Month (S_2)	A_1 - 0.1	7.92	7.46	7.60	7.41	7.66	7.61	
	A_2 - 0.2	7.75	8.41	8.76	8.39	7.07	8.08	
	A_3 - 0.3	7.50	7.51	7.94	7.10	7.38	7.49	
	Mean	7.72	7.79	8.10	7.63	7.37	7.72	
4 Month (S_3)	A_1 - 0.1	7.71	7.27	7.40	7.20	7.46	7.41	
	A_2 - 0.2	7.56	8.23	8.54	8.17	6.88	7.88	
	A_3 - 0.3	7.32	7.29	7.72	6.92	7.15	7.28	
	Mean	7.53	7.59	7.89	7.43	7.17	7.52	
6 Month (S_4)	A_1 - 0.1	7.49	7.04	7.16	7.01	7.22	7.18	
	A_2 - 0.2	7.34	8.02	8.33	7.88	6.64	7.64	
	A_3 - 0.3	7.10	7.07	7.46	6.71	6.94	7.06	
	Mean	7.31	7.38	7.65	7.20	6.93	7.29	
	Grand Mean (O)	7.61	7.68	7.97	7.51	7.25		7.61
* O_1 – 50g sugar/100 g of rind			O_2 –75g sugar/100 g of rind			O_3 – 100g sugar/100 g of rind		
O_4 – 100g syrup (60°Brix)/100 g of rind			O_5 – 100g syrup (70°Brix)/100 g of rind					
$CD_{0.05}$	O= 0.021 A= 0.017 S= 0.019		O×A= 0.038 O×S= NS A×S= NS			O×A×S= NS		

Conclusion

Water melon rind candy can be prepared by using 100 g sugar per 100 g rind containing 0.20 per cent citric acid (O_3A_2). The prepared candy was found superior based on nutritional as well as sensory quality and can be stored satisfactorily for period of six month in PP bags of 300 gauge.

References

1. Adedeji TO, Oluwalana IB. Physico-chemical, sensory and microbial analysis of wine produced from water melon and pawpaw blend. Fd. Sci. Qual. Manag. 2013; 19:41-50.
2. Ahmed J. Studies on water melon products. Indian Fd. Packer. 1996; 50(3):15-20.
3. Amerine MA, Pangborn RM, Roessler EB. Principles of sensory evaluation of food. Acad. Press, London, 1965.
4. AOAC. Official methods of analysis, Association of Official Analytical Chemists. 14th edn., Arlington, Virginia, USA, 1984.
5. Babariya VJ, Makwana AN, Hadwani M, Panjiar N. Standardization of recipe for preparation of candy (tuti fruiti) from unripe papaya. Asian J. Hort. 2014; 9(1):94-99.
6. Bhatnagar DK.. Utilization of water melon rind for jam making. Indian Fd. packer. 1991; 45(1):46-48.
7. Gontero M, Brandelli A, Noreia CZ. Production of crystallized fruit from water melon rind. Cien. Inv. Agr. 2010; 37(2):55-60.
8. Khan MR. Osmotic dehydration techniques for fruits preservation-A review. Pak. J Fd. Sci. 2012; 22(2):71-81.
9. Kumar P. Water melon- Utilization of peel waste for pickle processing. Indian Fd. Packer. 1985; 39(4):49-52.
10. Mishra DK, Saroj PL, Pathak S. Effect of packaging containers on storage stability of *bael* candy under ambient conditions. Prog. Hort. 2013; 45(1):122-125.
11. Nayak P, Tondon KD, Bhatt DK. Study on changes of nutritional and organoleptic quality of flavoured candy prepared from *aonla* during storage. Int. J. Nut. Metabolism. 2012; 4(7):100-106.
12. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers (2nd Ed.). ICAR publication, New Delhi (India), 1967, 381.
13. Pawar MB, Patil DR, Naik AG. Evaluation of different *aonla* varieties for osmodehydrated candy product processing. Int. J process. Post-Harvest Technol. 2013; 4:26-29.
14. Pawar MB, Patil DR, Naik AG. Evaluation of different *aonla* varieties for osmodehydrated candy product processing. Int. J process. Post-Harvest Technol. 2013; 4:26-29.
15. Priya MD, Khatkar BS. Effect of processing methods on keeping quality of *aonla* preserve. Int. Fd. Res. J. 2013; 20(2):617-622.
16. Raj D. Screening of Potato (*Solanum tuberosum* L.) cultivars for processing and value addition. Ph.d. Thesis submitted to Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh (India), 2004.

17. Ranganna S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw Hill Publishing Co. Ltd., New Delhi (India), 1997.
18. Sadasivam S, Manickam A. Biochemical methods, 2nd edn. New Age International (P) Ltd., New Delhi, India, 1996.
19. Saini SPS, Bains GS. A new method of mechanized production of water melon seeds and juice. Indian Fd. Packer. 1994; 48(2):55-57.
20. Singh SS, Gautam A. Effect of pretreatment methods on qualitative and organoleptic attributes of pineapple candy during storage. Fd. Sci. Res. J. 2010; 1(2):76-85.
21. Sivakumar KP. Standardization and storage stability of amla sweet candy. Madras Agric. J. 2013; 100(1-3):248-250.
22. Sivakumar KP. Standardization and storage stability of amla sweet candy. Madras Agric. J. 2013; 100(1-3):248-250.
23. Tripathi VK, Singh MB, Singh S. Studies on comparative compositional changes in different preserved products of *aonla*. (*Emblica officinalis)* var. Banarasi. Indian Fd. Packer. 1988; 42(4):60-66.
24. Yau EW, Rosnah S, Noraziah M, Chin NL, Osman H. Physico-chemical compositions of the red seedless water melons. Int. Fd. Res. J. 2010; 17:327-334.