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Effect of drying and storage on quality characteristics of *aonla* leather

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ABSTRACT

The study was under taken to prepare *aonla* leather by blanching of *aonla* fruits in boiling water for 10 min. and separation of segments and stones, followed by conversion of segments into pulp by addition of half amount of (w/w) water, followed by drying of pulp in a cabinet drier at a temperature of 58 ± 2°C up to 15% moisture level. The leather was packed in 200 and 400 g LDPE and 150 g PP pouches and was stored at low temperature (7°C) and ambient conditions (18-35°C) up to 6 months. Among the packaging material, 200 gauge HDPE was found to be the best for retaining better quality of *aonla* leather in respect of colour, flavour, texture and overall acceptability in comparison of 400 gauge LDPE and 150 gauge PP pouches for 4 months at room temperature and 6 months at low temperature (7.0 ± 2°C). The adsorption isotherm of *aonla* leather was found to be type-II sigmoid and 200 g HDPE as packaging material followed by storage at low temperature was the best process.

Key words: *Aonla*, leather, packaging material, quality, storage.

INTRODUCTION

Aonla fruits due to it's highly astringent and acidic taste is not relished by the consumers in the fresh form, but there is always demand for this fruits from consumers all over the world. Attempts have been made to process *aonla* fruit into a variety of products, include, sauce, candy, dried chips, powder, tablets, chutney and *murrabba* (Kadam, 5). Fruit leather is a relatively well established product overseas, and made by drying a very thin layer of fruit puree to obtain a product with a chewy texture similar to soft leather. The control of drying temperature is very important, as very high temperatures may cause case hardening, hindering the outflow of water.

Aonla fruits besides being healthful and nutritious, value addition of this fruits represents a significant way of earning valuable foreign exchange. *Aonla* leather which is dehydrated fruit based product that can be eaten as candy or snacks, and presented as flexible strips or sheets. Hence, the present investigation on value addition of *aonla* fruits was carried out to prepare *aonla* leather with the objective of to minimize the drying time and no use of any preservatives, in order to current requirement of consumers. The work was carried out to establish the best drying treatments and evaluation of the acceptance and storage stability of the product.

MATERIALS AND METHODS

Fruits of var. Chakaiya were procured from fruit orchard of Division of Fruits and Horticultural Technology, IARI, New Delhi. The whole, fruits were sorted out, washed and blanched in 1:2, fruits: boiling water (by weight) for 10 min., then stones were removed and segments were separated out. The segments were converted into pulp with pulper after addition of half amount of (w/w) water and heated up to the boiling to mix properly and passes through a 30 mesh sieve for obtaining fine pulp.

Next day the extracted pulp was mixed with 15, 20 and 25% sugar and one lot was kept as control. Treated and control samples were loaded on an aluminium tray @ 0.4, 0.45, 0.50 g/cm^2 and then dried in an electric cross flow hot air at a flow rate of 1.20-1.80 m/sec at a temperature of (58 ± 2°C) in a cabinet drier (Kilburn make, Model-0248) for 9 h and low temperature drier (45 ± 2°C) that have been previously oiled with glycerol upto 15-16 percent moisture. Drying rate was calculated after taking observations on moisture at 30 min. intervals and it was expressed as the rate of residual water to dry matter (kg of water/kg of dry matter).

The leather was packed in 200 g low density polyethylene (LDPE), 200 g HDPE, 260 g ALPE and 150 g PP pouches in the size of 8 cm × 6 cm of each pack as suggested by Ranganna (11) and stored at ambient temperature (AT) (17.0 - 33.5°C) and low temperature (LT) (7 ± 2°C) for storage studies. Samples were withdrawn at 2 months intervals for analysis during 6 months of storage.

Moisture content was determined by drying a known weight of the sample in an oven at 60 ± 2°C to a constant weight. The results were expressed as percent moisture content (Ranganna, 11). Reducing

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and total sugars, acidity ascorbic acid total phenols were determined by using standard procedures Total antioxidant power was determined by using FRAP method (Bezie and Strain, 3). Sensory evaluation of *aonla* leather was done by Hedonic procedure as described by Amerine *et al*. (1). The *aonla* leather prepared by treating with 20% sugar concentration followed by drying in cabinet drier was found to be the best and was used for adsorption isotherms. Procedure adopted by Iglesias and Chirife (4) was followed for adsorption isotherms of *aonla* leather at 20, 30, and 40°C. Statistical analysis of variance technique was done with three replications, as per Panse and Sukhatme (9).

RESULTS AND DISCUSSION

The effect of sugar concentration and drying methods on nutritional quality is given in Table 1. The method of drying and concentration of sugar profoundly affect the nutrient composition of *aonla* leather. The moisture content was low in the samples dried in cabinet drier as compared to low temperature drier. This might be due to faster removal of moisture from the samples dried in cabinet drier as compared to low temperature drier. However, moisture content decreased significantly with an increase in concentration of sugar. Titratable acidity reduced significantly with increase in sugar concentration and it was higher in the control samples. However, acidity was low in the leather prepared with 25% sugar concentration and dried with cabinet drier. This might be due to less moisture content & increase in sugar concentration. Mehta and Tomar (7), also reported a decreasing trend in acid content when samples were steeped in higher concentrations of sugar syrup. Ascorbic acid content was significantly higher in cabinet drier as compared to low temperature drier. This could be due to low thermal degradation of ascorbic acid dried in cabinet drier due to faster removal of moisture and less time took for drying. Similarly ascorbic acid content was highest in the product prepared using high amount of sugar. This may be due to better protection of ascorbic acid by the higher sugar concentration. Similar results have also been reported by Metha and Tomar (7) in dried guava and papaya fruits. Reducing sugar was found more in *aonla* leather prepared with higher sugar concentration and dried in cabinet drier. This might be due to more gain of solid contents with increase in sugar concentration. Torreggiani *et al.*, 15) have reported maximum sugar penetration at higher sugar concentration as the solid gain increased with increase in syrup concentration in cherries.

Total sugars increased with increase in sugar concentration. This could be attributed to the effect of sugar used as osmotic agent in the present study. This result was in conformity with the results of Mehta and Tomar (7) in case of dried guava and papaya fruits. The phenols content were significantly higher in the leather dried with cabinet drier as compared to low temperature drier. However, phenol content were found more in the leather treated with sugar as compared to control. Which might be due to faster biochemical changes during drying at high temperature and protection of phenolics by the sugars due to sugar being as preservative agent. Total antioxidant decreased significantly over the control with increased in sugar concentration in the

Table 1. Effect of sugar concentration and method of dehydration on quality characteristics of *aonla* leather.

Drier	Sugar conc. (%)	Moisture (%)	Acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugar (%)	Total sugars (%)	Total phenols (mg/100 g)	Total antioxidant (μmol Trolox)	NEB (at 420 nm)	Sensory quality
CD	0	16.38	1.86	477	12.86	38.70	348	53.67	0.263	5.63
CD	15	15.75	1.78	495	13.67	40.21	357	48.17	0.252	7.63
CD	20	14.67	1.78	606	14.33	42.58	368	42.93	0.250	8.53
CD	25	14.33	1.74	612	14.74	45.32	388	44.10	0.235	7.93
LTD	0	17.57	1.76	416	12.40	37.08	228	45.09	0.294	7.25
LTD	15	16.33	1.63	490	13.67	39.12	239	44.53	0.290	7.70
LTD	20	15.4	1.63	526	14.12	41.37	251	41.17	0.277	8.38
LTD	25	14.83	1.55	477	13.60	44.72	254	41.17	0.263	7.73
$CD_{0.05}$										
Drier		0.226	0.020	36.26	0.265	0.579	2.97	1.57	0.0255	NS
Conc.		0.319	0.28	51.28	0.375	0.819	4.20	2.218	NS	0.318

CD = Cabinet drier, LTD = Low temperature drier, CD = Critical difference pulp. This might be due to positive effect of sugar on physical properties of *aonla* leather as it acts as anti-browning agent.

Non- enzymatic browning (NEB) was lower in *aonla* leather prepared with addition of sugar as compared to control. However, non-enzymatic browning was found significantly higher in low temperature dried samples as compared to cabinet drier. This might be due to more reduction in chemical reactions between sugars, acids, ascorbic acid, and phenol content which might have reduced the oxygen and cause the low NEB in the leather. Sensory score for *aonla* leather was significantly higher in the pulp treated with 20% sugar as compared to control and other treatments. This may be due to an appropriately mutual compensated balance between sugars and NEB, which might have contributed better appearance of the leather (Table 1).

Moisture content in the pulp decreases with increase in drying time for a particular tray load. The optimum tray load for drying in *aonla* leather was found to be 0.40 g/cm^2 under cabinet drier and it was 0.35 g/cm^2 for low temperature drier. It took 9 and 11 h to dry the product under these dryers respectively (Fig. 1). Besides texture properties the dried product was also superior in cabinet drier when it was compared to low temp drier. This might have due to the faster removal of water, low RH and constant air flow in cabinet drier. Hence, the sugar concentration of 20% followed by drying in cabinet drier at a temperature of 58 ± 2°C were found optimal to improve the properties of *aonla* leather.

The relationship between equilibrium relative humidity (ERH) and equilibrium moisture content (EMC) of *aonla* leather at 20, 30, and 40°C is presented in Fig. 2. It can be seen from the figure that the EMC of *aonla* leather increased with an increase in ERH at all three temperatures, while it decreased with increase in temperature. The result may be explained that at higher temperatures the kinetic energy of the water molecules was high and water absorption at a given ERH was low (Mohamed *et al*., 8). The moisture uptake was slow in the region of a_w: 0.0-0.45, followed by a linear and steady rise in the region of a_w: 0.45-0.85 and a subsequent accelerated rise in the region of a_w: 0.85-1.0. A reduction in moisture sorption and water binding capacity was observed as the temperature of sorption increased from 20-40°C. Similar trend has been reported by previous researcher for sugar-rich fruit and dairy dried products (Suresh and Sagar, 14).

The moisture content increased significantly with increase in storage period and it was significantly higher in the leather packed in 150 g PP and least in 200 g HDPE pouches. It could be due to greater protection against water vapour infusion in HDPE and higher permeability of PP and LDPE films to water vapours (Table 2). A similar trend has been reported by Sagar and Maini (12) for onion powder. The acidity decreased with increase in storage period and it was significantly less in the leather packed in 200 g LDPE and 150 g PP pouches. However, the loss of acidity in 150 g PP and 200 g LDPE was significantly

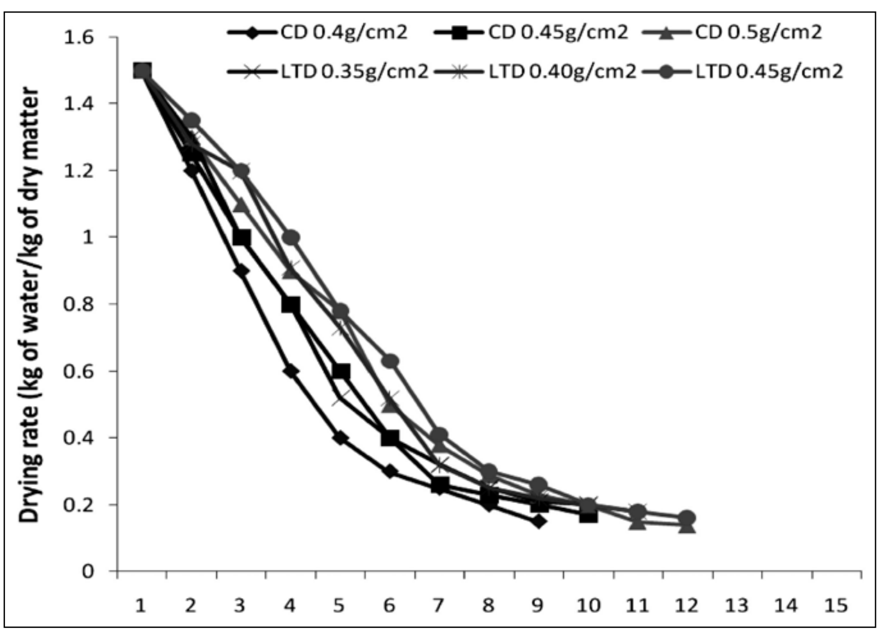


Fig. 1. Effect of tray load for dehydration of *aonla* leather.

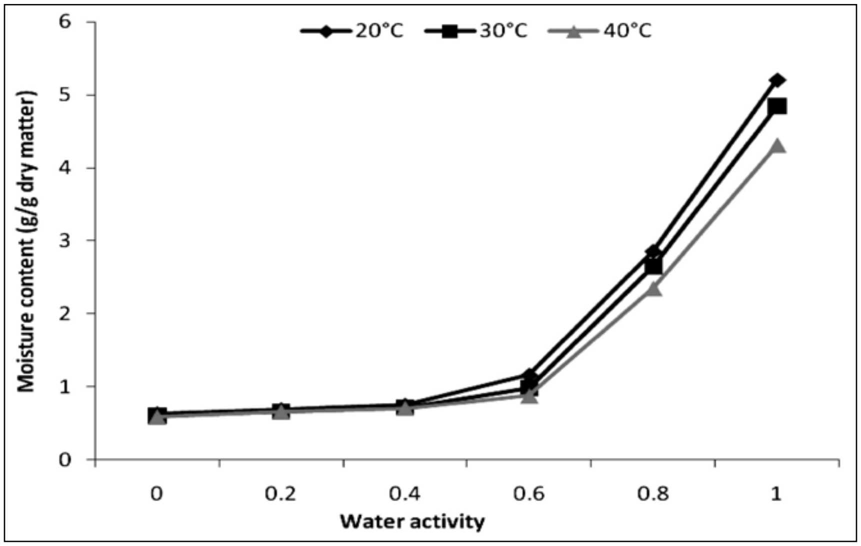
Table 2. Effect of packaging material and storage temperature on chemical constituents of *aonla* leather during storage.

Parameter	Initial value	Storage period (months)	Storage temp.						Package CD at 5%
			17.0 - 33.5°C			7 ± 2°C			
			150 g PP	200 g LDPE	200 g HDPE	150 g PP	200 g LDPE	200 g HDPE	
Moisture (%)	15.02	2	16.18	16.63	15.71	14.35	14.37	14.32	0.015
		4	16.95	16.98	15.76	15.26	15.40	14.62	
		6	17.18	17.31	16.12	16.92	16.95	15.92	
Storage temperature CD at 5%					0.012				
Acidity (%)	1.78	2	1.75	1.75	1.78	1.77	1.74	1.74	0.053
		4	1.68	1.65	1.73	1.55	1.72	1.75	
		6	1.64	1.63	1.68	1.67	1.63	1.74	
Storage temperature CD at 5%					NS				
Vitamin C (mg/100 g)	498	2	392	383	418.67	426	415	499	1.258
		4	366.33	773.67	391.0	397	380.33	418.67	
		6	319.0	385.0	376	332	306	398.33	
Storage temperature CD at 5%					1.027				
Reducing sugar (%)	14.18	2	15.57	15.20	15.85	16.20	16.13	16.23	0.039
	4	16.22	16.18	16.35	16.49	16.53	16.32		
	6	16.38	16.48	16.32	16.41	16.81	16.70		
Storage temperature CD at 5%					0.032				
Total sugars (%)	42.62	2	44.20	43.91	44.86	45.32	45.15	45.78	0.166
		4	47.14	46.16	48.20	46.22	46.15	47.36	
		6	47.85	46.95	47.83	46.73	47.82	48.36	
Storage temperature CD at 5%					0.136				
Total phenols (mg/100 g)	256	2	269.7	268.7	273.0	271.3	271.0	273.0	0.719
		4	272.3	271	273	272.7	269.3	273.3	
		6	273.3	272.0	275.3	273.3	271.3	273.3	
Storage temperature CD at 5%					NS				
Antioxidants (μmol Trolox/g)	42.5	2	45.33	42.33	45.0	45.33	43.67	47.33	NS
		4	45.0	44.67	46.0	45.0	45.33	47.33	
		6	45.67	44.67	42.33	42.33	46.0	47.67	
Storage temperature CD at 5%					0.557				
NEB,OD_{420} nm	0.252	2	0.550	0.590	0.530	0.543	0.570	0.510	0011
	4	0.840	0.933	0.840	0.823	0.900	0.793		
	6	1.333	1.257	1.043	1.033	1.028	0.950		
Storage temperature CD at 5%					0.009				

Each value is the average of three replicates, n = 3

higher than in 200 g HDPE. This may be due to low gas transmission rate in HDPE (Mahadeviah and Gawramma, 6). The reducing and total sugars were significantly higher in 200 g HDPE than in 200 g LDPE and 150 g PP pouches, which could be due to low moisture content in the product, and due to partial hydrolysis of starch to sugars and thereby increase in total sugar levels.

The ascorbic acid content of *aonla* leather decreased significantly during storages and it was significantly higher in samples packed in 200 g HDPE pouches than 200 g LDPE and 150 g PP pouches,



n= 3

Fig. 2. Desorption isotherms of *aonla* leather at different temperatures.

which could be due to low moisture content and less degradation of ascorbic acid. Phenol content increased significantly with increasing period of storage, the decrease was slow at low temperature than ambient temperature. The non-enzymatic browning increased significantly with increase in storage period in all the samples at both the storage temperatures. The increase in non-enzymatic browning was more in the samples packed in 150 g PP pouches and least in 200 g HDPE pouches. This could be due to low moisture content in 200 g HDPE pouches, which helped to maintain the better colour of the product. Similar trend has been reported by Sagar and Maini (12) in onion powder.

There were significant variations in sensory evaluation of *aonla* leather during storage due to either packaging material or storage conditions (Table 3). The sensory score was significantly higher in the

Table 3. Effect of packaging material and storage condition on sensory evaluation of *aonla* leather after 6 months of storage.

Sensory character	Initial value	Storage period (months)	Storage temperature						Package CD at 5%
			17.0 - 33.5°C			7 ± 2°C			
			150 g PP	200 g LDPE	200 g HDPE	150 g PP	200 g LDPE	200 g HDPE	
Colour	9	2	7.30	7.77	8.53	7.53	8.27	8.77	0.149
		4	6.67	7.57	8.57	7.67	7.83	8.30	
		6	6.30	7.47	8.23	7.53	7.30	8.20	
Storage temperatures C.D. at 5%					0.122				
Flavour	9	2	7.33	7.63	8.40	7.77	8.54	8.58	0.146
		4	6.64	7.63	8.53	7.47	8.45	8.37	
		6	6.51	7.71	7.62	7.46	8.40	8.17	
Storage temperatures C.D. at 5%					0.119				
Texture	9	2	7.73	7.73	8.4	7.85	8.40	8.57	0.166
	4	7.53	7.53	7.62	7.70	7.67	8.37		
	6	6.77	7.29	7.50	7.44	7.41	8.37		
Storage temperatures C.D. at 5%					0.135				

Each value is the average of seven replicates, n = 7 *aonla* leather packed in 200 g HDPE pouches than others and stored at low temperature. The scores were slightly lower in 200 g LDPE and 150 g PP compared to 200 g HDPE, which might be due to the less moisture absorption and gas permeability characteristics of the films, and slower chemical reactions at low temperature comparable to ambient temperature, which might have protected the texture and colour of the product at low temperature hence thereby increases the higher sensory score. Similar reduction has been reported by Sagar *et al*. (13) in dehydrated ripe mango slices.

Better quality of *aonla* leather in respect of colour, flavor and texture could be prepared with addition of 20% sugar concentration followed by drying in cabinet drier at a temperature of 58 ± 2°C for 9 h without addition of any preservatives to the pulp. However, *aonla* leather could be stored up to 6 months at LT and 4 months at AT after packaging it in 200 g HDPE or 400 g LDPE pouches with maximum nutritional quality.

REFERENCES

1. Amerine, M.A., Pangborn, R.M. and Roesseler, E.B. 1965. *Principles of Sensory Evaluation of Food*, Academic Press, London.
2. A.O.A.C. 1994. *Official Methods of Analysis*, Official Analytical Chemists, Washington D.C.
3. Benzie, I.F.F. and Stain, J.J. 1996. The ferric reducing ability of plasma (FRAP) as a member of “Antioxidant power”. The Frap assy. *Anal Biochem*. **339**: 70-76.
4. Iglesias, H.A. and Chirife, J. 1982. *Handbook of Food Isotherms: Water Sorption Parameters for Food and Food Components*, Academic Press, New York.
5. Kadam, S.S. 2001. New product from the arid and semi arid fruits. *Indian J. Hort.* **58**: 170-77.
6. Mahadeviah, M. and Gawramma, R.V. 1995. Packaging of processed fruit and vegetable products; meat and marine products, Profile on Food Packaging, Ministry of Food Processing Industry, Gov. of India, pp. 40-76.
7. Mehta, G.L. and Tomar, M.C. 1980. Studies on dehydration of tropical fruits in Uttar Pradesh. 11. Guava (*Psiduim guajava* L.). *Indian Fd. Packer*, **34**: 12-15.
8. Mohamed, L.A., Kouhila, M., Jamali, A., Lahsasni, S. and Mahrouz, M. 2004. Moisture sorption isotherms and heat of sorption of bitter orange leaves (*Citrus aurantium*). *J. Fd. Engg*. **67**: 491-98.
9. Panse, V.G. and Sukhatme, P.V. 1989. *Statistical Methods for Agricultural Workers*, Publication and Information Division, ICAR, New Delhi.
10. Palipane, K.B. and Driscoll, R.H. 1992. Moisture sorption characteristics of in shell macademia nuts. *J. Fd. Engg*. **25**: 63-76.
11. Ranganna, S. 2002. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd Edn.), Tata McGraw Hill Publication, Co. Ltd., New Delhi 110012.
12. Sagar, V.R. and Maini, S.B. 1997. Studies on the Packaging and storage of onion powder. *Indian Fd. Packer*. **41**: 2343-40.
13. Sagar, V.R., Khurdiya, D.S. and Balakrishanan, K.A. 1998. Effect of storage temperature and period on quality of dehydrated ripe mango slices. *J. Fd. Sci. Tech.* **35**: 147-50.
14. Suresh, Kumar, P. and Sagar, V.R. 2009. Influence of packaging materials and storage temperature on quality of osmo-vac dehydrated aonla segments. *J. Fd. Sci. Tech.* **46**: 259-62.
15. Torreggiani, D., Elisabelta, F. and Anna, R. 1987. Osmotic dehydration of fruits. Part 2. Influence of the osmosis time on stability of processed cherries. *J. Fd. Process. Preserv.* **12**: 27-44.

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