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RESEARCH PAPER

Studies on osmotic dehydration of aonla fruits

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SUMMARY : An investigation was conducted to study osmotic dehydration of aonla fruits. The organoleptically acceptable dehydrated sweetened aonla slices with better quality was obtained by blanching for five minutes and sliced pieces steeped in two per cent salt for two hours + steeping in 60^0B sugar syrup for 24 hours followed by drying under open sun. The sun dried sweetened aonla slices gave higher recovery biochemical composition with better organoleptic quality as compared to solar dried slices.

KEY **W**ORDS : Aonla fruits, Blanching, Salt Solution, Sugar syrup, Dehydration, Recovery

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Aonla (*Emblica officinalis* Gaerth) is an important arid zone fruit crop. It is probably the only fruit to fill the gap of astringent food recommended by Ayurvedic system of medicine for a balanced diet and sound health. Fruit is a very rich source of ascorbic acid. Fruit is highly acid and astringent in taste and hence, unsuitable for fresh consumption. Various products like murabba, candy, pickle, jam, sauce, squash, syrup are prepared from this fruit. But available information on preparation of dehydrated sweetened aonla slices is limited and during osmodehydration of aonla slices there is a change in bio-chemical composition fruit. Hence, there was a need to study and standardize a simple, economical and appropriate method for preparation of highly acceptable, good quality dehydrated sweetened aonla slices. With this view, the present investigation was under taken to study osmotic dehydration of aonla fruits.

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EXPERIMENTAL METHODS

Preparation of dehydrated aonla slices :

Fresh aonla fruits cv.SUREBAN (Local Variety) procured from Lingadhal village, Belgaum district (Karnataka) were used for present investigation. The experiment was laid out in factorial Completely Randomized Design (CRD) with three replications consisting of 15 treatments and two methods of drying. Fresh fruits were washed in clean water and blanched for five minutes and made into slices. The details of treatments are as follows:

T_1 : Control (blanching)
T_2 : Blanching + steeping slices in 2% salt for 1 hour
T_3 : Blanching + steeping slices in 2% salt for 2 hour
T_4 : Blanching + steeping slices in 2% salt for 3 hour
T_5 : Blanching + steeping slices in 2% salt for 1 hour + 50^0B syrup* for 24 hours
T_6 : Blanching + steeping slices in 2% salt for 2 hour + 50^0B syrup for 24 hours
T_7 : Blanching + steeping slices in 2% salt for 3 hour + 50^0B syrup for 24 hours
T_8 : Blanching + steeping slices in 2% salt for 1 hour + 60^0B syrup for 24 hours
T_9 : Blanching + steeping slices in 2% salt for 2 hour + 60^0B syrup for 24 hours
T_{10}: Blanching + steeping slices in 2% salt for 3 hour + 60^0B syrup for 24 hours
T_{11}: Blanching + steeping slices in 2% salt for 1 hour + 70^0B syrup for 24 hours
T_{12}: Blanching + steeping slices in 2% salt for 2 hour +

70^0B syrup for 24 hours

T_{13}: Blanching + steeping slices in 2% salt for 3 hour + 70^0B syrup for 24 hours

T_{14}: Dipping in 0.5% hot lye (NaOH) solution for 5 minutes + steeping slices in 60^0B syrup for 24 hours

T_{15}: Dipping in 0.5% hot lye (NaOH) solution for 5 minutes

* Sugar syrup contains 0.2% Potassium Meta bisulphite (KMS).

The treated slices were dried under open sun and in solar cabinet drier and packed in 250 guage polythene bags.

The dehydrated aonla slices were analysed for physico-chemical parameters. The recovery of dehydrated slices was noted down and percentage of dehydrated slices was calculated by the ratio of weight of dehydrated slices to the weight of fresh slices. The drying time was determined by counting number of hours taken for attaining constant moisture content. A known weight of dehydrated aonla slices placed in electric drier at 700^0C until constant weight was obtained. The per cent moisture present in aonla slices was calculated using a formula:

$$\text{Moisture content (\%)} = \frac{\text{Initial weight (g)} - \text{final weight (g)}}{\text{Initial weight (g)}} \times 100$$

Non enzymatic browing was determined as per the procedure given by Srivastava and Sanjeevkumar (1998). Ascorbic acid was estimated as per AOAC method (Anonymous, 1984). The data has been analysed statistically and reported at 1per cent significance level (Panse and Sukhatme,1985.)

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation are summarized in Table 1 and 2.

Significantly highest recovery (59.07%) was recorded in blanched slices steeped in two per cent salt for two hours followed by steeping in 70^0B sugar syrup, while lowest (19.37%) was recorded in blanched slices steeped in two per cent salt for one hour. It was also observed that, the recovery increased proportionately with the increase in syrup strength from 50^0B to 70^0B. The increase in recovery of dehydrated slices may be attributed to the transfer of sugars from syrup to fruit slices through osmosis during period of osmodehydration. The sun dried slices gave higher per cent recovery (40.54%) as compared to solar dried slices (38.45%). This may be due to retention of higher moisture content at the end of drying. Similar results of higher recovery in sun drying as compared to solar drying have been reported by Keshatti (2003) in aonla and Indhudhara

Table 1: Effect of treatments and methods of drying on recovery and quality of dehydrated aonla slices

Treatments	Recovery (%)			Time taken for drying (Hr)			Moisture content (%)			Non-enzymatic browning (OD at 440nm)			Ascorbic acid (mg/100g)		
	A	B	Z	A	B	Z	A	B	Z	A	B	Z	A	B	Z
T_1	20.73	21.73	21.23	15.53	14.10	14.82	13.13	13.53	13.33	0.185	0.207	0.196	358.33	368.67	363.50
T_2	19.67	19.06	19.37	16.03	14.10	15.07	15.73	13.33	14.53	0.163	0.175	0.168	354.58	359.58	357.08
T_3	21.07	22.80	21.93	16.10	14.14	15.11	15.53	12.73	14.13	0.146	0.168	0.157	346.75	348.00	347.38
T_4	20.13	20.40	20.27	16.20	14.20	15.20	10.33	9.13	9.73	0.137	0.162	0.150	338.00	340.67	339.33
T_5	40.23	40.97	40.60	23.03	18.08	20.56	7.40	7.33	7.37	0.118	0.115	0.117	305.58	307.48	306.53
T_6	40.57	42.30	41.43	23.06	18.10	20.58	7.30	7.13	7.23	0.131	0.113	0.122	296.87	300.00	298.43
T_7	39.83	42.37	41.10	23.05	18.08	20.57	9.33	9.33	9.33	0.136	0.111	0.123	287.07	295.00	291.03
T_8	46.00	40.40	43.20	26.35	21.12	23.74	12.93	11.73	12.33	0.083	0.120	0.101	291.92	294.00	292.96
T_9	48.00	40.87	44.43	26.36	21.12	23.74	15.53	12.53	14.03	0.097	0.126	0.112	283.00	290.33	286.67
T_{10}	46.67	41.90	44.28	26.36	21.14	23.75	13.13	13.33	13.23	0.098	0.136	0.117	270.25	282.83	276.54
T_{11}	59.67	54.37	57.02	29.00	25.08	27.04	10.30	13.73	11.93	0.113	0.131	0.122	284.58	287.33	285.96
T_{12}	57.33	54.60	55.97	29.06	25.13	27.10	13.13	13.53	13.33	0.113	0.131	0.122	275.50	280.57	278.03
T_{13}	63.33	54.80	59.07	29.08	25.10	27.09	11.73	10.33	11.03	0.124	0.133	0.129	269.36	274.00	271.68
T_{14}	37.90	36.27	37.08	25.06	19.84	22.45	10.13	9.93	10.03	0.128	0.149	0.138	295.17	298.23	296.70
T_{15}	47.00	43.97	45.48	27.07	21.30	24.18	7.33	8.73	8.03	0.140	0.171	0.156	277.83	281.00	279.42
Mean	40.54	38.45	39.49	23.43	19.37	21.40	11.52	11.09	11.31	0.127	0.143	0.135	302.32	307.18	304.75
For comparing means of	S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)	
Treatment (T)	0.652	2.438		0.046	1.740		0.043	0.161		0.0022	0.0081		0.461	1.687	
Drying method (D)	0.238	0.889		0.017	0.063		0.016	0.060		0.0008	0.0029		0.168	0.615	
Tx D	0.922	3.447		0.065	0.243		0.061	0.228		0.0031	0.0113		0.651	2.382	

(2003) in fig.

Highly significant differences with respect to drying time were observed among the treatments and drying methods. The drying time in different treatments irrespective of methods of drying was found to be significantly minimum (15.07hr) in T_2 followed by T_3 (15.12hr), whereas, maximum drying time (27.10 hr) was observed in T_{12}. The increased concentration might have increased with the time taken for drying, because the sugar layer present at the surface of slices hinders the free escape of moisture from the slices, especially during later period of drying. Similar results of enhanced drying period in fruit slices treated with sugar syrup have been reported by Kallemullah *et al*. (2002) in papaya. The mean drying time irrespective of treatments was found to be significantly lower in slices dried under solar drier (19.37hr) as compared to sun drying (23.43 hr). This may be due to higher temperature of drying in solar drier as compared to lower temperature maintained in the surrounding atmosphere of the drying trays kept in open sun. Similar results were also observed by Basavaraj (2002) in sapota and Nagaraju (2002) in ber. Interaction effect between the treatments and methods of drying was also found to be significant. Significantly maximum time taken for drying (29.08 hr) observed in T_{13} was found to be on par with T_{11} and T_{12} in sun drying, whereas, minimum time taken for drying (14.10 hr) was recorded in T_2 and T_1 in solar drying.

Significantly highest moisture content (%) of dehydrated aonla slices was recorded in T_2 (14.53%) followed by T_3 (14.13%), which was at par with T_9 (14.03%), whereas, the lowest moisture content was recorded in T_6 (7.23%). The per cent moisture content of dehydrated aonla slices irrespective of treatments was found to be significantly higher in sun drying (11.52%) as compared to solar drying (11.09%). The attainment of lower moisture percentage in slices dried under solar drier might be due to the presence of high temperature and hot air circulation in the solar drier. Similar results of lower moisture content of solar dried samples have been reported by Kotimani (2003) in sapota. Interaction effect also found to be significant. Significantly highest moisture content was recorded in T_2 (15.73%) followed by T_3 and T_9 (15.53%) in sun drying, whereas, the lowest moisture content was recorded in T_6 (7.13%) in solar drying.

The non-enzymatic browning for overall treatment and irrespective of drying methods was lowest in T_8 (0.101) and

Table 2 : Organoleptic evaluation of dehydrated aonla slices as influenced by treatments and methods of drying (scores out of 5.00)

Treatments	Colour and appearance			Texture			Taste			Overall acceptability		
	Sun drying	Solar drying	Mean	Sun drying	Solar drying	Mean	Sun drying	Solar drying	Mean	Sun drying	Solar drying	Mean
T_1	1.17	1.17	1.17	1.16	1.00	1.08	1.17	1.17	1.17	1.16	1.16	1.16
T_2	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.66	1.16	1.42
T_3	1.17	1.17	1.17	1.17	1.16	1.16	2.17	1.67	1.92	1.17	1.16	1.16
T_4	1.17	1.17	1.17	1.17	1.17	1.17	2.17	1.17	1.67	1.42	1.16	1.29
T_5	2.17	1.18	1.92	2.17	1.17	1.92	2.67	2.17	2.42	2.67	2.17	2.42
T_6	2.67	2.57	2.62	2.17	2.16	2.17	2.16	2.17	2.17	2.77	2.67	2.72
T_7	2.17	2.87	2.52	2.67	2.67	2.67	2.66	2.16	2.42	2.57	2.17	2.37
T_8	4.17	3.17	3.67	3.67	3.47	3.57	2.66	3.66	3.17	3.17	3.67	3.42
T_9	4.67	3.67	4.17	4.50	3.67	4.08	4.17	4.17	4.17	4.37	4.17	4.27
T_{10}	4.17	3.77	3.97	3.83	3.66	3.75	3.83	3.87	3.85	4.17	3.92	4.04
T_{11}	3.67	3.67	3.67	3.83	3.66	3.75	4.00	3.77	3.88	3.73	3.67	3.70
T_{12}	4.00	3.67	3.83	4.17	3.92	4.04	4.20	3.87	4.03	4.37	4.07	4.22
T_{13}	4.10	3.67	3.88	4.17	3.92	4.04	3.67	3.87	3.77	4.17	4.07	4.12
T_{14}	3.27	2.67	2.97	3.16	3.17	3.17	2.50	3.42	2.96	2.67	3.66	3.16
T_{15}	3.17	2.87	3.02	3.16	3.17	3.17	3.67	3.67	3.67	3.66	3.66	3.66
Mean	2.86	2.59	2.73	2.81	2.64	2.73	2.86	2.80	2.83	2.91	2.84	2.88
For comparing means of												
	S.E.±	C.D.(P=0.01)		S.E.±	C.D.(P=0.01)		S.E.±	C.D.(P=0.01)		S.E.±	C.D.(P=0.01)	
Treatment (T)	0.110	0.411		0.118	o.441		0.118	0.441		0.106	0.396	
Drying method (D)	0.040	0.149		0.043	0.161		0.043	NS		0.039	NS	
T x D	0.156	0.583		0.167	NS		0.167	0.624		0.151	0.565	

NS-Non significant

highest in T_1 (0.196). Among drying methods, it was found to be significantly higher in solar drying (0.143) as compared to sun drying (0.127). This may be due to high drying temperature in the solar drier and presence of higher reducing sugar in solar dried slices which might have favoured the reactions between reducing sugar and acids present in the slices. Srivastava and Sanjeevkumar (1998) also reported that the development of brown pigmentation was due to the non-enzymatic browning stimulated by the higher temperature during dying of the produce. The interaction effect between treatments and methods of drying was also found to be significant. Significantly highest mean non-enzymatic browning was recorded in T_1(0.207) in solar drying whereas, the lowest value was recorded in T_8(0.083) in sun drying.

Significantly maximum ascorbic acid was observed in control (363.50mg/100g), whereas, minimum ascorbic acid (271.68mg/100g) was observed in blanched slices steeped in two per cent salt for three hours + steeping in 70^0B sugar syrup for 24 hours (Table 1). This might be due to loss of ascorbic acid during blanching and syruping treatments. Significantly higher level of ascorbic acid was recorded in solar dried slices (307.18mg/100g) as compared to sun dried slices (302.32mg/100g). Higher retention of ascorbic acid in solar dried slices may be due to lesser time of exposure to drying temperature as compared to sun drying. Similar results of higher levels of ascorbic acid in solar dried slices were observed by Balasaheb (1995) in fig and Keshatti (2003) in aonla.

The dehydrated sweetened aonla slices prepared by steeping the slices in two per cent salt for two hours followed by steeping in 60^0B sugar syrup containing for 24 hours and drying under open sun had highest scores (out of 5.00) for colour and acceptance (4.70). The higher organoleptic score with respect to colour and appearance may be attributed to the glossy appearance of the slices due to surface coating with sugar. The addition of high level of sugar and salt through osmosis and reduction in acidity and astringency of the fruit might have contributed to the better taste of dehydrated slices. The sun dried slices had significantly higher scores for colour and acceptance (2.86), texture (2.81), taste (2.86) and overall acceptability (2.91) as compared to solar dried slices. This may be attributed to the lower temperature of drying and better removal of moisture leading to good appearance. Similar results of superiority of sun drying over solar drying with respect to organoleptic quality of dehydrated product have been reported by Keshatti (2003) in aonla and Kotimani (2003) in sapota.

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