



## Utilization of Eureka Lemon Peel for Development of Value Added Product

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Received 21 May 2020; revised 29 September 2020; accepted 01 December 2020

The main purpose of this study was to prepare a delicious value added product from the osmo-dried eureka lemon peel flakes which otherwise is a wastage material. The peels of eureka lemon were used to prepare flakes. Plain water was used for washing of flakes, thereafter after washing these were blanched for five minutes and dipped in sugar and jaggery syrup concentrations as per the treatment combinations for 24 hours. In another 24 hours, the peel flakes were dried in cabinet tray drier (60°C) for 4–5 hours after draining out the water. Thereafter, the peel flakes were packed in LDPE bags and then stored at room temperature for 3 months. At the interval of 1 month, the various chemical and sensory characters were investigated. Osmo-dried eureka lemon peel flakes showed a decreasing trend in L\* value, b\* value, ascorbic acid and  $\beta$ -Carotene whereas an increasing trend was observed in reducing sugar, total sugar and a\* value during storage period of three months. On the basis of overall acceptability, treatment T<sub>7</sub> (75°Brix sugar syrup) was found to be the most preferred osmo-dried eureka lemon peel flakes. It could be concluded that osmo-dried eureka lemon peel flakes can be preserved safely for three months.

**Keywords:** Flakes, Jaggery, Osmo-dried, Sensory evaluation, Sugar

### Introduction

Due to its peculiar nature, eureka lemon (*Citrus limon* B) is grown up as a significant fruit which can be easily grown in dry and semi-dry areas of India due to its spineless and hefty fruit bearing nature.<sup>1</sup> It is high in vitamin C content which gave a solid protection against various diseases and contributes to a strong immune system and also contains phytochemicals, flavonoids giving it a greater antioxidant boost. Eureka lemon is generally utilized for making pickles, culinary purposes and for blending with other fruit juices for preparation of squash at small and large scale. Generally, left over pomace and peel of eureka lemon fruit after the extraction of juice is discarded as waste. Peel that constitutes 25–35 percent of fruit weight is quite nutritious but got wasted and could not fetch any economical price to the industry.<sup>2</sup> Besides the utilization of residual waste as cattle feed, the other useful option is to utilize waste eureka lemon peel for developed value added product. Thus, citrus processing industry can easily opt for making candied peel which finds the ready market in confectionary. The peel candy can be consumed as such or in the form of value added products like steamed pudding

*etc.* where it can be incorporated to improve consumer's acceptability of such products. The various other industries like cake, biscuits and breads, the candied citrus fruit rinds can be used safely. These can be marketed as mixed candied fruits and can also be consumed as such.<sup>3</sup> Osmotic dehydration is one of the most effective food preservation techniques in the processing of dehydrated foods. Dehydration is mainly the process of removal of water from natural materials such as fruits and vegetables and is mainly done by dipping the material in high osmotic pressure aqueous solution generally made by dissolving sugar and salts. For vegetables, common salt is used whereas sucrose for fruits.<sup>4</sup> This work was mainly planned with major objective to minimize the wastage of eureka lemon peel and to develop value added product *i.e.* osmo-dried eureka lemon peel flakes.

### Materials and Methods

The fully matured Eureka lemon fruits were procured from RRSS, SKUAST-J, Raya, Samba (J&K UT) and were taken to Division of FST, SKUAST-J for further processing. The fruit was used for squash and the waste material *i.e.* peel was used for making osmo-dried eureka lemon peel flakes. Peels of almost same size were selected for the processing of the peel flakes. The peel flakes were washed thoroughly in tap water and were subjected to pre-treatment like

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blanching. On the other hand, sugar and jaggery syrup of different concentrations/treatments (50, 55, 60, 65, 70 and 75°Brix) were prepared. In control, no sugar or jaggery dipping treatment was applied. After blanching, the peel flakes were dipped in sugar and jaggery syrup, boiled for 2–3 min and kept for 24 h according to the treatment combination. After completion of dipping time, sugar and jaggery syrup was drained and then osmo-dried peel flakes were spread on trays. The osmo-dried peel flakes were dried for 4–5 h at 60°C. After drying, the peel flakes were collected and packed in LDPE bags and stored at room temperature for a period of three months. The osmo-dried eureka lemon peel flakes were analyzed at an interval of 0, 1, 2 and 3 months of storage for chemical and organoleptic evaluation. The method of Lane and Eynon's was followed for the determination of reducing and total sugars.<sup>5</sup> Ascorbic acid was estimated by using 2-6, dichlorophenol indophenol dye.<sup>5</sup>  $\beta$ -Carotene was determined using an ultra-violet-visible recording spectrophotometer at 452 nm as per the method.<sup>5</sup> The hunter colour values ( $L^*$ ,  $a^*$  &  $b^*$ ) were determined as per the method of Grabowski *et al.*<sup>6</sup> Organoleptic evaluation was carried out by a panel of minimum 10 semi-trained judges on 9-point hedonic rating scale.<sup>7</sup> The data obtained was statistically analyzed using CRD factorial for interpretation of results through analysis of variance.<sup>8</sup>

## Results and Discussion

### Reducing Sugar

Initially the statistically higher reducing sugar (19.08 percent) noted in  $T_7$  (75°Brix sugar syrup), however lowest (6.50 percent) recorded in control, which increased significantly after three months of storage period. The same treatment (75°Brix sugar syrup) recorded statistically higher reducing sugar content (20.90 percent) and was followed by  $T_6$  (70°Brix sugar syrup). However, statistically lower value (6.98 percent) of reducing sugar observed in control. On the basis of overall mean values, it was observed that higher reducing sugar (19.95%) was observed in 75°Brix syrup and lowest of 6.76 percent in control. The treatment, storage as well as interaction between different treatments over the various storage periods were found to be significant (Table 1). The conversion of non-reducing sugars to reducing sugars and hydrolysis of polysaccharides might be the reason for increment of reducing sugars

during the various storage periods. Results obtained with amla jam<sup>9</sup> and bael preserve<sup>10</sup> are in accordance with the findings of this research.

### Total Sugar

Treatment 75°Brix sugar syrup observed significantly higher amount of total sugar content (69.90 percent), however, statistically lower total sugar content *i.e.*, 7.85 percent was observed in control (Table 1). Statistically significant total sugar content (72.40%) recorded in 75°Brix sugar syrup treatment; also the values of total sugars had increased during the advancement in storage periods. However, after 3 months of storage minimum value of total sugar (8.95 percent) was recorded in control. Mean values for storage of total sugar in eureka lemon peel flakes increased significantly from 50.20 to 52.58 percent. The conversion of polysaccharides into monosaccharides might be the possible reason for a continuous enhancement in total sugar content during 0 month of storage to 3 months of storage. Similar findings were also reported in ber chuhara.<sup>11</sup>

### Ascorbic Acid

Statistically considerable decrease in ascorbic acid in eureka lemon peel flakes was recorded during storage (Table 1). Higher values of ascorbic acid (11.70 mg/100 g) observed in 50°Brix sugar syrup treatment which was immediately followed by treatment  $T_3$  (55°Brix sugar syrup) and statistically lower value (7.05 mg/100 g) observed in control ( $T_1$ ) initially. After three months of storage period ascorbic acid content decreased and highest value (5.10 mg/100 g) noticed in 50°Brix syrup, whereas control evinced the minimum value (1.71 mg/100 g). During the different storage periods mean values of ascorbic acid reduced from 10.60 to 4.10 mg/100 g. The treatment, storage as well as interaction between them in various storage periods were significant. The ascorbic acid present in eureka lemon peel flakes might have destroyed during processing and also afterwards during storage. The possible reason behind it could be that as ascorbic acid is sensitive to heat and thus oxidized rapidly in the presence of oxygen. The decreasing trend in ascorbic acid during different storage periods had also been reported in Galgal peel sticks<sup>12</sup> and Karonda candy.<sup>13</sup>

### $\beta$ -Carotene

At beginning, significantly higher amount of  $\beta$ -Carotene to the tune of 11.12 mg/100 g was recorded

Table 1 — Effect of treatments and storage period on reducing sugar (%), total sugar (%), ascorbic acid (mg/100 g) and  $\beta$ -Carotene (mg/100 g) of osmo-dried eureka lemon peel flakes

Treatments	Reducing sugar					Total sugar					Ascorbic acid					$\beta$ -Carotene				
	Storage period (months)					Storage period (months)					Storage period (months)					Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean
T <sub>1</sub> (Control)	6.50	6.71	6.85	6.98	6.76	7.85	8.21	8.51	8.95	8.38	7.05	4.81	3.15	1.71	4.18	4.45	4.40	4.36	4.31	4.38
T <sub>2</sub> (50°Brix sugar syrup)	16.35	16.85	17.40	18.02	17.15	42.95	43.65	44.56	45.47	44.15	11.71	7.97	6.11	5.10	7.72	9.78	9.73	9.69	9.65	9.71
T <sub>3</sub> (55°Brix sugar syrup)	16.90	17.42	18.05	18.68	17.76	47.49	48.05	49.04	50.02	48.65	11.63	7.93	6.06	5.00	7.65	9.85	9.81	9.78	9.74	9.79
T <sub>4</sub> (60°Brix sugar syrup)	17.62	18.10	18.72	19.32	18.44	52.10	52.85	53.75	54.61	53.32	11.56	7.76	5.51	4.90	7.43	9.89	9.83	9.79	9.76	9.82
T <sub>5</sub> (65°Brix sugar syrup)	18.10	18.68	19.25	19.81	18.96	58.05	59.00	60.13	61.06	59.56	11.39	7.49	5.49	4.81	7.29	9.95	9.91	9.88	9.86	9.90
T <sub>6</sub> (70°Brix sugar syrup)	18.76	19.20	19.78	20.32	19.51	64.21	65.05	65.90	66.85	65.50	11.32	7.30	5.35	4.75	7.18	10.02	9.96	9.91	9.88	9.94
T <sub>7</sub> (75°Brix sugar syrup)	19.08	19.62	20.22	20.90	19.95	69.90	70.66	71.51	72.40	71.11	11.15	7.25	5.18	4.54	7.03	10.09	9.99	9.94	9.91	9.98
T <sub>8</sub> (50°Brix jaggery syrup)	14.95	15.52	16.05	16.48	15.75	41.05	41.69	42.49	43.35	42.14	10.66	5.48	4.45	4.00	6.14	10.81	10.78	10.74	10.71	10.76
T <sub>9</sub> (55°Brix jaggery syrup)	15.35	15.75	16.25	16.61	15.99	44.90	45.51	46.37	47.21	46.00	10.59	5.30	4.37	3.91	6.04	10.86	10.82	10.79	10.74	10.80
T <sub>10</sub> (60°Brix jaggery syrup)	15.78	16.22	16.71	17.20	16.48	49.25	49.87	50.76	51.53	50.35	10.42	5.28	4.10	3.82	5.90	10.94	10.91	10.88	10.86	10.89
T <sub>11</sub> (65°Brix jaggery syrup)	16.12	16.60	17.05	17.52	16.82	53.81	54.49	55.31	56.12	54.93	10.25	5.15	3.90	3.75	5.76	10.99	10.93	10.88	10.84	10.91
T <sub>12</sub> (70°Brix jaggery syrup)	16.38	16.85	17.40	17.91	17.13	58.02	58.77	59.65	60.45	59.22	10.18	4.95	3.81	3.64	5.64	11.06	11.00	10.95	10.93	10.98
T <sub>13</sub> (75°Brix jaggery syrup)	16.92	17.41	17.95	18.45	17.68	63.05	63.84	64.72	65.57	64.29	10.01	4.75	3.75	3.49	5.50	11.12	11.07	11.03	11.00	11.05
Mean	16.06	16.53	17.05	17.55		50.20	50.89	51.74	52.58		10.60	6.26	4.71	4.10		9.98	9.93	9.89	9.86	
CD (5%)																				
Treatments			0.02					0.01					0.02					0.01		
Storage			0.01					0.03					0.01					0.02		
Treatments x storage			0.03					0.04					0.03					0.03		

in treatment T<sub>13</sub> (75°Brix jaggery syrup) and significantly lower value (4.45 mg/100 g) in control. As the storage period advanced,  $\beta$ -Carotene decreased and the minimum value (4.31 mg/100 g) observed in control, however maximum value (11.00 mg/100 g) was found in T<sub>13</sub> (75°Brix jaggery syrup) after three months of storage. The storage mean values of  $\beta$ -Carotene decreased from 9.98 to 9.86 mg/100 g (Table 1). However, the interaction between different storage periods and treatment combinations was recorded to be significant. Various factors like oxidation and its stimulation due to presence of light, temperature and enzyme have further accelerated the process. Similar results were also reported in Kinnow peel candy<sup>14</sup> and in dehydrated carrot slices.<sup>15</sup>

#### Hunter Color Values

Colour is the most important attribute of food items for consumer acceptability. The initial mean value of L\* value decreased significantly from 47.90 to 46.88, a\* value increased significantly from 5.34 to 6.02 and

b\* value also decreased significantly from 21.84 to 21.73 during three months of storage (Table 2). This might be due to the increased rate of Millard reaction because of the availability of more sugar. Muzaffar *et al.*<sup>16</sup> reported similar changes in L\*, a\* and b\* values, they attributed this to occurrence of non-enzymatic browning that results in darkening of the product thus decreased L\* value, a\* value showed increase during storage of pumpkin candy. They further reported that degradation of carotene pigment also take place during storage thus was responsible for the decrease in b\* value.

#### Overall Acceptability

A significant decline in overall acceptability score of eureka lemon peel flakes were recorded during the different storage time (Table 2). During the storage of three months, overall acceptability declined significantly from 8.11 to 7.93. mean storage. Statistically higher overall acceptability score (8.50) recorded in 75°Brix sugar syrup treatment and it was

Table 2 — Effect of treatments and storage period on lightness (L\* value), redness (a\* value), yellowness (b\* value) and overall acceptability of osmo-dried eureka lemon peel flakes

Treatments	Lightness (L* value)					Redness (a* value)					Yellowness (b* value)					Overall acceptability				
	Storage period (months)					Storage period (months)					Storage period (months)					Storage period (months)				
	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean
T <sub>1</sub> (Control)	43.15	42.75	41.95	41.10	42.24	3.75	3.95	4.20	4.71	4.15	18.81	18.79	18.76	18.74	18.77	6.99	6.82	6.75	6.70	6.81
T <sub>2</sub> (50°Brix sugar syrup)	49.75	49.15	48.85	48.60	49.09	4.10	4.32	4.52	4.85	4.45	22.96	22.96	22.91	22.88	22.93	8.10	8.02	7.94	7.88	7.99
T <sub>3</sub> (55°Brix sugar syrup)	49.26	48.85	48.56	48.30	48.74	4.55	4.62	4.84	5.09	4.78	22.91	22.88	22.85	22.81	22.86	8.21	8.15	8.10	8.06	8.13
T <sub>4</sub> (60°Brix sugar syrup)	48.80	48.64	48.10	47.91	48.36	4.88	5.08	5.32	5.59	5.22	22.87	22.84	22.80	22.76	22.82	8.30	8.21	8.13	8.07	8.18
T <sub>5</sub> (65°Brix sugar syrup)	48.41	48.15	47.75	47.50	47.95	5.30	5.52	5.75	6.01	5.64	22.80	22.81	22.78	22.75	22.78	8.42	8.38	8.33	8.29	8.35
T <sub>6</sub> (70°Brix sugar syrup)	48.00	47.66	47.20	46.94	47.4	5.75	5.70	6.12	6.40	5.99	22.78	22.75	22.71	22.68	22.73	8.50	8.41	8.34	8.30	8.39
T <sub>7</sub> (75°Brix sugar syrup)	47.65	47.15	46.85	46.65	47.07	6.10	6.25	6.45	6.75	6.39	22.73	22.69	22.66	22.62	22.67	8.58	8.52	8.48	8.42	8.50
T <sub>8</sub> (50°Brix jaggery syrup)	49.00	48.56	48.20	47.99	48.44	4.65	4.79	5.02	5.27	4.93	21.50	21.45	21.41	21.38	21.43	7.80	7.74	7.69	7.65	7.72
T <sub>9</sub> (55°Brix jaggery syrup)	48.55	48.10	47.84	47.60	48.02	5.09	5.28	5.48	5.75	5.40	21.40	21.40	21.35	21.31	21.36	7.91	7.85	7.80	7.76	7.83
T <sub>10</sub> (60°Brix jaggery syrup)	48.10	47.85	47.50	47.23	47.67	5.57	5.75	5.98	6.25	5.89	21.37	21.34	21.30	21.26	21.32	7.93	7.94	7.89	7.75	7.88
T <sub>11</sub> (65°Brix jaggery syrup)	47.75	47.49	47.16	46.90	47.33	6.05	6.20	6.45	6.69	6.35	21.31	21.29	21.25	21.22	21.27	8.10	8.03	7.98	7.94	8.01
T <sub>12</sub> (70°Brix jaggery syrup)	47.28	47.10	46.80	46.55	46.93	6.55	6.70	6.92	7.25	6.86	21.26	21.21	21.17	21.13	21.19	8.24	8.17	8.11	8.06	8.14
T <sub>13</sub> (75°Brix jaggery syrup)	47.00	46.65	46.40	46.18	46.56	7.02	7.19	7.42	7.64	7.32	21.20	21.15	21.11	21.07	21.13	8.38	8.32	8.27	8.23	8.30
Mean	47.90	47.55	47.17	46.88		5.34	5.49	5.73	6.02		21.84	21.81	21.77	21.74		8.11	8.04	7.99	7.93	
CD (5%)																				
Treatments	0.04					0.04					0.05					0.03				
Storage	0.02					0.02					0.03					0.01				
Treatments x storage	0.08					0.09					NS					0.05				

closely followed by treatment 70°Brix sugar syrup; however, control envisaged the statistically lower score value of 6.81. However, the similar pattern was followed during three months storage. The data was found statistical significant at 0, 1, 2 and 3 months of storage. During the different storage periods there might be changes in chemical composition of the product which could have facilitated in loss of various factors like colour, taste and texture. Similar findings have also been reported in citron peel candy<sup>17</sup> and in intermediate moisture beetroot cubes.<sup>18</sup>

### Conclusion

The results of the present study on preparation of eureka lemon peel flakes revealed that peels of eureka lemon which otherwise are discarded can be well utilized properly to yield nutritious, attractive value added product. On the basis of overall acceptability, osmo-dried peel flakes of eureka lemon prepared from treatment 75°Brix sugar syrup proved to be superior in comparison to other treatment combinations. This

will also improve the effective utilization of waste of eureka lemon and also add value to citrus fruit and benefits to growers thus increasing their income and a step towards doubling of farmers' income.

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