Research Article

Development of Osmo-Dried Peel Flakes from Eureka Lemon

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Abstract

The osmo-dried peel flakes were developed from the peels of Eureka lemon, the peel flakes were washed with plain water, blanched for 5 min and dipped in sugar and jaggery syrup concentrations (50, 55, 60, 65, 70, 75 ^{o}Brix) for 24 h. After one day, the syrup was drained out and osmo-dried peel flakes were dried in cabinet tray drier (60^{o}C) for 4-5 h. The osmo-dried peel flakes were cooled at room temperature and the prepared flakes were packed in LDPE bags and stored for three months to ascertain the changes in physico-chemical and microbiological characteristics at an interval of one month. Fresh fruit of eureka lemon peel had moisture content, total soluble solids (TSS), acidity, ascorbic acid, reducing sugar, total sugar, β-carotene, tannin, ash, crude fiber, phosphorus, hunter colour values L*, a* and b* values to be 73.50%, 11.20 ^{o}Brix, 0.50%, 35.20 mg/100 g, 4.40%, 6.45%, 7.33 mg/100 g, 168 mg/100 g, 6.45%, 16.11%, 18.10, 45.15, 2.33 and 27.00, respectively. With the advancement of storage period, an increasing trend was observed in TSS whereas decreasing trend in moisture content and phosphorous content was recorded during three months of storage. Maximum microbial count was observed in control whereas minimum microbial count was found in treatment T_7 (Dipping in 75 ^{o}Brix sugar syrup).

Keywords: Osmo-dried, eureka lemon peel, flakes, physico-chemical parameters

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Introduction

Citrus generally requires good amount of water as compared to other sub-tropical fruits because sap circulation never entirely ceases and transpiration takes place throughout the year as the crop is evergreen. Eureka lemon (*Citrus limon* Burm) has become the important fruit crop of arid and semi-arid region of the country because of its precocity, thornlessness and heavy bearing nature [1]. In Jammu and Kashmir UT, citrus crop is grown on an area of about 2565 Mha with a production of 7337 MTs [2]. Generally, lemon fruit is only utilized for pickle making, culinary purposes and for blending with other fruit juices for squash preparation at small scale. Left over pomace and peel after extraction of juice from the fruits is discarded as waste. For citrus processing industry, disposal of fruit peel and other residual materials is a big problem. Peel of citrus fruit which is about 25-35% of the fruit weight; is quite nutritious but it goes waste and do not fetch any economical price to the industry or grower [3]. The fruit waste *i.e.* peel obtained from the fruit industry could be well utilized by making candy. Hence, citrus processing industry can easily opt for making candied peel which could find a ready market in confectionery. The candied citrus peel is used in baking industry in the preparation of cakes, cookies and fruit breads. The judicious processing of waste peel into candy will not only add to the income of processing industry but it will also provide remunerative price to the growers as well [4, 5]. Keeping in view the importance of Eureka lemon peel and the need to minimize their wastage the present study was planned.

Materials and Methods

The objective of the present study was to utilize the waste of eureka lemon for the development of osmo-dried peel flakes and to study the physico-chemical changes during storage of the developed product. Fully matured eureka lemon fruits were procured from Rainfed Research Sub- Station for Subtropical Fruits (RRSS), SKUAST-J, Raya, Samba (J&K) and were taken to Food Processing and Training Centre (FPTC) of Division of Food Science and Technology (FST), SKUAST-J for further processing. Eureka lemon fruit was used for squash and the waste material *i.e.* peel was used for making osmo-dried Eureka lemon peel flakes. Peel flakes of almost same size were selected. The peel flakes were washed thoroughly in tap water and were subjected to pre-treatment like blanching. On the other hand, sugar and jaggery syrup of different concentrations/treatments (50, 55, 60, 65, 70 and 75^{o}Brix) were prepared (**Table 1**). 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 combinations. After completion of dipping time, sugar and jaggery syrup was drained and 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 osmo-dried peel flakes were collected and packed in LDPE bags and stored at room temperature for a period of three months (**Figure 1**). The osmo-dried eureka lemon peel flakes were analyzed at an interval of 0, 1, 2 and 3 months of storage for physico-chemical and microbiological parameters. Total soluble solids were determined by using a hand refractrometer and readings were expressed as °Brix. The moisture content was determined by using an electronic moisture analyzer at 105°C. Phosphorus content was estimated as the standard procedure of AOAC [6]. Total plate count of micro-organisms was determined according to method given by Harrigan and McCance [7]. The data obtained was statistically analyzed using CRD factorial for interpretation of results through analysis of variance [8].

Table 1 The details of the treatments are given below

Treatment Symbol	Treatment Details
T_1	Control
T_2	Dipping in 50 °Brix sugar syrup
T_3	Dipping in 55 °Brix sugar syrup
T_4	Dipping in 60 °Brix sugar syrup
T_5	Dipping in 65 °Brix sugar syrup
T_6	Dipping in 70 °Brix sugar syrup
T_7	Dipping in 75 °Brix sugar syrup
T_8	Dipping in 50 °Brix jaggery syrup
T_9	Dipping in 55 °Brix jaggery syrup
T_{10}	Dipping in 60 °Brix jaggery syrup
T_{11}	Dipping in 65 °Brix jaggery syrup
T_{12}	Dipping in 70 °Brix jaggery syrup
T_{13}	Dipping in 75 °Brix jaggery syrup

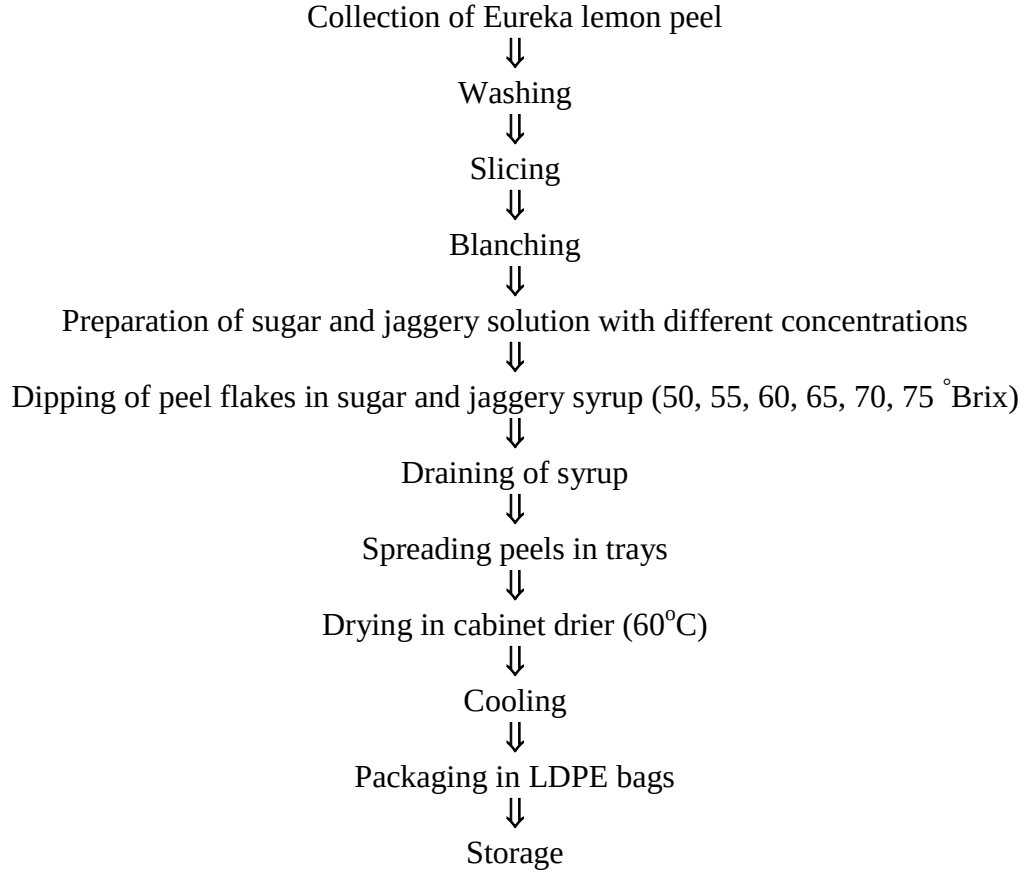

Figure 1 Process flow chart of osmo-dried eureka lemon peel flakes

Results and Discussion

Physico-chemical characteristics of fresh eureka lemon peel

The values of various parametres like moisture content, total soluble solids (TSS), acidity, ascorbic acid, reducing sugar, total sugar, β-Carotene, tannin of peel of fresh fruit was found to the tune of 73.50%, 11.20^{o}B, 0.50%, 35.20 mg/100 g, 4.40%, 6.45%, 7.33 mg/100 g and 168 mg/100 g, respectively (**Table 2**). These values are in accordance with the findings of Abou-Arab *et al*. [9], Alquezar *et al*. [10], Ahmed *et al*. [11] and Rafiq *et al*. [12] while working on the nutritional composition of lemon peel and processed product of eureka lemon peel; comparative evaluation of the proximate chemical composition and antioxidant properties of fresh eureka lemon peel and the drying method effects on the fresh lemon peel, respectively which coincides with the values of present findings.

The ash and crude fiber content of fresh eureka lemon peel was recorded to be 6.45 and 16.11% and the mean value of phosphorous found to be 18.10 mg/100 g which coincides with the results of Janati *et al*. [13] and Mahmoud *et al*. [14] who also reported similar results while studying the chemical characteristics of citrus peel and their by-products, respectively. Further L*, a* and b* value of fresh peel of eureka lemon were found to be 45.15, 2.33 and 27.00, respectively which were supported by the findings of Aggarwal and Michael [15] and Shamrez *et al*. [16] while working on citron peel and its value-added product, respectively.

Table 2 Physico-chemical characteristics of fresh peel of eureka lemon

Attributes		Quantity
Moisture Content (%)		73.50
TSS (^{o}B)		11.20
Acidity (%)		0.50
Ascorbic Acid (mg/100 g)		35.20
Reducing Sugar (%)		4.40
Total Sugar (%)		6.45
β- Carotene (mg/100 g)		7.33
Tannin Content (mg/100 g)		168
Ash (%)		6.45
Crude Fiber (%)		16.11
Phosphorous (mg/100 g)		18.10
Hunter Colour Values	L*	45.15
	a*	2.33
	b*	27.00

Total soluble solids

Statistically higher TSS content (79.40^{o}B) recorded in treatment T_7 (75^{o}B sugar syrup) which was followed by treatment T_{13} (75^{o}B jaggery syrup) and T_6 (70^{o}B sugar syrup) obtaining values 78.00 and 75.48^{o}B, respectively (**Table 3**). After three months of storage, T_7 (75^{o}B sugar syrup) obtained significantly higher TSS value (83.00^{o}B) whereas control registered the lowest TSS (17.90^{o}B) value. During the entire storage period, mean values of TSS increased significantly from 62.21 to 64.93^{o}B. The interaction effect of treatment and storage was found to be significant at 5 per cent level of significance. Rise in the values of total soluble solids might due to loss of moisture in the samples, or due to the partial hydrolysis of polysaccharides like cellulose and starch substances into simple substances. Similar observations were also observed in *kandi* lemon peel candy [4], karonda candy [17] and litchi-beetroot RTS beverage [18].

Moisture content

Perusal of data in Table 3 depicted decrease in moisture content during the different storage periods. Initially, significantly higher moisture content (15.85%) was recorded in treatment T_8 (50^{o}B jaggery syrup) which was immediately followed T_2 (50^{o}B sugar syrup) and T_9 (55^{o}B jaggery syrup) having values as 15.80 and 15.05 and lowest 6.87% in control. After three months of storage, the highest moisture content of 15.00% recorded in treatment T_2 (50^{o}B sugar syrup) and the lowest (6.31%) in control. During storage period of three months the mean values of moisture content of eureka lemon peel flakes showed a decline from initial value of 13.79 to 13.21 per cent. The interaction effect between treatment and storage were found to be significant at 5 per cent level of significance. The decrease in moisture content might be due to the fact that with an increase in syrup concentration, the rate of osmosis

increases that leads to decrease in moisture content. These results are in conformation in darunj peel candy [19] and ber chuhara [20].

Table 3 Effect of treatments and storage period on TSS (^{0}B) and moisture (%) of osmo-dried eureka lemon peel flakes

Treatments	Total Soluble solids Storage period (months)					Moisture Storage period (months)				
	0	**1**	**2**	**3**	**Mean**	**0**	**1**	**2**	**3**	**Mean**
T_1 (Control)	16.50	17.01	17.50	17.90	17.23	6.87	6.63	6.48	6.31	6.57
T_2 (50 ^{o}B sugar syrup)	54.50	55.15	56.32	57.10	55.77	15.80	15.65	15.30	15.00	15.43
T_3 (55 ^{o}B sugar syrup)	58.00	59.32	60.33	61.33	59.74	14.95	14.70	14.55	14.35	14.63
T_4 (60 ^{o}B sugar syrup)	65.60	67.00	68.66	69.15	67.58	14.25	14.05	13.90	13.85	14.01
T_5 (65 ^{o}B sugar syrup)	68.60	69.22	70.14	71.00	69.74	14.00	13.84	13.68	13.55	13.76
T_6 (70 ^{o}B sugar syrup)	75.48	76.20	77.00	78.33	76.75	13.75	13.51	13.24	13.07	13.39
T_7 (75 ^{o}B sugar syrup)	79.40	81.00	82.33	83.00	81.43	13.05	12.80	12.62	12.49	12.74
T_8 (50 ^{o}B jaggery syrup)	52.43	53.82	55.54	56.31	54.52	15.85	15.70	15.35	15.16	15.51
T_9 (55 ^{o}B jaggery syrup)	57.16	58.26	59.66	59.75	58.71	15.05	14.85	14.71	14.60	14.80
T_{10} (60 ^{o}B jaggery syrup)	62.80	63.52	64.17	65.26	63.94	14.55	14.49	14.30	14.15	14.37
T_{11} (65 ^{o}B jaggery syrup)	67.52	68.15	69.66	70.12	68.86	14.02	13.91	13.75	13.65	13.83
T_{12} (70 ^{o}B jaggery syrup)	72.80	73.02	73.57	73.81	73.30	13.90	13.76	13.55	13.48	13.67
T_{13} (75 ^{o}B jaggery syrup)	78.00	79.33	80.13	80.99	79.61	13.20	13.01	12.85	12.55	12.90
Mean	62.21	63.15	64.23	64.93		13.79	13.60	13.38	13.21	
Effect	$CD_{0.05}$		$CD_{0.05}$							
Treatment	0.02		0.01							
Storage	0.01		0.03							
Treatment x Storage	0.03		0.04							

Table 4 Effect of treatments and storage period on phosphorus (mg/100 g) and microbial count (cfu/g×10^6) of osmo-dried eureka lemon peel flakes

Treatments	Phosphorus Storage period (months)					Total number of colonies (cfu/g×10^6) Storage period (months)			
	0	**1**	**2**	**3**	**Mean**	**0**	**1**	**2**	**3**
T_1 (Control)	16.10	16.02	15.96	15.91	16.00	ND	ND	ND	1.30
T_2 (50 ^{o}B sugar syrup)	20.91	20.87	20.84	20.81	20.86	ND	ND	ND	0.24
T_3 (55 ^{o}B sugar syrup)	20.87	20.84	20.80	20.76	20.82	ND	ND	ND	0.23
T_4 (60 ^{o}B sugar syrup)	20.84	20.81	20.78	20.75	20.79	ND	ND	ND	0.22
T_5 (65 ^{o}B sugar syrup)	20.80	20.76	20.72	20.68	20.74	ND	ND	ND	0.20
T_6 (70 ^{o}B sugar syrup)	20.76	20.71	20.68	20.64	20.70	ND	ND	ND	0.19
T_7 (75 ^{o}B sugar syrup)	20.72	20.69	20.65	20.61	20.67	ND	ND	ND	0.17
T_8 (50 ^{o}B jaggery syrup)	19.71	19.65	19.60	19.56	19.63	ND	ND	ND	0.32
T_9 (55 ^{o}B jaggery syrup)	19.67	19.63	19.59	19.53	19.60	ND	ND	ND	0.31
T_{10} (60 ^{o}B jaggery syrup)	19.61	19.58	19.54	19.50	19.56	ND	ND	ND	0.29
T_{11} (65 ^{o}B jaggery syrup)	19.56	19.52	19.48	19.45	19.50	N D	ND	ND	0.28
T_{12} (70 ^{o}B jaggery syrup)	19.51	19.47	19.43	19.39	19.45	ND	ND	ND	0.26
T_{13} (75 ^{o}B jaggery syrup)	19.46	19.42	19.38	19.33	19.40	ND	ND	ND	0.25
Mean	19.89	19.84	19.80	19.76					
Effect	$CD_{0.05}$								
Treatment	0.01								
Storage	0.03								
Treatment x Storage	NS								

Phosphorous

The phosphorous content of different treatments revealed that during the different storage periods; mean phosphorus content significantly decreased from the initial level of 19.89 to 19.76 mg/100 g, respectively (**Table 4**). After two months of storage, maximum phosphorus content of 20.84 mg/100 g was recorded in T_2 (50^{o}B sugar syrup) followed

by T_3 (55°B sugar syrup) and T_4 (60°B sugar syrup) with the values 20.80 and 20.78 mg/100 g, respectively. However, the minimum phosphorus content of 15.96 mg/100 g was recorded in control. After three months of storage, the highest phosphorus content of 20.81 mg/100 g was recorded in T_2 (50°B sugar syrup) and the lowest phosphorus content (15.91 mg/100 g) was recorded in control which was followed by T_{13} (75°B jaggery syrup) and T_{12} (70°B jaggery syrup). The interaction between treatments and storage period was found non-significant at 5 per cent level of significance. The present findings were also similar in aonla ladoo [21] and intermediate moisture beetroot cubes [22].

Microbial studies

All the samples were found to be free from microbial count upto two months of storage. However, after three months of storage, the highest microbial count of $1.30x10^6$ cfu/g was recorded in Control which was followed by T_8 (50°Brix jaggery syrup) and T_9 (55°B jaggery syrup) whereas the lowest of $0.17x10^6$ cfu/g recorded in T_7 (75°Brix sugar syrup), which was followed by T_6 (70°Brix sugar syrup), T_5 (65°Brix sugar syrup), T_4 (60°Brix sugar syrup), T_3 (55°Brix sugar syrup) and T_2 (50°Brix sugar syrup) with the values of 0.19, 0.20, 0.22, 0.23 and $0.24x10^6$ cfu/g, respectively (Table 4). Yet it remained below the range than the limits specified by FDA for such products. An acceptable count of microbes was also observed in kinnow peel candy [23], in flavored ladoo [24] and litchi-beetroot leather [25].

Cost of Production of the eureka lemon peel flakes

The cost of production of eureka lemon peel flakes was based upon the fixed and variable cost of all the ingredients used and some other factors *viz*. processing charges, packaging materials *etc*. The cost was calculated on the basis of current market price of ingredients used. The cost of production of osmo dried eureka lemon peel flakes comes to Rs. 5.44/40 g (**Table 5**). Since the cost of production has been calculated on the laboratory scale basis, however, there may be some variation in cost if manufactured on large scale.

Table 5 Cost of production of the osmo-dried eureka lemon peel flakes

Ingredients	Rate (Rs.)	Quantity	Amount (Rs.)
Eureka lemon peel	4/kg	500g	2.00
Sugar	45/kg	750g	33.75
Citric acid	120/kg	5g	0.60
Laminated pouches	0.50	12	6.00
Total ingredients cost			42.30
Overhead charges (including labour fuel and machinery depreciation)	@ 20%		8.46
Profit	@ 15%		7.61
GST	@ 12%		7.00
Grand total			65.36
Cost/pouch (40 g)			5.44

Conclusion

From the overall observations of the experiment it was concluded that storability study revealed that eureka lemon osmo-dried peel flakes prepared with T_7 (75°Brix sugar syrup) have good shelf life and can be kept for more than 90 days. The cost of production of eureka lemon peel flakes is economical. Hence this technology of eureka lemon peel can be utilized properly to yield nutritious, attractive value added product.

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