Journal of Agricultural Engineering and Food Technology
p-ISSN: 2350-0085; e-ISSN: 2350-0263; Volume 3, Issue 3; July-September, 2016 pp. 203-209

http://www.krishisanskriti.org/Publication.html

"Effect of Drying on Nutrition of Orange Leather Fortified with Orange Peel"

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Abstract—*The effect of selected drying methods (microwave and freeze drying) was studied on the overall quality of orange bar stored at room temperature during three months storage. Stabilizer was added at the rate of 1% (pectin) in to 0% (control), 5% and 10% incorporation of conventionally dehydrated orange peel powder were used. All the treatments were analyzed physico -chemically (moisture, total soluble solids, ash, reducing sugar, pH, titratable acidy, ascorbic acid and total microbial count) and sensory (color, texture, taste and overall acceptability) of the bar. Results showed that decrease occurred in moisture content (from 18.56 to 14.45%), ascorbic acid (102.75 to 87.42mg/100g), pH (3.90 to 3.69), ash (2.26 to 2.11%), color (7.78 to 6.20), texture (7.90 to 6.86), taste (7.63 to 6.52) and overall acceptability (8.20 to 6.76) while increase was observed in % acidity (1.13 to 1.33%), TSS (74.6 to 76.5^{o}brix) and reducing sugar (10.52 to 10.70%) during storage. The maximum mean values were observed for moisture in OL_0 (18.37), ascorbic acid OL_5 (102.07), pH OL_0 (3.82), titrable acidity OL_0 (1.26), total soluble solid OL_0 (76.5), reducing sugar OL_0 (11.75), ash OL_2 (2.38), color OL_4 (8.17), texture OL_4 (7.54), taste OL_4 (7.79) and overall acceptability OL_4 (8.20), the results showed that treatment OL_4 followed by OL_1 were found most acceptable both organoleptically and physico - chemically.*

Keywords*: Leathers, physicochemical, microbial and organoleptic evaluation.*

1. INTRODUCTION

Citrus (*Citrussp.* from Rutaceae) is one of the most important world fruit crops and isconsumed mostly as fresh produce or juice because of its nutritional value and special flavour. The health benefits of citrus fruit have mainly been attributed to the presence of bioactive compounds, such as phenolics (e.g. flavanone glycosides, hydroxycinnamicacids) (Marchand, 2002), vitamin C (Halliwell, 1996), and carotenoids (Rao and Rao,2007). Although, the fruits are mainly used for dessert, they are also sources of essential oils due to their aromatic compounds (Minh Tu et al., 2002; Chutia et al., 2009). Antioxidant molecules such as phenolics, sugars, ascorbic acid and carotenoids were also quantified in order to understand their contribution to the overall bioactive properties. Orange refers to the citrus tree, *Citrus sinensis*, and the fruits of this tree. Belonging to the Rutaceae family, oranges are a kind of *hesperidium*, or berry, because they have many seeds, are fleshy, soft, and derived from a single ovary. It is well known citrus fruits contain a range of key nutrients including high levels of vitamin C and significant amounts of dietary fibre, beta-carotene and folic acid. They have a low ratio of sodium to potassium and are low in fat and dietary energy, making them nutrient dense, energy-dilute foods with a low glycemic index. Citrus fruits are also extremely rich in antioxidants. In recent years increasing attention has been given to the sum of biologically active elements found in citrus fruits – particularly their plant-based non-nutrients called phytochemicals – because of the role they might play in preventing a range of chronic disease conditions including cancer and heart disease.

Peel, also known as rind or skin, is the outer protective layer of a fruit is usually the botanical exocarp. A fruit with a thick peel, such as a citrus fruit, is called a hesperidium. In hesperidiums, the inner layer (also called *albedo* or, among non-botanists, *pith*) is peeled off together with the outer layer (called flavedo), and together they are called the peel. The flavedo and albedo, respectively, are the exocarp and the mesocarp. The juicy layer inside the peel (containing the seeds) is the endocarp. The peel of citrus fruits is bitter and generally not eaten raw with tangy flavor. Orange peel represents approximately 30-40 g/100g of the fresh fruit weight and could be used to develop value-added products.

There are a number of advantages of microwave drying in food processing technology like significant reduction in the thermal processing time while making food safe for consumption is the major advantage of microwave sterilization processing, reduction in processing time results in more fresh-like taste and texture, and improves visual appeal of the food. The reduction of processing time may also potentially increase retention of nutrients in the thermally processed foods. Instantaneous turn-on and off of the process allows for a more precise process control, better energy usage, and cleaner working environment in food processing facilities.

Freeze-drying also causes less damage to the substance than other dehydration methods using higher temperatures. Freeze-drying does not usually cause shrinkage or toughening of the material being dried. In addition, flavours, smells and nutritional content generally remain unchanged, making the process popular for preserving food.

Fruit leather is product that can be made using drying process. Fruit leathers are dried sheets of fruit pulp that have a soft, rubbery texture and a sweet taste. They are produced by dehydrating of fruit puree into a leathery sheet (Raab and Oehler, 1999). The edible portion of fruit (one or more types) is puree, mixed with other ingredients to improve its physicochemical and sensory characteristics, heated, formed (flattened and shaped) and then dried on flat trays until a cohesive fruit leather is obtained (Moyls, 1981; Phimpharian *et al*., 2011).

Bars can be made from a wide variety of fruit including pawpaw, guava, banana and sweet potato (Collins and Hatsell, 1987).When dried, the product is pulled from the surface, rolled and consumed as snack. The control of the drying temperature is very important, as very high temperatures may cause case hardening, hindering the outflow of water. Besides, it is also important to control the fruit puree load, as a too thin layer of puree can make the product brittle and difficult to be pulled from the surface. In contrast, a thick puree layer results in a very low drying rate (Henriette *et al*, 2005). Although fruit Bars is a relatively well established product overseas, few studies have been published about this kind of product.

Objectives:

- To prepare value added product of orange peel with different dehydrated pulp.
- To study the physicochemical properties (acidity, TSS, carbohydrate,protein content) and sensory evaluation of leather.
- To investigate the therapeutic property of leather.

2. MATERIALS AND METHODS

Fresh oranges purchased from local area of Sambalpur, Odisha. Fruits were selected on the basis of a similar degree of ripeness and apparent fruit quality (firmness, size, colour and absence of physical damage). The study was carried out in the year 2015-16 at Sambalpur University, JyotiVihar, Burla, Sambalpur.

Sample Preparation:

Leather samples were prepared separately by adding 20% of sugar, 0.2% of citric acid, and 1% pectin to 80% of their fruit pulp with 0%, 5% and 10% of dried powdered peels. It is then boiled, cooled and spread on trays oiled with cooking oil. It was then dried at 60°C for 8 hours before packaging. The process of pectic gelification leading to a fruit leather has the following requirements: a soluble solid content greater than 55% w/w, composed of fruit pulp and, optionally, by added polysaccharides. Besides, the pH of the formulation must be of 3.5 or below. Pectins with high degree of esterification are necessary as well after making the fruit leathers they are rolled in plastic wraps and kept in air tight containers. The leathers are stored at room temperature for further study of carbohydrate content, antioxidant content and moisture content, pH and TSS.

Packaging: The prepared bar was packed in a transparent LDPE packaging material.

Physicochemical Analysis: pH, TSS, Ash, Moisture content, Acidity, Reducing sugars were determined by the standard method of AOAC (2012).

Total microbial count: The sample was analyzed for the total microbial count by the total plate count method as describe Dillello (1982).

Sensory evaluation: The guava bar was organolaptically judged for taste, color, overall acceptability and texture by the panels of 15 judges. The evaluation was carried out by using 9 points hedonic scale of Larmond (1977).

Statistical analysis: All the results were statistically analyzed by CRD 2 factorial according to methods of Steel *et al*., (1996).

3. RESULTS AND DISCUSSION

Moisture (%)

Moisture content was significantly affected by orange bars and storage intervals (Table 1). Higher moisture content (16.37), were observed at OL_0 of orange bar followed by (16.34) at OL_5 of orange bar whereas lower moisture content (14.87) were observed at OL_1 of orange bar. Higher moisture (18.57) were observed at day one fallowed by (17.55) at 15 days after storage while lowest moisture (13.53) were observed at 90 days storage interval. Graph showed that the guava bars with storage interval the moisture was decreased with the increase of storage duration. Throughout the storage highest fall in moisture content was recorded in OL_2 (34.39%) followed by OL_1 (32.27%), in compare minimum fall was observed in OL_4 (20.24%) followed by OL_5 (20.87%).

Similar result of moisture content were reported by Ashaye *et al.* (2005), Okilya *et al.* (2010) in guava bar by Duangmal and Khachonsakmetee (2009), pear fruit leather by Huang and Fu-Hung and Durian Fruit Leather by Irwandi *et al* (1998). There was a clear relationship between moisture content and water activity the higher the moisture content the higher the water activity similar observations were made on kiwifruit leather by Lodge (1981) and jackfruit leather by Che Man and Taufik (1995).

Ascorbic Acid

Ascorbic acid was significantly affected in orange bars within storage intervals (Table 2). Higher ascorbic acid (109.07) were observed at OL_5 of orange bar followed by (94.92) at OL_4 of orange bar whereas lower ascorbic acid (82.33) was observed in OL_0 followed by OL_1 (80.59) of orange bar. Similarly ascorbic acid decrease with increase of storage interval. Higher ascorbic acid (92.75) were observed at day one fallowed by (90.01) at 15 days after storage while lowest ascorbic acid (77.82) were observed at 90 days storage interval. Graph showed that the orange bars with storage interval the ascorbic acid was decreased with the increase of storage duration. Throughout the storage the highest fall in ascorbic acid was recorded in OL_0 (19.73%) followed by OL_2 (19.69%), while lowest fall was observed in OL_1 (13.62%) followed by OL_5 (15.63%).

Loss of ascorbic acid has earlier been reported in mango leather during of 3 months storage by Rao and Roy (1980). Similar results have been reported by Sreemathi *et al*. (2008) in sapota -papaya bar during 3 months of storage, guava leather by Jain and Nema (2007) and Sharma *et al.*, (2013).

pH

pH was significantly affected in orange bars with in storage intervals (Table 3). Higher pH (3.82) were observed at OL_1 of orange bar followed by (3.8) at OL_4 of orange bar whereas lower pH (3.78) were observed at OL_o of orange bar. Similarly pH decrease with increase of storage interval. Higher pH (3.90) were observed at day one fallowed by (3.87) at 15 days after storage while lowest pH (3.69) were observed at 90 days storage interval. Graph showed that the orange bars with storage interval the pH was decreased with the increase of storage duration. Throughout the storage interval highest fall in pH was recorded in OL_0 (5.41%) followed by OL_2, OL_4 and OL_5 (5.40%), in compare minimum fall was observed in OL_1 (5.15%) followed by OL_4 (5.37%).

Similar result of pH were reported pineapple leather by Phimpharian *et al.,* (2011), mango leathers by Azeredo *et al*., (2006), pawpaw and guava leathers Babalola *et al* (2006) and apple leather by Natalia *et al* (2012).

Total Acidity (%)

Analysis of data showed that orange bar and storage duration significantly affected Total acidity (Table 4). Higher acidity (1.26) were observed at OL_1 of orange bar followed by (1.25) at OL_4 of orange bar whereas lower total acidity (1.20) were observed at OL_0 of orange bar. Similarly acidity increase with increase of storage interval. Higher acidity (1.33) were observed at 90 day fallowed by (1.30) at 75 days after storage while lowest acidity (1.13) were observed at days one of storage interval. Graph showed that the orange bars with storage interval the acidity was increased with the increase of storage duration. Throughout the storage the highest raise in acidity was recorded in OL_5 (79.666%) followed by OL_2 (79.003%), while lowest raise was observed in OL_0 (57.460%) followed by OL_4 (57.729%). Similar results of rising in acidity were also found in banana leather by Ekanayake and Bandara (2002), mango sheet by Rao and Roy (1980) and Mango leather by Effah-Manu *et al*. (2013).

Total Soluble Solids

Analysis of data showed that orange bar and storage duration significantly affected total soluble solids (Table 5). Higher total soluble solids (76.5) were observed at OL_1 of guava bar followed by (76.4) at OL_4 of orange bar whereas lower total soluble solids (73.2) were observed at OL_0 of orange bar. Similarly total soluble solids increase with increase of storage interval. Higher total soluble solids (76.5) were observed at 90 day fallowed by (76.2) at 75 days after storage while lowest total soluble solids (74.6) were observed at days one of storage interval. The data showed that the orange bars with storage interval the total soluble solids was increased with the increase of storage duration. Throughout the storage the highest raise in TSS was recorded in OL_2 (3.1%) followed by OL_0 (3%), while lowest raise was observed in OL_3 and OL_5 (2.1%) followed by OL_1 (2.6%). Similar results of TSS were reported by Phimpharian *et al.,* (2011).

Reducing Sugar (%)

Analysis of data showed that orange bar and storage duration significantly affected reducing sugar (Table 6). Higher reducing sugar (11.87) were observed at OL_1 of orange bar followed by (11.36) at OL_4 of orange bar whereas lower reducing sugar (8.49) were observed at OL_0 of orange bar. Reducing sugar increased with increasing of storage interval. Higher reducing sugar (10.70) were observed at 90 day fallowed by (10.67) at 75 days after storage while lowest reducing sugar (10.52) were observed at days one of storage interval. Graph showed that the orange bars with storage interval the reducing sugar was increased with the increase of storage duration. Throughout the storage the highest raise in reducing sugar was recorded in OL_0 (2.21%) followed by OL_5 (2.19%), while lowest raise was observed in OL_1 (1.59) followed by OL_3 (1.60%). The increase in reducing sugar during storage interval may be due to the conversion of sucrose to reducing sugar (glucose, fructose etc).

Similar result of reducing sugar were reported by Sharma *et al.,* (2013), mango leather by Rao and Roy (1980), apricot - soy toffees and papaya leather by Thakur et al. (2007), Phimpharian *et al.,* (2011), guava leather by Duangmal and Khachonsakmetee (2009) and sapota papaya bar by Sreemathi *et al*. (2008).

Ash (%)

Ash content was significantly affected by orange bars and storage intervals (Table 7). Higher ash content (2.38) were observed at OL_1 of orange bar followed by (2.37) at OL_4 of orange bar whereas lower ash content (1.60) were observed at OL_0 of orange bar. Similarly Ash content decrease with increase of storage interval. Higher Ash content (2.24) were observed at day one fallowed by (2.24) at 15 days after storage while lowest ash content (2.11) were observed at 90 days storage interval. Data showed that the orange bars with storage interval the Ash content was decreased with the increase of storage duration. Throughout the storage highest fall in ash content was recorded in OL_5 (9.55%) followed by OL_0 (8.71%), while in minimum fall was observed in OL_3 (5.81%) followed by OL_1 (5.97%). Similar result of ash were reported by the ash content is a measure of the total amount of minerals present within a food. High mineral contents are sometimes used to retard the growth of certain microorganisms and can have beneficial effects on the physicochemical properties of foods (Effah-Manu *et al.* 2013).

Total Microbial Count

Microbial activity was significantly affected by orange bars and storage intervals (Table 8). Higher microbial activity (11.42) were recorded at OL_0 of orange bar followed by (10.71) at OL_5 of orange bar whereas lower microbial activity (8.14) were recorded at OL_2 of orange bar. Similarly, microbial activity decrease with increase of storage interval. Higher microbial activity (14.00) were recorded at day one fallowed by (12.43) at 15 days after storage while lowest microbial count (5.68) were recorded at 90 days storage interval. Graph showed that the orange bars with storage interval the microbial activity was decreased with the increase of storage duration. Throughout the storage highest fall in microbial count was recorded in OL_2 (69.23%) followed by OL_1 (61.54%), in compare minimum fall was observed in OL_0 (64.67%). According to Troller (1980), most of the microorganisms can barely survive a water activity lower than 0.60. Similar result of microbial count was reported by Huang and Fu-hung (2005) the results of microbiological analyses reported in previous studies (Irwandi and Che Man 1996; Irwandi *et al.*, 1998). Mean values followed by different letter are significantly (P<0.05) different from each other.

Table 1: Moisture (%) as affected by treatments and storage duration.

Treatments	Storage Interval (Days)							% Decrease	Mean
	0	15	30	45	60	75	90		
OL0	18.55	18.00	17.73	16.01	15.42	14.49	14.40	22.36	16.37 a
OL1	18.12	17.70	15.83	14.18	13.09	12.88	12.27	32.27	14.87 b
OL2	17.00	16.40	15.25	14.36	13.42	12.22	11.15	34.39	14.26 c
OL3	18.26	17.57	17.06	16.36	15.85	14.00	13.50	26.05	16.09 a
OL4	18.31	17.79	16.21	15.68	15.99	14.88	14.60	20.24	16.21 a
OL5	18.53	18.00	17.31	16.45	15.03	14.86	14.23	23.21	16.34 a
Mean	18.17 a	17.55 b	16.60 c	15.49 d	14.83 e	14.05 f	13.53 f		

Table 2: Ascorbic acid (mg/100g) as affected by treatments and storage duration.

Treatments	Storage Interval (Days)							% Decrease	Mean
	0	15	30	45	60	75	90		
OL0	92.17	88.17	85.00	81.99	78.99	75.99	73.99	19.73	82.33 e
OL1	95.50	92.50	90.50	89.50	87.50	85.50	82.50	13.62	89.07 a
OL2	90.00	88.70	86.90	83.00	81.00	78.90	75.93	15.63	83.49 cd
OL3	93.50	89.33	86.00	84.89	80.89	77.89	75.88	18.84	84.05bc
OL4	92.00	89.50	87.00	85.99	82.99	79.98	76.98	16.33	84.92 b
OL5	94.00	90.50	87.50	84.50	81.50	78.50	75.50	19.69	84.57bc
Mean	92.75 a	90.01 b	87.60 c	85.84 d	83.09 e	80.57 f	77.82 f		

Table 3. pH as affected by treatments and storage duration

Treatments	Storage Interval (Days)							% Decrease	Mean
	0	15	30	45	60	75	90		
OL0	3.88	3.85	3.81	3.78	3.75	3.71	3.67	5.41	3.78 e
OL1	3.92	3.89	3.85	3.80	3.78	3.76	3.72	5.15	3.82 a
OL2	3.89	3.86	3.82	3.78	3.74	3.71	3.68	5.40	3.78 e
OL3	3.90	3.87	3.83	3.79	3.75	3.72	3.69	5.38	3.79 cd
OL4	3.91	3.88	3.84	3.79	3.75	3.73	3.70	5.37	3.80bc

OL5	3.91	3.89	3.83	3.79	3.77	3.73	3.70	5.40	3.80 b
Mean	3.90 a	3.87 b	3.83 c	3.79 d	3.76 e	3.72 f	3.69 f		

Table 4. acidity as affected by treatments and storage duration

Treatments	Storage Interval (Days)							% Decrease	Mean
	0	15	30	45	60	75	90		
OL0	1.11	1.14	1.17	1.20	1.23	1.26	1.29	13.95	1.20 e
OL1	1.14	1.19	1.23	1.26	1.29	1.33	1.36	16.18	1.26 a
OL2	1.12	1.16	1.19	1.22	1.25	1.27	1.30	14.15	1.22 d
OL3	1.14	1.17	1.21	1.23	1.26	1.29	1.32	13.64	1.23 c
OL4	1.13	1.18	1.21	1.25	1.28	1.32	1.35	16.30	1.25 b
OL5	1.13	1.17	1.20	1.24	1.27	1.30	1.34	15.67	1.24 c
Mean	1.13 a	1.17 b	1.20 c	1.24d	1.27e	1.30f	1.33f		

Table 5. Total soluble solids as affected by treatments and storage duration

Treatments	Storage Interval (Days)							% Increase	Mean
	0	15	30	45	60	75	90		
OL_0	72.0	72.5	72.9	73.3	73.5	73.8	74.2	3.0	73.2 f
OL_1	75.5	75.9	76.2	76.6	76.9	77.2	77.5	2.6	76.5 b
OL_2	74.6	75.0	75.5	75.9	76.2	76.6	77.0	3.1	75.8 a
OL_3	75.3	75.5	75.7	76.0	76.2	76.5	76.9	2.1	76.0 a
OL_4	75.4	75.7	76.0	76.4	76.9	77.2	77.5	2.7	76.4c
OL_5	75.4	75.7	76.0	76.3	76.5	76.7	77.0	2.1	76.2 e
Mean	74.6 a	74.9 b	75.2 c	75.6 d	75.9 e	76.2 f	76.5 g		

Table 6. Reducing Sugar (%) as affected by treatments and storage duration

Treatments	Storage Interval (Days)							% Increase	Mean
	Initial	15	30	45	60	75	90		
OL_0	8.39	8.42	8.46	8.49	8.52	8.55	8.58	2.21	8.49 g
OL_1	11.78	11.81	11.84	11.87	11.90	11.94	11.97	1.59	11.87 a
OL_2	9.46	9.49	9.52	9.55	9.58	9.61	9.64	1.87	9.55 e
OL_3	9.87	9.90	9.93	9.95	9.98	10.00	10.03	1.60	9.95 d
OL_4	11.27	11.29	11.32	11.36	11.39	11.43	11.46	1.66	11.36 b
OL_5	10.23	10.26	10.29	10.32	10.36	10.38	10.41	1.73	10.32 c
Mean	10.52 g	10.55 f	10.58 e	10.61 d	10.64 c	10.67 b	10.70 a		

Table 7.Ash (%) as affected by treatments and storage duration

Treatments	Storage Interval (Days)							% Decrease	Mean
	0	15	30	45	60	75	90		
OL_0	1.68	1.64	1.61	1.59	1.57	1.55	1.53	8.71	1.60 f
OL_1	2.45	2.43	2.41	2.39	2.36	2.33	2.30	5.97	2.38 a
OL_2	2.33	2.31	2.28	2.25	2.22	2.20	2.18	6.44	2.25 d
OL_3	2.41	2.39	2.36	2.34	2.31	2.29	2.27	5.81	2.34 c
OL_4	2.46	2.42	2.39	2.37	2.34	2.30	2.28	7.32	2.37 b
OL_5	2.45	2.42	2.39	2.37	2.33	2.30	2.27	7.20	2.36 b
Mean	2.26 a	2.24 b	2.21 c	2.19 d	2.16 e	2.13 f	2.11 g		

Table 8: Over All Acceptability as affected by treatments and storage duration

Treatments	STORAGE INTERVAL							% Decrease	Mean
	0	15	30	45	60	75	90		
OL_o	7.2	6.4	5.8	5.3	4.7	4.7	3.7	48.61	5.40 e
OL_1	8.5	8.1	7.7	7.5	7.2	6.9	6.6	22.35	7.50 a
OL_2	8.6	7.6	7.3	6.9	6.5	6	5.6	34.88	6.93cd
OL_3	8.6	7.7	7.3	6.9	6.6	6.2	5.9	31.40	7.03bc
OL_4	8.6	7.9	7.5	7.1	6.8	6.5	6.2	27.91	7.23 b
OL_5	8.5	7.5	7.4	7	6.7	6.3	5.9	30.59	7.04bc
Mean	8.28 a	7.50 b	7.08 c	6.72 d	6.32 e	6.04 f	5.56 g		

4. CONCLUSION”

From the results of this research it was concluded that in physicochemical analysis, total microbial count and sensory evaluation the performance of OL_4 (peel 5%) was best followed by OL_1.Orange bar was best for nutrients element at 45 days storage. The result of analyzed sample showed a linier decrease for texture among treatments during storage periods.

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