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Effect of Different Concentrations of Sucrose and Honey on the Physiochemical and Sensory Properties of Strawberry Leather

Muhammad Kaleem[a], Ihsan Mabood Qazi[a], Arsalan Khan[b]*, Muhammad Ali Khan[c], Ibrar Hussain[b], Muhammad Ayub[a], Abid Shah Shinwari[b], Falak Naz Shah[b] and Ata Ur Rehman[a]

[a]The University of Agriculture Peshawar, Khyber Pakhtunkhwah, Pakistan

[b]Agriculture Research Institute (ARI), Tarnab, Peshawar, Pakistan

[c]Abdul Wali Khan University Mardan, Khyber Pakhtunkhwah, Pakistan

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Abstract. The aim of the present research work was to study the effect of different levels of sucrose and honey content on strawberry leather stored at room temperature for a total period of 90 days. The sucrose and honey was added at the level of 300:0, 250:50, 200:100, 150:150, 100:200, 50:250 and 0:300, representing each treatment. The prepared strawberry leather were analysed physiochemically for pH, acidity, ascorbic acid, reducing and non-reducing sugar content, sugar acid ration and organoleptically for colour, taste, texture and overall acceptability for a total period of 90 days. Statistical results revealed that treatment and storage interval had a significant ($P< 0.05$) effect on both physiochemical and organoleptic evaluation. Results also revealed that the decrease occurred in moisture content from (18.17-13.53%), pH (3.58 to 3.43), ascorbic acid (34.41 to 25.53), non-reducing sugar (5.09 to 4.85), sugar-acid ratio (71.03-65.37%), and sensory evaluation included colour (8.17 to 5.10), texture (8.31 to 5.69), taste (8.37 to 6.04) and overall acceptability (8.37 to 5.61), while increase was found in total acidity (1.137-1.267%), total soluble solid (80.96 to 83.04 °Brix) and reducing sugar (19.09-19.45%) during storage. The maximum mean values were observed for moisture in SL_5 (16.37), ascorbic acid SL_4 (31.59), pH SL_4 (3.57), titratable acidity SL_4 (1.230), total soluble solid SL_4 (82.80), total solid SL_4 (82.80), reducing sugar SL_4 (26.47), non-reducing sugar SL_1 (6.20), colour SL_4 (7.13), texture SL_4 (7.54), taste SL_4 (7.79), overall acceptability SL_4 (7.5) and sugar-acid ratio SL_6 (70.76). Among all the treatments, T_4 was found to be the best both physiochemically and organoleptically.

Keywords: strawberry fruit, leather, sucrose, honey

Introduction

Among all berries, strawberry is one of the most important berry fruit and different wild species of strawberry are grown all over the world (John, 1994). Strawberry (*Fragaria* spp.) is a herbaceous member of family Rosaceae and with more than six hundred varieties have different taste, texture and sizes (Childer, 1983). According to Food and Agriculture Organization, the world production of strawberries exceeded 4 million tonnes, with United States being major contributor with 28% production (FAO, 2009).

In Pakistan, strawberries are grown in Punjab and Khyber Pakhtunkhwa (Amin, 1996). The favourable varieties grown are Tuft, Mission, Corona, Sweet Charlie, Super Faction and Festival. During 2009-2010 the production of strawberry was 274 tonnes on the area of about 193 acres in Pakistan (Aslam and Rasool, 2012). The production of strawberries has increased due to its nutritional values.

*Author for correspondence;
E-mail: arsalankhan.fst@gmail.com

From the nutritional point of view, one cup of strawberry contain 10.5 g carbohydrate, 1.6 g fibre, 0.6 g fats, 84.5 mg vitamin C, 1 g protein, 26.4 g folic acid, 0.1 g thiamine, 0.4 g niacin, 0.6 g iron, 0.1 g riboflavin, 21 g calcium, 2 g sodium, 16 g magnesium and 45 Kcal. The level of vitamin C in strawberry is more the in oranges and strawberry also gives rare supply of vitamin K, B5, B6, manganese, potassium, copper and omega 3 fatty acids (USDA, 2011; 1998). The main organic acids which contribute in aroma are malic and citric acid. The non-nutrients which are present in strawberry fruit are phenol and flavonoids as compared to other berries (Hakkinen and Torronen, 2000). Strawberry fruit possess different attributes such as juicy, tiny, flavourful, nourishing, syruping flavour, diuretic, remineralizing and tonic (Johnson and Peterson, 1974).

Strawberry fruit is normally used in fresh form and can be preserved as jellies, jams, and squashes that can be utilized throught out the year (Galleta and Bringhurst, 1995). The shelf life of the product can be increased by using different chemical preservatives. Among them most important preservatives are sodium benzoate, potassium sorbate, potassium bisulphate, ascorbic acid, and sulphur dioxide (Krebs *et al*., 1983).

Fruit leathers are dehydrated fruit products which are eaten as snacks or desserts. They are flexible sheets that have a concentrated fruit flavour and nutritional aspects. Most fruit leathers are prepared by mixing fruit puree and other additives like sugar, pectin, acid, glucose syrup, colour and potassium metabisulphite then dehydrating them under specific conditions (Diamante *et al*., 2014).

Sweetener add the taste of food items and in earlier times foods were sweetened with honey and molasses as desired by the consumer. There are two types of sweeteners used in foods i.e., nutritive and non nutritive sweeteners (Mitchell and Pearson, 1991). Sucrose provides sweet taste and flavour to the product. It also provides freshness and contribute to the product quality (Ayub *et al*., 2005). The addition of simplest sugars to jams and jellies holds growth of microorganism and later on spoilage. Sucrose has a long lasting connection for water reduction, and to reduce moisture loss in baked products therefore, increased the life of these products. The addition of sugars to canned vegetables and fruits helps in maintaining soundness and reduces oxidation, also shield changes in texture, flavour and colour resulting from the breakdown of different substances (Clarke, 1997).

In last decade the popularity of fruit leather increased significantly due to its richness in Vitamin C (Naz, 2012). Nonetheless, the future of strawberry production and processing is helpful in boosting the economy of developing agricultural countries, as it fetches high economic returns. The overall aim of this study was to prepare strawberry bar with addition of sucrose and honey in different levels and to study their effect on strawberry bar quality. Effect of honey addition on storage duration of these leather will be studied for commercial transportation of these products to long distance market.

Materials and Methods

Selection of fruits. Strawberry fruit at optimum maturity was purchased from the local market of Peshawar and was brought to the Laboratory of Food Science and Technology section, Agriculture Research Institute Tarnab, Peshawar for preparation of strawberry leather.

Pre-treatment of fruits. Strawberry fruit were carefully sorted to discard diseased, damaged, bruised and immature fruits. The sorted fruits were thoroughly washed with tap water to remove dirt and clay. Washing was repeated for two to three times for complete washing of strawberry fruit. After washing the strawberry fruits were crushed with the help of pulper machine (Model.35027 Rochdale, England) to prepare the pulp.

Preparation of strawberry leather. Strawberry leather was an intermediate food (IMF) product prepared by blending all the ingredients in appropriate amount (Table 1). The homogenised material was first cooked and then spread on stainless steel tray covered with aluminium foil and were kept in dehydrator (Mitchell dryer, model 7230/60) at a temperature of 50 °C for 24 h. After drying, the leather samples were cooled and then packed in polyethylene bags to be studied for physiochemical characteristics and sensory attributes for three months at room storage with 15 days of interval (Khan *et al*., 2014).

Physiochemical analysis. All the samples were analysed physiochemically for pH, total soluble solids, % acidity, ascorbic acid, reducing sugar and non reducing sugar by method of AOAC (2012).

Sensory evalution. The samples of strawberry leather were sensory evaluated for colour, texture, flavour and overall acceptability by 10 trained judge's panel. Organoleptic study was carried out at each 15 days interval during 3 months storage. The evaluation was conceded out by using 9 points hedonic scale of Larmond (1977). The results are of scoring rate 1-9 awarded by panel of judges.

Statistical analysis. All the data concerning treatments and storage interval were statistically analysed by means of Completely Randomized Design (CRD) 2 Factorial and means were separated by applying least significant difference (LSD) test at 5% possibility level as defined by Steel and Torrie (1997).

Table 1. Proposed plan of study for research

Sample	Strawberry pulp (g)	Sucrose (g)	Honey (g)	Pectin (%)	Sodium benzoate (g)
SL_0	700	300	_	0.5	2
SL_1	700	250	50	0.5	2
SL_2	700	200	100	0.5	2
SL_3	700	150	150	0.5	2
SL_4	700	100	200	0.5	2
SL_5	700	50	250	0.5	2
SL_6	700	_	300	0.5	2

Results and Discussion

Moisture (%). Both treatment and storage have significant ($p<0.05$) influence on the moisture content of strawberry leather (Table 2). This is revealed from treatment means that higher moisture content was observed in SL_5 (16.37%) and SL_0 contained the lower moisture content (14.26%). During storage the maximum moisture content decreased as observed in SL_0 (34.41%), while minimum moisture content decreased was found in SL_4 (20.26%) during 90 days of storage. However, microbial growth and activity was inhibited below this moisture content range with exception of Europhilic mold and osmophilic yeast (Jay *et al*., 2005; Raab and Oehler, 1976). On the other hand, Chavan and Shaik (2015) reported that the moisture content of guava leather decreased during storage from 15.85 to 14.67%. They further reported that due to ambient temperature moisture loss was higher in guava leather (Shakoor *et al*., 2015). Hence, it was concluded that guava leather moisture content was well below the range where no microbial growth occurs and due to room temperature moisture slightly reduces and ensure safety of the product during storage.

Ascorbic acid. The ascorbic acid content of strawberry leather was significantly ($p<0.05$) affected by storage period and treatment (Table 3). Mean data revealed that highest ascorbic acid content was observed in SL_4 (31.59%) and SL_0 contained the lowest ascorbic acid content (28.73%). However, data presented here showed that sample SL_1 has more ascorbic acid content (30.36%) than rest of the strawberry leather samples. In most liable nutrients Vitamin C is very important because of its degradation property that is used as an indicator of quality. The losses of ascorbic acid may be attributable to oxidation of ascorbic acid to dehydroascorbic acid followed by hydrolysis of the final 2,3-diketogluconic acid, which undergoes polymerization to other nutritionally inactive products (Shakoor *et al*., 2015; Dewanto *et al*., 2002). Similar results were found by Chavan and Shaik (2015). They reported that there was a decrease

Table 2. Effect of different levels of sucrose and honey on moisture content (%) of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	17.0	16.4	15.25	14.36	13.42	12.22	11.15	34.41	14.26c
SL_1	18.12	17.7	15.83	14.18	13.09	12.88	12.27	32.28	14.87b
SL_2	18.53	18.0	17.31	16.45	15.03	14.86	14.23	23.21	16.34a
SL_3	18.40	17.4	16.83	15.38	15	14.99	14.56	20.87	16.08a
SL_4	18.31	17.79	16.21	15.68	15.99	14.88	14.6	20.26	16.21a
SL_5	18.55	18.0	17.73	16.01	15.42	14.49	14.4	22.37	16.37a
SL_6	18.26	17.57	17.06	16.36	15.85	14	13.5	26.07	16.09c
Mean	18.17a	17.55b	16.60c	15.49d	14.83e	14.05f	13.53f		

Values with different letters are significantly ($p < 0.05$) different from each other.

Table 3. Effect of different levels of sucrose and honey on ascorbic acid (mg/100 g) of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	33.1	31.33	30.43	29.41	27.87	25.78	23.19	29.94	28.73c
SL_1	35.08	33.77	31.67	29.98	27.65	26.13	24.43	30.36	29.82b
SL_2	34.56	33.12	31.13	29.89	28.75	26.1	25.34	26.68	29.84a
SL_3	33.21	31.12	30.08	29.91	28.61	26.24	25.91	21.98	29.30a
SL_4	35.22	34.33	32.55	31.87	30.76	28.98	27.41	22.17	31.59a
SL_5	35.23	34.4	32.82	30.77	28.83	27.67	26.91	23.62	30.95a
SL_6	34.44	32.13	30.12	28.76	27.88	26.87	25.55	25.81	29.39c
Mean	34.41a	32.89b	31.26c	30.08d	28.62e	26.82f	25.53g		

Values with different letters are significantly ($p < 0.05$) different from each other.

in the ascorbic acid of guava leather samples during 3 months of storage. Ascorbic acid decreased in the range of 99.36 to 73.09 mg/100 g at ambient temperature. It was to be noted that ascorbic acid of the samples was at lower level when stored at ambient temperature. Ascorbic acid content may be decreased due to oxidation of ascorbic acid at high storage temperature or due to light.

pH. Statistical analysis showed that the pH of strawberry leather samples was significantly ($p<0.05$) effected during storage (Table 4). Mean data showed that higher pH was observed in SL_4 (3.57) and SL_6 contained the lower pH content (3.40). During storage the maximum pH (3.58) was observed at day one, whereas minimum pH (3.43) was recorded after 90 days of storage. However, data presented here showed that sample SL_1 has lost more pH (4.40) than rest of the strawberry leather samples. Similar result was found by Offia-Olua *et al*. (2015). They reported that pH of the guava leathers was decreased when packed in different packing materials during storage period. Shakoor *et al*. (2015) also revealed decrease in pH value of guava leather with storage. Variation in pH is directly related to change in acidity of samples. Comparable increase in acidity and decrease in pH were also reported by Jain and Nema (2007).

Total acidity (%). Total acidity of strawberry leather was affected significantly ($p<0.05$) during storage (Table 5). This is revealed from the mean values of data that higher total acidity was observed in SL_4 (1.230%) and SL_6 contained the lower total acidity (1.171%). During storage the maximum total acidity (1.267%) was observed at day one, whereas minimum total acidity (1.137%) was recorded after 90 days of storage. However, data presented here showed that sample SL_0 revealed maximum increase in total acidity (11.72%) than rest of the strawberry leather samples. Similar results were found by Chavan and Shaik (2015) who reported increase in the acidity of the guava leather samples as a whole. At ambient temperature it increased from 0.476 to 0.518% while in refrigerated temperature it increased from 0.476 to 0.506% during three months of storage

Table 4. Effect of different levels of sucrose and honey on pH of strawberry leather

Treatment	Storage interval							% Decrease	Mean
	0	15	30	45	60	75	90		
SL_0	3.54	3.52	3.49	3.47	3.45	3.43	3.41	3.67	3.47e
SL_1	3.64	3.61	3.59	3.56	3.53	3.51	3.48	4.40	3.56b
SL_2	3.56	3.54	3.51	3.49	3.47	3.44	3.41	4.21	3.49d
SL_3	3.57	3.55	3.52	3.51	3.48	3.46	3.43	3.92	3.50c
SL_4	3.65	3.64	3.59	3.56	3.54	3.52	3.5	4.11	3.57a
SL_5	3.55	3.51	3.49	3.48	3.46	3.44	3.41	3.94	3.48e
SL_6	3.48	3.45	3.42	3.39	3.38	3.36	3.34	4.02	3.40f
Mean	3.58a	3.55b	3.52c	3.50d	3.48e	3.46f	3.43g		

Values with different letters are significantly ($p < 0.05$) different from each other.

Table 5. Effect of different levels of sucrose and honey on total acidity (%) of strawberry leather

Treatment	storage interval							% Increase	Mean
	0	15	30	45	60	75	90		
SL_0	1.13	1.15	1.18	1.2	1.23	1.26	1.28	11.72	1.204cd
SL_1	1.15	1.17	1.19	1.21	1.23	1.25	1.27	9.45	1.210bc
SL_2	1.14	1.17	1.2	1.22	1.24	1.25	1.28	10.94	1.214b
SL_3	1.14	1.16	1.18	1.2	1.22	1.24	1.26	9.52	1.200d
SL_4	1.15	1.18	1.21	1.24	1.26	1.28	1.29	10.85	1.230a
SL_5	1.13	1.15	1.17	1.19	1.21	1.23	1.25	9.60	1.190e
SL_6	1.12	1.12	1.14	1.17	1.19	1.22	1.24	9.68	1.171f
Mean	1.137g	1.157f	1.181e	1.204d	1.226c	1.247b	1.267a		

Values with different letters are significantly ($p < 0.05$) different from each other.

period. The increase in acidity might be due to development of acidic substances by the degradation of pectic bodies or breakdown and also attributed to hydrolysis of polysaccharides (Shakoor *et al*., 2015).

Total soluble solid (TSS). Total soluble solid content of strawberry leather was affected significantly ($p<0.05$) during storage (Table 6). This is revealed from the mean data that higher TSS content was observed in SL_4 (82.80) and SL_0 contained the lower TSS content (79.54). During storage the minimum TSS content (80.96) was observed at day one, whereas maximum TSS content (83.04) was recorded after 90 days of storage. However, data presented here showed that increased higher percent was observed in treatment SL_0 (2.97%) than rest of the strawberry leather samples. Similar result was reported by Chavan and Shaik (2015) that increase in TSS of the guava leather might be due to decrease in the moisture content. It may also increase in the TSS content. Shakoor *et al*. (2015) observed increase in total soluble content of guava leather due to the conversion of non-soluble polysaccharides to soluble di and mono-saccharides.

Reducing sugar. The reducing sugar content of strawberry leather was affected significantly ($p<0.05$) during storage (Table 7). The statistical results showed that higher reducing sugar content was observed in SL_4 (26.47%) and SL_0 contained lower reducing content (9.54%). During storage the maximum reducing sugar content (19.45%) was observed at 90 days of storage, whereas minimum reducing sugar content (19.09%) was recorded at day first. However, data presented here showed that sample SL_0 has lost more reducing content (5.77%) than the rest of the strawberry leather samples. Chavan and Shaik (2015) reported that reducing sugar content of the guava leather increased with the progress of the storage period. During storage period the guava leather samples increase the reducing sugar, it might be due to the inversion of added sugar. At ambient temperature range of the reducing sugar content, means value increased from 13.88 to 16.35% while at refrigerated temperature it ranges from 13.88 to 16.02% during three months of storage. Increase in reducing sugar of ambient temperature was more than the refrigerated temperature.

Table 6. Effect of different levels of sucrose and honey on total soluble solid of strawberry leather

Treatment	storage interval							% Increase	Mean
	0	15	30	45	60	75	90		
SL_0	78.3	78.8	79.3	79.6	79.9	80.2	80.7	2.97	79.54e
SL_1	81.4	81.9	82.3	82.5	82.8	83.1	83.5	2.51	82.50b
SL_2	81.5	81.8	82.1	82.4	82.7	83	83.5	2.40	82.43b
SL_3	81.8	82.2	82.5	82.8	83.1	83.4	83.7	2.27	82.79a
SL_4	81.8	82.2	82.5	82.8	83.1	83.4	83.8	2.39	82.80a
SL_5	80.5	80.7	81	81.3	81.6	81.9	82.3	2.19	81.33c
SL_6	80.1	80.4	80.7	81.1	81.4	81.7	82.2	2.55	81.09d
Mean	80.96g	81.38f	81.74e	82.02d	82.32c	82.62b	83.04a		

Values with different letters are significantly ($p < 0.05$) different from each other.

Table 7. Effect of different levels of sucrose and honey on reducing sugar of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	9.31	9.34	9.4	9.51	9.63	9.72	9.88	5.77	9.54g
SL_1	15.57	15.59	15.62	15.66	15.69	15.75	15.85	1.77	15.68f
SL_2	17.76	17.79	17.82	17.88	17.96	18.03	18.09	1.82	17.90e
SL_3	19.36	19.39	19.45	19.51	19.55	19.59	19.64	1.43	19.50d
SL_4	26.26	26.36	26.41	26.47	26.52	26.59	26.67	1.54	26.47a
SL_5	23.38	23.42	23.49	23.56	23.61	23.67	23.73	1.47	23.55b
SL_6	21.99	22.05	22.12	22.16	22.19	22.24	22.29	1.35	22.15c
Mean	19.09f	19.13f	19.19e	19.25d	19.31c	19.37b	19.45a		

Values with different letters are significantly ($p < 0.05$) different from each other.

Non reducing sugar. The non-reducing sugar content of strawberry leather was affected significantly ($p<0.05$) during storage (Table 8). Mean data revealed that higher non reducing sugar content was observed in SL_4 (6.20%) and SL_6 contained the lower non reducing sugar content (4.21%). During storage the maximum non reducing sugar content (5.09%) was observed at day one, whereas minimum non reducing content (4.85%) was recorded after 90 days of storage. However, data presented here showed that sample SL_6 has lost more non reducing sugar content (5.10%) than rest of the strawberry leather samples. Comparatively greater decrease was noted in SL_0 due to the use of pure sucrose alone. The changes occur on the sample containing sugars in the form of honey (reducing sugar) and sucrose (non-reducing sugar). The reason for reduction of the non-reducing sugar was due to the inversion of sucrose in the presence of acid and temperature. Similarly, Hussain *et al*. (2004) also concluded that the degradation in non-reducing sugar range from (8.82 to 7.3). The same results 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) and Phimpharian *et al*. (2011), guava leather by Duangmal and Khachonsakmetee (2009) and sapota papaya bar by Sreemathi *et al*. (2008).

Sensory evaluation. ***Colour.*** The colour of strawberry leather was affected significantly ($p<0.05$) during storage (Table 9). Mean values of data showed that higher colour score was observed in SL_4 (7.13) and SL_0 assumed the lower colour score (5.07). During storage the maximum colour (8.17) was observed at day one, whereas minimum colour (5.10) was recorded after 90 days of storage. However, data presented here showed that sample SL_0 has lost more colour (47.06%) than rest of the strawberry leather samples. Similar result was found by Chavan and Shaik (2015) who reported that there was a gradual decrease in colour range from 8.35 to 7.45 at ambient temperature, whereas in refrigerated temperature 8.35 to 7.80 was noted at 3 months of storage. The score 8.35 was noted in guava leather sample stored at refrigerated condition. Related trend for colour and appearance of guava leathers was noted at ambient condition but values were at lower level then the refri-gerated storage. The deterioration of the colour was more in guava leather at ambient condition when it was stored. The deterioration of colour may be due to the degradation of pigments that might have occurred ambient temperature. A decrease in colour score with storage interval might be due to Millard reaction that occur during drying at high temperature (Shakoor *et al*., 2015).

Texture. The texture of strawberry leather was affected significantly ($p<0.05$) during storage (Table 10). The mean data showed that higher texture score was observed in SL_4 (7.54) and SL_0 contained the lower texture score (5.2). Statistical results revealed that mean value of the texture score decreased from (8.31 to 5.69) during 90 days of storage. However, data presented here showed that higher percent decrease in texture was found in sample SL_0 (51.39%) than the rest of the strawberry leather samples. Similar result was found by Chavan and Shaik (2015) who reported that there was a gradual decrease in the texture of guava leather. At ambient temperature the decrease in texture score ranged from 8.27 to 7.56 while in refrigerated temperature it decreased in the range of 8.27 to 7.80. Score of the texture decreased significantly at ambient temperature during storage period than stored at refrigerated temperature. During

Table 8. Effect of different levels of sucrose and honey on non-reducing sugar of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	4.75	4.72	4.69	4.66	4.63	4.6	4.57	3.79	4.66e
SL_1	5.36	5.31	5.25	5.21	5.17	5.14	5.1	4.85	5.22c
SL_2	5.51	5.46	5.41	5.37	5.32	5.27	5.24	4.90	5.37b
SL_3	4.88	4.85	4.81	4.76	4.72	4.68	4.65	4.71	4.76d
SL_4	6.36	6.29	6.24	6.19	6.15	6.11	6.04	5.03	6.20a
SL_5	4.44	4.39	4.37	4.35	4.32	4.28	4.23	4.73	4.34f
SL_6	4.31	4.28	4.24	4.21	4.17	4.14	4.09	5.10	4.21g
Mean	5.09a	5.04b	5.00c	4.96d	4.93e	4.89f	4.85g		

Values with different letters are significantly ($p < 0.05$) different from each other.

storage period a gradual decrease in the texture score is due to the hardening effect resulting from the loss of moisture content (Shakoor *et al*., 2015).

Taste. The taste of strawberry leather was affected significantly ($p<0.05$) during storage (Table 11). The mean data showed that higher taste score was observed in SL_4 (7.79) and SL_0 assumed the lower taste score (5.71). The mean value of the taste score decreased from (8.37 to 6.04) after 90 days of storage. However, data presented here showed that sample SL_0 has lower score (48.68%) than rest of the strawberry leather samples. Similar result was found by Chavan and Shaik (2015), who reported that there was a gradual decrease in the taste score of guava leather from 8.30 to 7.49 at ambient temperature and from 8.30 to 7.98 at refrigerated temperature was noted. In guava leather the taste deterioration was more at ambient condition than that of refrigerated temperature. This might be due to the consistency of guava leather or proper blending of sugar and acidity. For guava leather both storage condition gave acceptable taste score. It is reported that the taste score decreased during storage with respect to storage condition and storage period in sweet potato leather (Collins and Hutsell, 1987) and in guava leather (Shakoor *et al*., 2015).

Overall acceptability. The overall acceptability of strawberry leather was affected significantly ($p<0.05$) during storage (Table 12). This is revealed from the mean data that higher overall acceptability score was observed in SL_4 (7.5) and SL_0 contained the lower overall acceptability (5.4). Mean data in the table showed that the maximum overall acceptability (8.37) was observed at day one, whereas minimum overall acceptability (5.61) was recorded after 90 days of storage. However, data presented here showed that sample SL_0 has more overall acceptability loss (48.61%) than rest of the strawberry leather samples. Generally all sensory characteristics are related to overall acceptability and similar result was found by Chavan and Shaik (2015). They reported that there was a gradual decrease in the overall acceptability score from 8.38 to 7.53 at ambient temperature and from 8.38 to 7.78 at refrigerated temperature. It was noted

Table 9. Effect of different levels of sucrose and honey on colour of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	6.8	6	5.4	5	4.6	4.1	3.6	47.06	5.07f
SL_1	8.4	7.4	6.9	6.5	6	5.6	4.9	41.67	6.53de
SL_2	8.4	7.3	6.9	6.4	6	5.5	5.1	39.29	6.51e
SL_3	8.4	7.7	7.2	6.8	6.3	6	5.7	32.14	6.87b
SL_4	8.4	7.8	7.4	7	6.7	6.5	6.1	27.38	7.13a
SL_5	8.4	7.5	7.1	6.7	6.2	5.7	5.2	38.1	6.69cd
SL_6	8.4	7.6	7.2	6.7	6.2	5.7	5.1	39.29	6.7c
Mean	8.17a	7.33b	6.87c	6.44d	6.00e	5.59f	5.10g		

Values with different letters are significantly ($p < 0.05$) different from each other.

Table 10. Effect of different levels of sucrose and honey on texture of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	7.2	6.4	5.7	5.1	4.6	3.9	3.5	51.39	5.2f
SL_1	8.5	7.6	7.2	6.8	6.3	5.9	5.7	32.94	6.86de
SL_2	8.5	7.3	6.9	6.6	6.1	5.7	5.4	36.47	6.64e
SL_3	8.5	8	7.7	7.3	7	6.7	6.4	24.71	7.37ab
SL_4	8.5	8.1	7.8	7.6	7.2	6.9	6.7	21.18	7.54a
SL_5	8.5	7.8	7.3	6.9	6.6	6.3	6.1	28.24	7.07cd
SL_6	8.5	7.9	7.4	7	6.7	6.4	6	29.41	7.13bc
Mean	8.31a	7.59b	7.14c	6.76d	6.36e	5.97f	5.69g		

Values with different letters are significantly ($p < 0.05$) different from each other.

that decrease in the ambient temperature was faster than at refrigerated temperature in overall acceptability. Refrigerated temperature depicted highest overall acceptability score than the ambient temperature. It may be due to quicker deterioration in relation with taste, texture flavour and colour at higher temperature during ambient condition. It is reported that decrease in the score of the overall acceptability during storage is retaled to the storage condition and period. It is reported that fruits and vegetable acceptability is subjected to their odour (Karmas and Harris, 1998). Similar results were found by Iman *et al*. (2011) during physiochemical analysis and quality evaluation of intermediate moisture in apple slices.

Table 11. Effect of different levels of sucrose and honey on taste of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	7.6	6.9	6.4	5.7	5	4.5	3.9	48.68	5.71d
SL_1	8.5	7.9	7.5	7.2	6.9	6.7	6.3	25.88	7.29b
SL_2	8.5	8.1	7.8	7.5	7.1	6.5	6.1	28.24	7.37b
SL_3	8.5	8	7.6	7.3	7	6.8	6.6	22.35	7.4b
SL_4	8.5	8.3	8	7.8	7.6	7.3	7	17.65	7.79a
SL_5	8.5	8.1	7.7	7.4	7.1	6.8	6.5	23.53	7.44b
SL_6	8.5	7.7	7.3	6.9	6.5	6.1	5.9	30.59	6.99c
Mean	8.37a	7.86b	7.47c	7.11d	6.74e	6.39f	6.04g		

Values with different letters are significantly ($p < 0.05$) different from each other.

Table 12. Effect different levels of sucrose and honey on overall acceptability of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	7.2	6.4	5.8	5.3	4.7	4.7	3.7	48.61	5.4e
SL_1	8.6	7.6	7	6.7	6.2	5.8	5.4	37.21	6.76d
SL_2	8.6	7.6	7.3	6.9	6.5	6	5.6	34.88	6.93cd
SL_3	8.6	7.9	7.5	7.1	6.8	6.5	6.2	27.91	7.23b
SL_4	8.5	8.1	7.7	7.5	7.2	6.9	6.6	22.35	7.5a
SL_5	8.5	7.5	7.4	7	6.7	6.3	5.9	30.59	7.04bc
SL_6	8.6	7.7	7.	6.9	6.6	6.2	5.9	31.4	7.03bc
Mean	8.37a	7.54b	7.14c	6.77d	6.39e	6.06f	5.61g		

Values with different letters are significantly ($p < 0.05$) different from each.

Table 13. Effect of different levels of sucrose and honey on sugar acid ratio of strawberry leather

Treatment	storage interval							% decrease	Mean
	0	15	30	45	60	75	90		
SL_0	69.29	68.52	67.20	66.33	64.96	63.65	63.05	9.01	66.14e
SL_1	70.78	69.41	68.02	66.53	65.71	64.92	64.73	8.55	67.16d
SL_2	71.49	69.91	68.42	67.54	66.69	66.40	65.23	8.75	67.96c
SL_3	70.26	69.31	68.39	67.58	66.72	65.89	65.24	7.15	67.63c
SL_4	71.13	70.26	69.33	68.43	67.56	66.72	65.91	7.34	68.48b
SL_5	71.24	70.17	69.23	68.32	67.44	66.59	65.84	7.58	68.40b
SL_6	73.04	73.39	72.37	70.77	69.83	68.36	67.58	7.47	70.76a
Mean	71.03a	70.14b	68.99c	67.93d	66.99e	66.08f	65.37g		

Values with different letters are significantly ($p < 0.05$) different from each other.

Sugar acid ratio. The sugar acid ratio of strawberry leather was affected significantly ($p<0.05$) during storage (Table 13). This is revealed from the mean data that higher sugar acid ratio was observed in SL_4 (70.76) and SL_0 contained the lower sugar acid ratio (66.14%). Maximum sugar acid ratio (71.03) was observed at the initial day, whereas minimum sugar acid ratio (65.37) was recorded after 90 days of storage. However, data presented here showed that sample SL_0 has lost more sugar acid ratio (9.01%) than rest of the strawberry leather samples. These results are found in agreement with the results of Chyau *et al*. (1992).They found that during the ripening of guava fruit, the contents of total pectin, total sugar, reducing sugar and acidity dropped obviously from the mature to the ripe stage but the sugar acid ratio increased inversely.

Conclusion

Drying of strawberry fruit into intermediate moisture food i.e., leather will help to reduce the post-harvest loss due to the high perishability of strawberry fruit as it contain higher moisture content. The physiochemical and organoleptic evaluation showed that treatment SL_4 (sucrose 100: 200 honey) was found adequate among all other treatments. Results also revealed that as the concentration of honey increases from 0 to 300 g/kg, the structure characteristic of the strawberry leather become more sticky and shows low textural property. The results also indicated the stability of strawberry leather up to 90 days under ambient temperature.

It is recommended to study the effect of different packaging materials on the overall quality of strawberry leather. Further, the effect of different gums on keeping quality of strawberry leather, needs to be studied.

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