

Original Research Article

Studies on guava based protein enriched fruit leather rollups

ABSTRACT

Aims: To standardize the protocol for protein enriched guava leather rollups preparation and to study the biochemical and organoleptic quality of guava-based protein enriched fruit leather rollups

Study design: Completely Randomized Factorial Design

Place and Duration of Study: It was conducted at Post Harvest Technology, College of Horticulture, Dr Y.S.R Horticultural University in the year 2022.

Methodology: Lalit pulp, palmyra jaggery, sugar, whey protein, soya protein, cashew and almond were used for experimental studies. The fruits are thoroughly washed and the pulp was extracted by homogenizing the slices in the mixer grinder and later the pulp was sieved. The pulp is blended with sugar or palmyra jaggery and honey. After that protein was added (Whey or Soya or Cashew or Almond) based on the treatment in the concentration of 5%, spreading of pulp on the tray and allowed to dry at 65° C for 12 hours. Dried fruit bars were cut into rectangular pieces and are rolled.

Results: The fruit leather roll-ups prepared from Lalit and Palmyra jaggery using tray drying method fortified with whey protein (B₁C₁) recorded the highest vitamin-C content (69.68 mg/100g), protein content (2345 mg /100g) and and flavour (8.60). Whereas, the highest TSS (70.26 °B), taste (8.80) and overall acceptability (8.90) recorded for the fruit leather roll-ups prepared from Lalit and sugar by tray drying fortified with whey protein (B₂C₁).

Conclusion: Results revealed that the vitamin-C content (mg 100 g⁻¹), protein content (mg 100 g⁻¹), TSS (°B), taste, flavor and overall acceptability followed a decreasing trend from the day of storage to 90 days after storage. The highest vitamin-C content, protein content, and flavour was observed in rollups prepared from Lalit and palmyra jaggery by tray drying treated with whey protein (B₁C₁). Whereas, the highest TSS, taste and overall acceptability was observed in the rollups prepared from Lalit and sugar by tray drying treated with whey protein (B₂C₁).

1. INTRODUCTION

The guava (*Psidium guajava*) is a member of the Myrtaceae family and it is a typical fruit grown in different parts of tropical and subtropical regions of the world. Guava is rich in nutrients, antioxidants, Vitamin C and A, lycopene, calcium, manganese and potassium. It is low in calories and high in fibre. The variety Lalit with firm pink flesh is most suitable for both table and processing purposes.

Food fortification has become popular and refers to the addition of vital nutrients that are either missing or depleted during processing. Soya flour is an excellent source of high quality protein and provides all the essential amino acids. The mild flavour of whey protein ingredients make them compatible with a variety of flavours and ensures high consumer acceptability.

Cashew gives approximately 553 calories along with 18.22 g protein, 3.30g fibre and 43.85g fat per 100g of cashews. Cashew have health benefits like reduce risk of anemia, boosts bone and oral health, diabetic friendly, works as cancer chemopreventive agent and prevent gallstones.

The nutritional value of almonds includes 21.15g protein, 12.50g fibre and 49.24 fat in 100g of almonds. They are used to lower cholesterol, helps in keeping a healthy weight, lowers blood pressure, better blood sugar control and for better gut health.

Nutritional composition of palmyra jaggery is 0.35% protein, 0.75% minerals, 90.60% carbohydrates, 2.5 mg g⁻¹ iron, 24 mg 100 g⁻¹ vitamin B1 and (11mg 100 g⁻¹)² vitamin C content stated by Vengaiah *et al.* (2013).

2. MATERIAL AND METHODS

Lalit pulp, palmyra jaggery, sugar, whey protein, soya protein, cashew and almond were used for experimental studies. The fruits are thoroughly washed and the pulp was extracted by homogenizing the slices in the mixer grinder and later the pulp was sieved. The pulp is blended with sugar or palmyra jaggery and honey. After that protein was added (Whey or Soya or Cashew or Almond) based on the treatment in the concentration of 5%. Then the pulp was heated at 85 °C for 20 minutes and to avoid charring the pulp was stirred continuously on a low flame, spreading of pulp on the tray and allowed to dry at 65° C for 12 hours. Dried fruit bars were cut into rectangular pieces and are rolled. They are packed in polypropylene covers and were subjected to storage studies at ambient conditions for a period of 3 months at 30 days interval (Bisen and Verma, 2020).

3. RESULTS AND DISCUSSION

3.1 Biochemical changes during storage of protein enriched guava leather rollups

3.1.1 Vitamin- C content (mg /100g)

The data related to the vitamin-C content (mg /100g) of protein enriched guava leather rollups at 0, 30, 60, 90 days of storage under ambient conditions are presented in table 1.

Data revealed that mean vitamin-C content among the different treatment combinations decreased gradually from 74.12 mg/100g (on initial day of storage) to 67.50 mg/100g (at 90 days after storage). Significant differences were found between interactions at 0, 30, 60 and 90 days after storage. At 30 days after storage, the maximum vitamin-C content (74.44 mg/100g) was obtained in the leather rollups prepared from Lalit and palmyra jaggery by tray drying fortified with whey protein (B₁C₁). And, the minimum vitamin-C content (70.99 mg/100g) was resulted in the leather rollups prepared from Lalit and sugar by tray drying treated with almond (B₂C₄). The highest vitamin-C content was observed in the leather rollups made from Lalit and palmyra jaggery using tray drying fortified with whey protein (B₁C₁) at 60 days (72.91 mg/100g) and 90 days (69.68 mg/100g). And, the lowest vitamin-C content was noticed in the leather rollups made from Lalit and sugar using tray drying treated with almond (B₂C₄) at 60 days (69.12 mg/100g) and 90 days (65.92 mg/100g) after storage.

A perusal of data revealed that the vitamin-C content decreased with increase in storage period. The decrease in vitamin-C content may be due to oxidation of ascorbic acid to dehydro ascorbic acid followed by further degradation to 2, 3-diketogluconic acid and finally to furfural compounds which enter browning reaction as reported by Kuchi *et al.* (2014) in guava jelly fruit bar, Majid *et al.* (2014) in guava fruit bar and Basha *et al.* (2018) in guava fruit bar.

3.1.2 Protein content (mg /100g)

The data pertaining to the protein content (mg /100g) of protein enriched guava leather rollups at 0, 30, 60, 90 days of storage under ambient conditions are represented in the table 2.

Results noticed that the mean protein content among the different treatment combinations decreased gradually from 1539 mg/100g (on initial day of storage) to 1176 mg/100g (at 90 days after storage). Significant difference among different treatment combinations in the protein content was observed.

Throughout the storage, the highest protein content was observed in the rollups prepared from (B₁C₁) Lalit and palmyra jaggery by tray drying fortified with whey protein (2849, 2467, 2463 and 2345 mg/100g respectively during 0, 30, 60 and 90 days). Whereas, the minimum protein content was resulted in the rollups prepared from (B₂C₃) Lalit and sugar by tray drying treated with cashew (385, 330 and 305 mg/100g respectively at 30, 60 and 90 days after storage).

A remarkable decrease in protein content of protein enriched fruit leather roll-ups during storage has been attributed to its possible participation in Maillard browning reactions. Similar results of decrease in protein percent was also observed in sea buckthorn leather by Kaushal *et al.* (2013) and Kumar and Madhumathi (2017a) in papaya guava fruit bar fortified with skim milk powder and defatted soya flour and Awati *et al.* (2022) in protein fortified sapota based mixed fruit bar.

3.1.4 TSS (o Brix)

The data related to TSS of protein enriched fruit leather rollups at 0, 30, 60, 90 days of storage under ambient conditions are presented in table 4.

The mean TSS content among the different treatment combinations decreased gradually from 67.99^oB on initial day of storage to 67.06 ^oB at 90 days after storage. Significant differences in the TSS between interactions was observed during all the days of storage. From day one to 30th day of storage, the maximum TSS content (70.26 ^oB and 69.70 ^oB respectively) was observed in the rollups prepared from Lalit and sugar by tray drying fortified with whey protein (B₂C₁) and the minimum TSS content (65.87^oB and 65.55^oB respectively) was noticed in the rollups prepared from Lalit and palmyra jaggery by tray drying fortified with almond (B₁C₄).

The highest TSS content was obtained in the rollups made from Lalit and sugar by tray drying treated with whey protein (B₂C₁) at 60 days (69.21^oB) and 90 days (69.06 ^oB) after storage and the lowest TSS content was observed in the rollups made from Lalit and palmyra jaggery by tray drying treated with almond (B₁C₄) at 60 days (65.20 ^oB) and 90 days (65.13 ^oB) after storage. There was a gradual decrease in TSS with the storage period. The decrease in TSS might be due to the increase in moisture content during the storage period. Similar observations were recorded by Attri *et al.* (2014) in papaya toffee and leather, Kuchi *et al.* (2014) in guava jelly fruit bar. Kumar and Madhumathi (2017a) in papaya guava fruit bar fortified with skim milk powder and defatted soya flour.

3.2 Changes in sensory quality of protein enriched guava leather rollups during storage

3.2.1 Taste

The data pertaining taste of protein enriched fruit leather roll-ups as influenced by different protein sources are presented in the table 5.

The mean taste value of protein enriched roll-ups steadily decreased from 8.46 on day one of storage to 7.94 at 90 days after storage. On day one and 30th day of storage, the minimum taste score (7.66 and 7.53 respectively) was observed in the leather rollups prepared from Lalit and palmyra jaggery by tray drying fortified with almond (B₁C₄) and the maximum taste score (9.23 and 9.06 respectively) was noticed in the leather rollups prepared from Lalit and sugar by tray drying fortified with whey protein (B₂C₁).

Significant differences are found between interactions at 60 and 90 days after storage. At 60 and 90 days after storage, the lowest taste score was obtained in the rollups made from Lalit and palmyra

jaggery by tray drying treated with almond (B₁C₄) at 60 days (7.33) and 90 days (7.10) and the highest taste score was observed in the rollups made from Lalit and sugar by tray drying treated with whey protein (B₂C₁) at 60 days (8.96) and 90 days (8.80). The decrease in taste score during storage might be due to fluctuations in acids, pH and sugar/acid ratio. Organic acid and sugars ratio primarily creates a sense of taste which is perceived by specialized taste buds on the tongue. The findings are in consonance with Attri *et al.* (2014) in papaya toffee and leather.

3.2.2 Flavour

From the table 6, it is revealed that different protein sources have a significant effect on the flavour of the protein enriched guava based fruit leather roll-ups. The mean value of flavour decreased gradually from 8.54 (initial day) to 7.93 (90 days after storage). On day one, 30th, 60th and 90th of storage, the lowest flavour score (7.76, 7.50, 7.33 and 7.23 respectively) was obtained in the rollups prepared from Lalit and sugar by tray drying treated with almond (B₂C₄) and the highest flavour score (9.23, 9.10, 8.83 and 8.60 respectively) was observed in the rollups prepared from Lalit and palmyra jaggery by tray drying treated with whey protein (B₁C₁).

Aroma results from volatile substances such as esters, ketones, terpenes, aldehydes and others. The loss of these volatiles leads to a decrease in aroma detection. A decreasing pattern of flavor rating value was observed during storage of the protein enriched guava based fruit leather roll-ups. The reason for this is the production of off-flavour adversely which affects the taste and aroma of product and there are certain enzymatic, physiological or biochemical changes, which resulted in the production of off-flavour of the product.

3.2.3 Overall acceptability

The results of overall acceptability of protein enriched fruit leather roll-ups are presented in the table 7. Regarding storage, there was a significant difference in the mean value of overall acceptability as influenced by storage. A perusal of data showed that mean overall acceptability decreased from 8.73 on initial day of storage to 8.14 at 90 days after storage.

Significant differences are found between interactions at 0, 30, 60 and 90 days after storage. At 30, 60 and 90 days after storage, the highest overall acceptability scores (9.23, 9.10 and 8.90 respectively) were observed in the rollups prepared from Lalit and sugar by tray drying treated with whey protein (B₂C₁). During the storage, the lowest overall acceptability scores (8.06, 7.83, 7.60 and 7.40 respectively on day one, 30th, 60th and 90th days) were obtained in the rollups prepared from Lalit and palmyra jaggery by tray drying fortified with almond (B₁C₄). Overall acceptability score has decreased during storage due to changes in loss of taste, flavour and chemical composition of the product. Similar observations were recorded by Vijayanand *et al.* (2000) in guava fruit bar, Narayana *et al.* (2003) in banana fig fruit bar and Attri *et al.* (2014) in papaya toffee and leather.

Table 1 Effect of vitamin-C content (mg 100 g⁻¹) in protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	76.06	74.96	74.48	74.36	74.97	74.44	73.34	72.88	72.23	73.22
B2	73.87	73.82	72.73	72.60	73.26	72.11	71.79	71.20	70.99	71.52
Mean C	74.97	74.39	73.61	73.48	74.12	73.27	72.57	72.04	71.61	72.37
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B

B1	72.91	71.86	71.39	70.74	71.73	69.68	68.71	68.14	67.47	68.50
B2	70.35	70.00	69.64	69.12	69.78	67.08	66.75	66.30	65.92	66.51
Mean C	71.63	70.93	70.51	69.93	70.76	68.38	67.73	67.22	66.69	67.50

Vitamin-C content of different treatment combinations

Table 2 Effect of protein content (mg 100 g-1) on protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	2849	2197	1937	2069	2263	2647	1999	1741	1874	2065
B2	1475	726	464	595	815	1277	635	385	516	703
Mean C	2162	1461	1201	1332	1539	1962	1317	1063	1195	1384
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	2463	1829	1576	1709	1894	2345	1714	1470	1600	1782
B2	1128	578	330	457	623	1058	508	305	412	571
Mean C	1795	1203	953	1083	1258	1702	1111	887	1006	1176

Protein content of different treatment combinations

Table 3 Effect of TSS (o Brix) on protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	67.65	67.21	66.34	65.87	66.77	67.18	66.77	65.90	65.55	66.35
B2	70.26	69.80	68.58	68.22	69.21	69.70	69.22	68.37	67.69	68.75
Mean C	68.95	68.51	67.46	67.04	67.99	68.44	67.99	67.14	66.62	67.55
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	66.76	66.37	65.52	65.20	65.96	66.66	66.26	65.44	65.13	65.87
B2	69.21	68.87	67.96	67.49	68.38	69.06	68.73	67.87	67.36	68.26

Mean C 67.99 67.62 66.74 66.34 67.17 67.86 67.50 66.66 66.25 67.06

TSS of different treatment combinations

Table 4 Effect of different protein sources on taste of protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	9.03	8.56	7.87	7.66	8.28	8.80	8.47	7.70	7.53	8.12
B2	9.23	8.77	8.36	8.17	8.63	9.06	8.60	8.20	8.03	8.48
Mean C	9.13	8.67	8.12	7.92	8.46	8.93	8.53	7.95	7.78	8.30
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	8.70	8.27	7.50	7.33	7.95	8.60	8.03	7.30	7.10	7.76
B2	8.96	8.43	8.03	7.83	8.32	8.80	8.27	7.80	7.63	8.12
Mean C	8.83	8.35	7.76	7.58	8.14	8.70	8.15	7.55	7.36	7.94

Taste of different treatment combinations

Table 5 Effect of flavour on protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	9.23	8.86	8.47	8.30	8.72	9.10	8.70	8.27	8.06	8.53
B2	9.06	8.67	7.93	7.76	8.36	8.87	8.50	7.73	7.50	8.15
Mean C	9.15	8.76	8.20	8.03	8.54	8.98	8.60	8.00	7.78	8.34
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	8.83	8.43	8.07	7.86	8.30	8.60	8.23	7.86	7.67	8.09
B2	8.63	8.26	7.53	7.33	7.94	8.43	8.07	7.40	7.23	7.78
Mean C	8.73	8.35	7.80	7.60	8.12	8.52	8.15	7.63	7.45	7.94

Flavour of different treatment combinations

Table 6 Effect of overall acceptability on protein enriched guava leather rollups

Treatment	0th day of storage					30th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	9.20	8.80	8.27	8.06	8.58	9.03	8.63	8.03	7.83	8.38
B2	9.40	9.00	8.66	8.47	8.88	9.23	8.83	8.40	8.23	8.68
Mean C	9.30	8.90	8.46	8.26	8.73	9.13	8.73	8.22	8.03	8.53
Treatment	60th day of storage					90th day of storage				
	C1	C2	C3	C4	Mean B	C1	C2	C3	C4	Mean B
B1	8.83	8.43	7.80	7.60	8.17	8.60	8.30	7.60	7.40	7.98
B2	9.10	8.60	8.20	8.00	8.48	8.90	8.43	8.03	7.83	8.30
Mean C	8.96	8.52	8.00	7.80	8.32	8.75	8.37	7.82	7.62	8.14

Overall acceptability of different treatment combinations

4. CONCLUSION

Results revealed that the vitamin-C content (mg 100 g⁻¹), protein content (mg 100 g⁻¹), TSS (°B), taste, flavor and overall acceptability followed a decreasing trend from the day of storage to 90 days after storage. The highest vitamin-C content, protein content and flavour was observed in rollups prepared from Lalit and palmyra jaggery by tray drying treated with whey protein (B₁C₁). Whereas, the highest TSS, taste and overall acceptability was observed in the rollups prepared from Lalit and sugar by tray drying treated with whey protein (B₂C₁).

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