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Development and quality evaluation of Harad-Ber blended leather

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Abstract
The present investigation was carried out to develop blended fruit leather using Harad and Ber in six different combination T_1 (100:0::HP:BP), T_2 (70:30::HP:BP), T_3 (60:40::HP:BP), T_4 (50:50::HP:BP), T_5 (40:60::HP:BP), and T_6 (30:70::HP:BP) and evaluated for proximate composition during storage at room temperature. Physicochemical attributes (moisture, crude protein, crude fibre, fat, and ash) were analysed during six months of storage at an interval of 0,2,4,6 months. Results indicated that treatment T_1 (100:0 HP:BP) exhibited the highest crude protein (3.48 %), crude fibre (5.15%), crude fat (1.72%), and ash content (4.07%) at initial day. Whereas, the treatment T_6 (70:30 HP:BP) recorded the lowest values. A significant decline ($p \leq 0.05$) in all nutritional parameters was observed over the analysis attributed to enzymatic activity, moisture loss, and Maillard reactions. During storage there was decreased in moisture content from 10.49% to 9.33%, crude protein 2.88% to 2.48%, crude fibre 4.45 to 4.22, crude fat 1.19 to 0.98 and ash content from 3.37 to 3.08% respectively. Overall blending and storage had a significant impact on the nutritional profile of leather.

Keywords: Terminalia chebula, Zizyphus mauritiana, fruit leather, storage, proximate composition, nutritional quality

1. Introduction

Medicinal plants have been a valuable source of both curative and preventive medical therapeutic preparations for humans, as well as for the extraction of key bioactive substances (Thirumalai *et al*., 2009) [37]. Nearly 80% of people worldwide rely on traditional medicine and goods for their medical requirements, particularly in third-world nations. *Terminalia chebula*, also known as Harad or Chebulic Myrobalan, is one of the most highly valued medicinal herbs and wide range of phytoconstituents. Harad fruits are known as drupes, and they are 2.5-4 cm long, glabrous to ellipsoidal or obovoid in shape with a broad base, and a yellowish green more or less 5-ribbed shape when dried. It is mostly produced in the northwestern Indian states of Himachal Pradesh, Jammu and Kashmir, Punjab, Haryana, Uttar Pradesh, and Uttarakhand (Sankanur *et al*., 2015) [27]. It is highly regarded as the 'King of medicines' in the Ayurvedic Medicines. It is very nutritious containing essential vitamins, minerals, and proteins. It contains potassium, iron, copper, manganese, selenian, and vitamin C. It is used to treat a wide range of symptoms, including neurological problems, hepatomegaly, diabetes, rheumatism, tumours, intermittent fever, paralysis, memory loss, and constipation (Gupta, 2012) [12].

One of India's oldest fruits is ber (*Zizyphus mauritiana* Lamk.). Ber, a member of the Rhaminaceae family, is known as the "king of arid zone fruits". In India, ber has been known as a beneficial edible fruit from ancient times (Take and Bhotmange, 2012) [36]. It is widely cultivated in different states of India, i.e. Madhya Pradesh, Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra and to limited extent in several other states (Samant *et al*., 2008) [26]. Although Indian jujube is grown primarily in India, it is found throughout the world's warm climates. It contains carbohydrates, moisture, protein, fat and fiber. This fruit also contains minor elements including magnesium, copper, iron, zinc, and sodium (Sareen *et al*., 2020) [28].

Demand for nutritious and safe food is rising around the world because eating a balanced diet is the recommended approach to avoid health issues like obesity, diabetes, and nutritional deficiencies, which are mostly caused by dietary mistakes.

The current trend of eating nutritious, inventive and healthful cuisine has resulted in a steady increase in the fruit bar market (Saleem *et al*., 2023) [25]. Thus, there is a need for diversity in commercial utilization of fruits. Fruits can be utilized in numerous ways by processing into juice, squashes, jams, concentrates, pulp, dehydrated products, jellies and fruit leather. Fruit leathers are restructured fruits created from fresh fruit pulp or a mixture of fruit juice concentrates and other components following an innovative dehydration procedure (Maskan *et al*. 2002) [15]. Different drying methods used in processing fruit leather. Therefore, the current research was designed to developed harad fruit leather in combination with ber fruit for preservation of nutrients and analysis its physico-chemical properties of harad-ber blended leather.

2. Materials and Methods

Blended leathers were prepared using the Chavan *et al*. (2016) [39] method. The Harad pulp was blended with ber pulp in different proportions T_1 (100:00::HP:BP), T_2 (70:30::HP:BP), T_3 (60:40::HP:BP), T_4 (50:50::HP:BP), T_5 (40:60::AP:BP) and T_6 (30:70::HP:BP) for the preparation of leather. Blended pulp was heated along with desired quantities of sugar and citric acid with constant stirring on a uniform flame. The pulp or puree was spread on oil-smeared stainless steel trays.The pulp/puree was dried at 50 ºC for 7-10 hrs in cabinet tray drier. After that, the semi surface dried pulp sheets were cut into desired size usually of rectangular shape and again dried for 4-5 hrs. Then desired cutting was done and dried under fan for 2-3 hrs. The blended leather was stored in laminated pouches under ambient conditions (30-35 °C) for a period of six months. The samples were analyzed for physico-chemical parameters during six months of storage at an interval of 0, 2, 4 and 6 months.

The moisture content was estimated using the AOAC method (2012) [3]. Kjeldahl method was used to determined crude protein using Sadasivam and Manickam, (2008) [24] methodology. Crude fibre was estimated by AOAC (2005) [4] Ash content was measured using a weighing balance (GM 1501), an analytical balance (Shimadzu ATX 224), and an electric muffle furnace (Thermolyne 1400 Furnace), as reported by AACC (2000) [1]. Crude fat was determined by the Soxhlet extraction technique (AOAC, 2012) [3]. Factorial completely randomized design (FCRD) was used to statistically analyze the data (Gomez & Gomez, 1984) [11].

3. Results and Discussion

Table 1: Physico-chemical composition of raw materials

Characteristics	Harad Pulp	Ber Pulp
Moisture (%)	59.62	81.27
Titratable acidity (%)	3.10	0.41
Crude protein (%)	2.62	1.21
Crude fibre (%)	4.36	2.31
Fat (%)	1.59	0.16
Ash (%)	3.22	1.60

3.1 Proximate composition

The data pertaining to the physical properties of the raw materials in Table 1 revealed that the moisture and titratable acidity in fresh harad pulp were represented as 59.62% and 3.10 percent which were in close compliance to the findings of Navhale *et al*., (2011) [18] and Bhutia *et al*., (2018) [7]. The crude protein, crude fibre, fat and ash in fresh harad pulp were found to be 2.62%, 4.36%, 1.59% and 3.22%, respectively which concurred with the outcomes of Singh *et al*., (2017) [32].

The moisture content, and titratable acidity in fresh ber pulp were recorded as 81.27% and 0.41%, respectively which coincide by Pandey *et al*., (2019) [19] and Kavitha *et al*., (2014) [14]. The crude protein, crude fibre, fat and ash were found to be 1.21%, 2.31%, 0.16% and 1.60% which are in accordance with the findings of Dewan (2021) [9], Sharma and Rana (2017) [30], Sharif *et al*., (2022) [29] and Pareek (2013) [20] in fresh ber pulp.

3.2 Moisture Content

The mean moisture content of blended leather (Table 2) ranged from 9.19 to 10.41% and varied significantly with varying levels of harad pulp and ber pulp. The highest mean moisture content of 10.41 was observed in treatment T_6 (30:70:: HP : BP) whereas the lowest mean moisture content of 9.19 was recorded in treatment T_1 (100:00:: HP : BP). The decrease in moisture content might be due to evaporation of water from leather during storage (Bhatt and Jha, 2015) [6]. Kaushal *et al*. (2017) [13] also reported decrease in moisture content during storage in ginger plum leather. Ahmed *et al*. (2021) [2] observed similar results, indicating a decrease in moisture content of pear and grapes blended leather after three months of storage.

3.3 Crude protein

It was apparent from Table 3 that treatment exerted a considerable effect on the crude protein of blended leather. The highest and lowest treatment mean crude protein of 3.26% and 2.24% were found in treatment T_1 (100:00::HP:BP) and T_6 (70:30::HP:BP), respectively. There was a significant decrease in the mean value of blended leather from initial value of 2.88 to 2.49%, during 6 months of storage duration. The decrease in protein content during storage might be due to hydrolysis of peptide bond by the help of protease enzyme that causes splitting of protein molecules and denaturation and degradation of protein into amino acid during storage. The crude protein of the blended leather decreases with the advent of storage period which are quite similar with the findings of Kaushal *et al*. (2015) [33] and Patil *et al*. (2017) [22] in leather variant prepared from the seabuck leather and peach-soy fruit leather, respectively.

3.4 Crude fibre

The maximum and minimum mean value of crude fibre (Table 4) of 5.01 and 3.72 were recorded in treatment T_1 (100:00::HP:BP) and T_6 (30:70::HP:BP), respectively. Significant decrease in crude fibre was observed from 4.55 to 4.22 during storage period in the blended leather. The decrease in crude fibre might be due to the degradation of hemicelluloses and other structural polysaccharides during storage. Also, heat and moisture solubilizers degraded pectic substances leading to the decrease in the fibre content (Sharon and Usha, 2006) [31]. Decrease in crude fibre with storage of leather was also reported by Rahman (2021) [23] in the mulberry aloe vera blended leather. Similar decline in crude fibre content was also reported by Ghimire and Ojha (2016) [10] trend in papaya-soy fruit leather.

3.5 Crude fat

The maximum and minimum mean crude fat of 1.61 and 0.71% were found in treatment T_1 (100:00::HP:BP) and T_6 (30:70::HP:BP), respectively. There was decrease in crude fat (Table 5) of blended leather from initial mean value 1.91 to 0.98% during six months of storage. The decrease in the crude fat content might be because of enhanced lipolytic activity of enzymes like lipase and lipoxygenase in response to increased relative humidity of storage environment causing conversion of fats into esters and glycerol (Zahra *et al*. 2020) [38]. The finding of Bhat *et al*. (2014) [5], who similarly reported a decrease in the crude fat content of soy peach blending leather.

3.6 Ash

The data pertaining to ash content of different treatments in Table 6 depicted a decrease in ash content. At initial day of storage the highest mean ash content of 3.91% was recorded in treatment T_1(100:00:HP::BP) and lowest by 2.63% in treatment T_6 (70:30:HP::BP). During storage the mean ash content of blended leather decreased significantly from 3.37 to 3.08%. The decrease in ash content of blended leather might be attributed to mineral losses from binding of minerals by Maillard reaction products during storage (Nadarajah and Mahenran, 2015) [17]. Similar decrease in ash content is in line with orange leather fortified with orange peel by Parida, (2016) [21]. These findings were also reported by Das and Das (2025) [8] in Kinnow Mandarin fruit leather.

Table 2: Effect of treatments and storage period on moisture content (%) of harad and ber blended leather

Treatments	Storage period(months)				
	0	2	4	6	Mean
T_1 (100:0 :: HP: BP)	9.80	9.36	8.90	8.69	9.19
T_2 (70:30:: HP: BP)	10.20	9.68	9.29	8.97	9.54
T_3 (60:40:: HP: BP)	10.42	9.97	9.62	9.31	9.83
T_4 (50:50:: HP: BP)	10.65	10.17	9.80	9.52	10.03
T_5 (40:60:: HP: BP)	10.83	10.39	9.94	9.65	10.20
T_6 (30:70:: HP: BP)	11.08	10.58	10.13	9.88	10.41
Mean	10.49	10.02	9.61	9.33	
Effects	C.D. ($p \leq 0.05$)				
Treatment (T)	0.03				
Storage (S)	0.03				
T × S	0.06				

Table 3: Effect of treatments and storage period on crude protein (%) of harad and ber blended leather

Treatments	Storage period(months)				
	0	2	4	6	Mean
T_1 (100:0 :: HP: BP)	3.48	3.31	3.16	3.09	3.26
T_2 (70:30:: HP: BP)	3.05	2.89	2.77	2.68	2.84
T_3 (60:40:: HP: BP)	2.90	2.78	2.59	2.49	2.69
T_4 (50:50:: HP: BP)	2.75	2.60	2.47	2.36	2.54
T_5 (40:60:: HP: BP)	2.63	2.44	2.35	2.23	2.41
T_6 (30:70:: HP: BP)	2.49	2.31	2.14	2.05	2.24
Mean	2.88	2.72	2.58	2.49	
Effects	C.D. ($p \leq 0.05$)				
Treatment (T)	0.02				
Storage (S)	0.02				
T × S	0.05				

Table 4: Effect of treatments and storage period on crude fibre (%) of harad and ber blended leather

Treatments	Storage period(months)				
	0	2	4	6	Mean
T_1 (100:0 :: HP: BP)	5.15	5.03	4.97	4.89	5.01
T_2 (70:30:: HP: BP)	4.80	4.71	4.65	4.57	4.68
T_3 (60:40:: HP: BP)	4.52	4.43	4.37	4.29	4.40
T_4 (50:50:: HP: BP)	4.34	4.25	4.18	4.12	4.22
T_5 (40:60:: HP: BP)	4.11	4.02	3.95	3.87	3.98
T_6 (30:70:: HP: BP)	3.82	3.76	3.69	3.62	3.72
Mean	4.45	4.36	4.30	4.22	
Effects	C.D. ($p \leq 0.05$)				
Treatment (T)	0.03				
Storage (S)	0.03				
T × S	0.06				

Table 5: Effect of treatments and storage period on crude fat (%) of harad and ber blended leather

Treatments	Storage period(months)				
	0	2	4	6	Mean
T_1 (100:0 :: HP: BP)	1.72	1.64	1.57	1.52	1.61
T_2 (70:30:: HP: BP)	1.39	1.31	1.26	1.15	1.25
T_3 (60:40:: HP: BP)	1.25	1.18	1.12	1.07	1.16
T_4 (50:50:: HP: BP)	1.09	1.02	0.95	0.89	0.98
T_5 (40:60:: HP: BP)	0.93	0.86	0.79	0.71	0.82
T_6 (30:70:: HP: BP)	0.81	0.74	0.68	0.62	0.71
Mean	1.19	1.12	1.06	0.98	
Effects	C.D. ($p \leq 0.05$)				
Treatment (T)	0.02				
Storage (S)	0.02				
T × S	0.04				

Table 6: Effect of treatments and storage period on ash (%) of harad and ber blended leather

Treatments	Storage period(months)				
	0	2	4	6	Mean
T_1 (100:0 :: HP: BP)	4.07	3.95	3.84	3.79	3.91
T_2 (70:30:: HP: BP)	3.67	3.54	3.42	3.28	3.47
T_3 (60:40:: HP: BP)	3.45	3.32	3.25	3.17	3.29
T_4 (50:50:: HP: BP)	3.23	3.16	3.07	2.99	3.11
T_5 (40:60:: HP: BP)	3.01	2.91	2.83	2.75	2.87
T_6 (30:70:: HP: BP)	2.79	2.67	2.59	2.50	2.63
Mean	3.37	3.25	3.16	3.08	
Effects	C.D. ($p \leq 0.05$)				
Treatment (T)	0.04				
Storage (S)	0.03				
T × S	0.08				

4. Conclusion

In the development of blended fruit leather, varying proportions of harad pulp (HP) and ber pulp (BP) significantly influenced the proximate composition. Treatments with higher harad pulp ratios (T_1: 100:0 HP:BP) exhibited higher levels of moisture, crude protein, fibre, fat, and ash. However, storage for six months resulted in a significant decrease in all parameters across treatments. These reductions can be attributed to factors such as enzymatic degradation, Maillard reactions, moisture loss, and structural polysaccharide breakdown. Overall, blending and storage had a significant impact on the nutritional profile of the leather, with harad pulp contributing more robustly to its nutritional quality.

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