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Adding value to wild Himalayan fig (*Ficus palmata*): Composition, functional and sensory characteristics of jam

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ABSTRACT

Wild Himalayan fig is an underutilized wild fruit with various nutritional components. The fruit was evaluated for different parameters like crude fibre value (18.90 - 16.38 %), total phenols (72.6 – 65.4 mg/100g) and the energy value (99.84 Kcal). The shelf life of this fruit was enhanced by converting it into value added product like jam. To standardize the technology for jam preparation, different treatments were designed by varying the concentration of pectin and citric acid. Among these treatments, T_3C_1 containing 0.7 percent pectin and 0.3 percent citric acid was found best with higher titratable acidity (12.02%) as citric acid, ascorbic acid content (1.24mg/100g), total sugar (66.42 %) and reducing sugar (58.85%), total phenol (39.8 mg/100g), anthocyanin 17.05 mg/100 g). Further, on the basis of sensory evaluation, the standardized product had high overall acceptability along with higher score for colour, flavor etc. The FTIR analysis of prepared jam and fig pulp clearly revealed that there was no alteration in physicochemical properties of fig pulp after its processing. Hence, the results from the present investigation clearly revealed that development of jam from wild fig can also be one of the alternative for the utilization of this nutritional rich underutilized crop for commercial purposes.

Keywords: Jam, *Ficus palmata*, Wild Himalayan Fig.

INTRODUCTION

Ficus palmata belongs to family Rosaceae is one of the important wild fruits found growing in western Himalayan regions of India. The tree is deciduous in nature and found in the forests, around the villages in wastes lands or on the bunds of farmer fields [1, 2]. The wild Himalayan fig is commonly found in states of Uttarakhand, Punjab, Kashmir and areas of western Himalayan region [1]. Fresh fig fruits weight, length and breadth ranged between 11.6-36.8 g, 16.7-28.6 cm and 17.3-31.0 cm, respectively [3]. Figs are an excellent source of phytosterols [4], crude fibre, minerals [5], carotenoid [6], anthocyanins [7-9] and polyphenol [8, 10]. The fig is used in various diseases e.g. gastrointestinal, hypoglycemic, anti-tumour, anti-ulcer, anti-diabetic, lipid lowering and antifungal activities [11]. However, there is no documented data available on the production of this fruit. Till date, the fruits are underutilized and farmers are even cutting these fruit trees as they are unawareness about the nutritional quality characteristics of the fruit. Furthermore, the fruit is edible along with the seeds and has high medicinal value along with sensory scores [2, 12]. However, presently the green fruits of the wild Himalayan fig are utilized as cooked vegetable by the rural people of these regions [1]. It can also be used for making various products such as squash, jam and jelly [12, 13]. The fruits are safe for human consumption and may possess high value components such as sugars, phenols, antioxidants and fibre that may be used in development of value added products with high nutritive value [1]. Saklani and Chandra (2011b) reported that bark, root, leaves, fruit and latex of this plant are used for the various illnesses treatment [14]. Solomon *et al.* (2006) reported that fig fruit skin was richest source of anthocyanin and polyphenol in comparison to other parts of fig fruit [7]. Glimpses of present research conducted into various fig products have not been a true reflection of the importance and potential of this crop.

Many processes designed to preserve food will involve a number of food preservation methods. Among these, Jam is one of the most common techniques. In India, since the fruit is underutilized no work has been done on development and evaluation of wild Himalayan fig jam for its commercialization. To enhance the value of *Ficus palmata*, one should begin with a survey of the physicochemical

characteristics of the raw material from the local material. Subsequently, laboratory assays may be conducted in order to prepare and evaluate *Ficus palmata* products with high added value such as fig jam. Further, the knowledge of physico-chemical characteristics of the final products is also essential for conception of equipment size and process. Hence, this paper reports on the value addition of fig from the underutilized species *Ficus palmata* through characterization of the raw material. Further, the development and evaluation of wild Himalayan fig would provide sustainable means to the local people of these regions. This would also be helpful for farmers and industries to utilize and design new food products, machinery and quality control for commercialization of such products.

MATERIALS AND METHODS

Collection of *Ficus palmata* fruits

This study was conducted on wild Himalayan fig (*Ficus palamta)* which is one of the underutilized fruit in mid-Hill region of Himachal Pradesh, India. Fully ripened fruits of wild Himalayan fig were collected from different districts (Hamirpur, Bilaspur, Kangra, Solan). The fruits were washed and sorted for the presence of any defects and packed in polyethylene bags and kept at 4ºC until analysed/utilized.

Preparation of pulp

The fig pulp was prepared by boiling the fruits with water (1:1 ratio) for 15 mins.

Preparation of Wild Himalayan fig jam

Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, yeasts, etc.), addition of sugar (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination). Different treatments of jam were prepared using varying concentration of citric acid (0.3 to 0.7 %) and pectin (0.3 to 0.7 %). The jam was prepared by adding sucrose to raise the final TSS to 68º Brix in an open pan, with continuous stirring. Finally, when the TSS reached to final concentration, the jam was poured in pre sterilized glass jars. The jars were cooled to room temperature and stored at ambient conditions (RT 25-27ºC) till further evaluation of various physico-chemical, storage and sensory characteristics.

Physico-chemical analysis of Wild Himalayan fig and jam

Total soluble solids content (Brix) was determined using an Abbe refractometer at 25ºC [15]. Titratable acidity in terms of percent citric acid was determined according to the AOAC methods [16]. Total and reducing sugar content was determined as per the method described by Rangana [17]. Ascorbic acid content was measured as mg/100 g using 2,6-Dichlorophenol-Indophenol visual titration [17]. Total phenolic content was determined at 725 nm using Folin-Ciocalteau reagent method [18] and expressed as gallic acid equivalents (GAE mg/100 g of sample, fresh weight). Crude fibre content was measured according to the method given by Rangana [17]. Anthocyanin content was determined as per the method described by Thimmaiah [19]. Further, antioxidant activity was measured as % DPPH scavenging activity [20]. The water activity of Wild Himalayan Fig jam was measured at 25 ºC in Rotronic HW4 apparatus (Rotronic instrument corp, New York). Further, the FTIR analysis of the prepared treatments was conducted in Agilent instrument.

Sensory evaluation

The sensory evaluation of jam was conducted by semi-trained panel of 10 judges. Each judge was given a set of treatments separately in isolated booths and provided with a glass of fresh water to rinse their mouth before tasting the next sample. Each sample was evaluated for various quality attributes viz., colour, flavor, consistency/texture, taste/acid sugar blend and overall acceptability. Judges were asked to rate the samples on a prescribed sensory evaluation performa of composite scoring.

Statistical analysis

Analytical values were determined, using three independent determinations. Values of different parameters were expressed as the mean ± standard deviation (X±SD). The data of quantitative estimation of various physico-chemical characteristics of different jam treatments was analyzed by Completely Randomized Design (CRD) as described by O'Mahony (1985).

Cost of production

The economics of production (per unit) of developed jam at the laboratory scale was worked out based on the cost of all ingredients, 10 per cent overhead charges, 20 per cent processing charges (cost of making puree/pulp/slurry) and 20 per cent profit margin.

RESULTS AND DISCUSSION

Compositional and functional characteristics of Wild Himalayan Fig

The proximate composition of wild Himalayan Fig (ripened fruit) collected from different districts of Himachal Pradesh is presented in Table 1. It is clearly seen from the results that wild fig is a good source of crude fiber (18.90-18.03 %) with relatively low content of ascorbic acid (3.8 - 3.09 mg/100 g). The total soluble solid content of the fruit from different districts ranged between 12.8 to 11.2^{0}B with highest in samples collected from District Hamirpur and minimum in fruits from Bilaspur. Since, total soluble solids are one of the important quality attribute for the raw consumption and processing of fruits. Hence, the fruits can be effectively used for the development of value added products from wild fig. Among the different districts, the titratable acidity content was recorded between 0.44 - 0.38 per cent as citric acid. The maximum value for titratable acidity was recorded in samples collected from Solan and minimum in fruits from Hamirpur. Further, wild figs also contain total phenols (72.6 – 65.4 mg/100 g) although the quantity is less in comparison to cultivated fig varieties. Indeed, they were rich in sugars and fiber deserving to be used for value-added product formulation. The perusal of the data further revealed that the protein content and reducing sugar of fruits collected from different locations ranged between 1.35-1.82 per cent and 4.17 – 3.06 mg/100g with 0.20-0.17 percent pectin. The results on energy value (99.84 – 94.26 Kcal) of fruit also signify that wild fig fruit is a good source of energy. There were significant differences among the fruits collected from different locations of the Himachal Pradesh for presence of antioxidants (Table 2). The highest antioxidant activity (78.25%) by DPPH method was recorded in fruits

collected from Distt Hamirpur. Further, the results pertaining to FRAP and ABTS activity also support the presence of higher antioxidants in fruits collected from Hamirpur District of Himachal Pradesh. Furthermore, the similar trend was also recorded in ABTS activity of Wild Himalayan fig collected from different locations.

Chemical Characteristics of wild Himalayan fig Jam

The perusal of data in Table 3 revealed that among the various treatments, T_3C_1 (0.7%+0.3%) was found best having higher titratable acidity (0.56 asper cent citric acid), ascorbic acid content (1.24 mg/100g), total sugar (66.42 %) and reducing sugar (58.85 %) respectively.

Further, Table 4 revealed that there were significant differences among the treatments for total phenols which ranges from 39.8 to 37.2 mg/100g. The highest content of phenols was recorded in treatment T_3C_1 whereas, non-significant differences were observed in anthocyanins and % DPPH scavenging activity respectively. Further, the setting of all the jams was recorded at 68-71 °B. The increase in reducing sugars content in jam compared with the raw material could be explained by a partial hydrolysis of sucrose (initial and added) during cooking (Pearson, 1976). The reducing sugars, which have more affinity for water than sucrose, could contribute to the reduction of the jam crystallization phenomenon [21]. The cost of production of fig jam was worked out to be Rs. 28 per 250 gjar (Table 5) which was found to economical when compared with other jams in the market.

FTIR analysis of prepared jam and pulp

The results pertaining to the FFTIR analysis have been shown in Table 6. The grouping present in the pulp having same peak at particular wavelength as in prepared jam. The various functional groups present (Fig 1 and 2) in both fig pulp and jam were (-C=C-O-C) (Ether), (-OH) (Hydroxyl), (-O-NO_2) (3º Amide), (-C-OH) (Phenol) and (-C-OH) (1º and 2º Alcohol).

The presence of these functional groups represents the molecular composition of both pulp and jam which further derives the conclusion that there is no interaction in characteristic functional groups of pulp with the ingredients of jam. Therefore, no alteration in physiochemical properties were observed.

Sensory characteristics of wild Himalayan fig jam

Fig jam was characterized by a better colour, texture and flavour. Different treatments of fig jam were presented to panel of judges for sensory evaluation on composite scoring performa and the results (Table 7 and Fig 3) showed the highest overall acceptability scores of 81.25 out of 100 were awarded to treatment T_3C_1 along with highest scores for other characteristics also such as colour, flavor, sugar acid blend etc.

Table 1: Proximate Composition of fresh Wild Himalayan fig from various Districts of Himachal Pradesh

Parameters	Quantity				$CD_{(0.05)}$
	Hamirpur	Bilaspur	Kangra	Solan	
Moisture (%)	76.8	74.2	79.5	76.4	1.18
TSS (ºB)	12.8	11.2	12.1	11.9	0.17
Titratable acidity (%)	0.380	0.440	0.421	0.445	0.01
Protein (%)	1.35	1.41	1.68	1.82	0.17
Total sugar (%)	7.01	6.56	6.12	6.41	0.12
Reducing sugar (%)	4.17	4.16	4.06	3.06	0.15
Total phenols (mg/100g)	72.6	65.4	68.9	70.6	5.42
Ascorbic acid (mg/100g)	3.67	3.2	3.09	3.8	0.19
Pectin (%)	0.20	0.17	0.19	0.18	NS
Crude fibre (%)	18.90	18.03	18.78	18.61	NS
Crude fat (%)	1.07	1.15	0.69	0.78	0.14
Ash (%)	0.92	0.84	0.72	0.98	NS
Anthocyanins (A_{525})	0.181	0.179	0.176	0.180	NS
Carbohydrate (mg/100g)	19.84	18.40	19.11	18.32	1.13
Energy (Kcal)	99.84	95.6	98.10	94.26	1.16

All values given are means of three determinations. Means in line with different letters are significantly different (P < 0.05).

Table 2: Antioxidant activity of fresh Wild Himalayan fig from different locations of Himachal Pradesh

Antioxidant Tests	Wild Himalayan fig				Mean	$CD_{(0.05)}$
	Hamirpur	Bilaspur	Solan	Kangra		
DPPH (%)	78.25	76.51	76.87	78.03	77.41	1.13
FRAP [µmol Fe(II)/g extract]	987	856	896	971	927.5	2.72
ABTS (%)	92.05	89.01	89.23	91.04	90.33	0.179

All values given are means of three determinations. Means in line with different letters are significantly different (P < 0.05).

Table 3: Effect of different concentration of Pectin: Citric acid on Titratable acidity, ascorbic acid, total sugar, reducing sugar and setting of jam.

Treatments	Titratable Acidity (%)	Ascorbic Acid (mg/100g)	Total Sugar (%)	Reducing Sugar (%)
T_1C_1 (0.3%+0.3%)	0.53±0.02^b	1.56±0.01^c	65.82±0.04^a	58.03±0.03^b
T_1C_2 (0.3%+0.5%)	0.57±0.02^c	1.87±0.03^d	65.50±0.03^a	58.27±0.10^b
T_1C_3 (0.3%+0.7%)	0.61±0.01^d	0.95±0.02^a	66.01±0.04	58.05±0.06^b
T_2C_1 (0.5%+0.3%)	0.56±0.01^c	1.23±0.02^b	65.19±0.02^a	57.41±0.14^a
T_2C_2 (0.5%+0.5%)	0.52±0.02^a	2.01±0.02^e	65.56±0.03^a	57.04±0.05^a
T_2C_3 (0.5%+0.7%)	0.68±0.03^e	1.92±0.03^e	66.71±0.04^b	58.24±0.05^b
T_3C_1 (0.7%+0.3%)	0.56±0.02^c	1.24±0.04^b	66.42±0.06^b	58.85±0.04^b
T_3C_2 (0.7%+0.5%)	0.52±0.01^a	1.97±0.04^e	65.48±0.05^a	57.96±0.06^a
T_3C_3 (0.7%+0.7%)	0.62±0.02^d	1.84±0.02^d	65.71±0.04	58.01±0.04
Mean±SD	**0.57±0.08**	**0.9±0.15**	**36.90±0.37**	**28.12±0.87**

Data are presented as mean±SD (n=3)

Table 4: Effect of different concentration of Pectin: Citric acid on Total Phenol, anthocyanin and % DPPH Scavenging activity of jam.

Treatments	Total phenol (mg/100g)	Anthocyanin (A_{525})	% DPPH Scavenging activity	Jam setting (ºBrix)
T_1C_1 (0.3%+0.3%)	37.2±0.10^a	0.066±0.11^c	27.51±0.18^c	71±0.03^c
T_1C_2 (0.3%+0.5%)	38.3±0.04^b	0.062±0.19^b	26.82±0.11	71±0.04^c
T_1C_3 (0.3%+0.7%)	38.7±0.02^b	0.067±0.05^c	26.52±0.05^b	71±0.03^c
T_2C_1 (0.5%+0.3%)	37.4±0.01^a	0.068±0.04	27.63±0.05^c	69±0.01^b
T_2C_2 (0.5%+0.5%)	39.2±0.12^c	0.062±0.06^b	22.96±0.14^a	69±0.03^b
T_2C_3 (0.5%+0.7%)	37.5±0.6^a	0.059±0.01^a	25.05±0.17^b	69±0.01^b
T_3C_1 (0.7%+0.3%)	39.8±0.4^c	0.067±0.08^c	27.53±0.15^c	68±0.03^a
T_3C_2 (0.7%+0.5%)	38.2±0.9^b	0.064±0.15^b	23.89±0.18^a	68±0.04^a
T_3C_3 (0.7%+0.7%)	39.1±0.01^c	0.063±0.06^b	26.71±0.17^b	68±0.01a
Mean±SD	**38.4±2.94**	**0.064±0.003**	**26.06±1.70**	**69±0.03**

Data are presented as mean±SD (n=3)

Table 5: Cost of production of Jam:

Particulars	Quantity	Rate (Rs)	Amount (Rs)	
			(Glass jar)	(Plastic jar)
Fruit	500g	30/kg	15.0	15.0
Sugar	498.4g	40/kg	19.93	19.93
Sodium benzoate	0.8g	480/kg	0.38	0.38
Citric acid	3.0g	450/kg	1.35	1.35
Cardamom flavor	12 ml	15/25 ml	7.2	7.2
Pectin	5g	3500/500 g	35.0	35.0
Glass jar 250 g	1	9/jar	9	-
Plastic jar 250 g	1	15/jar	-	15
Total cost			87.86	93.86
Overhead cost @10 %			8.78	9.38
Total cost			96.64	103.24
Profit @ 20%			19.32	20.64
Net cost (cost per 250 g jar)			28.75	30.97

Table 6: Comparison of functional groups present in Fig pulp and jam

Sample	-C=C-O-C (Ether) Stretching	-OH (Hydroxyl) stretching	-O-NO_2 (3º Amide) Stretching	-C-OH (Phenol) Stretching	-C-OH (1º and 2º Alcohol) Stretching
Fig pulp	1030	3223	1640	1395	1298
Fig jam	1045	3231	1644	1339	1268

*Expressed as wavenumber

Table 7: Sensory properties of standardized Fig jam:

Quality attributes	Score	Samples								
		T_1C_1	T_1C_2	T_1C_3	T_2C_1	T_2C_2	T_2C_3	T_3C_1	T_3C_2	T_3C_3
Colour	**20**	14.0	14.25	16.0	10.25	13.25	15.5	17.0	11.5	12.75
Texture	**20**	15.75	13.75	16.5	11.75	12.25	15.25	16.0	13.75	13.5
Flavour	**20**	14.5	14.15	14.25	12.75	11.5	15.75	16.75	13.0	14.5
Sugar- acid blend	**20**	14.0	14.75	18.0	12.0	11.25	15.5	15.75	11.25	13.0
Absence of defects	**20**	17.5	15.75	14.25	13.5	13.75	14.5	15.75	15.25	14.25
Total score	**100**	75.75	72.75	78.75	60.25	62.0	76.75	81.25	64.75	68.0

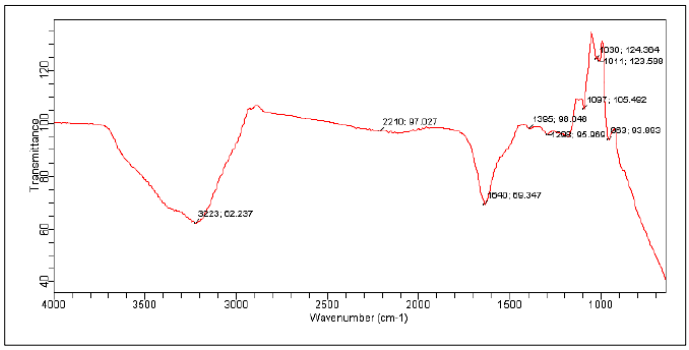

Figure 1: Graphical representation of FTIR analysis of Fig pulp

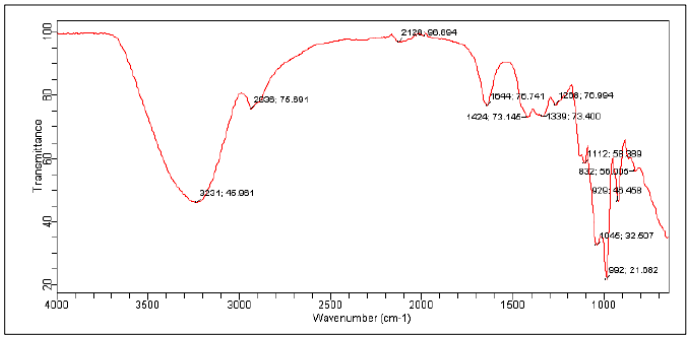

Figure 2: Graphical representation of FTIR analysis of fig jam

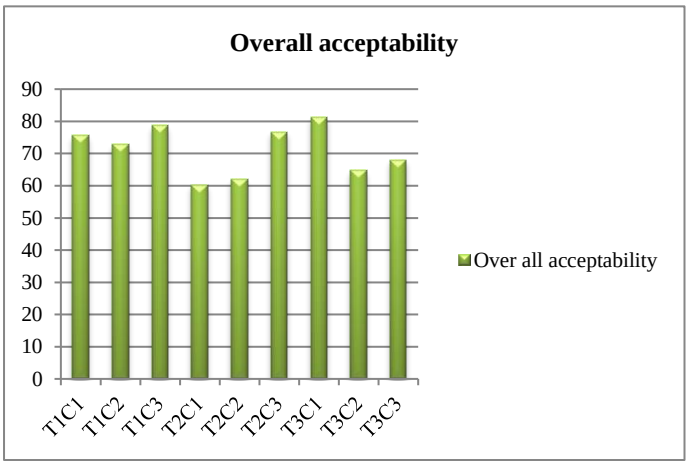

Figure 3: Overall acceptability scores of Wild Himalayan fig jam

CONCLUSSION

It can be concluded from the study that wild Himalayan fig is one of the nutritious underutilized fruit crop grown in the Himachal region of western Himalayas. The fruit has higher fibre content with optimum amount of other nutrients such as sugars, phenols, antioxidants, anthocyanins etc. and low ascorbic acid. The utilization of these wild fruits for jam making can be one of the alternative for adding value to the crop and as an income source to the farmers. Further, the knowledge of the physico-chemical and sensory properties of this product will also encourage the farmers to develop the products on an industrial scale. The use of fig jam may also be attractive to consumers as a positive alternative to conventional fruit jams available in the market.

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