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Nutrient and antioxidant composition in value added products made with underutilized Prunus (*Prunus nepalensis*) fruits

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Abstract
Prunus fruits which have a short post harvest life can be successfully utilized for development of various value added products. The products like Prunus Crush (PC) and Prunus-Apple fruit rolls (PAFR) were very well accepted as per sensory scores among the other products developed. Nutrient composition, antioxidant activity and radical scavenging activity was evaluated in the best accepted prunus products (PC and PAFR) along with prunus pulp (PP). Among the three, PP exhibited higher antioxidant activity and total phenolic contents compared to the other two processed products. Radical scavenging (ABTS activity, Hydroxyl radical activity) was high in PP and PAFR respectively. The results indicate that value added products developed from prunus are not only attractive in sensory parameters due to the colour imparted by the anthocyanin pigments of prunus, they are also beneficial in maximizing the health benefits due to the rich nutrients, antioxidant and radical scavenging activity present in fresh and value added prunus products.

Keywords: underutilized, prunus nepalensis, value addition, nutrient, antioxidant

Introduction
The North East Hill Region of India is considered as plethora of plant biodiversity in the world and have many varieties of indigenous crops grown throughout the region, which have higher nutritional value than that of available foods in other parts of the country (Agrahar and Subbulakshmi, 2005; Seal, 2011) [1, 37]. The indigenous crops available in these areas are underutilized due to various factors like non availability of post harvest processing technologies, poor transportation, lack of knowledge on processing techniques etc. There is a need to fully commercialize and improve the utilization of such indigenous crops, being a source of rich nutrients with potential health benefits. *Prunus nepalensis* (Sohiong) is an indigenous underutilized fruit, also called as Khasi Cherry, abundantly available in the hills of Meghalaya and Manipur of North East India. It belongs to Rosaceae family (Maynard, 2008; Rymbai *et al*., 2016) [22, 35]. The plant grows to 15-20 m height and bears fruits after seven to eight years of planting. The fruit is round in shape with smooth surface having resemblance to jamun or blackberry. This fruit with unique taste, flavour and colour is widely consumed among the local population as fresh or used for production of squash, ready to serve beverage, jams, preserves and wine. The fruits are rich in phytochemicals such as purpurin, tannic acid, methyl gallate, reserpine, gallic acid, ascorbic acid, catechin and rutin, which exhibit excellent radical scavenging and iron chelation properties (Chaudhuri *et al*., 2015) [7]. Several bioactive compounds, such as quercetin, quinic acid, rutin, scopoletin, naringenin, palmitoleic acid and many others, have been isolated from different species of *Prunus* available in China (Zhou *et al*., 2011) [48]. The high content of bioactive components in fruit having strong radical scavenging activity, will prevent the onset and progression of degenerative diseases (Seal, 2011) [37].
Maskan *et al*., (2002) [27] reported that most fresh fruits have a short harvest season and are sensitive to deterioration even when stored under refrigerated conditions; therefore, making value added products from fresh fruits is an effective way to preserve fruits. Prunus fruits also have a very short post harvest life and value addition to the fruits will help preserve the fruits for a longer period. Owing to rich nutrients along with reddish purple colour of the fruit, there is a probable prospective future with the value added Prunus products to meet the growing demands of food industry. Hence an attempt was made to develop the value added prunus products, which can ensure year round availability of most demanded fruit in North East India and also fetch more income to the farmers and entrepreneurs.

Methodology

Fresh fruits were procured from NEH- ICAR complex Manipur, Imphal, North eastern state of India. Freshly harvested prunus fruits were used for product development. Ingredients required for value addition were purchased from local markets to formulate different products. All chemicals used for analysis were purchased from Merck, India and all solvents used were of analytical grade. Value addition, product development, sensory evaluation and nutrient analysis were done at NEH- ICAR complex Manipur, Imphal and MFPI – Quality Control Laboratory, Hyderabad, India.

Primary processing of Prunus: Fresh prunus fruits were cleaned and blanched in hot water (90 ± 2°C) for 3 minutes (Prunus fruits : water in 1:2 ratio). The blanched prunus fruits were cooled immediately in cold water at 4°C equilibrium value (AOAC, 1995). The prunus fruits were drained after cooling and the residual moisture was evaporated at room temperature, on a clean dry cloth with constant turning over. One set of blanched fruits were sliced with stainless steel knife and seeds were removed. The sliced fruit was dried in a tray drier at 55°C for 8-10 hours. The dried prunus were ground into powder in Commercial Blender (WCG75, Torrington, CT) at medium speed for 3 min and sieved using a sieve analyser (Redmond and Griffith, 2003) [33] to get even textured powder. The dried prunus powder was packed in an air tight container and stored in a refrigerator (4ºC) until further use.

Another set of blanched deseeded prunus fruits were crushed and pulp was extracted by using blender to obtain a smooth even textured pulp. Sodium benzoate preservative (250ppm) was added and homogenized pulp was packed in a sterilized glass bottle and stored at refrigerated temperature (-4°C) for further use.

Secondary processing of Prunus: The processed Prunus pulp and powder were used in different proportions to develop a variety of products such as Prunus Squash (PS), Prunus Ready to Serve Beverage (PRTSB), Prunus Crush (PC), Prunus osmotic dehydrated flakes (PODF), Prunus Health mix (PHM), Prunus weaning mix (PWM), Prunus fruit rolls (PFR) and Prunus Apple fruit Rolls (PAFR).

Prunus Squash (PS) was prepared with Prunus pulp (32.2%) in combination with sugar, water and sodium benzoate preservative (600ppm) as described by Sharma *et al.,* (2002) [39]. Prunus Ready to Serve Beverage (PRTSB) was prepared with Prunus pulp (27.27%) in combination with sugar and water (Jood and Ketarpaul, 2002). Prunus Crush (PC) was prepared using Prunus pulp (28.27%) in combination with sugar (Srivastava and Sanjeev Kumar, 2005) [41]. Prunus crush can be use as a topping of on icecreams, smoothies etc. Prunus suash and crush can be served as cold beverage by adding 1: 3 ratio of Squash / Crush and chilled water. All standardized products can be stored in refrigerated temperatures for one year.

Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits and vegetables (Chavan and Amarowicz, 2012) [8]. PODF were prepared by soaking blanched and deseeded prunus in sugar syrup of 55% brix for 24 hours and then dried in tray drier at 55°C temperature for 14 hours. The dried flakes were stored in an air tight container for further use.

Instant health mixes are simple and convenient foods, which are easy and fast to prepare besides being hygienic, convenient to consume and also gaining popularity among consumers since few years. Instant mixes comprise of a mixture of processed cereals, pulses, oilseeds, dried vegetables and fruit powders in varying combinations (Divya *et al*., 2017) [12]. Prunus Health mix (PHM) was developed with Prunus powder (10%) and osmotic dehydrated flakes (10%) in combination with Jowar (*Sorghum bicolor*) flakes, malted and roasted ragi (*Eleusine coracana*) and green gram (*Vigna radiata*) flours. Prunus weaning mix (PWM) was prepared with Prunus powder (15%) in combinations with Jowar flakes powder, malted ragi and Green gram flours, roasted bengal gram (*Cicer arietinum*) powder, milk powder and cardamom powder (Shobana and Malleshi, 2007) [40].

Fruit rolls or leathers are considered as fruit snack or dessert which are considered to be a healthy food. Basically, fruit pulps are mixed with appropriate quantities of sugar, pectin, acid and then dried into sheet-shaped products (Lemuel *et al*., 2014) [21]. Two healthy variants of fruit leathers ie., Prunus fruit rolls (PFR) and Apple prunus fruits rolls (PAFR) were prepared. Prunus pulp (100%) along with citric acid (0.2%), KMS (0.2%), pectin (0.2%) and 55ºbrix sugar syrup were subjected to heating to adjust the final brix between 25-30, (Saranya *et al.,* 2017) [36]. Later the homogenized prunus pulp was spread uniformly over greased fibre sheets (1cm thickness) in Ezidri for 16 hrs at 55ºC. Melted white chocolate (2mm thickness) was added on the dried fruit layer obtained and was rolled. The rolled prunus fruit layer was refrigerated for 30 minutes and cut into 1 inch thickness to obtain uniform fruit roll cylinders, which were packed in LDPE and stored at refrigerated temperature. The same process was applied in preparation of PAFR using Prunus pulp (50%), apple pulp (50%) along with citric acid (0.2%), KMS (0.2%), pectin (0.2%) and 55ºbrix sugar syrup.

Sensory Evaluation: The standardized Prunus products were subjected to sensory evaluation as specified by Meilgaard *et al*., (1999) [24] using a nine-point hedonic scale (0 = Dislike extremely to 9 = Like extremely). Thirty semi-trained panel members from department of Foods and Nutrition of Professor Jayashankar Telangana State Agricultural University, Hyderabad, India evaluated the products for acceptability based on its colour, flavour, texture, taste and overall acceptability using standardized protocol. The panelists were provided water to cleanse their palate between samples. Five samples were coded by three digit numbers and subjected to evaluation during each session. The sensory evaluations were carried out under normal daylight conditions at ambient temperature in a purpose-built, six-booth sensory evaluation laboratory.

Nutrient composition: Moisture, ash, crude fat, crude fibre, crude protein of the samples was determined according to the AOAC (2012) [2] methods. Reducing sugar was determined with Nelson somoyogi method (Somogyi, (1952) [43] and total soluble sugar were analysed according to method of (Roe, 1955) [34].

Anti-oxidant properties: Proline content was determined using method described by Bates *et al*. (1973) [3]. A reaction mixture of 2 ml supernatant (0.5 g samples extracted with 10 ml) + 2 ml acid-ninhydrin + 2 ml glacial acetic acid was used for the determination. The chromophore containing toluene was read at 520 nm in a UV Visible spectrophotometer. Total phenol content was analysed by the method of Singleton *et al*. (1999) [38]. To 1 ml extract, 1 ml of Folin-Ciocalteau reagent, 2 ml of 20 % Na_2CO_3 solution was added, heated in a boiling

water bath for one min and then cooled. The blue solution (diluted upto 25 ml) was recorded at 650 nm and Catechol (Hi Media, India) was used as standard. Ascorbic acid (ASA) was determined according to Mukherjee and Choudhuri (1983) [26] method by reading the absorbance of reaction of the extract (0.2 g sample with 5 ml of 6% TCA; 2% dinitrophenyl hydrazine (in acidic medium); 10 % thiourea in 70 % ethanol) in acidic medium at 530 nm.

One gm of sample was extracted with 10 ml of aqueous methanol (80 % v/v) at ambient temperature with agitation for 18-24 hr. The extracts were filtered and aliquot was analyzed for flavonoid content and reducing power capacity. Total flavonoid content was determined according to Ordoñez (2006) [29]. To 0.5 ml of the sample, 0.5 ml of 2 % $AlCl_3$ ethanol solution was added and kept for one hour at room temperature. Absorbance was measured at 420 nm. Total carotenoid content was analysed using the protocol described by Jensen (1978) [19] with slight modification. 100mg sample was ground with 5ml distilled acetone. After centrifugation, the supernatant was made up to 10ml with 80 % acetone and read at 480nm and 510nm. Carotenoids present in the sample was calculated as per the following formula:

$$\text{Total carotenoids (mg/g)} = \frac{(7.6 \text{ X OD at } 480) - (1.49 \text{ XOD at } 510) \text{ X Final volume (ml)}}{1000 \text{ X Weight of the sample (g)}}$$

Reduced Glutathione was examined as per method described by Moron (1979) [25]. Homogenate of 0.1ml (extracted using 0.5 g sample) was used for the study and final absorbance of reaction mix was read at 412 nm and GSH was used as standard. Anthocyanins were quantified with a spectrophotometer (Talcott and Howard, 1999; Fuleki and Francis, 1968) [45, 15].

Radical scavenging activities

The FRAP assay was performed according to the method given by Benzie and Strain, (1996) [4]. Sample extract was diluted 1:100 times with distilled water to obtain reading that is within the linear range of the spectrophotometer at 593nm. 0.1ml of the diluted sample was pipette out in a test tube with 3ml of FRAP reagent containing acetate buffer (300mM, pH 3.6), TPTZ (0.031mg in 10ml 40mM HCl) and ferric chloride (20mM) in the ratio of 10:1:1. After 4 minutes, the absorbance was recorded at 593nm against FRAP as blank. Result was expressed as millimol ascorbic acid equivalent per 100gram Sohiong dry matter (mmol AAE/ 100g dm). The FRAP value was derived from standard curve using ascorbic acid (R2 = 0.9977).

The reducing power ability of the extracts was evaluated by the method described of Oyaizu (1986) [30] and Pavithra and Sasikumar (2015) [31]. The reaction mixture which had 1.0mL of extracts, 2.5mL of 1% potassium ferricyanide and 2.5mL of 0. mol/L sodium phosphate buffer was incubated at 50°C for 30min and the reaction was terminated by the addition of 2.5mL of 10% trichloroacetic acid, followed by centrifugation at 3000r/min for 10min. 2.5mL of the upper layer was mixed with 2.5mL of deionized water and 0.5mL of 0.1% ferric chloride. The absorbance was measured at 700nm against blank (distilled water and phosphate buffer). Increase in absorbance indicated increased reducing power of the sample. BHT was used as standard.

For DPPH assay, the method was adapted from the method given by Brand-Williams *et al*. (1995) [5] with minor changes. Appropriate dilution factor (1:4) was determined by diluting an aliquot of the test sample with extract until the absorbance at 520nm shows a reading that is within the linear range of the spectrophotometer. Briefly 0.1 ml of the diluted sample was treated with 3.9ml of 0.1mM methanolic DPPH solution and allowed to stand for 30minutes in the dark at 37°C. The absorbance was recorded at 517nm immediately against methanol as blank. Percent inhibition of the DPPH radical was calculated using the following equation:

$$\text{DPPH inhibition (\%)} = (A_b - As/A_b) \times 100$$

Where, As is absorbance of DPPH after reacting with given concentration of sample extract or standard and Ab is absorbance of DPPH solution with methanol blank instead of sample. The result is given as milligram Trolox equivalent antioxidant capacity per gram Sohiong dry matter (mg TEAC/ g dm) derived from standard graph using Trolox as positive standard (R2= 0.9994). ABTS {2,2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid} activity was determined by using the method of Re *et al.* (1999) [32] and Hydroxyl Radical Scavenging activity (HRS) activity was carried out using the procedure reported by Elizabeth and Rao (1990) [14] method.

Statistical analysis

All experiments were performed in duplicate and designed in complete random. The data were analyzed and presented as mean values with standard deviations. The data obtained from sensory evaluation was subjected to analysis of variance (ANOVA) to test the difference between means (within in the samples) and were analyzed by the Tukey test at 95% ($p < 0.05$) level of significance using Indo Stat statistical software.

Results and Discussion

Results of sensory evaluation of the developed prunus products is given in table 1. Colour acceptability was found to be high for PAFR (8.50 ± 0.13), followed by PC (8.45 ± 0.17), PS (8.35 ± 0.16) and PFR (8.25 ± 0.12). The natural pigments of prunus facilitated high colour acceptability among the products. Prunus fruits are rich in anthocyanins, an important subclass of polyphenols which are characterized by a wide range of spectrum varying from blue to red, pink to orange in varying concentrations in different parts of plants (Dinkova *et al*., 2014) [11]. All the products developed with prunus pulp and powder were very attractive in terms of their colour due to the unique colour imparted by the fruit. Flavour was rated highest for PAFR (8.30 ± 0.14) followed by PFR (8.25 ± 0.09), PM (8.20 ± 0.19) and PRTSB (8.05 ± 0.17). Texture of the PAFR (8.25 ± 0.19) was highly rated among all the products followed by PFR (8.20 ± 0.17) and PM (8.00 ± 0.17). Taste was rated high for PAFR (8.60±0.13) among all the developed products. The results of the overall acceptability was found to be high for PAFR (8.50 ± 0.13) and PC (8.45 ± 0.17), least score was found for PHM (7.30 ± 0.29).

Anthocyanin pigments are not only important in defining the aesthetic value of foods and beverages, but also play a significant role from a nutritional point of view (Stintzing and Carle, 2004) [44]. The natural colourants and major pigments in plants like anthocyanins, carotenoids, betalins, chlorophyll, flavones and chalcones, works effectively against various human ailments (Sowbhagya, and Chitra, 2010) [42]. Value

added prunus fruit products are rich in anthocyanins, due to which the sensory acceptability was high for most of the products like PAFR, PFR, PS, PC, PM and PRTSB. However among all the products, PC and PAFR were most acceptable as per the sensory scores and hence these products were evaluated for nutrient composition, antioxidant properties and radical scavenging properties in comparision with Prunus pulp (PP).

Nutrient composition such as moisture, ash, crude fat, crude fiber, protein, total soluble sugars and reducing sugars of PP, PC and PAFR are given in the table-2. The moisture content was 49.77±5.54% in PC and 8.05±0.59% in PAFR, when compared to 81.07±2.15% in prunus pulp (PP). The ash content decreased to 1.17±0.15% in PAFR and 0.23±0.12% in PC, compared to 4.27±1.34% PP. Crude fat also decreased to 2.10±0.58% in PC and 0.66±0.40% in PAFR compared to 2.68±.20% in PP. Similarly crude fiber and protein content also was less in PC and PAFR compared to that of PP. This decrease in ash, fat, fiber and protein content could be due to reduced content of prunus in the value added products, among the other ingredients as compared to PP which is a pure form of prunus.

Total Soluble Sugars **(**TSS) reflects dry matter content and is inversely proportionate to fruit size (Baxter *et al*., 2005; Gautier *et al.,* 2010 and Georgelis *et al.,* 2004) [6, 16, 17]. TSS has increased in both PC (13.20±1.73) and PAFR (52.87±8.66), when compared to PP (4.73±0.16). Reducing sugars content also increased in both PC (0.85±0.00) and PAFR (1.17±0.004) after processing the pulp (0.45±0.05). This could be due to addition of sugar and liquid glucose in PC and PAFR respectively during the product development. Added sugar/liquid glucose gives the product a sweeter taste and also increase the solids content (Lemuel *et al,* 2014) [21].

Antioxidant properties of the PP, PC and PAFR are presented in the table-3. Amount of proline, phenolics, ascorbate, total flavonoids, total carotenoids, anthocyanin and activity of reduced glutathione was low in both PC and PAFR, when compared to PP. Demarchi *et al.* (2013) [10] studied the effect of different temperatures (50, 60, and 70°C) on the hot-air drying rate and retention of antioxidant capacity (AC) in apple leathers. Retention of AC in the apple leathers was low (6–16%) and decreased for increasing air temperatures even when the resulting drying times were shorter. In mathematical terms, this effect is explained by the higher activation energy for AC losses (above 31 kJ/mol), compared with that for drying (Lemuel *et al.,* 2014) [21]. The oxidative reactions influenced by the high temperature processing also might have resulted in decline of antioxidant content (phenolics, flavonoid content, carotenoids and reduced glutathione activity) and ascorbic acid content of the product during processing. As both PC and PAFR are subjected to heat processing, the antioxidant content could have decreased, as compared to the prunus pulp. Our results are similar to the findings of Demarchi *et al.,* (2013) [10]. The total anthocyanin contents found in this study were lower than the contents reported by Rymbai *et al*., (2016) [35]. This could be due to variations in the anthocyanin and antioxidant content in different genotypes used in various studies (Lopes da Silva *et al.* 2007) [9].

Antioxidants are directly associated with reduction of stress, anxiety and life style disorders like cancer, diabetes, neurodegenerative and cardiovascular diseases. Reducing power assay measures the electron-donating capacity of an antioxidant and is indicative of higher reducing activity (Kavitha *et al.,* 2015; Nagendran *et al*. 2005) [20, 28]. Radical scavenging activity is of importance in knowing the functional attributes of various products. Radical scavenging activity of fresh prunus pulp and its products (PC & PAFR) are given in table 4. Results indicate that ABTS (96.72 ± 0.08) and DPPH activity (88.98 ± 1.11) were higher in Fresh prunus pulp. ABTS (89.55 ± 0.47) and hydroxyl activity (60.76 ± 1.30) were higher in prunus crush, whereas Hydroxyl Radical activity was highest (65.38±0.70) in PAFR. ABTS (60.83±0.27) was also good in PAFR. The results indicate that processing (Heating and drying) could have altered the radical scavenging activity as compared to fresh fruit (Dwivedy *et al*. 2011; Wani *et al*., 2016) [13, 47]. Intermediate drying temperatures may contribute to higher values of total phenolic content and better quality of antioxidant activities. Different drying methodologies have an influence on the antioxidant activity in various products (Tan *et al*., 2013) [46]. Heating may contribute to the formation of novel compounds such as Maillard reaction products having antioxidant activity, thus increasing the hydroxyl radical scavenging activity. Hydroxyl (OH) radicals are extremely reactive and may be generated in the human body under physiological conditions, where they can react with non-selective compounds, such as proteins, DNA, unsaturated fatty acids, and almost every biological membrane (Murcia *et al.,* 2001) [23]. Higher hydroxyl scavenging activity in PAFR could enable excellent antioxidant effects if include in the diet.

Table 1: Sensory evaluation of value added prunus products

S. No	Name of the Products	Colour	Flavour	Texture	Taste	Overall Acceptability
1	PS	8.35 ± 0.16^{ab}	7.30 ± 0.25^{bcd}	7.50 ± 0.25^{c}	7.80 ± 0.20^{bc}	7.95 ± 0.11^{bc}
2	PRTSB	7.95 ± 0.17^{bcd}	8.05 ± 0.17^{a}	6.85 ± 0.27^{d}	8.15 ± 0.16^{abc}	7.95 ± 0.21^{bc}
3	PC	8.45 ± 0.17^{ab}	7.70 ± 0.37^{abc}	7.85 ± 0.31^{abc}	$8.35 \pm 0.24^{a\,b}$	8.45 ± 0.17^{abc}
4	PWM	7.80 ± 0.21^{cd}	7.25 ± 0.25^{cd}	7.70 ± 0.16^{abc}	7.80 ± 0.24^{bc}	8.05 ± 0.11^{ab}
5	PHM	7.45 ± 0.26^{d}	$7.15^{a} \pm 0.31^{dc}$	7.40 ± 0.22^{cd}	7.55 ± 0.28^{ab}	7.30 ± 0.29^{c}
6	PM	7.60 ± 0.18^{d}	8.20 ± 0.19^{ab}	8.00 ± 0.17^{abc}	8.30 ± 0.20^{abc}	8.05 ± 0.18^{abc}
7	POSDF	7.75 ± 0.23^{cd}	6.85 ± 0.33^{d}	7.66 ± 0.26^{bc}	7.90 ± 0.24^{bc}	7.85 ± 0.24^{c}
8	PAFR	8.50 ± 0.13^{a}	8.30 ± 0.14^{a}	8.25 ± 0.19^{a}	8.60 ± 0.13^{a}	8.50 ± 0.13^{a}
9	PFR	8.25 ± 0.12^{abc}	8.25 ± 0.09^{a}	8.20 ± 0.17^{ab}	8.05 ± 0.17^{abc}	8.20 ± 0.11^{abc}
	CD value	0.51384	0.70179	0.64900	0.60039	0.51787
	Std.E Value	0.18409	0.25140	0.23249	0.21508	0.26236

Note: All the values are expressed as Mean ± SD. Values with similar superscripts within rows are statistically similar at 0.05% level. Prunus Squash (PS), Prunus Ready to Serve Beverage (PRTSB), Prunus Crush (PC), Prunus osmotic dehydrated flakes (PODF), Prunus Health mix (PHM), Prunus weaning mix (PWM), Prunus fruit rolls (PFR) and Prunus Apple fruit Rolls (PAFR).

Table 2: Nutrient composition of Prunus pulp (PP), Prunus Crush (PC) and Prunus-Apple fruit rolls (PAFR)

Sl. No.	Products	Moisture content (%)	Ash content (%)	Crude Fat (%)	Crude Fibre (%)	Protein (mg/g FW)	Total Soluble Sugars (mg/g FW)	Reducing Sugar (mg/g FW)
1	PP	81.07±2.15	4.27±1.34	2.68±.20	4.50±0.44	17.60±3.67	4.73±0.16	0.45±0.05
2	PC	49.77±5.54	0.23±0.12	2.10±0.58	0.27±0.29	12.88±2.08	13.20±1.73	0.85±0.00
3	PAFR	8.05±0.59	1.17±0.15	0.77±0.15	0.66±0.40	1.87±0.27	52.87±8.66	1.17±0.004

Note: All the values are expressed as Mean ± SD.

Table 3: Antioxidant properties in Prunus pulp (PP), Prunus Crush (PC) and Prunus-Apple fruit rolls (PAFR)

Sl. No	Products	Proline (µ moles /gm FW)	Phenolics (mg/g FW)	Ascorbate content (mg/g FW)	Total Flavonoids (mg/g FW)	Total Carotenoids (mg/g FW)	Reduced glutathione (uM/g FW)	Anthocyanin (mg eq Cyanin CI/g)
1	PP	3.08±0.08	6.17±0.48	13.95±0.28	0.48±0.04	2.16±0.09	3.68±0.14	0.65±0.01
2	PC	0.21±0.00	5.06±0.08	10.97±0.19	0.02±0.00	0.07±0.00	1.62±0.08	0.18±0.01
3	PAFR	0.44±0.01	2.56±0.01	7.95±0.04	0.20±0.00	0.15±0.01	0.29±0.01	0.32±0.29

Note: All the values are expressed as Mean ± SD.

Table 4: Radical scavenging activity (RSA) in Prunus pulp (PP), Prunus Crush (PC) and Prunus-Apple fruit rolls (PAFR)

S. No	Products	FRAP (mg equi Fe/g FW)	Reducing Power (mg/g FW)	DPPH (% activity)	ABTS (% activity)	Hydroxyl Radical (% activity)
1	PP	0.13±0.01	3.82±0.10	88.98±1.11	96.72±0.08	32.09±4.08
2	PC	0.12±0.02	1.13±0.02	57.25±3.75	89.55±0.47	60.76±1.30
3	PAFR	0.15±0.03	2.58±0.012	28.64±0.30	60.83±0.27	65.38±0.70

Note: All the values are expressed as Mean ± SD

Conclusion

Fresh prunus fruits are excellent sources of vitamins, minerals, fibers, carbohydrates and other bioactive compounds like phenols, flavonoids, ascorbate, antioxidant activity and radical scavenging activity. Processing of prunus to develop value added products can result in various products like Prunus Squash, Prunus Ready to Serve Beverage, Prunus Crush, Prunus osmotic dehydrated flakes, Prunus Health mix, Prunus weaning mix, Prunus fruit rolls and Prunus Apple fruit Rolls which are all attractive, colored and flavorsome with excellent potential for marketing. In the value added products, few nutrients like ascorbic acid, antioxidants activity etc will be reduced due to heat processing. However, the overall nutrient content of the products are par excellent as compared to many products due to the anthocyanins, carotenoids etc present in the prunus fruits. Fresh prunus fruits have a short harvest season and are sensitive to deterioration even when stored under refrigerated conditions; therefore, development of value added products from fresh prunus fruits is an effective way to preserve these fruits.

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References

1. Agrahar-Murugkar D, Subbulakshmi. GNutritive values of wild edible fruits, berries, nuts, roots and spices consumed by the Khasi tribes of India. Ecology of food and nutrition. 2005; 44(3):207-223.
2. AOAC. AOAC Official Methods of Analysis, (18th ed.), Association of Official Analytical Chemists, Arlington, VA. 2012; 4:1-45.
3. Bates GW, Schlabach MR. The reaction of ferric salts with transferrin. Journal of Biological Chemistry, 1973; 248(9):3228-3232.
4. Benzie Iris FF, Strain JJ *et al*. The Ferric Reducing Ability of Plasma (FRAP) as a Measure of Antioxidant Power: The FRAP Assay. Analytical Biochemistry. 1996; 239(1):70-6.
5. Brand-Williams W, Cuvelier ME, Berset CLWT *et al*. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology. 1995; 28(1):25-30.
6. Baxter CJ, Sabar M, Quick WP, Sweetlove LJ *et al*. Comparison of changes in fruit gene expression in tomato introgression lines provides evidence of genome-wide transcriptional changes and reveals links to mapped QTLs and described traits. Journal of Experimental Botany. 2005; 56(416):1591-1604.
7. Chaudhuri D, Ghate NB, Panja S, Das A, Mandal N *et al*. Wild edible fruit of prunusnepalensis ser.(steud), a potential source of antioxidants, ameliorates iron overload-induced hepatotoxicity and liver fibrosis in mice. PloS one. 2015; 10(12):1-20.
8. Chavan UD, Amarowicz R. Osmotic dehydration process for preservation of fruits and vegetables. Journal of Food Research. 2012; 1(2):202.
9. Da Silva FL, Escribano-Bailón MT, Alonso JJP, Rivas-Gonzalo JC, Santos-Buelga C *et al*. Anthocyanin pigments in strawberry. LWT-Food Science and Technology. 2007; 40(2):374-382.
10. Demarchi SMNA, Quintero Ruiz A, Concellon Giner SA *et al*. Effect of temperature on hot-air drying rate and on retention of antioxidant capacity in apple leathers. Food and Bioproducts Processing. 2013; 91:310-318.
11. Dinkova R, Heffels P, Shikov V, Weber F, Schieber A, Mihalev K *et al*. (Effect of enzyme-assisted extraction on the chilled storage stability of bilberry (myrtillus L.)

anthocyanin's in skin extracts and freshly pressed juices. Food research international. 2014; 65:35-41.
12. Divya K, Barmavath D, Dayakar B *et al*. Health mix product development by incorporating the bi-product of sorghum flakes powder & pulses and its organoleptic evaluation. Journal of Pharmacognosy and Phytochemistry. 2017; 6(5):1434-14.
13. Dwivedi UN, Singh P, Pandey VP, Kumar A *et al.* Structure–function relationship among bacterial, fungal and plant laccases. Journal of Molecular Catalysis B: Enzymatic. 2011; 68(2):117-128.
14. Elizabeth K, Rao MNA. Oxygen radical scavenging activity of curcumin. Int. J Pharm. 1990; (58):237-240.
15. Fuleki T, Francis FJ. Quantitative methods for anthocyanin's. Journal of food science. 1968; 33(3):266-274.
16. Gautier H, Lopez-Lauri F, Massot C, Murshed R, Marty I, Grasselly D, Genard M *et al*. Impact of ripening and salinity on tomato fruit ascorbate content and enzymatic activities related to ascorbate recycling. Functional Plant Science and Biotechnology. 2010; 4(1):66-75.
17. Georgelis N, Scott JW, Baldwin E *et al*. A Relationship of tomato fruit sugar concentration with physical and chemical traits and linkage of RAPD markers. Journal of the American Society for Horticultural Science. 2004; 129(6):839-845.
18. Jood S, Khetarpaul N. Food preservation. Agrotech Pub. Academy, 2002.
19. Jensen Miller W, SM0. Location and the theory of production: A review, summary and critique of recent contributions. Regional Science and Urban Economics. 1978; 8:117-128.
20. Kavitha C, Kuna A, Supraja T, Sagar SB, Padmavathi TVN, Prabhakar N *et al*. Effect of gamma irradiation on antioxidant properties of ber Zizyphusmauritiana) fruit. Journal of food science and technology. 2015; 52(5):3123-3128.
21. Lemuel M, Diamante Xue Bai, Janette Busch *et al*. Fruit Leathers: Method of preparation and effect of different conditions on qualities. International journal of food science. 2014.
22. Maynard DN. Underutilized and underexploited horticultural crops. Hortscience. 2008; 43(1):279-279.
23. Martinez-Tome M, Jimenez AM, Ruggieri S, Frega N, Strabbioli R, Murcia MA. Antioxidant properties of Mediterranean spices compared with common food additives. Journal of food protection. 2001; 64(9):1412-1419.
24. Meilgaard M, Civille GV, Carr BT *et al*. Sensory Evaluation Techniques. 3rd edition. CRC Press, Boca Raton, 1999.
25. Moran JM, Maydan D. High resolution, steep profile resist patterns. Journal of Vacuum Science and Technology. 1979; 16(6):1620-1624.
26. Mukherjee SP, Choudhuri MA. Implications of water stress-induced changes in the levels of endogenous ascorbic acid and hydrogen peroxide in Vigna seedlings. Physiologiaplantarum. 1983; 58(2):166-170.
27. Maskan Aysun, Sevim Kaya, Medeni Maskan *et al*. Hot air and sun drying of grape leather. (Pestil). Journal of Food Engineering. 2002; 54(1):81-88.
28. Nagendran B, Tan YA, Sambanthamurthi R, Sundram K, Samman S *et al*. Antioxidant properties of palm fruit extracts. Asia Pacific journal of clinical nutrition. 2005; 14(4):319.
29. Ordonez AAL, Gomez JD, Vattuone MA *et al*. Antioxidant activities of Sechiumedule (Jacq.) Swartz extracts. Food chemistry. 2006; 97(3):452-458.
30. Oyaizu M. Studies on products of browning reaction: antioxidative activities of products of browning reaction prepared from glucosamine. Jpn. J Nutr. 1986; 44:307-315.
31. Pavithra K, Vadivukkarasi. Evaluation of free radical scavenging activity of various extracts of leaves from Kedrostisfoetidissima (Jacq.) Cogn. Food Science and Human Wellness. 2015; 4(1):42-46.
32. Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C *et al*. Antioxidant activity applying an improved ABTS radical cation decolourization assay. Free radical biology and medicine. 1999; 26(9-10):1231-1237.
33. Redmond EC, Griffith CJ. Consumer food handling in the home: a review of food safety studies. Journal of food protection. 2003; 66(1):130-161.
34. Roe JH. The determination of sugar in blood and spinal fluid with anthrone reagent. Ibid. 1955; 212:335-343.
35. Rymbai H, Roy AR, Deshmukh NA, Jha AK, Shimray W, War GF *et al*. Analysis study on potential underutilized edible fruit genetic resources of the foothills track of Eastern Himalayas, India. Genetic resources and crop, 2016.
36. Saranya V, Devi KU, Suneetha J, Suneetha KB *et al.* Development and shelf life study of papaya fruit rollups. Journal of Pharmacognosy and Phytochemistry. 2017; 6(6):1420-1424.
37. Seal T. Nutritional composition of wild edible fruits in Meghalaya state of India and their Ethno-botanical importance. Research Journal of Botany. 2011, 58-67.
38. Singleton VL, Orthofer R, Lamuela-Raventós RM *et al*. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. In Methods in enzymology Academic press. 1999; 299:152-178.
39. Sharma R, Barwal VS, Lal-Kaushal BB. Preparation and evaluation of spiced plain squash. Bevarage Food World. 2002; 29:23-26.
40. Shobana S, Malleshi NG. Preparation and functional properties of decorticated finger millet (Eleusinecoracana). Journal of Food Engineering. 2007; 79(2):529-538.
41. Srivastava RP, Kumar S. Fruit and vegetable preservation: principles and practices. International Book Distributing Company, 2005.
42. Sowbhagya HB, Chitra VN. Enzyme-assisted extraction of flavorings and colorants from plant materials. Critical reviews in food science and nutrition. 2010; 50(2):146-161.
43. Somogyi M. Notes on sugar determination. Journal of biological chemistry. 1952; 195:19-23.
44. Stintzing FC, Carle R. Functional properties of anthocyanins and betalains in plants, food, and in human nutrition. Trends in food science & technology. 2004; 15(1):19-38.
45. Talcott ST, Howard LR. Phenolic autoxidation is responsible for color degradation in processed carrot puree. Journal of Agricultural and Food Chemistry. 1999; 47(5):2109-2115.
46. Tan ES, Abdullah A, Maskat MY *et al*. Effect of drying methods on total antioxidant capacity of bitter gourd

(Momordicacharantia) fruit. In AIP Conference Proceedings. 2013; 1571(1):710-716.
47. Wani SM, Riyaz U, Wani TA, Ahmad M, Gani A, Masoodi FA *et al*. Influence of processing on physicochemical and antioxidant properties of apricot (Prunus armeniaca L. variety Narmo). Cogent Food & Agriculture. 2016; 2(1):117-127.
48. Zhou J, Xie G, Yan X. Encyclopedia of Traditional Chinese Medicines: Molecular Structures, Pharmacological Activities, Natural Sources and Applications. Verlag Berlin Heidelberg: Springer, 2011.