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# Physico-functional characteristics of *Opuntia Ficus-indica*

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**Abstract**
In current investigation opuntia fruits were analysed for the Physico-chemical properties, Total Phenolic Content and Antioxidant Activity. The findings of thorough investigation show that the fruit contains $11^0$ Bx TSS, 4.6 pH and 0.075 % Titratable Acidity. The fruit founds great source of antioxidants (Betalains, Total Phenolic Content, Vitamin C and β-carotene), and hence it was investigated for the same. The most crucial colouring pigments Betalains were found about 564.645 mg/100g. The Total Phenolic Content was determined using Folin-ciocalteu reagent with varying solvent viz. Methanol (50%) and Distilled Water (100%). Results noted that Methanol as solvent shows 42.454 mg of GAE/100g whereas Distill Water (100%) showed about 38.736 mg of GAE/100g Total Phenolic Content. According to DPPH method the Antioxidant Activity was recorded and results depicted that fruits having 526.238 mg of AAE/100g and 513.764 mg of AAE/100g Antioxidant Activity for Methanol and Distilled Water respectively. Vitamin C was reported 31.95 mg/100g in the fruit pulp. Moreover, β-carotene was analyzed and it founds in negligible amount i.e. 0.85 µg/100g. Finally it is concluded that the Antioxidant Activity of fruit is a combined effect of Betalains, Total Phenolic Content, Vitamin C and β-carotene.

**Keywords:** antioxidant activity, betalains, total phenolic content, vitamin c

## 1. Introduction
*Opuntia* spp. fruit generally known as Indian fig or cactus pear in India belongs to Cactaceae family. It was first originated in Mexico [7]. Cactus pear (*Opuntia* spp) is native to arid and semi-arid regions. Cactus fruit consist of three major parts, the thick pericarp with spines that can penetrate human skin and cause irritation and the juicy pulp embedded with the hard seeds. The cactus pear has the ability to withstand the drought and hence it can be one of the crucial food sources for people living in arid and semi-arid regions [1, 14]. The shape of *Opuntia* fruit is oval somewhat elongated; technically we can call it as fleshy berry. Depending on the betalain content of the fruit the colour of the fruit various from orange red to red purple [25]. Betalains are the water-soluble pigments found in cactus fruit which also possess good antioxidant activity [27]. The *Opuntia* fruit is characterized by high pH values and low acidity. The fruit do not have any typical aroma but they are sweet and the main sugar components responsible for this sweetness are glucose and fructose [16]. Taking into consideration the high-water content of the fruit it can reach 50 kcal/100 g which is similar to that of other fresh fruits like orange, apricot and pear [5]. The antioxidant activity is worth to be noted. There are many compounds present in the fruit which possess antioxidant activity. The compounds like Vitamin C, Betalains, phenlolic compounds and flavoniods are some of them [4]. Some of the flavonoids present in *Opuntia* fruit are flavonones, Glycosilated flavonols, dihydro flavonols and flavonols. Among which the crucial flavonoids are quercitin, kaempferol and isorhamnetin [10]. The antioxidant activity in the *Opuntia* fruit shows medicinal effect on the body. It prevents our body from various degenerative diseases like hypercholesterolemia, diabetes, cancer, arteriosclerosis or cardiovascular and gastric diseases [8, 11].

The present investigation emphasizes on the physio-chemical characteristics and antioxidant activity of the fruit. The outcome of study constructs the roadmap for utilization of fruit in manufacturing of various processed food products with nutraceutical value.

## 2. Materials and Methods
### 2.1 Materials
*Opuntia Ficus-indica* was the species selected for the research study. The fruits were purchased from the market of Rajkot, Gujarat. The analytical instruments or equipment's viz. Thermometer, Refractometer, pH meter, Oven, Lovibond Tintometer and Desiccators etc. were utilized from laboratories of MITCFT, Pune.

### 2.2 Methods
The fruit and pulp was studied for various physico-chemical properties and functional properties.

#### 2.2.1 Physical Properties
**a. Weight**
Prickly pear fruits were weighed using weighing balance by taking average of 10 fruits [20].

**b. Shape and Size**
Shape and size of the prickly pear fruit was determined using Vernier caliper [20].

**c. Pulp and Seed Percent**
Pulp and seed ratio of fruit was determined by weighing the seed and pulp [20].

**d. Density/Specific Gravity**
Density and specific gravity of prickly pear fruit pulp was analysed using pycnometer [20].

**e. Colour**
Colour of the *Opuntia* fruit pulp was determined using Lovibond tintometer [20].

**2.2.2 Chemical Properties**

**a. Determination of Moisture**

Moisture content of the fruit pulp was determined using hot air oven (Ranganna, 2017).

**b. Determination of TSS**

TSS of the fruit pulp was measured using refractometer at $27^0$C (FSSAI, 2016).

**c. Determination of pH Value**

The pH of fruit pulp was measured using pH meter with reference to standard buffer solutions (FSSAI, 2016).

**d. Titratable Acidity**

Titratable acidity of the fruit pulp was determined by titrating the sample against 0.1N sodium hydroxide and using phenolphthalein as an indicator [20].

**2.2.3 Functional Properties**

**a. Determination of β-Carotene**

β-carotene in the fruit pulp was determined using spectrophometric method given by [24].

**b. Determination of Vitamin C (Ascorbic Acid)**

The vitamin C of the fruit pulp was determined by titrimetric method using 2, 6 -dichlorophenol indophenols dye [6].

**c. Betalains**

Betalains in the fruit pulp were determined by spectrophotometric method [12].

**d. Total Phenolic Content**

The pulp weighing 5g was mixed with 50 ml of 50% methanol and 100% distill water. Extraction was done for 24 h at room temperature, with magnetically stirring. Later on this solution was centrifuged at 4500 rpm for 20 min and supernatant was collected for further studies. Total phenolic content of the fruit pulp was assessed using Folin-ciocalteu reagent by slight modification in the method given by [29]. 100 µl of the sample was mixed was mixed with 900 µl of Folin-Ciocalteu reagent (diluted 1:10 with water). 0.75 ml of 7% sodium bicarbonate solution was added after 5 min. Incubation period given was 90 min in dark at ambient temperature. The absorbance was measured at 765nm. Gallic acid was used as standard and results were interpreted as gallic acid equivalent (GAE).

**e. DPPH Radical Scavenging Activity Assay**

The hydrogen atom or electron donation abilities of some pure compounds are measured by the bleaching of a purple coloured methanol solution of the stable 2, 2-diphenyl-2-picrylhydrazyl (DPPH) radical. Antioxidant activity in the fruit pulp was determined using DPPH solution and Ascorbic acid equivalent with slight modification in the method given by (Brand-Williams *et al*., 1995). 100 µl of the sample was mixed with 3.99 ml of DPPH solution having absorbance between 0.800 and 0.850. Incubation time was 90 min in dark and at ambient temperature. The results were recorded at 515nm using Ascorbic acid equivalent. The inhibition of free radical DPPH ($I$ %) was calculated as

$$Inhibition\% = [(A0 - A1)/A0] \times 100$$

Where $A0$ = absorbance values of the blank; $A1$ = absorbance value of test sample

**3. Results and Discussion**

**3.1 Physical Properties of Fruit**

Physical properties of any fruit represent its physiological status which helps in post-harvest operations and processing.

**Table 1:** Physical Properties of Fruit

| Sr. No. | Parameters | Results |
|---|---|---|
| 1 | Size | 3.4-3.8 cm |
| 2 | Weight | 22-28g (per fruit) |
| 3 | Edible Portion (Pulp) | 62.40% |
| 4 | Non-edible Portion (Peel and Seed) | 37.60% |
| 5 | Density of Pulp | 1.05 g/ml |
| 6 | Specific Gravity of Pulp | 1.053 |
| 7 | Colour of Pulp | 22R+3B+1.3Y |

*Each value is of three determinations

The weight and size of the fruits is greatly affected by variety, environmental conditions, maturity stage and post-harvest treatment [21]. The weight of fruit was found within 22 to 28g each. The edible portion (pulp) and non-edible portion (peel and seed) comprises about 62.40% and 37.60% respectively [13, 16, 17, 18, 19, and 25]. Density and specific gravity of the fruit pulp was recorded 1.05 g/ml and 1.053 respectively. The colour of fruit pulp was determined using lovibond tintometer and the results obtained shows 22R+3B+1.3Y values for color. According to results it could be observed that pulp has red color with some amount of dullness due to the higher value of blue than yellow (Crimson color).

**3.2 Chemical Properties of Fruit**

**Table 2:** Chemical Properties of Fruit

| Sr. No. | Parameters | Results |
|---|---|---|
| 1 | Moisture Content | 88.96 % |
| 2 | T.S. S | $11^0$ Bx |
| 3 | pH | 4.6 |
| 4 | Acidity | 0.075 % |

*Each value is an average of three determinations

The results for chemical characteristic fruit pulp are depicted in table no. 2. According to results depicted in above table, the moisture content was found about 88.96 %. The TSS for fruit pulp was recorded $11^0$ Bx. The pH and acidity of fruit was noted as 0.075 % 4.6 respectively [5, 26].

**3.3 Functional Properties of Fruit**

The functional properties are referred to the properties of foods which reflect on processing and nutritional value of processed product.

**Table 3:** Functional Properties of Fruit

| Sr. No. | Parameter | Results |
|---|---|---|
| 1 | Vitamin C (mg/100g) | 31.95 |
| 2 | Beta carotene (µg/100g) | 0.85 |
| 3 | Betalains (mg/100g) | 564.645 |
| | Betacyanins (mg/100g) | 379.31 |
| | Betaxanthin (mg/100g) | 185.32 |
| 4 | Total Phenolic Content | |
| | Methanol (50%) (mg of GAE/100g) | 42.454 |
| | Distilled Water (100 %) (mg of GAE/100g) | 38.736 |
| 5 | Antioxidant activity | |
| | 50% Methanol (mg of AAE/100g) | 526.238 |
| | Water (mg of AAE/100g) | 513.764 |

*Each value is an average of three determinations

Vitamin C acts as an antioxidant in our body and scavenges the free radicals. The table no 3 shows a noticeable vitamin C content (31.95 mg/100g) in fruits which resembles the results of Sepulveda and Saenz (1990) [22]. Vitamin C is responsible for 30-40% of the total antioxidant capacity of the fruit [3]. The Beta carotene content of fruit is affected by various factors viz. variety, soil composition etc. It was found in very negligible amount about 0.85µg/100g in fruit [28].

It was found that Betalains have higher antioxidant value when compared with Vitamin C and rutin. Cactus fruit have good antioxidant activity as compared to apple, pear, tomato, banana, and white grape, and from the same order as pink grapefruit, orange, and red grape [27]. As the betalains content of fruit is one of major constituent responsible for antioxidant activity it becomes an obligatory to analyze it. As mentioned in above table no 3 betalains was found about 564.64 (mg/100g) in the fruit pulp. Betalains are water soluble pigment that comprise of 2 main components that are red to violet (betacyanins) and yellow to orange (betaxanthyns). Comparatively betacyanins contributes a maximum portion 379.31 (mg/100g) than betaxanthin 185.32 (mg/100g), and the results are comparable with Odoux and Dominguez-López (1996) [15].

### 3.3.1 Total Phenolic Content

In *Opuntia ficus-indica* the dominant polyphenolic compounds are flavonoids and phenolic compounds [9]. Some of the important flavonoids found in *Opuntia* fruit are Glycosilated flavonols, dihydro flavonols, flavonones and flavonols. Flavonoids protects from injury or damage caused by free radicals in our body through various ways. Moreover, the phenolic constituents of fruits have a great impact on antioxidant activity and hence it has analysed, and results are noted in above table no 3. Standard curve for gallic acid is given in fig 1. The curve was plotted using various concentration of standard gallic acid and the absorbance measured. The total phenolic content of the fruit pulp was determined using gallic acid equivalent.

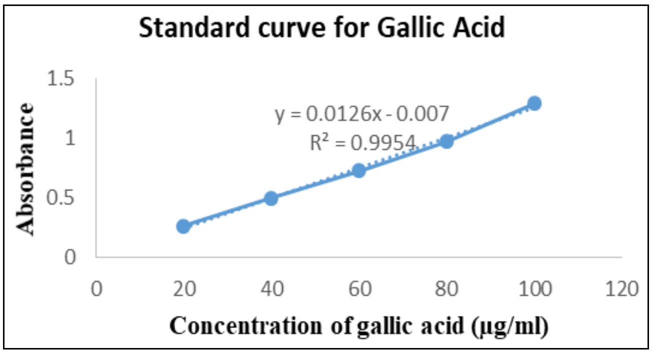


**Fig 1:** Standard graph of gallic acid for determining total phenolic content

Two solvents namely methanol (50%) and distil water (100%) was used for determining total phenolic content of the fruit pulp. Total phenolic content of the fruit pulp extracted using distilled water was found 38.7367 (mg of GAE/100g) and with methanol was found 42.454 (mg of GAE/100g). The extraction done using methanol showed higher total phenolic content as compared to sample extracted using distill water alone [10].

### 3.3.2 Antioxidant Activity

The Antioxidant activity of the fruit pulp was determined using Ascorbic acid equivalent. The standard curve of % inhibition of standard Ascorbic acid is shown in fig 2. The graph was plotted using % inhibition of ascorbic acid and concentration of ascorbic acid.

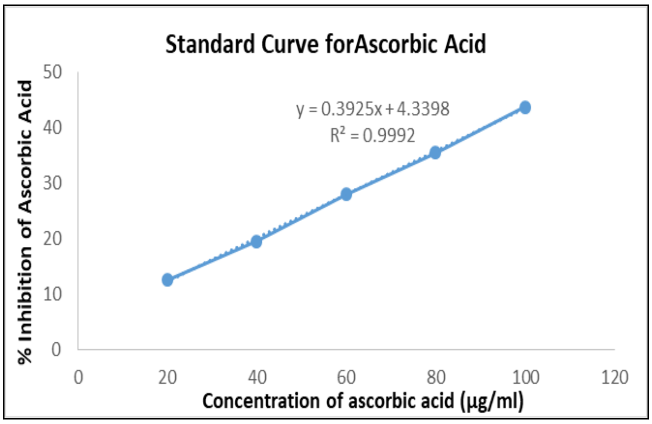


**Fig 2:** Standard graph of ascorbic acid for determination of antioxidant activity.

The antioxidant activity for the fruit pulp extracted using methanol (50%) was found 526.238 (mg of AAE/100g) and that of with distilled water (100%) was found 513.7644 (mg of AAE/100g). From the result we can interpret that the antioxidant activity was found higher in the sample extracted using 50% methanol as compared to that of water. Furthermore, it has recorded that the flavonoids having higher antioxidant activity when compared to that of vitamins [23].

## 4. Conclusion

The outcome of research findings shows that fruit contains a noticeable amount of vitamin C, betalains, and total phenolic content and hence possess good antioxidant activity. It has also noted that the extract of the fruit pulp prepared using methanol showed higher total phenolic content and antioxidant activity as compared to distilled water. Furthermore, it is verified that betalains, vitamin C, phenolic compounds are collectively responsible for the antioxidant activity possessed by *Opuntia ficus –indica*. Despite a promising source of natural colouring agent betalains, a good antioxidant activity bearing fruit, it is at nascent stage of processing because of some physiological threats. Thus, it motivates to think through development of technologies to overcome these threats to manufacture different processed food products at commercial level.

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