A study on biochemical properties of different parts of three *Opuntia* species (*Opuntia ficus-indica*, *O. microdasys*, and *O. basilaris*)

Ehya Pasandide Talemi and Shahram Sedaghathoor*

Ornamental Plants, Horticulture, Rasht Branch, Islamic Azad University, Rasht, Iran.
*Corresponding Author: sedaghathoor@yahoo.com

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ABSTRACT

Cacti are thorny plants originated from America that grow in most parts of the world. It is used as an ornamental plant thanks to its unique fleshy and beautiful appearance. The fruits of *Opuntia* are rich in antioxidants, which makes it possible for this species to tolerate grueling adverse environments. The biochemical properties of fruits and stems of three *Opuntia* species (*Opuntia ficus-indica*, *O. microdasys*, and *O. basilaris*) were studied in a trial based on a completely randomized design with three replications. The intended traits were estimated for the tissues of stems and fruits. They included total protein, dissolved sugar, enzymatic antioxidants like catalase and peroxidase, anthocyanin content, carotenoid, chlorophyll, pH, total acidity, vitamin C and Brix degrees content in the juice. The results revealed that the stems and fruits of *O. ficus-indica* had the highest carotenoid and chlorophyll *a*, the stems of *O. microdasys* had the highest antioxidant capacity, anthocyanin, carotenoid, chlorophyll, peroxidase, and protein, and the fruits of *O. basilaris* had the lowest antioxidant capacity, anthocyanin, catalase, peroxidase, and Brix.

Keywords: Prickly pear, anthocyanin, peroxidase, carotenoid, antioxidant capacity.

INTRODUCTION

Opuntia cactus (*Cactaceae*) is a fleshy species producing about 200 – 300 species and is mainly growing in arid and semi-arid zones (Stintzing and Carle, 2005). The leaves of *Opuntia* cactus are inconspicuous, however the plate-like sections of the stem are often thought of as leaves (Gilman, 2014). Traditionally, cactus pads contribute considerably to the human diet in some regions and still serve as therapeutic agents. In folk medicine, especially *O. fuliginosa* and *O. streptacantha* have been used for the treatment of gastritis, fatigue, dyspnoe, and liver injury following alcohol abuse (Hitchcock Nol *et al*. 1997; Shapiro and Gong, 2002; Stintzing and Carle, 2005). These plants possess diverse chemicals that are instrumental to their survival. The treatment of patients with the products of this species amounts to $1.5 billion throughout the world (Fugan, 2013).

Enzymatic antioxidant system is composed of multiple enzymes including superoxide dismutase (SOD), peroxidase (POD) and catalase (CAT). Non-enzymatic antioxidant systems include vitamin E, carotenoid, anthocyanin, and phenolic compounds (Felsot, 2004; Singh *et al*. 2007). Peroxidase is a part of enzymatic defense system of plant cells,

and oxidizes a wide range of hydrogen donor compounds in the presence of H_2O_2. In fact, they trigger the conversion of H_2O_2 to H_2O and oxygen (Gaspar *et al*. 1982).

Anthocyanins are the most important pigments among flavonoids. They can be found in colorful foods like strawberries, apples, cherries, blackberries, oranges, grapes, figs, mangoes, pomegranates, red cabbages, and sweet potatoes (Lee *et al*. 2005).

Carotenoids are one of the most important natural pigments with a different chemical structure (Sass-Kiss *et al*. 2005). They are usually responsible for yellow, red and orange colors in most fruits and vegetables. In addition to their main function as light absorption pigments, carotenoids are found to safeguard tissues against oxidative damages (Hodges, 2003).

Vitamin C is a water-soluble vitamin that can be readily oxidized to dehydroascorbic acid (Groff *et al*. 1995). Vitamin C is characterized with its role in the deactivation of free radicals before they can damage cell membrane (Jacoby, 1999). The increased levels of some elements in soil, like P and N, result in the loss of vitamin C content of citruses. Furthermore, higher level of K enhances vitamin C content (Nagy, 1980).

Kuti (2004), studied antioxidant compounds in four *Opuntia* cacti and found that antioxidant capacity of cactus fruits might be attributed to their flavonoid, ascorbic acid, and carotenoid contents. He reported that cactus fruits are a rich source of natural antioxidants for foods. Yeddes *et al.* (2013), found that *Opuntia stricta* fruits exhibited the best antioxidant activities as compared to the two forms of *O. ficus indica*, while the total phenolic compound was more important in *O. ficus indica* than in the *O. stricta* fruits.

The objectives of the present work were to determine the antioxidants and biochemical parameters of three *Opuntia* species and to compare their biochemical traits.

MATERIALS AND METHODS

Plant material and experiment design

The study examined three *Opuntia* species including *Opuntia basilaris* (the so-called beavertail cactus) procured from Flower and Ornamentals Research Center of Nowshahr, *O. ficus-indica* (the so-called Indian fig *Opuntia*) procured from Mahallat, and *O. microdasys* (the so-called bunny ears cactus) procured from Guilan Province (Figure 1). Two tissues of these three *Opuntia* species were assessed in a completely randomized design with three replications. Trial materials included *O. ficus-indica* stem (T1), *O. ficus-indica* fruit (T2), *O. microdasys* stem (T3), *O. microdasys* fruit (T4), *O. basilaris* stem (T5), and *O. basilaris* fruit (T6).

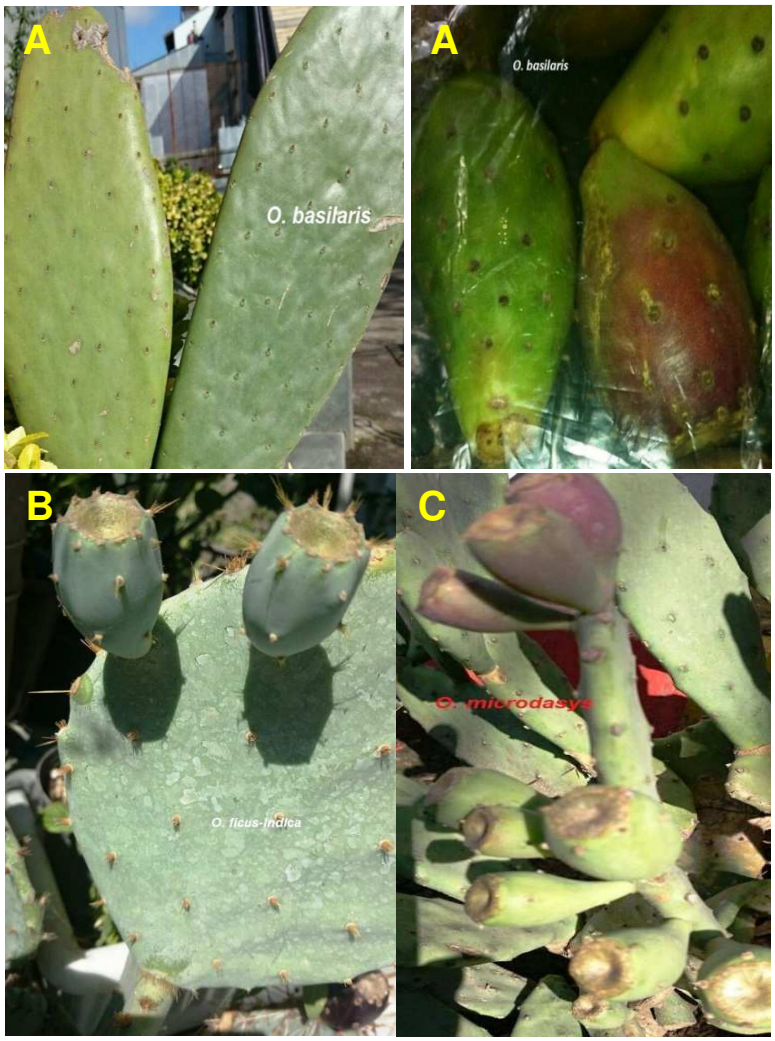

Figure 1. (A) Fruits and stems of *O. basilaris*; (B) *O. ficus-indica* and (C) *O. microdasys.*

Trial characteristics

The intended traits of stems and fruits were assessed in three replications. They included total protein, dissolved sugar, antioxidant enzymes like catalase and peroxidase, anthocyanin, carotenoid, chlorophyll, pH, total acidity, and vitamin C.

Antioxidant capacity

In order to estimate antioxidant capacity, 1 g of the plant was wrapped in a piece of foil and was placed in liquid nitrogen for 2-3 minutes. Then, it was ground with 10 mL methanol 85% and the samples were left in room temperature for one hour. Next, their extract was infiltrated and centrifuged for five minutes. Next, 150 µL was taken from it and was added with 850 µL DPPH. The solution was stirred fast and was kept in room temperature at darkness for 20 minutes. After placing the blank and resetting the instrument, first only DPPH was poured into the cuvette and it was read. Then, the sample was read at 517 nm with a spectrophotometer (Apel PD-303 UV). The antioxidant capacity of the extracts was calculated by the following equation in terms of % inhibition in DPPH (Brand-Williams *et al*. 1995):

$$\%DPPH = \frac{A_{cont} - A_{samp}}{A_{cont}} \times 100$$

Where,

%DPPH = percent inhibition,
A_{cont} = absorption rate of DPPH, and
A_{samp} = absorption rate (sample + DPPH).

Chlorophyll content

Different treatments were sampled to measure the chlorophyll content. So, 0.5 g of the samples was weighed and was ground in a Chinese mortar containing 50 cc acetone 80% (80 cc acetone + 20 cc distilled water). Then, it was infiltrated, was adjusted to 50 cc, and was poured in cuvettes. The chlorophyll content was read at 643 and 660 nm with a spectrophotometer. Then, they (A) were replaced in the following equations to estimate chlorophyll *a*, chlorophyll *b*, and total chlorophyll (Mazumdar and Majumder, 2003):

$$\text{Total chlorophyll (mg/ml)} = 7.12(A_{660}) + 16.8(A_{643})$$

$$\text{Chlorophyll } a \text{ (mg/ml)} = 9.93(A_{660}) - 0.777(A_{643})$$

$$\text{Chlorophyll } b \text{ (mg/ml)} = 17.6(A_{643}) - 2.81(A_{660})$$

Carotenoid and anthocyanin content

To measure carotenoid content, 0.5 g of sample was ground with 50 cc acetone 80% (80 cc acetone + 20 cc distilled water). Then, it was infiltrated, was adjusted to 50 cc, and was poured into cuvettes. The extracts were read at 645, 663 and 660 nm and they were replaced in the following equation to estimate carotenoids (Mazumdar and Majumder, 2003):

$$\text{Carotenoid content} = 4.69(A_{660}) - 0.268(A_{645}) + 8.02(A_{663})$$

To quantify anthocyanin, 0.5 g of the sample was ground in a Chinese mortar containing 50 cc ethanol-hydrochloric acid (85 parts of ethanol 95% + 15 parts of hydrochloric acid). Then, the extract was infiltrated, was adjusted to 50 cc, and was poured into cuvettes. The cuvettes were placed in a refrigerator at 4°C for 24 hours followed with placing in darkness for two hours. To measure anthocyanin content, the extracts were read at 535 nm with a spectrophotometer and the following equation was used (Mazumdar and Majumder, 2003):

$$\text{Total absorption} = \frac{a \times b \times c}{d \times a} \times 100$$

Where,

a = sample weight (0.5 g)
b = volume taken for measurement (5 cc)
c = total volume (50 cc)
d = fraction taken for 0.1 sample
e = figure read at 535 nm

$$\text{Total anthocyanin \% in sample} = \frac{\text{total absorption of sample}}{98.2}$$

Protein content

Protein was measured by Bradford's (1976) method, in which 100 mL Tetris buffer 0.5 mol with the pH of 6.8 was added with 2 g SDS. Then, 200 µL of the buffer was added to the plant sample and was mixed with a sterile glass bar. All stages were carried out at 4°C. Then, the solutions were centrifuged at 13,000 rpm for 20 minutes. Five mL of Bradford solution was added with 100 µL of the extract, and after 30 minutes in laboratorial conditions, its absorption was read at 595 nm, and the protein content was measured in $mg.g^{-1}$. Standard protein solution was prepared by dissolving 1 mg BSA powder in 5 mL twice distilled water. Then, 5 mL of Bradford solution and pre-determined volumes of standard BSA solution from 20 to 200 µL were poured into test tubes and were diluted to 500 µL by adding distilled water. Afterwards, the absorption of the standard solutions was read at 595 nm with a spectrophotometer, and a standard curve was drawn.

Vitamin C content

Vitamin C was measured by titration with dichlorophenolindophenol, for which 2 g of plant tissue was ground in a Chinese mortar with liquid nitrogen. Then, 10 cc meta-phosphoric acid 3% was added and was titrated with 2,6 dichloro phenol-indophenols (DIP) until a light pink color emerged (Ladaniya, 2008). Vitamin C content was obtained by

$$\text{Vit C (mg } 100^{-1}) = \frac{e \times d \times b}{c \times a} \times 100$$

Where,

a = sample weight
b = the volume of meta-phosphoric used for extraction
c = the volume of sample taken for titration
d = color factor
e = mean DIP used for titration

$$d = \frac{0.5}{\text{amount of DIP used for standard titration of ascorbic acid}}$$

Brix index

To measure Brix, a part of the plant was detached and its sap was poured on a sensitive glass plate of refractometer [ATAGO (N-1ά)], the cap was closed, glass plate was placed in front of radiation, and after reading Brix number, the reference table was used to determine the percentage of the substance in the liquid.

Peroxidase and catalase activity

To measure the activity of peroxidase enzyme, its extract was prepared, and then, the variations of OD were read at 430 nm with a spectrophometer every 30 seconds for 2 minutes (Addy and Goodman, 1972).

The procedure to measure catalase enzyme was as follows (Dazy *et al*. 2008): 0.01 molar phosphate buffer (pH=7), 0.5 mL H_2O_2 0.2 molar, and 2 mL acid reagent (dichromate/acetic acid) was added to 1 g plant tissue ground in 4 mL ethanol. Then, its absorption was read at 610 nm with a spectrophotometer.

Statistical analysis

Data were statistically analyzed using MSTATC package, and means were compared by LSD test.

RESULTS AND DISCUSSION

Antioxidant capacity

According to analysis of variance (Table 1 and 3), there were significant differences among plant parts and the studied species in antioxidant capacity, anthocyanin content, vitamin C content, carotenoid, chlorophyll *a* and *b* content, total chlorophyll, catalase enzyme activity, peroxidase enzyme, protein content, Brix, total acidity, and pH ($p<0.01$).

The results revealed that the highest antioxidant capacity was related to the fruits of *O. microdasys* and the lowest one to fruits of *O. basilaris* (Table 2). Kuti (2004), reported that antioxidant capacity (ORAC value) in fruit extracts of *Opuntia lindheimeri* was higher than *O. ficus-indica*. It has been shown that maturity stage is dramatically effective on enhancing antioxidants (N'Dri *et al*. 2010). Medium temperatures (25-30°C) improve antioxidants. Also, plant growth in cold (12-18°C) or very hot (over 35°C) conditions reduces antioxidants content (Wang and Zheng, 2001).

Cultivar, genotype, climatic conditions, and the consumed part of the plant impact the antioxidants content in different cultivars of the plants so that the stems of broccoli display stronger antioxidant properties than their leaves (Kaur *et al*. 2007). Similarly, it was observed various antioxidant capacities in different species and different parts (fruits or stems). The results revealed that the fruits of *O. microdasys* had three times higher antioxidant capacity than those of *O. basilaris*. It seems that plant genetics influence antioxidant trait significantly.

Table 1. Analysis of variance for biochemical characteristics of three *Opuntia* species.

S.O.V.	df	Means of squares						
		Antioxidant	**Anthocyanin**	**Vitamin C**	**Carotenoid**	**Chlorophyll *a***	**Chlorophyll *b***	**Total chlorophyll**
Treatment	8	0.06**	72908.68**	6.74**	0.66**	2.01**	0.16**	3.14**
Error	18	0.001	402.39	0.12	0.08	0.11	0.02	0.10
C.V. (%)	-	10.42	9.29	3.39	25.92	17.79	29.73	21.03

** shows significant differences at 1% level.

Total anthocyanin

It was revealed that the highest anthocyanin was observed in the stems of *O. microdasys* and the lowest one in the fruits of *O. basilaris* (Table 2). Anthocyanin content increases at fruit maturity stage and is maximal in fruit flesh and peel. Chemical compounds in fruits and vegetables are affected by multiple endogenous and exogenous factors like variety, harvest time, plant age, maturity stage, environment, and genetic features (Singh *et al*. 2007). As maturity process is completed, anthocyanin production starts to decline, possibly because of its dissolution. It was observed the lowest anthocyanin content in the fruits of *O. basilaris*. Therefore, it can be said that the loss of anthocyanin was caused by its dissolution in these fruits. The results showed that the stems of *O. microdasys* (having the highest anthocyanin content) and the fruits of *O. basilaris* (having the lowest anthocyanin content) had a 300%

difference in anthocyanin content. Accordingly, anthocyanin content seems to be determined by plant genetics.

Table 2. Means comparison for biochemical characteristics of three *Opuntia* species.

Treatment	Antioxidant (%DPPH)	Anthocyanin (g 100 g^{-1} DM)	Vitamin C (mg 100 ml^{-1})	Carotenoid (g l^{-1})	Chlorophyll *a* (mg ml^{-1})	Chlorophyll *b* (mg ml^{-1})	Total chlorophyll (mg ml^{-1})
Stems of *O. ficus-indica*	30^{b}	200.3^{c}	11.48^{a}	1.48^{a}	1.75^{a}	0.68^{a}	2.42^{a}
Fruits of *O. ficus-indica*	40^{a}	142.6^{d}	11.05^{ab}	0.56^{b}	0.42 ^{a} b	0.23^{b}	0.65^{b}
Stems of *o. microdasys*	41^{a}	314.0^{a}	7.85^{c}	1.32^{a}	2.09^{a}	0.65^{a}	2.75^{a}
Fruits of *O. microdasys*	42^{a}	273.3^{ab}	10.98^{ab}	1.36^{a}	0.60^{b}	0.37^{b}	0.96^{b}
Stems of *O. basilaris*	37^{ab}	266.5^{b}	10.48^{b}	1.25^{a}	0.92^{b}	0.23^{b}	0.15^{b}
Fruits of *O. basilaris*	14^{c}	98.44^{d}	10.26^{b}	0.60^{b}	0.48^{b}	0.40^{ab}	0.87^{b}

Similar letter(s) in each column show insignificant differences at the 1% probability level according to LSD test.

Protein content

The highest protein content was found in the stems of *O. microdasys* and *O. ficus-indica* and the lowest one was observed in the fruits of *O. ficus-indica* (Table 4). The protein content is less than 1% of the fresh mass of fruit and vegetable tissues. Fruits are low in proteins, but nuts are a good source of high-quality proteins (Vicente *et al*. 2009). Therefore, the results suggest that the fruits of the studied cactus species can be used as a source of protein. According to the results of the present study, protein content may vary across species, variety, and plant organ.

Table 3. Analysis of variance for biochemical characteristics of three *Opuntia* species.

S.O.V.	df	Means of squares					
		Catalase	Peroxidase	Protein	Brix	pH	Total acidity
Treatment	8	0.03**	0.017**	0.15**	8.46**	1.05**	0.23**
Error	18	0.00	0.02	0.01	0.49	0.12	0.03
C.V. (%)	-	4.91	14.31	14.87	12.60	8.94	14.40

** shows significant differences at 1% level

Brix index

The fruits of *O. ficus-indica* had the highest Brix, but the lowest Brix was related to the stems of *O. basilaris* (Table 4). Sugar content of the studied cacti ranged from 5 to 8%. The sugar content is 5-8% in pome fruits, 6-12% in nuts, 13-20% in grapes, and 3-13% in mulberries. This study shows that the fruits of the studied cacti are rich in sugar. *O. ficus-indica* is an important food source in dry regions. Although it is used as forage, it is mostly consumed as a sweet food in these regions. Recently, studies have been done on the fruits of *O. ficus-*

indica to make fruit juice, marmalade and other types of processed foods and also on extending the longevity of the fresh fruits (Saenz *et al*. 1998).

Table 4. Means comparison for biochemical characteristics of three *Opuntia* species.

Treatment	Catalase (Int. unit mg^{-1} protein)	Peroxidase (Int. unit mg^{-1} protein)	Protein (g 100 g^{-1} FW)	Brix (%)	pH	Total acidity (%)
Stems of *O. ficus-indica*	0.04^{c}	0.92^{bc}	0.71^{a}	6.10^{b}	3.41^{c}	1.45^{a}
Fruits of *O. ficus-indica*	0.03^{c}	0.78^{bc}	0.20^{c}	8.17^{a}	4.49^{ab}	1.35^{ab}
Stems of *O. microdasys*	0.08^{b}	1.25^{a}	0.75^{a}	4.77^{bc}	3.72^{bc}	0.93^{c}
Fruits of *O. microdasys*	0.04^{c}	1.01^{ab}	0.51^{b}	4.43^{c}	3.33^{c}	1.50^{a}
Stems of *O. basilaris*	0.36^{a}	0.78^{bc}	0.59^{ab}	4.30^{c}	$4 .50^{a}$	1.30^{abc}
Fruits of *O. basilaris*	0.03^{c}	0.68^{c}	0.59^{ab}	5.50^{bc}	3.78^{abc}	1.00^{bc}

Similar letter(s) in each column show insignificant differences at the 1% probability level according to LSD test.

Vitamin C content

The stems of *O. ficus-indica* had the highest vitamin C content and the fruits of *O. microdasys* had the lowest one (Table 2). Ascorbic acid (vitamin C) is found in leaves in mM concentrations and, as a part of antioxidant system, plays a key role in plant's tolerance to stresses. As well, it contributes to photosynthesis regulation, cell development, root elongation, and electron transfer across the membrane (Guo *et al*. 2005). The variations in vitamin C depend on different factors including variety, species, growth conditions, region, and harvest conditions. Perimeter temperature variations, photosynthesis process, relative humidity, oxidative stresses, and exposure to solar radiation are some other factors that determine vitamin C content. Furthermore, vitamin C content may show variations at fruit maturity stage (Ben-ahmed *et al*. 2009). We found that vitamin C content in superior treatment (the stems of *O. ficus-indica*) was over 30% higher than that in the stems of *O. microdasys*. Furthermore, vitamin C content of stems of *O. ficus-indica* and *O. basilaris* was relatively higher than that of their fruits, though the difference was not statistically significant. Significant differences in betalain content, phenolic compounds, flavonoids, and vitamin C were found among the 15 xoconostle genotypes (Martínez *et al.* 2015).

Carotenoid content

Means comparison did not show statistically significant differences among the stems of *O. ficus-indica*, the stems of *O. microdasys*, the fruits of *O. microdasys*, and the stems of *O. basilaris* in carotenoid content, but the highest carotenoid content was related to the stems of *O. ficus-indica* and the lowest one to the fruits of *O. ficus-indica* and *O. basilaris* (Table 2). In a study on phenol content and carotenoid compounds in the fruits of roses, Marie *et al*. (2005) reported that phenolic compounds and carotenoid content were mainly determined by species and cultivar and that the variations in phenol compounds was subtle among wild rose species whilst the variations in total carotenoid content was substantial among species. *Rosa spinosissima* showed the lowest carotenoid content, and the darker

fruits had higher anthocyanin content than other species. They reported that phenolic compounds and carotenoid largely depended upon species and cultivars.

Chlorophyll a, b and total chlorophyll

It was found that the highest chlorophyll *a* was related to the stems of *O. microdasys* and *O. ficus-indica* and the lowest one to the fruits of *O. ficus-indica* (Table 2). The highest chlorophyll *a* content was five times higher than the lowest one. In general, we observed that the stems of all studied species had higher chlorophyll *a* content than the fruits. The highest chlorophyll *b* content was seen in the stems of *O. ficus-indica* and the lowest one in the fruits of *O. ficus-indica* and the stems of *O. basilaris* (Table 2). Total chlorophyll content was higher in the stems of *O. microdasys* and *O. ficus-indica* than other treatments, and the lowest total chlorophyll content was related to the fruits of *O. ficus-indica* (Table 2). The difference in total chlorophyll between most and least superior treatments was over 400%. The results showed that in all three studied species, total chlorophyll was higher in stems than in fruits as is expected in most plants.

The present work showed that the stems of *O. microdasys* and *O. ficus-indica* had the highest total chlorophyll content. In general, chlorophyll content is a useful measure for the physiological evaluation of a certain plant (Jiang and Huang, 2001). These authors have, also, mentioned chlorophyll content in plants as an important determining factor of their potential photosynthesis. Various environmental factors influence photosynthesis intensity and its related processes. This impact varies with crop, its cultivar, and climatic conditions (Heidarisharirabad, 2001). The physiological characteristics of leaves like cell structure, chloroplast movements, and water status may have a paramount influence on leaf chlorophyll (Vidal *et al*. 1999). One main cause of chlorophyll loss is its destruction by active oxygen species (Navari-Izzo *et al*. 1990). The difference in chlorophyll content observed in the present study may be dependent on variety, plant genetics, and/or radiation conditions during the trial that created specific conditions for the studied species.

Catalase enzyme

Catalase enzyme was the most active in the stems of *O. basilaris*, while it was the least active in the fruits of *O. basilaris* and the fruits of *O. ficus-indica* (Table 4). The difference in catalase enzyme content was extremely high (8.6 times) among the experimental materials, and stems had higher catalase content than fruits in all cases. Catalase is one of the enzymatic antioxidants that stop chain reactions of free radicals and protects the plants against oxidative stress by the removal of hydrogen peroxide (Vinchnevestkania and Roy, 2001; Rukmini *et al*. 2004). It converts hydrogen peroxide to water and oxygen by its antioxidant activity (Gaspar *et al*. 1982). Also, the enzyme has a molecule that, as an oxidoreductase, loses an extra electron and/or accepts an electron (Savoure *et al*. 1999).

Peroxidase activity

The highest amount of peroxidase was obtained from the stems of *O. microdasys* and the lowest one from the fruits of *O. basilaris* (Table 4). The stems were found to have higher peroxidase than the respective fruits. Peroxidase is involved in most cell processes like auxin metabolism, wood formation, transverse links in plant cell walls, response to environmental stress, and so on (Yamasaki *et al*. 1997). All researchers who have worked on this enzyme agree that it is very difficult to precisely determine its physiological functions and it still needs to be studied further (e.g. Tong *et al*. 1998; Mathe *et al*. 2010).

pH and acidity

Data in Table 4 reveal that the stems of *O. basilaris* displayed the highest pH and the fruits of *O. microdasys* displayed the lowest one. All in all, it was found that the pH of the studied cacti was acidic. The approximate ranges of pH for fruits and vegetables are usually 3.7-4.5. Crop resistance to bacterial diseases and fungi depends upon its acidity. Crops with lower pH are more resistant to bacterial diseases, and fungi grow better in lower pH (Ramaswamy and Marcotte, 2006). We found that the pH of cacti was in the pH range of vegetables, i.e., 3.7-4.5.

The fruits of *O. microdasys* had the highest acidity and its stems had the lowest acidity. Acidity varies with cultivar, rootstock, environmental conditions, and pre-harvest garden practices. Acidity combined with sugar forms the flavor of the fruit (Monselise, 1986). Mean acidity is 0.04-1% in pome fruits, 0.09-4% in mulberries, and 1% in lemons. Unlike sugar content that increases with maturity (and declines after full maturity), fruit acidity declines during maturing (Marsh *et al*. 2000).

CONCLUSIONS

Results revealed that the stems of *O. ficus-indica* had the highest carotenoid, chlorophyll *a* and *b*, total chlorophyll, acidity, vitamin C, and protein, and its fruits had the highest antioxidant capacity and Brix and the lowest carotenoid, chlorophyll *a* and *b*, total chlorophyll, catalase enzyme, and protein. According to our results, *O. ficus indica* can be recommended as an edible fruit. Also, it is recommended to conduct further studies on identifying the chemicals and medicinal compounds in *Opuntia* species. According to Tesoriere *et al.* (2004), consumption of cactus pear fruit positively impacts the body's redox balance, decreases oxidative damage to lipids, and improves antioxidant status in healthy humans.

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