Research Article

Mohammed Bourhia*, Hamza Elmahdaoui*, Riaz Ullah, Samir Ibenmoussa, Abdelaaty Abdelaziz Shahat

Physicochemical evaluation of the fruit pulp of Opuntia spp growing in the Mediterranean area under hard climate conditions

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Abstract: Barbary fig called prickly pear is a plant belonging to family Cactaceae growing under hard climate conditions. A spiny variety of prickly pear named "Drbana" (Opuntia megacantha) and two non-spiny varieties named "Akria" and "Mlez" (Opuntia ficus-indica) growing in the Rhamna region (Morocco) were studied in terms of physicochemical characteristics. The physicochemical characterization (humidity, water activity, pH, total titratable acidity, Brix, and ash content) and the biochemical characterization (total carotenoid content, betalain content, total polyphenolic content, and ascorbic acid content) of the fruit pulp of prickly pear were performed according to the previously reported methods. The finding of physicochemical characterization of all studied varieties showed that the fruit pulp also contained an interesting bioactive compound classes in humidity, water activity, pH, total titratable acidity, Brix, and ash content. Regarding the biochemical characterization, the obtained finding showed the fruit pulp also contained an

interesting bioactive compound classes particularly the total betalains, polyphenols, carotenoids, and ascorbic acids. Based on the obtained results in the current research work, we can affirm that the fruits of all studied varieties meet the requirement for being exploited in food, cosmetic, and pharmaceutical industries.

Keywords: prickly pear, variety, biochemical characterization, physicochemical characterization, *Opuntia megacantha*, *Opuntia ficus-indica*

1 Introduction

Prickly pear (Barbary fig) is a plant belonging to family Cactaceae, which is characterized by considerable genetic diversity, including 2,000 species springing from over 20 to 30 genera [1]. It is native to the arid and semi-arid areas of Mexico. It has been cultivated in Africa since the sixteenth century [2].

In Morocco, the cultivation of prickly pear has increased from 45,000 ha in early 1990 to more than 1,50,000 due to efforts exercised by the government in plant cultivation. The great efforts dedicated by the Moroccan state for the development of cactus crops in different areas throughout the country (cultivation and valorization) have been due to the resistance of the investigated plant to hard climate conditions and its ability to grow in areas where other fruit plants cannot [3].

Prickly pear is an important component of the human diet due to its organoleptic and nutritional properties. It also has considerable potential for use in pharmaceutical and cosmetic industries. In addition to its cladodes and flowers, its fruits have high sugar content and low acidity that make them delicious. Moreover, prickly pear fruits contain betalain pigments (betacyanins and betaxanthins), as reported in earlier published data [4].

Prickly pear could be used as an alternative for the treatment of chronic diseases due to its documented

Abdelaaty Abdelaziz Shahat: Department of Pharmacognosy (Medicinal Aromatic and Poisonous Plants Research Center), College of Pharmacy, King Saud University, P.O. Box 2457, Riyadh 11451, Saudi Arabia; Chemistry of Medicinal Plants Department, National Research Centre, 33 El Bohouth St., (former El Tahrirst.) 12622, Dokki, Giza, Egypt

^{*} Corresponding author: Mohammed Bourhia, Laboratory of Chemistry, Biochemistry, Nutrition, and Environment, Faculty of Medicine and Pharmacy, University Hassan II, Casablanca, Morocco, e-mail: bourhiamohammed@gmail.com

^{*} Corresponding author: Hamza Elmahdaoui, Laboratory of Food Technology and Quality, Regional Center for Agricultural Research in Marrakesh, National Institute for Agricultural Research, INRA, Marrakesh, Morocco, e-mail: hamza.elmahdaoui@edu.uca.ac.ma Riaz Ullah: Department of Pharmacognosy (Medicinal Aromatic and Poisonous Plants Research Center), College of Pharmacy, King Saud University, P.O. Box 2457, Riyadh 11451, Saudi Arabia Samir Ibenmoussa: Laboratory of Chemistry, Biochemistry, Nutrition, and Environment, Faculty of Medicine and Pharmacy, University Hassan II, Casablanca, Morocco

activities. The following activities were reported: (1) prickly pear induces a decrease in the total cholesterol, low-density lipoprotein—cholesterol, triglycerides, fibrinogen, blood glucose, insulin, and uric acid. (2) Prickly pear could be effective in insulin-independent diabetic mellitus type 2. (3) *Opuntia ficus-indica* seed oil exhibited potent antioxidant and prophylactic effects. (4) The treatment with cladode and flower infusions of *Opuntia ficus-indica* showed an increase in diuresis and natriuresis as reported in earlier found data. The mucilage extracted from prickly pear possesses promising effects on chronic gastric ulcers. (5) The role of prickly pear in gas protection was also documented.

This study aims to evaluate the physicochemical content in the fruit pulp of three prickly pear varieties named "Drbana" (*Opuntia megacantha*), "Akria", and "Mlez" (*Opuntia ficus-indica*) growing in the Mediterranean region under hard climate conditions.

2 Materials and methods

2.1 Study area

Barbary fig fruit sampling was effectuated in the Skhour Rhamna region located at the west-central of Morocco (32° 29′ N: 7° 55′ W) at 98.7 km Northwest of Marrakech city (Figure 1).

2.2 Climatic and soil conditions

The Rhamna region is characterized by an arid Mediterranean climate with a cold winter and a dry summer (Emberger's Pluviothermic Quotient: Q2 = 20.6). The Rhamna region is recognized by low and irregular annual rainfall over the year (Xeric Climate). The average annual precipitation is 130 mm (methodological station of Ben Guerir, 2017). The Gaussen and Bagnouls diagram of the Rhamna region reveals that the dry climate occurs during the whole year (Figure 2).

2.3 Plant material

The plant sampling of three varieties of prickly pear (*Opuntia* spp.), locally known as Akria, Drbana and Mlez, was conducted in the Rhamna region in August 2015–2016. The collected varieties were authenticated by a botanist. The fruits were peeled and ground to remove



Figure 1: Geographical location of the study area (Skhour Rhamna).

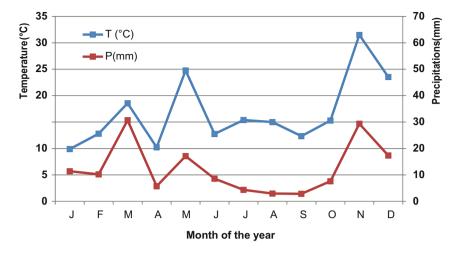


Figure 2: Gaussen and Bagnouls diagram of the studied region (2015–2016).

the seeds, and the pulp was then frozen at -20°C to avoid potential alteration. Figures 3–5 show Akria, Drbana, and Mlez varieties, respectively.

weight before and after drying enables the determination of the humidity percentage:

Humidity% =
$$(I_{\rm W} - F_{\rm W}/I_{\rm W}) \times 100$$
,

2.4 Physical and physicochemical analyses of Barbary fig pear fruits

2.4.1 Moisture

Moisture is currently measured by drying the sample in an oven until the weight stabilization [5]. Five grams of the fruit pulp were weighed using a precision balance and placed in an oven at 105°C for 48 h. The difference in

where $I_{\rm w}$ is the weight of the sample before steaming (g) and $F_{\rm w}$ is the weight of the sample after steaming (g).

2.4.2 Water activity

The activity of water (aw) is a parameter that characterizes the amount of free water in a product [6]. Aw was evaluated according to the previous literature [8].

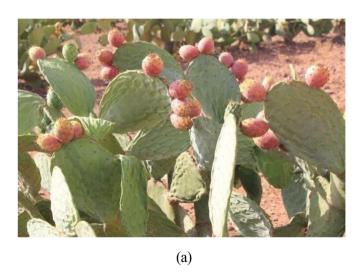




Figure 3: Akria (Opuntia ficus-indica) variety: (a) plant of Akria variety and (b) fruit of Akria variety.

568 — Mohammed Bourhia et al. DE GRUYTER

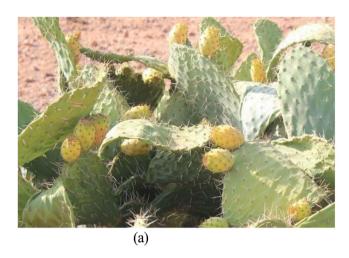




Figure 4: Drbana (Opuntia megacantha) variety: (a) plant of Drbana variety and (b) fruit of Akria variety.

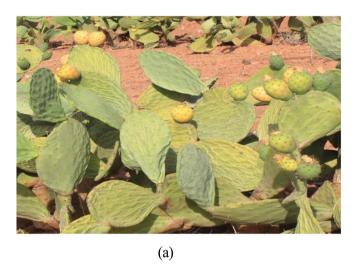




Figure 5: Mlez (Opuntia ficus-indica) variety: (a) plant of Mlez variety and (b) fruit of Mlez variety.

Briefly, 5 g of the fruit pulp was analyzed at 25°C. The aw value was recorded after more than 2 h.

2.4.3 pH

The pH value was determined at 25°C after calibration with buffer solutions at pH 7. The pH value of the crushed pulp was measured using a protocol reported in the previous study [8].

2.4.4 Total titratable acidity

One hundred milliliters of the fruit pulp of each variety were titrated with a solution of NaOH (0.1 N) up to a pH

of 8.1 [7]. The findings were reported in grams of citric acid per 100 g of fresh material (FM). Total titratable acidity was performed according to the earlier found formula [8].

2.4.5 Brix

The Brix scale is used for measuring the percentage of soluble dry matter (DM) in a product. Fifteen grams of the pulp were centrifuged in a 3–30 K Sigma centrifuge at 12,000 rpm for 30 min. We then recovered the supernatant for the measurement of Brix using an RFM 830 refractometer after filtration of this supernatant through a filter paper. The assay was performed in triplicate. The results were reported in degrees Brix (° Bx).

2.4.6 Ash content

Five grams of the pulp were weighed and then placed for incineration in a furnace at a temperature of 500°C for 7 h. The assay was effectuated in triplicate. The ash content was reported as a percentage relative to the DM according to earlier data [8].

2.5 Biochemical analysis of Barbary fig fruits

2.5.1 Total carotenoid content

Ten grams of the pulp of the studied varieties (Drbana, Mlez, and Akria) were extracted with 10 ml of solvents (hexane solvent/acetone solvent/ethanol solvent [50:25:25, v/v]). The obtained solution was centrifuged at 6,500 rpm at 5°C for 5 min. The layer of hexane including the pigments was recovered and adjusted again with hexane. The total carotenoid was determined according to the earlier found formula [8].

2.5.2 Betalain content

The betalain content was determined with respect to the method described in the previous study [9]. Two grams of the pulp were macerated with 10 ml of methanol 80 %(v/v) for 1 min. The obtained extract was centrifuged at 4,000 rpm for approximately 20 min to obtain the supernatant including betalains. The betalain content was determined in regard to the previous protocols [8].

2.5.3 Total polyphenol and ascorbic acid content

2.5.3.1 Extraction

Ten grams of the pulp were subjected to extraction with 10 ml of acetone (70%) and (80%). The extract was centrifuged at 5,000 rpm for 30 min and finally filtered through a filter paper. The obtained extract was used for determining the total polyphenol and ascorbic acid content.

2.5.3.2 Total polyphenols

The total polyphenolic content was determined according to the instructions reported in previous methods [8].

2.5.4 Ascorbic acid content

Five hundred microliters of the fruit pulp extract were added to 3.5 ml of water and then vortexed. Two milliliters of the obtained solution were deposited on an OASIS conditioned with 3 ml of MeOH + 2×3 ml of water and then rinsed twice with 2 ml of water. 0.5 ml of the aqueous solution was determined according to earlier data [8].

2.6 Statistical analysis

One-way analysis of variance (ANOVA) was performed to compare the obtained mean values for different studied parameters. The Student-Newman-Keuls test allows, after rejecting the hypothesis of means equality, us to look for the homogeneous groups of mean values. Data were reported as mean \pm SD.

Ethical approval: The conducted research is not related to either human or animal use.

3 Results and discussion

3.1 Physicochemical characterization of the fruit pulp of prickly pear

3.1.1 Juice content

One-way ANOVA showed a high difference between the juice content of the fruit pulp of the three studied varieties produced in both 2015 and 2016 crop years (p < 0.001). The fruit juice content of Drbana and Akria produced in 2015 was reported to be equal to 57.25% and 69%, respectively. These results were in accordance with those of the previous study [10], in which it was revealed that the juice content of prickly pear fruits was estimated to be 62.84%. Besides, similar results were reported in the previous literature concerning the juice content of prickly pear fruits (57.30%). The juice content of Drbana variety produced in 2015 and 2016 was 57.25% and 57.60%, respectively (Table 1) [11]. The difference recorded between the same prickly pear produced in different seasons of 2015 and 2016 in terms of juice content could be due to various climatic conditions over the 2 years. Indeed, the average annual rainfall recorded in 2016 (164.7 mm) in the study area was higher than that recorded in 2015 (131.9 mm). In addition, we note that the Akria and Mlez varieties have high water and juice content compared to that of the Drbana variety,

570 — Mohammed Bourhia et al. DE GRUYTER

Fable 1: Physicochemical criteria of the fruit pulp of the three prickly pear varieties (Akria, Drbana, and Mlez)

2015 Akria 67.45 ± 0.05 88.04 ± 0.02 0.877 ± 0.002 14.78 ± 0.05 5.26 ± 0.01 0.052 ± 0.001 Drbana 57.25 ± 0.05 87.03 ± 0.03 0.864 ± 0.002 15.79 ± 0.07 6.00 ± 0.13 0.027 ± 0.001 Mez 67.20 ± 0.10 87.56 ± 0.02 0.871 ± 0.001 15.13 ± 0.04 5.85 ± 0.01 0.042 ± 0.001 Drbana 57.60 ± 0.10 87.80 ± 0.03 0.857 ± 0.001 15.15 ± 0.07 6.34 ± 0.01 0.026 ± 0.001 Mlez 69.50 ± 0.10 88.77 ± 0.01 0.859 ± 0.001 14.67 ± 0.04 6.28 ± 0.01 0.035 ± 0.001	Years	Varieties	Years Varieties Juice content (%)	Humidity (%)	Water activity	Brix (°Bx)	Н	Total titratable acidity (g citric acid/100 g of FM	Brix/acid ratio	Ash content (g/100 g of DM
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	2015	Akria	67.45 ± 0.05	88.04 ± 0.02	0.877 ± 0.002	14.78 ± 0.05	5.26 ± 0.01	0.052 ± 0.001	281.98 ± 2.24	3.04 ± 0.04
Mlez 67.20 ± 0.10 87.56 ± 0.02 0.871 ± 0.001 15.13 ± 0.04 5.85 ± 0.01 6.075 ± 0.01 Akria 69.75 ± 0.05 89.05 ± 0.02 0.862 ± 0.001 13.78 ± 0.02 6.18 ± 0.01 6.18 ± 0.01 Drbana 57.60 ± 0.10 87.80 ± 0.03 0.857 ± 0.001 15.15 ± 0.07 6.34 ± 0.01 Mlez 69.50 ± 0.10 88.77 ± 0.01 0.859 ± 0.001 14.67 ± 0.04 6.28 ± 0.01		Drbana	57.25 ± 0.05	87.03 ± 0.03	0.864 ± 0.002	15.79 ± 0.07	6.00 ± 0.13	0.027 ± 0.001	575.94 ± 14.87	2.73 ± 0.01
Akria 69.75 ± 0.05 89.05 ± 0.02 0.862 ± 0.001 13.78 ± 0.02 6.18 ± 0.01 0 Drbana 57.60 ± 0.10 87.80 ± 0.03 0.857 ± 0.001 15.15 ± 0.07 6.34 ± 0.01 0 Mlez 69.50 ± 0.10 88.77 ± 0.01 0.859 ± 0.001 14.67 ± 0.04 6.28 ± 0.01 0		Mlez	67.20 ± 0.10	87.56 ± 0.02	0.871 ± 0.001	15.13 ± 0.04	5.85 ± 0.01	0.042 ± 0.001	363.68 ± 5.50	2.55 ± 0.03
Ta 57.60 ± 0.10 87.80 ± 0.03 0.857 ± 0.001 15.15 ± 0.07 6.34 ± 0.01 69.50 ± 0.10 88.77 ± 0.01 0.859 ± 0.001 14.67 ± 0.04 6.28 ± 0.01	2016	Akria	69.75 ± 0.05	89.05 ± 0.02	0.862 ± 0.001	13.78 ± 0.02	6.18 ± 0.01	0.042 ± 0.001	326.38 ± 1.30	3.08 ± 0.05
69.50 ± 0.10 88.77 ± 0.01 0.859 ± 0.001 14.67 ± 0.04 6.28 ± 0.01		Drbana	57.60 ± 0.10	87.80 ± 0.03	0.857 ± 0.001	15.15 ± 0.07	6.34 ± 0.01	0.026 ± 0.001	582.91 ± 3.88	2.95 ± 0.05
		Mlez	69.50 ± 0.10	88.77 ± 0.01	0.859 ± 0.001	14.67 ± 0.04	6.28 ± 0.01	0.035 ± 0.001	421.80 ± 3.20	3.43 ± 0.02

The findings were reported in mean \pm SD. Values marked with the same letter in the same column did not reveal a significant difference at p<0.05.

which was less in both water and juice content. The high levels of fruit juice shown in the studied varieties increase their commercial value, due to the fact that in the agro-industrial sector, the juice content is the first factor, which influences the cost price.

3.1.2 Humidity

Humidity influences the technological and the organoleptic properties of food products, as well as their conservation. For this reason, it is important to control the humidity level of food. The humidity level varies between the studied varieties, ranging from $87.03 \pm 0.03\%$ to $89.05 \pm 0.02\%$. The statistical analysis showed a highly significant difference between the humidity levels of the three studied fruits (p < 0.001). There was also a significant difference in humidity levels between the fruits of the same varieties harvested in different seasons of 2015 and 2016. The highest humidity level was recorded in the Akria variety fruits collected in 2016, while the lowest humidity level was found in the Drbana variety fruits harvested in 2015 (Table 1). The high humidity values of prickly pear fruits increase the perishability of these products and limit their ability to be stored at room temperature [12]. The seasonal effect on the moisture content of the three varieties of fruits could be due to climatic conditions since the prickly pear has not been irrigated in the study area. The humidity values revealed in the current work were consistent with those reported in the previous study [9], which reported that the humidity values of prickly pear range from $87.50 \pm 0.09\%$ to $89.62 \pm 0.08\%$. Our results were also in accordance with those reported in the literature regarding humidity value fluctuation of the studied plant [13].

3.1.3 Water activity

The water activity represents the free water contained in a product. It influences microbial growth (bacteria, yeasts, molds, etc.) and the ability of these microorganisms to alter food. According to our results presented in Table 1, there is a highly significant difference between the water activity contained in the pulp of the three studied varieties produced in 2015 (p < 0.001). However, there was no significant difference between the water activity of the fruit pulp of Drbana and Mlez varieties produced in 2016. Regarding the water activity of prickly pear fruits, the values reported in the current work ranging from 0.857 \pm 0.001 to 0.877 \pm 0.002 were in agreement with those reported in the previous study, ranging from 0.863 to 0.883 [14].

3.1.4 Brix

Brix represents the DM percentage, which is considered equal to the sugar content in the sample. One-way ANOVA showed a highly significant difference between the pulp Brix of the three varieties produced in different seasons of 2015 and 2016 (p < 0.001). The Brix values reported in the present work range from 13.78 \pm 0.02 to 15.79 ± 0.07 °Bx. The sweetest pulp was attributed to the Drbana variety harvested in 2015. However, the pulp of the Akria variety harvested in 2016 was the least sweet (Table 1). The prickly pear Brix values reported in our work were consistent with those reported in previous study, 13.50 \pm 0.95 and 15.87 \pm 1.64 °Bx [15]. However, our prickly pear Brix values were superior to those found in earlier data, 10.9 ± 0.05 to 11.9 ± 0.11 °Bx [16]. The high Brix values of the fruit pulp found in the current work can be due to climate aridity and rainfall scarcity. Moreover, the study area is dry and non-irrigated. Fruits produced in dryland are naturally being sweeter than those in irrigated and wetland [17,18]. The maturity degree also influences the Brix values of prickly pear fruit as shown in previous studies [19], which reported that the Brix values of green and ripe fruits were, respectively, 12.56 \pm 2.13 and 14.89 \pm 2.91 °Bx.

3.1.5 pH

pH parameter determines the microbial stability of fruit during storage [20]. It also influences the fruit's flavor [21]. One-way ANOVA showed a significant difference between the pH values of the fruit pulp of the studied varieties harvested in both 2015 and 2016 (p < 0.001). The pH values of these varieties vary from 5.26 \pm 0.01 to 6.34 ± 0.01 (weakly acidic). The fruit pulp of Akria was the most acidic compared to those of Drbana and Mlez varieties (Table 1). The pH values discussed in this work were consistent with those reported in previous study [22], which reported that the pH values of Hawara and Aissa varieties were 5.98 and 6.37, respectively. The pH values of Barbary fig fruits reported in our work were higher than the pH values of other fruits such as grapefruits (3.67 \pm 0.02) [23] and orange [24].

3.1.6 Total titratable acidity

The total titratable acidity is the sum of the free acid functions of a sample [25]. One-way ANOVA showed a significant difference between the total titratable acidity of the fruit pulp of the three reported varieties (p < p0.001). A significant difference was also observed between the fruit pulp of the two crop years, 2015 and 2016, regarding a given variety. The values of total titratable acidity are inversely proportional to the Brix values (negative correlation with -0.294; Table 1). The fruits of the Drbana variety harvested in 2016 presented the lowest acidity average, 0.026 ± 0.001 g of citric acid/ 100 g of FM. However, the fruits of the Akria variety harvested in 2015 were the most acidic in the order of 0.052 ± 0.001 g of citric acid/100 g of FM. The current results of acidity present in the studied varieties were in accordance with those reported in the previous literature [9], in which it was reported that the titratable acidity of the fruit pulp of Opuntia ficus-indica ranges from 0.04 to 0.07 g of citric acid/100 g of FM.

3.1.7 Brix/acidity ratio

The Brix/acidity ratio is an important indicator used to determine the taste quality of fruits. It is also used for determining the degree of fruit maturity. The fruits of the Drbana variety harvested in seasons of 2015 and 2016 exhibited the highest Brix/acidity ratio with values of 575.94 ± 14.87 and 582.91 ± 3.88 , respectively. Moreover, the fruits of the Drbana variety exhibited the highest Brix and the lowest acidity values (Table 1). As a result, these fruits could be considered the best fruits for being consumed because of their taste quality. Our results were partially comparable to those of other research [10], in which it was reported that the Brix/acidity value of nine species of genus Opuntia was 470. This highest value was relatively lower than that found in the current research work, 582.91 ± 3.88.

3.1.8 Ash content

Ash content is one of the most important parameters that refer to the mineral content of the food. One-way ANOVA showed a great difference between the ash content of the pulp of Drbana and Mlez varieties of both 2015 and 2016 crop years (p < 0.05). However, there is no significant difference in the ash content of the pulp of Akria of both 2015 and 2016 crop years (3.04 ± 0.04) and $3.08 \pm 0.05 \,\mathrm{g}/100 \,\mathrm{g}$ of DM). Moreover, the pulp of Akria variety possessed a higher content of mineral compounds compared to other reported varieties (Drbana and Mlez). The ash content reported in our work was higher than that found in earlier data [19].

The ash content ranges from 0.20 ± 0.09 to 0.34 ± 0.01 g/100 of DM as reported in previous data. The fruits of *Opuntia ficus-indica* are particularly rich in potassium, magnesium, and calcium as shown in previous results [26].

3.2 Biochemical characterization of the pulp of prickly pear fruit

3.2.1 Pigment content

3.2.1.1 Total carotenoids

Carotenoids are the photosynthetic pigments responsible for the orange, yellow, as well as red colors of fruits. They are also major determinants of the organoleptic and nutritional qualities of fruits [27]. The total carotenoid content varies according to species and fruit pulp color. Orange-yellow fruits (Drbana and Mlez) possess a higher carotenoid content compared to red-purple fruits (Akria; Figure 6). The total carotenoid content increased in the fruit pulp of the three varieties harvested in 2016 than the fruit pulp of the same varieties harvested in 2015 (Figure 6). The carotenoid content reported in our results was lower than that reported in previous data concerning *Opuntia ficus-indica* fruits, ranging from 17.7 ± 0.4 to $26.5 \,\mu\text{g}/100\,\text{g}$ of FM [9].

3.2.1.2 Betalains

The attractive colors of Barbary fig are due to betalains that contain betacyanin and betaxanthin pigments [28]. Statistical analysis revealed a significant difference in the betalain content of the fruit pulp of the studied varieties of produced in both 2015 and 2016 crop years (p < 0.001). For instance, the values ranged from 2262.71 \pm 24.99 to 4014.20 \pm 52.15 µg/100 g of FM for the Akria variety produced in 2015 and 2016, respectively (Figure 7). For the Akria variety, the results also showed ten-fold higher betacyanin content compared to other reported varieties (Drbana and Mlez). The Mlez and Drbana varieties were, respectively, four and three times richer in indicaxanthins compared to the Akria variety.

Results reported in the previous literature regarding the total betalain content contained in Moroccan varieties called Achefri and Amouslem were 2,990 and 9,459 µg/ 100 g of FM, respectively [29]. The betacyanin and indicaxanthin content in the pulp of purple and red fruits was estimated to be 181 and 2,808 µg/100 g of FM, respectively [29]. The total betalain value revealed in Opuntia megacantha fruits was 2,700 µg/100 g of FM as reported in earlier reports [30]. This value was in accordance with that found in our study regarding the Drbana variety harvested in the two mentioned crop years $(2,876.90 \pm 31.75 \text{ and } 3,151.46 \pm 34.69 \,\mu\text{g}/100 \,\text{g of FM}).$ Pigments of betalains possess antiviral, antioxidant, and antimicrobial effects [31]. Betalain pigments are considered substances for cancer prevention [32]. Betalains possess characteristics for being natural dye in food. [31].

3.2.2 Phenolic content

The phenolic content contained in the fruit pulp of the investigated varieties in the present work increased in

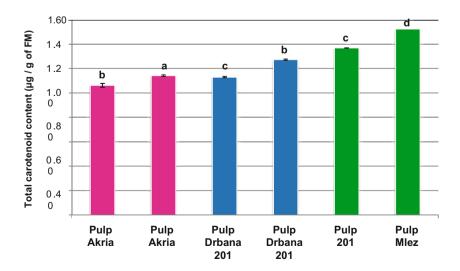


Figure 6: Total carotenoid content of the fruit pulp of Barbary fig varieties (Akria, Drbana, and Mlez) of both 2015 and 2016 crop years. Mean values with the same letter did not reveal a significant difference at p < 0.05.

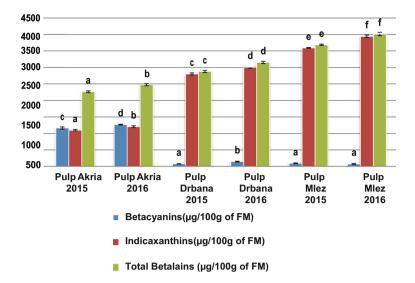


Figure 7: Betalain content (betacyanins, indicaxanthins, and total betalains) of the fruit pulp of the discussed varieties (Akria, Drbana, and Mlez) produced in both 2015 and 2016 crop years. Mean values with the same letter did not present a significant difference at p < 0.05.

the second 2016 crop year compared to the first 2015 crop year. For instance, the phenolic content of the Drbana variety increased from 48 ± 2 to 58.31 ± 1.07 mg acid gallic equivalent (AGE)/100 g of FM for both 2015 and 2016 crop years, respectively (Figure 8).

The current results of the phenolic content were comparable to those reported in the previous literature [26], in which it was reported that the phenolic content of Barbary fig was $59.33 \pm 2.51 \, \text{mg}$ AGE/100 g of FM. In contrast, the phenolic content of the fruit pulp of other Moroccan prickly pear varieties was ranging from 39.49 ± 0.74 to 64.36 ± 0 , $33 \, \text{mg}$ AGE/100 g of FM [13]. Phenolic compounds are natural antioxidants. Physiologically, they probably contribute to the body's defense against oxidative stress by trapping reactive oxygen species and opposing the macromolecule oxidation [33]. Moreover,

polyphenols may also play a protective role versus chronic and cardiovascular diseases [33].

3.2.3 Ascorbic acid content

No significant difference was recorded in the ascorbic acid content between the studied varieties harvested in 2016 (p > 0.05). However, the Akria variety possessed the highest content as reported in our finding (26.48 \pm 0.79 mg/100 g of FM; Figure 9).

The present results of ascorbic acid content were consistent with those of the previous studies, which reported that the ascorbic acid content of yellow-orange and purple Barbary fig fruits was 23.65 ± 2.03 to 32.19 ± 1.73 mg/100 g FM, respectively [9]. Due to its richness in

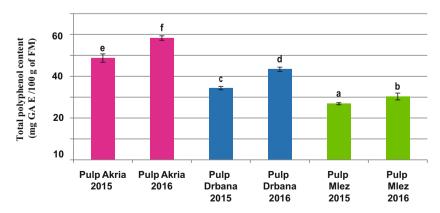


Figure 8: Phenolic content of the fruit pulp of the studied varieties (Akria, Drbana, and Mlez) produced in both 2015 and 2016 crop years. Average with the same letter did not present a significant difference at p < 0.05.

574 — Mohammed Bourhia et al. DE GRUYTER

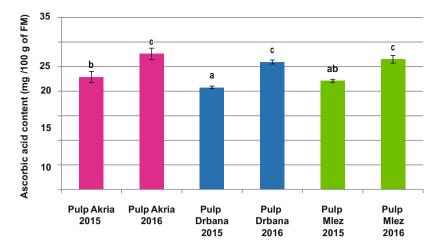


Figure 9: Ascorbic acid content of the fruit pulp of the investigated varieties (Akria, Drbana, and Mlez) produced in both 2015 and 2016 crop years. Average with the same letter did not reveal a significant difference at p < 0.05.

ascorbic acid (vitamin C) and its interesting phenolic content, the prickly pear is one of the best foods with natural antioxidants.

4 Conclusion

In the light of the reported results, we can affirm that the fruits of Barbary fig (pulp) of all investigated varieties such as "Drbana" (*Opuntia megacantha*), "Akria", and "Mlez" (*Opuntia ficus-indica*) could constitute a promoting source of natural compounds for launching the agro-industrial field. Moreover, the fruit pulp of the Drbana variety presents the best juice content and the Brix/acidity ratio as well. Hence, this variety can thus be regarded as an excellent fruit for being used in juice production.

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Conflict of interest: The authors declare that there is no conflict of interest.

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