

Algerian Prickly Pear (*Opuntia ficus-indica* L.) Physicochemical Characteristics

Temagoult Asma, Zitouni Bariza, Noui Yassine

Food Science Laboratory' LSA', Food Engineering Department. Institute of Agriculture and Veterinary Sciences,
University Hadj Lakhdar. Batna1. Biskra Avenue, Batna, 05005, Algeria.

Tema.mima@gmail.com, Zitounibariza@yahoo.fr, noui.yassine@gmail.com

Abstract—In Algeria, *Opuntia ficus-indica* production is important. This seasonal fruit is a characteristic of arid and semi-arid regions. Taking into account its high content in antioxidants, it has an excellent nutritional value.

The aim of this research is the prickly pear morphological and physicochemical characterization study, which is widely present in the Arris (Batna, Algeria) area.

The results of this experimental study are comparative to those of the same species from other world regions.

The whole fruit weight is estimated to reach 63.38 g with a juice ratio of 71.42 %, a pH of 5.54, moisture of 89.3 % and a brix of 10.4 %. The quantitative amount of the phenolic compounds of the fruit revealed contents of 45.70 mg GAE / 100 g of MF for total polyphenols.

Keywords— *Opuntia ficus-indica* , morphological characteristics, physicochemical characterization, polyphenols, Antioxidant activity, functional food.

I. INTRODUCTION

Several countries, including Algeria, undergo severe drought which has detrimental consequences on economic and agriculture activity of these countries. This drought has become a structural factor that has to be faced by adapting agriculture to become less dependent on climatic hazards. In this context, particular attention has been paid to *Opuntia* (*Opuntia ficus-indica*), a Cactaceae family perennial crop, originating from Central America and Mexico, better known as prickly pears [1].

Although *Opuntia* was introduced to Maghreb in 17th century, it plays a decisive ecological role in slowing down the rate of soil degradation: combating erosion and desertification. This species have agronomic importance attributed to its ability to be cultivated in arid and semi-arid areas, where irrigation is either insufficient or absent [2].

Opuntia ficus-indica (L.) Mill. is a very important food source which satisfies different population's nutritional needs, it is also an antioxidants natural source, due to its high content in flavonoid, ascorbic acid and Carotenoids [3].

In this study, physicochemical parameters and nutritional composition of *O. ficus-indica* (L.) were determined. This sample was from Algeria, Arris area. The results were compared with those of other varieties studied in KSA [4], Morocco [5], Mexico and Argentina [6], [7]. These results confirm the effects of variety, region and other parameters on the *Opuntia* fruit quality, also give an overview of the upcoming work; where fruits can be used as food supplements

for product development. It can then solve a food security problem in arid and semi - arid areas.

II. MATERIALS AND METHODS

A. Plant Material

Ripe fruits were harvested in November from Arris region wilaya of Batna, located at 1205 m altitude from the sea and 400 km north-east of the capital. Only ripe and healthy fruits have been harvested. The fruits were randomly sampled and transported to the laboratory.

Afterwards, the prickly pears were weighed, before and after being peeled, and the edible portion percentage has been calculated. Several portions of different fruits were weighed and the seeds were separated, washed with water and dried at room temperature, to calculate the seeds percentage in the edible fraction. Total phenol analyses were realized independently on three prickly pears units. For the other analyses, three or four prickly pear units were homogenized, and used, where acidity, pH, moisture, sugar, ash, refractive index and brix have been determined. These analyses were carried out immediately, the polyphenols were extracted, and the extracts were stored at -18 ° C.

B. Analytical Methods

1) *Morphological Characterization of Prickly Pear*: The prickly pear fruit *O. ficus-indica* sampling is done randomly where twenty-five varieties were selected to determine the following variables:

The fruit, pulp, seeds and the skin weights were determined by a precision scale. After weighing the whole fruit, the skin was removed from the pulp manually to obtain the weights of these parts separately. The same operation is subsequently done with the seeds and the amount of juice of each fruit.

Determination of ratios: the ratio is an average of n = 25 weighing samples.

The length (mm) and the diameter (mm) of each fruit were measured. The length is taken from the fruit attachment point to the fruit end pad. The diameter was measured at the fruit middle part.

The shape coefficient C_f given by this formula [8]:

$$C_f = \frac{\text{average fruit weight}}{\text{Average fruit diameter}} \quad (1)$$

The shape coefficient makes it possible to classify the varieties into three shape categories, particularly: $C_f < 0.8$:

flattened shape; $C_f > 1$: elongated shape and $0.8 < C_f < 1$: round shape.

Color Index

Color was measured using a Color reader, Minolta CR 10 (Minolta Camera, Japan). Results were expressed according to CIELAB system (L^* , a^* and b^*).

The color index (E^*) was determined by using the following equation [24].

$$E^* = [L^{*2} + a^{*2} + b^{*2}]^{0.5} \quad (2)$$

The determination of the quantities (L^* , a^* and b^*), concerns the whole fruit and the juice extracted.

2) *Physicochemical Characterization of Prickly Pear*: The moisture was determined by desiccation at 105 °C for 24 h [9]. The ash was determined by combustion of the sample in a muffle furnace (Heraeus), at 525 °C for 6 h. The pH was measured by pH meter at 20 °C [9]. The titrable acidity (expressed as g of citric acid per 100 g of sample) is determined by titration with NaOH (0.1 N) using phenolphthalein as an indicator according to AFNOR official standards. A soluble solid (TSS) was determined using an Abbe Refractometer, at 20 °C.

The total sugar content is determined by colorimetric using Dubois method [10].

The amount of reducing sugars according to the DNS colorimetric method (3,5-dinitrosalicylic acid) present a maximum absorption at 540 nm [11].

The phenolic compounds were extracted using: 3 g of the pulp were macerated in 120 ml of methanol and water mixture with a ratio (80:20, v / v). The mixture was filtered then the filtrate was evaporated using a rotary evaporator Type: (Heidolph). The total polyphenols were determined colorimetrically according to the method described by Juntachote [12], 500 µl of methanolic dates extract was added to 2.5 ml of Folin-Ciocalteu reagent (0.2 N). The mixture was agitated for 5 minutes, and then neutralized with 2 ml of Na_2CO_3 . After incubation in the dark for 1 hour; the absorbance was reading at 650 nm. The phenolic content is expressed as mg equivalent of Gallic acid (EGA) per 100 g of fresh weight.

III. RESULTS AND DISCUSSION

A. Physical Parameters

The results of the physical properties of the prickly pear, *Opuntia ficus-indica*, are presented in Table I (n= 25).

The (Table I), shows that the whole fruit weight average is 63.38 g, whereas that of the pulp and the skin is 36.54 g 26.45 g respectively.

These results are close to those of Bejaia prickly pear varieties [07]. In a study of the *Opuntia* fruit gathered from different Mexico and Argentina regions, the fruit weight was 112 g to 212 g [06]. In reference [13], the average value is 73 g. This difference in fruit weight may be due to environmental

factors such as the altitude, drainage, temperature, and soil precipitation that affect growth and development [14].

The ratio of pulp to *Opuntia ficus-indica* fruit is 57.65 %. This value is included within the interval of pulpy fruit who reported that pulp / fruit ratio for pulpy fruit exceed 50 %.

According to the shape coefficient C_f [08], which is 1.71%, this fruit was classified in the category of elongated shape.

TABLE I

PHYSICAL PROPERTIES OF THE PRICKLY PEAR

Parameters	Values
Whole fruit weight in (g)	63,38± 11,98
Pulp weight in (g)	36,54 ± 6,59
Skin weight in (g)	26,45 ± 8,35
Fruit length in (mm)	72,32 ± 7,45
Pulp length in (mm)	50,82 ± 5,12
Fruit diameter in (mm)	42,15 ± 2,69
Pulp diameter in (mm)	34,24 ± 2,71
Skin thickness in (mm)	02,66 ± 0,83
Number of seeds	273 ± 57
Weight of seeds	3,24 ± 0,72
Pulp / fruit ratio in (%)	57,65 ± 0,55
Seeds /fruit ratio in (%)	5,11 ± 0,06
Skin / fruit ratio in (%)	41,37 ± 0,69
Shape coefficient C_f	1,71 ± 0,36
Juice/pulp rate in (%)	71,42 ± 0,86

Color Index

The parameters L^* , a^* and b^* referring to the whole fruit and the juice extracted are shown in the table II.

TABLE II

VALUES OF „L“, „a“, „b“, COLOR INDEX E AND CHROMA OF FRUIT AND JUICE EXTRACTED.

Parameter	L	a	b	E	C
Whole fruit	43,06±0,76	24,66±1,61	16,45± 0,35	52,27	10,27
Juice extracted	36,56±0,59	11,66 ± 0,59	8,15± 0,18	39,23	11,84

According to the previous table, these results are superior to those in [15].

B. Physicochemical Characterization

1) *Determination of the Brix Degree*: The Brix value is 10.4 %. It is identical to that of cacti grown in Morocco [5]. The reference [06], reported an approximate range of 11.90 - 16 % for Mexico and Argentina varieties of *Opuntia ficus-*

indica, and 12-17 % was given for the prickly pears from Bejaia region [07].

This considerable difference is mainly due to the genotype and the degree of fruit ripeness. In addition, it is strongly influenced by cultural (fertilization and irrigation) and environmental practices.

TABLE III

BIOCHEMICAL COMPOSITION OF *OPUNTIA FICUS-INDICA*.

Parameters	Values (FW)	
PH at 20°C	5,54±0.012	
Moisture (%)	89,30±0.72	
Dry matter (%)	10,70±0.68	
°Brix (%)	10,4±0.70	
Titrate acidity (as citric acid,(%)	0,37 ± 0,06	
Total polyphenol content (mg GAE/ 100g FW)	45,70 ±0,26	
Sugar content (g/l)	Total sugar	14,42 ± 0,24
	Reducing sugar	9 ± 0,41
	Sucrose	5,42
Ash content (%)	2,45 ± 0,72	

2) *Determination of Moisture*: The fruit pulp present high moisture content 89.30 %, this latter is close enough to that found in [16], [17] and [07], which are respectively (87.07 ± 0.86 %, 87.4 % and 89 %).

3) *PH Determination*: The fruit extract pH is slightly acidic; it is of 5.54 ± 0.07. This value is almost the same in [05] with a value of 5.92, in a Mexico and Argentina varieties, the juice pH values are between 6.4 and 7.1 [19].

These differences in juice pH between the Algerian prickly pears and those developed in other countries may be due to environmental effects.

4) *Sugar Content*

Total Sugar Content: Total sugar in the fruit extract is 14.42 % ± 0.24 of fresh weight.

These contents are compatible with the results given in [05], with values ranging from 13.5 % and 15.87 % for different cultivars of *Opuntia ficus-indica* studied in Morocco,

Generally, the values found show the poverty of prickly pear in total sugars compared to other fruits (the date).

Reducing Sugar Content: According to Table III, the value of reducing sugars is 9 % of the fresh weight, which is close to results given by several works. Reference [18], shows a value of (9.79 - 11.12 g / 100 g) for the ElKelaâ variety. With values of 7.33 g / 100 g for the fruit extract of Egyptian *Opuntia ficus-indica* and extends from 5.0 to 14.0 g / 100 g for the Mexican species [19].

Sucrose Content: The results obtained show the high sucrose content of the fresh weight prickly pear which is of 5.42 %. This rate is higher than other results, with a value of 0.19 % [20].

5) *Total Ash Content*: The ash rate represents the total amount of mineral salts present in the fruit. Total ash in the sample studied is 2.45 %, which is approximate to that found in [18]; 2.80 % for half-ripe fruit and 3.15 % for ripe fruit and less than the rate determined in [17]; which is 4.03 ± 0.52 %, but remains higher than that in [20].

6) *Total Polyphenols Dosage*: The total phenol content of sample is 45.70 mg GAE/ 100 g of FW.

According to Table III, the results appear to be similar to those show in respectively [05], [21], which are between 44.73 mg GAE/ 100 g of fruit and 45.2 ± 7.4 mg / 100 g, but lower than that in [16], which is 64.36 mg GAE/ 100 g of fruit.

The polyphenols content of the sample studied is comparable to some fruits: pineapple (61 mg / 100 g), yellow pear (60 mg / 100 g), papaya (45 mg / 100 g) and nectarine (38 mg / 100 g) [22].

IV. CONCLUSION

According to the ratio of pulp / fruit which is 58 %, the prickly pear studied is a fleshy fruit. It is comparable to other varieties grown in Mexico and Morocco. The prickly pear juice yield is 71 %, which is interesting from the technological point of view, and makes it possible to transform the fruit into various food products.

The cultivar studied showed a considerable amount of phenolic compounds. According to the above results, prickly pear could be used as an additive for food supplements and functional foods.

It is also a powerful natural antioxidant against degenerative diseases. In spite of its abundance and its various usages, the *Opuntia ficus-indica*, remains insufficiently and badly exploited. It contains potentialities up to the unknown. So, a new development should be given to this shrub and to the products derived from it, especially the fruits, cladodes and the oil extracted from its seeds, which are not valued as they should be. In this context, it should be give interesting to the study of this species; which is present all around the Mediterranean basin. Characterizing the physicochemical proprieties of the fruit, from point of view, and then manufacturing different products, that are elaborated via this plant, which is widespread in arid and semi-arid regions.

REFERENCES

- [1] M. Schweizer, *Docteur Nopal, le médecin du Bon Dieu*, Clamecy, PARIS (France). Imprimerie Laballery, 1997, 81.
- [2] C. Sáenz, *Agro-industrial utilization of cactus pear*. FAO. Agricultural Services of FAO. Roma 2013; 162: 4-30
- [3] J. O. Kuti, (2004). "Antioxidant compounds of ovum *Opuntia cactus* pear fruit varieties". *Food Chemistry*, 85 (4), 527-533.
- [4] E.S. Abdel-Hameed, M.A. Nagaty, M.S. Salman and S.A. Bazaid, "Phytochemicals, nutritional and antioxidant properties of two prickly pear cactus cultivars (*Opuntia ficus-indica* Mill.) Growing in Taif, KSA", *Food Chemistry* 160: 31-38. 2014.

- [5] Z. Bouzoubaa, Y. Essoukrati, S. Tahrouch, A. Hatimi, S. Gharby and H. Harhar, 2014. "Phytochemical study of prickly pear from southern Morocco". *Journal of the Saudi Society of Agricultural Science. Laboratory technologies*, 8, No. 34.
- [6] P. Felker, S. Rodriguez, R.M. Casoliba, R. Filippini, D. Medina and R. Zapata, "Comparison of *Opuntia ficus-indica* varieties of Mexican and Argentine origin for fruit yield and quality in Argentina". *Journal of Arid Environments*, 60: 405-422. 2005.
- [7] N. Chougui, H. Louhaileche, S. Mohedeb, Y. Mouloudj, Y. Hammoui, A. Tamendjari, 2013. Physicochemical characterization and antioxidant activity of some *Opuntia ficus-indica* varieties grown in North Algeria. *African Journal of Biotechnology*. Vol. 12 (3), p. 299-307.
- [8] O. Fagbohoun and D. Kiki, Overview of the main varieties of local tomatoes grown in southern Benin. *Agricultural Research Bulletin of Benin*, 24, 10-21 *INRAB, Cotonou*, Republic of Benin, 1999.
- [9] AOAC (1990). In K. Helrich (Ed.). AOAC: food composition; Additives; Natural contaminants (Vol II). Arlington: AOAC.
- [10] Fournier E., (2001). Colorimetric Quantification of Carbohydrates. In: *Current Protocols in Food Analytical Chemistry*. m John Wiley & Sons, Inc. (Eds). Section E Carbohydrates: E1.1.1-E1.1.8. . 800p.
- [11] E.H. Fischer and E.A. Stein. 1961. α -amylase from human saliva. *Biochem. Prep.* 8, 27-35.
- [12] T. Juntachote, E. Berghofer, S. Siebenhandl, F. Bauer, 2005. "Antioxidative effect of added dried Holy basil and its ethanolic extracts on susceptibility of cooked ground pork to lipid oxidation." *Food chemistry*, 100 : 129-135.
- [13] Valdez-Cepeda, R. D., Blanco-Macias, F., Magallanes-Quintanar, R., Vazquez-Alvarado, R., & de Jesús Mendez-Gallegos, S. (2013). "Fruit weight and number of fruits per cladode depend on fruiting cladode fresh and dry weight in *Opuntia ficus-indica* (L.) Miller variety „Rojopelon“ ". *Scientia Horticulturae*, 161, 165 -169.
- [14] Erre, P .; Chessa, I .; Nieddu, G. & Jones, P.G., 2009. Diversity and spatial distribution of *Opuntia spp.* In the Mediterranean Basin. *Journal of Arid Environments*, 73: 1058-1066.
- [15] Saenz, C. & Sepulveda, E. (1999). " Physical, chemical and sensory characteristics of juices from pomegranate and purple cactus pear fruit". *Annals of the 22nd IFU Symposium*, Paris.Pp.91-100.
- [16] Medina E.M., Rodriguez E.M., Romero C.2007. "Chemical characterization of *Opuntia dillenii* and *Opuntia ficus-indica* fruits". *Food Chemistry* 103, 38-45
- [17] Chiteva R and Wairagu N, 2013.Chemical and nutritional content of *Opuntia ficus-indica* (L.). *African Journal of Biotechnology*.Vol. 12 (21), p. 3309-3312
- [18] El-Gharras H; Hasib A; Jaouad, A; El-Bouadili, A. 2006. Chemical and physical characterization of three cultivars of Moroccan yellow prickly pears at three stages of maturity. *Cienc. Tecnol. Food.* 5 (2) 93-99.
- [19] Pimienta-Barrios, E. (1994). Prickly Pear (*Opuntia spp.*): A valuable crop fruit for the semi-arid lands of Mexico. *Journal of Arid Environments*, 28, 1-11.
- [20] Nebbache S, Chibani A, Chadli R and Bouznad A; 2009.Chemical composition of *Opuntia ficus-indica* (L.) fruit, *African Journal of Biotechnology* Vol. 8 (8), p. 1623-1624
- [21] Dehbi F, Hasib A, Bouaziz M, Ouattmane A, Elbatal H, Jaouad A, Sayadi S. 2012. Effect of phenolic compounds and betalain pigments on the antioxidant capacity of Moroccan prickly pear juices, "Nature & Technology" *Journal. B- Agronomic and Biological Sciences*, Issue No. 09: 02-07
- [22] Isabelle M, Lee BL, Lim MT, Koh WP, Huang D, Ong CN. Antioxidant activity and profiles of common fruits in Singapore. *Food hem* 2010; 123: 77-84.