ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 14, Issue 2, 2021

Online - 2455-3891
Print - 0974-2441

Research Article

PHYSICOCHEMICAL CHARACTERIZATION OF JAMS, ARTINASAL, AND INDUSTRIAL PRODUCED FROM THE PRICKLY PEAR FRUIT OF *OPUNTIA FICUS-INDICA* L.

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Received: 12 November 2020, Revised and Accepted: 21 December 2020

ABSTRACT

Objective: This research work is aimed at production and evaluation of the physical-chemical, and sensory qualities of jam produced from the prickly pear fruit from two varieties: Timgad region (Batna, semi-dry area), Elkseur (Bejaia, temperate zone), and an industrial: Roumais jam (Elkseur).

Methods: The soluble solids content is determined by measuring the Brix at 20°C using a digital refractometer. Ash was determined by combustion of the sample in a muffle furnace at 550°C for 5 h. The total soluble sugar content was examined using phenol-sulfuric acid colorimetric method using a spectrophotometer (UV–VIS, Shimadzu). The total nitrogen content was determined by the micro-Kjeldahl method and total protein content was calculated using a 6.25 factor. Pectin content was determined by method of Golou and Bev. Reducing sugars were determined by the Fehling's test. The crude fiber content was determined using the traditional Van Soest method. Lipid content was determined using a Soxhlet apparatus HT 1034 according to the procedure described by Huang. Sensory evaluation was carried out by 10 panelists using a 9-point Hedonic scale.

Results: The physical and chemical analysis results give a very moderate total sugars (53.7; 46.4; and 23.2%), pectin (17.1; 16.0; and 12.0%), acidity (1.84; 1.45; and 2.9 g/100 g), °Brix (60; 62.3; and 27%), humidity (30.4; 32.4; and 71.8%), and fiber (13.3; 22.6; and 22.9%). The sensory results give for color (8.10; 6.62; and 7.22), for taste (7.89; 5.81; and 7.44), for odor (8.20; 6.64; and 7.98), and for texture (7.50; 8.30; and 5.23).

Conclusion: It would be good to extend the field of study to a mixture of prickly pear to others fruit to develop other quality products (jam, jelly, syrup, and candy) in the innovation framework.

Keywords: Acidity, Brix, Cactaceae family, Fiber, Pectin, pH, Total sugars.

 DOI: http://dx.doi.org/10.22159/ajpcr.2021v14i2.40227. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Opuntia ficus-indica (L.) Miller (Cactaceae family), belongs to the genus *Opuntia*, of the order *Caryophyllales,* is widely cultivated in the semi-dry area in Algeria for its high adaptation to the harsh desert environment. It's used for fruit production for its rich content of vitamin and presents important amount of minerals and fibers. In recent years, various parts of the plant such as root, stem, fruit, and flower have been used to prepare beverage, syrup, toffee, jams, marmalades, and dessert [1,2]. Unfortunately, *Opuntia ficus-indica* fruits are seasonal and perishable; their nutritional value and taste are at their best directly after harvesting, decreasing as time elapses [3].

Jam making is one of the technology fruit preservations [4]. According to European Union Council Directive 2001/113/EC [5], jams are a mixture, brought to a suitable gelled consistency, of sugars, with the pulp and/or puree of one or more kinds of fruit and water. Concentration is carried to at least 65% soluble solids for all jam, with some requiring up to 68% solids to achieve the desired qualities. Not <45 parts of fruit are permitted for each 55 parts of sugar.

METHODS

Plant material and preparation

Two kilograms of prickly pear fruits (*Opuntia ficus-indica*) of each variety were purchased from local markets. They were brushed under tap water to remove spines, cut up into small pieces, and homogenized into fine form using a food grinder, then filtered through a sieve to eliminate waste and seeds from the juice and pulp. The juice and pulp are mixed in similar proportions with sugar (m/m) and allowing the mix to soak for 24 h (let macerate for 24 h). The mix is then cooked to acquire the necessary final total soluble solid content [6] of 45 Brix.

Physical characterization of fruits

The axial dimensions of fruits were measured with a caliper and ruler. The fruits were weighed on an analytical balance (Sartorius Quintix 513-1S; 0.001 g). The various constituents of fruits (peel, pulp, and seeds) were separated and weighted.

Chemical analysis

The moisture content is determined by drying the fresh fruits in an oven Memmert SLE 400 at 65°C until constant weight was reached (AOAC, 2000) [7]. The pH is measured by a pH meter (CORNING), at 20°C (AFNOR, 1984) [8]. The titratable acidity is measured according to the AOAC method (2000) [7]. The soluble solids content is determined by measuring the Brix at 20°C using a digital refractometer, Reichert type, AR200 (AFNOR,1984) [8]. Ash was determined by combustion of the sample in a muffle furnace at 550°C for 5 h (AOAC, 1995) [9]. The total soluble sugar content was examined using phenol-sulfuric acid colorimetric method using a spectrophotometer (UV–VIS, Shimadzu) [10]. The total nitrogen content was determined by the micro-Kjeldahl method (AOAC, 1995) [9] and total protein content was calculated using a 6.25 factor. Pectin content was determined by method of Golou and Bev [11]. Reducing sugars were determined by the Fehling's test. The sucrose content is determined by the difference between the total sugar content and the reducing sugars present in the sample [12]. The crude fiber content was determined using the traditional Van Soest method [13,14]. Lipid content was determined using a Soxhlet apparatus HT 1034 according to the procedure described by Huang [15].

Sensory analysis

Sensory evaluation was carried out by 10 panelists using a 9-point Hedonic scale where (1) disliked extremely, (2) disliked very much, (3) disliked moderately,

(4) disliked slightly, (5) neither liked nor disliked, (6) liked slightly, (7) liked moderately, (8) liked very much, and (9) liked extremely [16].

Statistical analysis results were expressed as mean ± standard deviation and analyzed by Stat Box (6.0). Newman-Keuls test (p<0 05) was used to determine the significant differences between mean values. All analyses were conducted in triplicate.

RESULTS AND DISCUSSION

Physical characterization of fruits

The axial dimensions and weights of the fruit, skin, pulp, and seeds are described in Table 1. Fruit of Elkseur (FE) had the highest weight 78.43g. Regarding axial dimensions, it was the fruit that presented the highest values of height, width, and pulp yield. Timgad fruit (FT) showed the highest values of skin. By comparing these two fruits, we just notice a slight difference in the weight of the dried fruits (FT 16.41; FE 17.33), which concludes that FE is very rich in water.

Physicochemical characterization of fresh fruits

The results of the physicochemical fruit's composition are shown in Table 2.

The fruit has a high water content 80.68 % and 84,39%, respectively, for the two varieties: Timgad and Elkseur. This confirms the results 84–90% obtained in a previous study by Feugang *et al*. (2006). It showed a low amount of total sugar content 12.23% and 09.75%, this confirms the results 10–17% obtained by auteurs Feugang *et al*., 2006, and low amounts of lipid (Trace and 0.36%), compared to those reported by Feugang [17]. This low content of sugars and lipid gives *Opuntia ficus-indica* an appreciable fruit intended for diabetics. The content of protein, fiber, titratable acidity, and ash was nearly with the data found by Feugang [17]. In conclusion, prickly pear fruit is an interesting summer fruit, and its use in arid and semi-arid regions should be encouraged.

Physicochemical characteristics of elaborated jam

The pH analyses represented in Table 3 above mark different values which oscillate between 3.34; 4.10; and 3.48, the jam results are in the codex Alimentarius interval. The results of industrial jam remain stable which agrees with the codex standard Alimentarius. The acidity informs us about the degree of freshness of the jam and the good control of the manufacturing process. The value found for the three jams on the 1st day (1.81; 1.42; and 2.9) of production and so that after 21 days (Table 4) (1.84; 1.45; and 2.9) varies very slightly from 0.04, the industrial product remains fixed. Total sugars present 53.76/100 g for JT, 46.40 g/100 g for JE, and 23.25 g/100 g for JI, the elaborate jams slightly different from the author's standard CODEX STAN-19 [18] (65–70 g/100 g dry matter). The reducing sugars are around 8.57 g/100 g for JT, from 12.88 g/100 g for JE, and 16.82 g/100 g for JI. Sucrose is around 45.19 g/100 g for JT, 31.84 g/100 g for JE, and 6.14 g/100 g for JI. Ashes

Table 1: Physical characterization of the fruits

Characteristic	Fruit Timgad (FT)	Fruit Elkseur (FE)	References
Fruit weight (g)	43.4±6.06	78.4±13.6	40.0–212 g
Dry fruit weight (g)	16.4±1.17	17.3±1.23	15.0–23.0 (g/100 g)
Length (cm)	6.59±0.53	7.17±1.52	/
Width (cm)	4.25±0.14	5.96±1.02	4.00–9.00 cm
Skin weight (g)	15.4±4.17	12.0±6.80	/
Pulp weight (g)	28.0±1.89	66.3±6.82	/
Seeds weight (g)	6.03±0.27	6.84±0.54	4.5–9.6 g
Yield (%)	64.4±4.17	84.5±6.8	/

Table 2: Physicochemical characterization of fruits

Parameters	Fruit Timgad (FT)	Fruit Elkseur (FE)	References	
Moisture (%)	80.6±2.80	84.3±5.80	84.0–90.0	[16]
Pectin (mg/g)	3.72±0.30	2.28±0.41	/	/
pH	6.03±0.05	6.41±0.05	5.30–7.10	
°Brix %	13.0±0.5	12.0±0.50	12.0–17.0	/
Titratable acidity (g/100 g)	0.31±0,01	0.18±0,01	0.30–0.40	/
Total sugars (g/100 g)	12.2±0.51	9.75±0.19	10.0–17.0	[17]
Reducing sugars (g/100 g)	6.73±0.40	3.81±0.22	4.00–14.0	[17]
Sucrose (g/100 g)	5.50±0.45	5.94±0.17	/	/
Ash (g/100 g)	0.60±0.12	0.34±0.08	0.30–10	[17]
Fats (g/100 g)	trace	0.36±0.02	0.09–0.70	[17]
Protéins (g/l)	1.02±0.07	1.19±0.01	0.26–1.60	[17]
Fiber (g/100 g)	3.42±0.46	1.77±0.62	0.02–3.15	[17]

Table 3: Physicochemical characterization of jams

Parameters	Jam Timgad (JT)	Jam Elkseur (JE)	Jam industrial (JI)	References	
Moisture (%)	30.4±1.04	32.4±1.12	71.8±1.07	30.0–35.0	[18]
Pectin (mg/g)	17.1±0.18	16.0±0.2	12.0±0.27	/	/
pH	3.34±0.02	4.10±0.10	3.48±0.01	3.00–3.50	[19]
°Brix %	59.5±0.26	62±0.1	27±0.3	65.0–67.0	[19]
Titratable acidity (g/100 g)	1.81±0.12	1.42±0.18	2.90±0.18	/	/
Total sugars (g/100g)	53.76±1.92	46.4±1.1	23.2±1.95	65.0–70.0	[18]
Reducing sugars (g/100 g)	8.57±1.25	12.8±1.25	16.8±1.25	/	/
Sucrose (g/100 g)	45.1±1.31	31.8±0.17	6.14±0.21	/	/
Ash (g/100 g)	0.56±0.02	0.25±0.01	0.12±0.005	/	/
Fats (g/100 g)	trace	1.91±0.06	0.24±0.03	/	/
Protéins (mg/l)	4.47±0.16	8.95±0.31	2.11±0.26	300	[18]
Fiber (g/100 g)	13.34±0.75	22.6±0.5	22.91±0.1	1.10	[20]

Table 4: pH, °Brix %, and titratable acidity of jams, after 21 days, at room temperature

pH	3.42±0.08	4.14±0.02	3.48±0.01	3.00–3.50	[19]
°Brix %	60.00±0.30	62.3±0.20	27.0±0.02	65.0–67.0	[19]
Titratable acidity (g/100g)	1.84±0.02	1.45±0.01	2.90±0.02	/	/

Table 5: Sensory characteristic of jams

Parameters	J. Timgad (JT)	J. Elkseur (JE)	J. Roumais (JI)
Color	8.10±1.43	6.62±1.40	7.22±1.20
Taste	7.89±0.09	5.81±1.22	7.44±0.85
Odor	8.20±0.31	6.64±0.57	7.98±0.88
Texture	7.50±0.68	8.30±0.42	5.23±1.36

represent around 560 mg/100 g for JT, 250 mg/100 g for JE, and 120 mg/100 g for JI. A significant water content around 30.40% for JT and 32.40% for JE, they are the range of values found by CODEX STAN-19 [18], (30–35%), on the contrary, the water content of JI is much higher than these values (71.8%). Pectin's represents approximately 17.2 g/100 g for JT, 16 g/100 g for JE, and 12 g/100 g for JI. The protein content is around 4.47; 8.95; and 2.11 mg/g for the three jams JT, JE, and JI. These values are too low and differ completely from the data from the author CODEX STAN-19, [18], that is, 300 mg/g of jam. Fat values for JT are negligible, for leftovers are around 1.91 and 0.24 for JE and JI. These values decrease with temperature storage ambient. The fiber content is around 13.34; 22.06; and 22.91 for the three jams JT, JE, and JI, they are too high than the range of values found by USDA, 2007 [20], that is,1.1 g/100 g. We have increased the fiber content in the jam intentionally to improve the quality of the jam, since they are essential to the body, they have the particularity of promoting transit intestinal as well as regulating blood sugar and cholesterol levels. They also prevent weight gain, cardiovascular disease, colon cancer, and type II diabetes.

Sensory analysis

The results of sensory analysis of prepared jams are summarized in Table 5. The scores for color ranged from 8.10 to 6.62, for taste from 7.89 to 5.81, for odor from 8.20 to 6.64, and for texture from 8.30 to 5.30. The sensory evaluation revealed that JT was the most appreciate in term of color, odor, and taste. For texture JE was the most appreciate (8.30).

CONCLUSION

The study is limited to the qualitative aspect of the product rather than the economic evaluation which could be the subject of another research project. To this end, it would be good to make these recommendations: Extend the field of study to other fruits or a mixture of prickly pear to others fruit to develop other quality products (jam, jelly, syrup, and candy) in the innovation framework; vary, for the jam of *Opuntia ficus-indica*, other parameters such as sugar, fruit, and acid levels; use other varieties of prickly pear cultivated in other areas of culture.

ACKNOWLEDGMENTS

Our acknowledgments to Ms. Oulebsir Nadira, Vice-President of the National Association for Cactus Development. To Roumais Food Complex of El Kseur (Bejaia). To Prof. Khoudir Madani, the director of the Bejaia food technology research center (CRTAA).

AUTHORS' CONTRIBUTIONS

Boudaoud Yamina carried out the experiment. Abdessemed Dalila conceived the original idea, directed the project, and wrote the manuscript.

CONFLICTS OF INTEREST

No conflicts of interest.

AUTHORS' FUNDING

No financial support received from any funding agencies.

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