



Antimicrobial and antioxidant activities of Algerian prickly pears and two cultivars dates (Mech-Degla and Frezza)

Asma TEMAGOULT, Yassine NOUI, Bariza ZITOUNI

Cite this article as:

Temagoult, A., Noui, Y., Zitouni, B. (2023). Antimicrobial and antioxidant activities of Algerian prickly pears and two cultivars dates (Mech-Degla and Frezza). *Food and Health*, 9(3), 230-241. <https://doi.org/10.3153/FH23021>

University of Batna 1, Institute of Agriculture and Veterinary Sciences, Food Technology Department, Laboratory of Food Sciences, 05000, Batna, Algeria

ORCID IDs of the authors:

A.T. 0000-0002-4701-2100

Y.N. 0000-0002-8085-1715

B.Z. 0009-0000-2940-7283

Submitted: 21.02.2023

Revision requested: 11.04.2023

Last revision received: 10.05.2023

Accepted: 15.05.2023

Published online: 25.06.2023

ABSTRACT

This research aims to evaluate the biological activities and physicochemical characterization of the Algerian prickly pear and two varieties of dates (Mech-Degla and Frezza). The phenolic content of these fruits was determined by the Folin-Ciocalteu method. Then, antioxidant activities were studied using two different methods. The antimicrobial activities of the fruit were tested against four bacterial strains and two fungi and then compared to commercial antibiotics. Mech-Degla extract showed a strong antibacterial and antifungal inhibitory effect evaluated against *S. aureus*, *Streptococcus* spp, *E. coli*, *P. aeruginosa*, *G. capitatum*, and *Candida* spp. While Frezza date extract and prickly pear showed a weak effect against some bacterial strains, they had no inhibitory effect on fungi. The antimicrobial activity of Mech-Degla is superior to amikacin, ampicillin, and gentamicin. The Frezza variety had the highest antioxidant capacity, followed by Mech-Degla and the low iron reduction capacity is related to prickly pears. The tested fruits had high levels of polyphenols and flavonoids. This study confirms those species' antioxidant activity and antimicrobial properties and the critical effect of natural antibiotics compared to synthetic ones.

Keywords: Prickly pear, Dates, Algeria, Polyphenols, DPPH, Antimicrobial and antioxidant effects

Correspondence:

Asma TEMAGOULT

E-mail: asma.temagoult@univ-batna.dz



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Introduction

The nutritional value of the compounds in the fruits is essential for improving general well-being and protecting against several diseases. They may also be beneficial in treating other neurological disorders caused by oxidative stress (Chaouch et al., 2016; El Tanbouly et al., 2017).

Fruits contain beta-carotene, flavonoids, and phenolic compounds (Vaclavik and Christian 2007). The use of these bioactive molecules can improve human health and contribute to the resolution of several problems, such as resistance to synthetic antibiotics (Koubaa et al., 2015).

Cactus, Indian fig, and prickly pears are all names of *Opuntia ficus-indica* (L.) Mill. It occurs naturally in arid and semi-arid areas (El-Mostafa et al., 2014) and is highly environmentally tolerant (Astello-García et al., 2015). It was abundant in Mexico and the United States and was subsequently introduced into Mediterranean regions, notably South Africa and Algeria (El-Mostafa et al., 2014). Prickly pears are available worldwide in a variety of colors, including red, purple, green, and yellow (Aruwa et al., 2018). It was highly recommended for human consumption. Because this fruit is rich in minerals, vitamin C and flavonoids (such as kaempferol, quercetin, and isorhamnetin), phenolic acids, and betalain (Del Socorro Cruz-Cansino et al., 2015; Navarrete-Bolaños et al., 2013).

Palm-Date (*Phoenix dactylifera* L.) is an important crop in warm desert regions. Dates are marketed as high-value fruits worldwide (Abbès et al., 2013). Algeria is considered a date-producing country; annual date production is around 1.5 million euros, with 1136025 tons/ 170082 ha in 2019 (FAO-STAT, 2019).

The nutritional value of dates is attributed to their high levels of dietary fiber, sugars, and minerals such as magnesium, potassium, selenium, and copper (Al-Farsi and Lee, 2008). In addition to vitamins (B and C complexes), and antioxidant richness, polyphenols, flavonoids, and carotenoids (Bouhlali et al., 2016; Sánchez-Moreno and Larrauri, 2016).

This study aims to characterize the physicochemical properties and evaluate the biological activities of the prickly pear and two date varieties (phenolic content, flavonoids, antioxidant activities, and antimicrobial effect). Extracts from these fruits were tested to evaluate their antimicrobial activity against four bacterial and two fungal strains by comparing their effect to commercial antibiotics.

Materials and Methods

Sample Preparation

Fresh yellow-orange (*Opuntia ficus-indica*) fruits were collected in Arris, Algeria. The altitude is 1205 meters above sea level. The fruits of the prickly pear were washed, peeled, and kept at -20 °C until further analysis. In addition, this study was carried out on two varieties of dates (Mech-Degla and Frezza a Deglet Nour variety sorting gap). They were harvested from different palms from Biskra - Algeria. The date samples were stored in plastic bags and kept at -20 °C.

Physicochemical Characterization of Prickly Pear and Dates

To determine the moisture content, the fruits were dried in an oven (Binder, GmbH, Germany) at $103 \pm 2^\circ$ C and atmospheric pressure until a constant mass was obtained. Water content was equal to mass loss (AOAC, 1980).

A pH meter (HANNA, HI 2210, Romania) was used at 20° C to determine the potential difference by immersing the electrodes of the pH meter in the aqueous solution, which was tested according to the AFNOR method (1982).

Ash content was determined by incinerating the sample in a muffle furnace (Nabertherm, Germany) at 500°C. This determination is based on the destruction of any organic matter until whitish ash is obtained (AFNOR, 1982).

Dubois et al. (1956) used the phenol method to determine total sugar contents. Condensation between the formed compounds, by the addition of concentrated sulfuric acid and phenol, gave colored complexes (yellow-orange); (hydroxymethylfurfural in the case of a hexose and furfural in the case of a pentose).

To extract the desired components from the fruit, 1g of the fruit was added to 70 ml of distilled water. The mixture was then heated to 70°C for 30 minutes using a water bath. Subsequently, the mixture was filtered, and the volume was adjusted to 100 mL. Appropriate dilutions were made for each fruit extract. Then, 0.5 ml of sample and 0.5 ml of phenol (0.5%) were added to each test tube. After that, 3 ml of sulfuric acid was added to the test tubes, and the mixture was homogenized thoroughly using a vortex mixer. The test tubes were then placed in a water bath at 100°C for 30 minutes and allowed to cool down afterwards.

The optical density was measured at 490 nm using a visible UV spectrophotometer (Shimadzu, 120-02, Japan) (Fournier,

2001). This was done for each fruit. The standard range was prepared from a stock solution of glucose (mg/mL).

Determination of Total Phenolic Content

Polyphenols Extraction and Measurement

To determine the phenolic compounds, a solvent mixture was used. A 3 g sample was added to 120 ml of methanol: water (80:20 v/v) and allowed steep for 24 h, with agitation. The maceration was carried out at room temperature and in the dark. The extracts were filtered, then concentrated after maceration by the rotavapor (Buchi, Germany) at 45°C and 250 mbar. After that, they were covered with 10 ml of pure methanol and kept at -18°C until its use. This was done for each fruit.

The phenolic compounds were determined according to the method described by Juntachote et al. (2007). All measurements were done in three replicates. Fruit extract in 500 mL was combined with 1 mL of Folin-Ciocalteu reagent and 5 mL of distilled water. After 5 minutes of stirring, the mixture was neutralized with 1 mL of 7.5% Na₂CO₃.

The mixture was incubated in complete darkness at room temperature for an hour. At 760 nm, the absorbance was subsequently determined using a visible UV spectrophotometer (Shimadzu, 120-02, Japan). The results were expressed as Gallic acid equivalents in mg per 100g of fresh fruit (GAE/100g).

Determination of Total Flavonoid Content

The total flavonoid content of the extract was determined by spectrophotometry using the method reported by Bahorun et al. (1996). Both prickly pear and date extracts were tested separately. The results were reported as µg quercetin equivalent (QE) / mg extract.

1 ml of each fruit extract was added to 1 ml of trichloride of aluminium (2%). The mixture was stirred for 5 minutes and then incubated for 15 minutes at 25 °C. After incubating, the absorbance was determined at 430 nm using a visible UV spectrophotometer (Shimadzu, 120-02, Japan). The results were expressed as quercetin equivalents in µg per mg of fresh extract (QE/mg).

Radical Scavenging Activity of DPPH

The antioxidant capacity was evaluated using Farag's method (Farag et al., 2016) by scavenging the DPPH radical.

This method was based on reducing the DPPH radical from purple to yellow DPPH. The lowest absorbance indicates relatively highest activity. It was calculated using Eq. (1)

$$\% \text{ DPPH} = [1 - (A \text{ extract} / A \text{ control})] \times 100 \quad (1)$$

DPPH: radical scavenging activity (%)

A extract: absorbances of the sample (nm)

A control: absorbances of the control (nm)

Reducing Power Activity (FRAP)

The reducing power was calculated according to Sánchez-Moreno (2002). At 700 nm, the absorbance was measured. Increased absorbance mixture significantly increases reducing power activity; it was given in terms of Gallic acid equivalents.

Antimicrobial Activity

Four bacterial strains were used to determine the antibacterial activities. *S. aureus* and *Streptococcus* spp. are Gram-positive strains, *E. coli* and *P. aeruginosa* are Gram-negative strains. *G. capitatum* and *Candida* spp. were tested for anti-fungal activity. The disc diffusion method described by (Choi et al., 2006) was used for this evaluation.

The central microbiology laboratory, CAC (Anti-Cancer Center) Batna, Algeria, provided us with the bacterial and fungal organisms. Standard drugs, namely Amikacin, Colistin, Ofloxacin, Oxacillin, Tetracycline, Teicoplanin, Fluconazole, and Amphotericin B, were used as positive controls.

A sterile saline solution (0.9 %) was prepared with distilled sterile water and NaCl, also a 10 % of dimethyl sulfoxide (DMSO) solution was prepared.

The microorganisms were cultured in fresh nutrient broth overnight before being incubated at 37°C. Bacterial testing was done on Muller Hinton agar, and fungal testing on Sabouraud dextrose agar plates (EUCAST, 2020). The suspensions of each bacterial strain (0.5 Mc Farland opacity inoculum) were prepared from an 18-hour pure culture.

After inoculating Mueller-Hinton agar and impregnating Whatman paper discs (6 mm) with a small amount of extract (50 µl per disk), these discs were positioned on the surface, and DMSO-impregnated Whatman discs were used as negative controls. Until the visible growth of bacteria, Petri dishes were incubated overnight at 37°C. The same procedure was followed for fungi at 28°C.

The antibiotic susceptibility testing with appropriate antibiotics was performed to serve as positive controls and allow comparison of results. According to EUCAST's recommendations (EUCAST, 2020)

The calliper was used for reading the antibiotic susceptibility tests. An extract was considered active when there was no bacterial growth within the measured area, with a diameter greater than 8 mm.

Statistical Analysis

The results were presented as a mean, standard deviation ($n = 3$). The XLSTAT v. 14 and the Tukey HSD test were employed to improve variance analysis (ANOVA). When $p < 0.05$, the results were considered statistically significant. Principal component analysis (PCA) and pairwise correlations were applied to gain insight into the main data variation and to interpret the variable's relationships.

Results and Discussion

Physicochemical Characterization of Prickly Pear and Dates (Frezza and Mech-Degla)

The results of the physicochemical analyses of prickly pear and the two date varieties are mentioned in Table 1. They were the average of three repeats.

Table 1. Physicochemical characterization of prickly pear and dates fruits

Parameters	Values		
	Prickly pear	Mech-Degla	Frezza
Moisture (%)	84.00 ±0.72 ^a	7.79 ±0.42 ^b	11.24 ±0.35 ^c
pH	5.5 ±0.01 ^a	5.71 ±0.03 ^a	5.64 ±0.05 ^a
Ash [*]	1.97 ±0.72 ^a	2.12 ±0.05 ^a	2.13 ±0.01 ^a
Total sugars ^{**}	11.5 ±0.06 ^a	57.19 ±1.03 ^b	65.49 ±0.98 ^c

a,b, and c in the same row indicate a significant value difference at the $P \leq 0.05$ level. ^{*}: g/ 100g of fresh material ^{**}: g/ 100g of dry material

Based on the results in Table 1, both date varieties were considered dry fruits, given the low water content (according to the standard, the fruit was dry when the moisture content was <26%) Chibane (2008). On the other hand, the prickly pear was very rich in water and was considered a juicy fruit. This

criterion classifies prickly pear as a highly perishable fruit and dates as stable and long-stored fruits at ambient temperatures.

The moisture content of prickly pear pulp was 84%. This value was close to that of Chiteva and Wairagu (2013), who gave levels between 87.4% and 89%. Tonelli and Gallouin (2013) also found 87%. However, the Mech-Degla date was drier than Frezza (7.79 and 11.24 %), respectively. The moisture content found in this study was lower than those reported by Chibane (2008) for the same varieties and those mentioned by Noui (2016).

The three fruits' pH is slightly acidic and varies between 5.5 and 5.7. A slight difference is noted between the pH values of the two date varieties studied. The prickly pear's pH is 5.5. This value was slightly lower than that given by Bouzoubaa et al. (2014), which was between 5.80 and 5.92 for the 'Ache-fri' and 'Amouslem' varieties. Also, Mazari and Mahdeb (2021) in Souk-Ahras (south Algeria) reported a pH between 5.91 and 5.93.

The Mech-Degla date's pH was identical to that of Chibane (2008) for the same variety, 5.72. But it was superior to the Frezza variety, which was 5.06. It was also superior to that found by Mimouni (2009). The two dates studied have an acceptable pH according to the standard; the latter classifies those with a pH of 5.4 to 5.8 as quality dates (Hachani et al., 2018).

The ash content represents the total amount of mineral salts in the fruit. The ash content was between 1.97 and 2.13 % for the three fruits (Table 1); the Frezza variety was the richest in mineral salts compared with the other two. The ash content of the cultivar Frezza was identical to that studied by Chibane (2008), but the ash content of Mech-Degla was slightly higher. Noui (2018) mentioned 2.14% for the cultivar Mech-Degla. The result of the ash content of these two cultivars was lower than that found by El Arem (2012) for the same Tunisian cultivars in several maturation stages, also those found by Bouhlali et al. (2016) in other Moroccan cultivars.

The content of the prickly pear ash was 1.97 %; this value was higher than that of Mazari and Mahdeb (2021), which was between 0.26 and 0.44 %.

A clear significant difference between the total sugar contents of these three fruits. Sugars were the most important component in dates. According to the literature, the total sugar content of dates varies between 60 and 80 % depending on the variety and stage of maturation (Chibane et al., 2007).

The total sugar content of the two dates studied (Mech-Degla and Frezza) was 57.19 and 65.49 %, respectively (Table 1). Chibane (2008) indicated higher values for the same varieties, 63.8 and 77.3 %, and the Frezza variety was the richest in sugars. Assirey (2015) found higher levels in a study of ten date cultivars in Saudi Arabia. The content of these two varieties studied was like that reported by Tang et al. (2013), which was between 53.98 and 63.16 %.

After comparing the results of the sugar content obtained with those indicated in the standard (Hachani et al., 2018), therefore, it was concluded that the Mech-Degla variety was of poor quality in terms of sugar content (< 60%). At the same time, the Frezza variety was acceptable.

The total sugar content of prickly pear was 11.5 %. This value was lower than the results given by Bouzoubaà et al. (2014), which found values ranging from 13.5 to 15.87 % for different varieties of prickly pear studied in Morocco. Also lower than the results of Mazari and Mahdeb (2021), which were between 13.25 and 14.8 %.

Phenolic Compounds

The results of the phenolic compounds are presented in Table 2.

Table 2. Polyphenol content of prickly pear and dates (Frezza and Mech-Degla)

Parameters	Values		
	Prickly pear	Mech-Degla	Frezza
Total phenolics (mg GAE/100 g FW)	25.18 ±1.03 ^a	15.76 ±1.00 ^b	11.93±0.84 ^c
Total flavonoids (mg QE/100 g FW)	2.63 ±0.03 ^a	2.11 ±0.03 ^b	1.67 ±0.06 ^c

At the $P \leq 0.05$ level, different superscript letters in the same row indicate a significant value difference. GAE: Gallic Acid Equivalent; QA: Quercetin Equivalent; FW: Fresh Weight

According to the results presented in Table 2, the difference between the polyphenol content of the three extracts (prickly pear, Mech-Degla, and Frezza) was very clear, which were respectively 25.18 and 15.76 and 11.93 mg Gallic acid equivalent / 100 g of fresh weight.

The polyphenols content of prickly pears was like those obtained by Bouzoubaà et al. (2014), which ranged from 28.94 to 44.72 mg/100 g. However, it was lower than those found by Dehbi et al. (2013); Medina et al. (2007), respectively, between 45.2 mg and 64.36 mg GAE/100 g of fresh weight.

However, this polyphenol composition was superior to that of Bargougui et al. (2019). They extracted four cultivars of prickly pear from methanol and ethyl acetate: Ain Amara (Tunisia), Ain Jemaa (Morocco), Longissima (Algeria), and Sanguinea (Italy). Phenolic levels ranged from 2.53 to 0.80 mg/100 g. Several authors found that total polyphenols appear stable during refrigerated storage (Barba et al., 2012).

For date extracts, the results of phenolic levels found by Daas et al. (2014) and Chibane (2008) were even more important than those obtained in this study. Benmeddour et al. (2013) found higher values for these same cultivars and others in a study of ten varieties of Algerian dates (225.57 – 954.57 mg Gallic acid equivalent /100 g of fresh weight).

Total Flavonoid Contents

Flavonoid function was expressed by antioxidant activity and high affinity to polymers and especially heavy metals (Chibane, 2008).

The total flavonoid content of the three fruits ranged from 02.63 to 01.67 mg Quercetin equivalent /100 g (Table 2). This study showed that prickly pears have a higher flavonoid content than the dates studied.

Cruz-Bravo et al. (2019) found high values, ranging from 3.1 to 7.0 mg/100 g, in a comparative study of the flavonoid content of prickly pears during harvesting and storage. Also, El Mostafa et al. (2014) reported higher flavonoid values for prickly pear pulp, cladodes, and seeds.

The Frezza date had the lowest level of flavonoids. These results were lower than Daas et al. (2014) for Mech-Degla 6.01 mg Quercetin equivalent /100 g of fresh weight and Chibane et al. (2007) for the Frezza variety. Benmeddour et al. (2013) reported a significant difference in total flavonoid content between date cultivars in a comparative study (15.22-299.74 mg Quercetin equivalent /100 g of fresh weight). In addition, Chaira et al. (2009) found that the total flavonoid levels of dates varied significantly between some Tunisian cultivars, ranging from 6.41 to 54.46 mg QE/100 g. These variations could be attributed to cultivars, climate, cropping practices, and extraction methods.

Antioxidant Activity

DPPH Radical Scavenging Activity

According to Cruz-Bravo et al. (2019), the important antioxidant activity was due to polyphenols, flavonoids, and carotenoids, which play a protective role in the body.

Table 3 shows the antioxidant activity of the studied fruits. An important inhibitory activity reported for these fruits was their richness in polyphenols and flavonoids. Thus, a significant variation in the ability of the extracts to neutralize the DPPH radical.

As a result, the Frezza date had the highest anti-radical activity (83.33%), followed by prickly pear (80.66 %) and Mech-Degla date (61.11 %).

These results were comparable to Algerian and Italian prickly pear (Bargougui et al., 2019). However, they were higher than those found by Belviranli et al. (2019) for several varieties in Türkiye and Madrigal-Santillán et al. (2013), which showed that the best inhibition activity of prickly pear juice was 65%.

Concerning the inhibitory capacity of DPPH in both date varieties, the results were higher than those obtained by Benmeddour et al. (2013). The results found by Chibanen (2008) were like those obtained in this study for the Mech-Degla variety. However, they were lower than those of the Frezza variety.

Reducing Power Activity (FRAP)

A highly significant difference was estimated from the reductive power of the date (Frezza and Mech-Degla) compared to the prickly pear, which was respectively 19.15 - 18.38 and 05.75 mg/100 g, presented in Table 3.

The results of these date varieties were lower than those found by Benmeddour et al. (2013) in a comparative study of ten Algerian date cultivars. These results were also lower than the findings of Hachani et al. (2018) on five other Algerian date cultivars.

Chougui et al. (2013) and Medina et al. (2007) reported iron reductions of 66.57 mg/100 g and 19 mg/100 g for prickly pear.

Abdel-Hameed et al. (2014) found 81.38 mg/100 g of fresh prickly pear juice with yellow pulp and 123.23 mg/100 g of fruit juice with red pulp.

Table 3. Antioxidant activities of prickly pear and dates (Frezza and Mech-Degla)

	Prickly pear	Mech-Degla	Frezza
FRAP (mg/100 g)	5.75 ±0.34 ^a	19.15 ±0.22 ^b	18.38 ±0.39 ^b
DPPH %	80.66 ±3.28 ^a	61.11 ±1.84 ^b	83.33 ±2.70 ^a

Values are means ± SD. Different letters in each row indicate a significant difference ($P < 0.05$) among means of varying fruit. Extract

Antibacterial and Antifungal Properties

The extracts' bacteriostatic effects and fungal test were evaluated against six pathogenic strains to determine the presence or absence of inhibition area. The results are presented in Tables 4 and 5.

From the results, it was demonstrated that; Mech-Degla extract exhibited an inhibitory effect on the six strains tested. However, prickly pear extract only inhibited *E. coli* and *P. aeruginosa*. Regarding the Frezza date extract, all strains tested were resistant.

This significant inhibitory activity of these fruit extracts against certain bacteria was the same as that of certain commercial antibiotics, such as Amikacin, Colistin and Teicoplanin. However, it was more important and influential than Cephalexin, Ampicillin and Gentamicin.

It is essential to highlight the high efficiency of Mech-Degla extract, which was equal to that of Amikacin against *P. aeruginosa* and, more important, against *S. aureus* and *E. coli*. Mech-Degla extract showed equal activity regarding the antifungal ketoconazole or bifonazole. (The diameter of the zone of inhibition was more significant than that of the antibiotic used for antibiogram for the same bacterial strain).

The results of this variety of dates were more important than Daas et al. (2014) found.

The results found by Bargougui et al. (2019) confirm the effectiveness of the prickly pear extract against *P. aeruginosa* and *E. coli*.

The results of anti-fungal activity showed that only the Mech-Degla extract has a high efficiency. But these fungi were the most resistant to the effect of Frezza and prickly pear extract.

This antimicrobial activity was due to the ions present in these fruits. It is essential for reducing or preventing the initial adhesion of bacteria. Minerals like Mg^{2+} , Zn^{2+} , Na^+ , Fe^{2+} , Mn^{2+} , and K^+ mainly increase antibacterial activity (Meng et al., 2022).

Several authors explain the inhibitory effect against microbial pathogens by the phenolic composition of plant extracts (Balouiri et al., 2016). The inhibitory effect may be enzyme interaction, adsorption to the cellular membrane or metal ions, and substrate deprivation (Baydar et al., 2004).

Taleb et al. (2016) hypothesize that date phenolic compounds can be easily bound to proteins, and the interaction of these with the proteins of bacteria results in hydrogen bond interactions and ionic bonds. This will alter the protein activity of

the microorganism and make it more susceptible to treatment. It behaves like a prooxidant in systems that use redox-active metals such as iron and copper.

Polyphenols mainly compromise bioactive constituents, and these bioactive compounds influence H₂O₂ as an antimicrobial agent. Thus, further confirming the role of polyphenols as antioxidants that scavenge free radicals and reduce H₂O₂ and prooxidants generated in antibacterial activity.

So, depending on the antioxidant content, the bacterial cells proliferate and grow.

This is evident in the antibacterial results, which means that stress responses depend on the concentration of antioxidants.

Several data studies support this result (Abbès et al., 2013; Martín-Sánchez et al., 2014).

Principal Component Analysis

A PCA analysis evaluated the relationships between all the measured biological activities (Figures 1 and 2). The first two axes explain more than 94-98% of the variation. The first axis (F1) had a higher discriminating power of 67.51 % than the second (F 2), which had a discriminating power of 27.47 %. According to the first axis, a separation between the biological activities of the fruit extracts was observed.

The Mech-Degla date was characterized by the height antibacterial level, which correlates with the FRAP capacity on the right of the axis. While in the opposite sense, Frezza date and prickly pear were characterized as less antibacterial. But rich in flavonoids and polyphenols that promote a heightened antioxidant level.

For the second axis, a significant difference showed between prickly pear and the other dates in polyphenol and flavonoid rates.

Table 5. Antifungal activity of prickly pear and date fruits (Frezza and Mech-Degla)

Fungi	Diameter of the inhibition zone (mm)		
	Prickly P	MD	F
<i>Candida</i> spp	0.00 ^a	16.50 ±2.48 ^b	0.00 ^a
<i>G. capitatum</i>	0.00 ^a	14.50 ±1.98 ^b	0.00 ^a

Different lower-case letters in the same column indicate significantly different ($P \leq 0.05$)

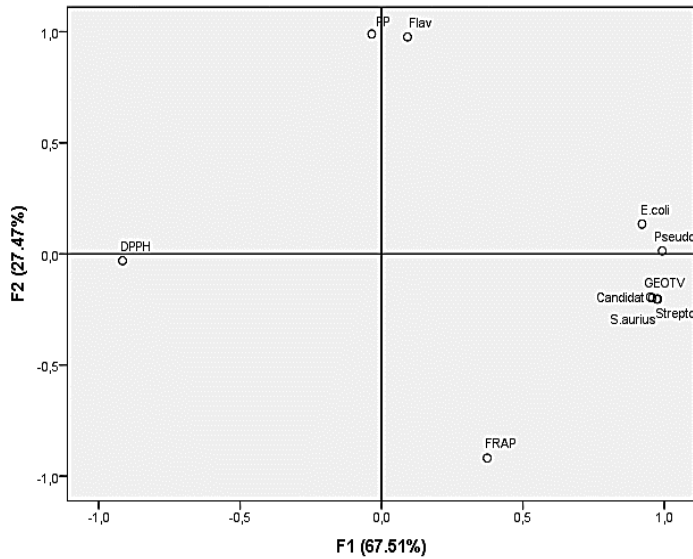
Candida: *Candida* spp., *G. capitatum*: *Geotricum capitatum*, Prickly P: Prickly Pear, MD: Mech-Degla, F: Frezza,

Table 4. Antibacterial activity of prickly pear and date (Frezza and Mech-Degla)

Bacteria	Diameter of the inhibition zone (mm)								
	Prickly P	MD	F	AK	CL	TE	VA	CN	OF
<i>S. Aureus</i>	0.00 ^a	10.50 ±0.7 ^b	0.00 ^a	8.0 ±0.0 ^c	-	08.0 ±0.0 ^c	14.0 ±0.0 ^d	-	11.0 ±0.0 ^b
<i>P. aeruginosa</i>	8.0 ±1.41 ^a	26.0 ±1.41 ^b	2.50 ±0.7 ^c	26.0 ±0.0 ^b	21.0 ±0.0 ^d	-	-	-	30.0 ±0.0 ^c
<i>E. Coli</i>	7.50 ±0.7 ^a	15.0 ±2.24 ^b	3.50 ±0.7 ^c	11.0 ±0.0 ^d	18.0 ±0.0 ^c	-	-	8.0 ±0.0 ^a	-
<i>Streptococcus</i> spp.	0.00 ^a	15.0 ±1.41 ^b	0.00 ^a	-	-	21.0 ±0.0 ^c	0.00 ^a	-	-

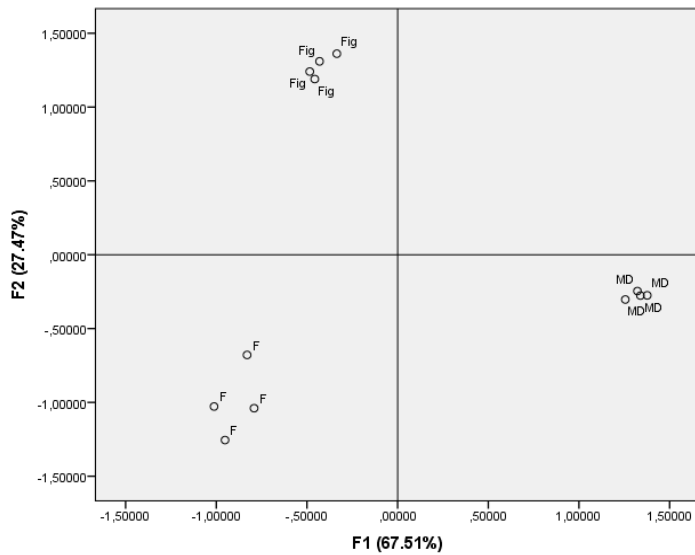
Different lower-case letters in the same column indicate significantly different ($P \leq 0.05$)

S. aureus: *Staphylococcus aureus*, *E. coli*: *Escherichia coli* and *P. aeruginosa*: *Pseudomonas aeruginosa*, Prickly P: Prickly Pear, MD: Mech-Degla, F: Frezza, AK: Amikacin, CN: Cefalexin, CL: Colistin, TE: Tetracycline, VA: Vancomycin. OF: Ofloxacin



S. aureus: *Staphylococcus aureus*, Strepto: *Streptococcus* spp., *E. coli*: *Escherichia coli* and *P. aeruginosa*: *Pseudomonas aeruginosa*, GEOTv: *Geotricum capitatum* and *Candida* spp., PP: Polyphenols, Flav: Flavonoids

Figure 1. Dispersion plot after space rotating obtained by CPA analysis of three fruits according to the biological characteristics



MD: Mech-Degla, F: Frezza and Fig: Prickly Pear

Figure 2. Dispersion plot after space rotating obtained by CPA analysis of prickly pear and dates (Frezza and Mech-Degla)

Conclusion

This study has shown a significant difference in the biological activities of three fruit extracts (prickly pear, Frezza and Mech-Degla dates) from eastern Algeria, confirming that some biochemical compounds show a significant antimicrobial effect.

The polyphenol content of the prickly pear extract was the highest. But it has the lowest value of FRAP, compared to the date varieties studied (Mech-Degla and Frezza); 19.15 ± 0.2 mg/100g and 18.3 mg/100g, respectively. The high antioxidant activity was noticed in the Frezza extract.

Mech-Degla extract exhibited an antimicrobial effect on the six strains tested. However, the activity of prickly pear extract only inhibited the growth of *E. coli* and *P. aeruginosa*. But the Frezza date extract has no antibiotic effect.

This significant inhibitory activity of these fruit extracts against certain bacteria was the same as that of some commercial antibiotics, such as Amikacin, Colistin, and Teicoplanin. However, it was more important and influential than Cephalexin, Ampicillin, and Gentamicin.

These results demonstrate that these natural products have the potential to be developed into new antimicrobial agents. These characteristics make them an excellent source of functional ingredients in producing many foodstuffs.

Compliance with Ethical Standards

Conflict of interests: The author declares that for this article, they have no actual, potential, or perceived conflict of interest.

Ethics committee approval: Authors declare that this study includes no experiments with human or animal subjects.

Funding disclosure: -

Acknowledgments: The authors would like to express their gratitude to all contributors to the realization of this work for their valuable help.

Disclosure: -

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