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Review Article

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Antioxidant, antimicrobial and antitumor activity of genus *Opuntia Spp*.

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ABSTRACT

Medicinal plants are extensively studied as source for discovery of new drugs. The study of the biological properties from medicinal species to provide security in its use. This study aimed toa literature review about Opuntia spp, related with antioxidant, antimicrobial and antitumor activities, in scientific databases, such as Scielo, LILACS, PubMed and CAPES/MEC Periodicals, using Opuntia spp. AND Antioxidant activity, Opuntia spp. AND Antimicrobial activity and Opuntia spp. AND Antitumor activity in Portuguese, English and Spanish, as descriptors. It were found 132 manuscripts in total, 25 containing antioxidant activity, 79 containing antimicrobial activity and 28 containing antitumor activity. The present study provides support for the development of new researches in area of medicinal natural products.

Keywords: *Opuntia spp.*; Antioxidant activity; Antimicrobial activity; Antitumor activity

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INTRODUCTION

The Brazilian flower biodiversity is considered as the largest in the world, because represent for over 20% of all species on the planet [1]. Actually, plants are still an important source for drug development, among these48% are natural product derivatives[2].

Several studies in medicinal plants that provide data about their biological properties, extends to culture conservation of the population. With the development of these studies, opportunities exist to solve the biological conservation problems and stimulate the local economy [3].

Actually, the Caatinga is a very threatened biome in Brazil. This biome presents specific native plant species, mainly from *Cactaceae* family, whose demonstrate significant biological properties in studies[4].

Cactaceae family is subdivided into *Maihuenioideae*, *Pereskioideae*, *Cactoideae* e *Opuntioideae*[5], which are spread in the American continent. In total, Brazil have registered approximately 40 genus and 200 species [6], which do not resemble, since they are suitable for different regions and climates. About the Northeast region from Brazil, it is possible to find 24 genus and 88 species [7].
Cactus are commonly reported in literature for many different purposes, including ethnomedicine, besides, serves to supply the lack of fodder over long periods of drought. In addition, it is also used as food [8].

Among the several genus found in Brazil, *Opuntia* spp, also known as *Palma Forrageira* is the most observed, specifically in the Northeast region. Palma is traditionally employed in the local medicine for treatment of some diseases, such as infection, inflammation, influenza, urethral problems, wound healing, abdominal cramps and

helminths. Additionally, in semiarid region of Alagoas and Pernambuco, Palma is utilized in the treatment of tumours, from scrape of its sap and its placement on the tumour, causing a regression in its size [9].

Palma applications, in addition to its versatility, should be further studied [10].This study is an analysis of secondary data, through a literature review, with hypothesis: "*Opuntia* spp genus has antioxidant, antimicrobial and antitumor activity? Therefore, the present study aimed to review the literature of the genus Opuntia spp related to antioxidant, antimicrobial and antitumor activity.

EXPERIMENTAL SECTION

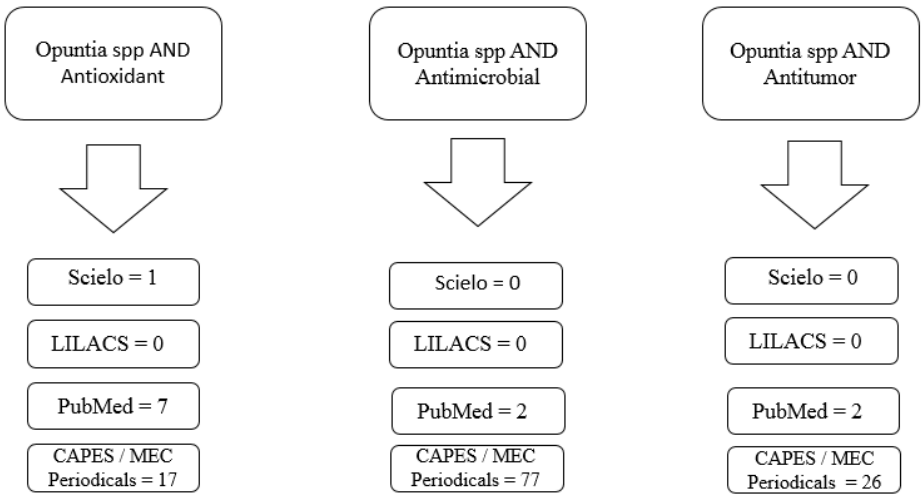
Data searches occurred in the period from October to November 2015, in electronic databases: Scielo, LILACS, PubMed, and Coordination for the Improvement of Higher Education Personnel (CAPES)/ Ministry of Education (MEC) Periodicals (CAPES/MEC Periodicals), employing descriptors: Opuntia spp. AND Antioxidant activity, Opuntia spp. AND Antimicrobial activity and Opuntia spp. AND Antitumor activity in Portuguese, English and Spanish. As time limit, it was used the period from 2010 to 2015 (five years).

The manuscript selection was based on inclusion criteria: articles published with key words in the title, abstract or full text. There was restriction concerning the publication periods and only the works reviewed by pairs were selected. For the selection of the manuscripts, two independent investigators first selected the articles according to title, then to abstract, and then through an analysis of the full-text publication. The resulting articles were manually reviewed with the goal of identifying and excluding the works that did not fit the criteria described above.

RESULTS AND DISCUSSION

It were found 132manuscripts in total, 25 containing antioxidant activity, 79containing antimicrobial activity and 28containing antitumor activity. Among these, only 11 manuscripts matched with the criteria used as analysis. In Figure 1 is shown the results found in each of searched databases.

Figure 1. Results from the methodological pathway employed in this work



In sense, it were selected 6 manuscripts related with antioxidant activity, 3 manuscripts related with antimicrobial activity and 2 manuscripts related with antitumor activity, using the criteria established before (Table 1). In addition, it were added 2 manuscripts considered as relevant.

Table 1. Studies found in the databases, Brazil, 2015

Authors	Year	Country	Species	Activity	Conclusion
Castillo et al.	2010	Mexico	*Opuntiaspp*.	Antimicrobial	Significant antimicrobial activity against *Rhizoctonia solani* Kühn fungus
Hahm et al.	2010	South Korea	*Opuntia humifusa*	Antitumor	Aqueous fraction from *O. humifusa* show therapeutic potential for treatment of glioblastoma.
Valente et al.	2010	Brazil	*Opuntia monacantha*	Antioxidant	Antioxidant activity of *O. monocantha*
Cardador-Martínez et al.	2011	Mexico	*Opuntia spp.*	Antioxidant	*Opuntia spp* by-products are good and cheap source of natural antioxidants
Castillo et al.	2011	Mexico	*Opuntia ficus-indica*	Antimicrobial	The extract present good bactericidal activity against *Campylobacter jejuni* and *C. coli*
Cayupán et al.	2011	Argentina	*Opuntia megacantha*	Antioxidant	*Opuntia megacantha* posses antioxidant activity
Moussa-Ayoub et al.	2011	Germany	*Opuntia macrorhiza*	Antioxidant	Fruits from *O. macrorhiza* are rich in β-cyanine and phenolic compounds with higher antioxidant activity
Osorio-Esquivel et al.	2011	Netherlands	*Opuntia joconostle*	Antioxidant	Present free phenolic acids and β-cyanine compounds with antioxidant activity
Hayek & Ibrahim	2012	United State of America	*Opuntia matudae*	Antimicrobial	Extract from *Opuntia matudae* shows antimicrobial activity against *E. coli*
Kim et al.	2013	Republic of Korea	*Opuntia humifusa*	Antioxidant and Antitumor	Presence of antioxidants and anti-proliferative effects
Madrigal-Santillán et al.	2013	Mexico	*Opuntia ficus-indica* (L.) Mill	Antioxidant	Juice act as antioxidant and may be involved with the anticlastogenic effect
Serra et al.	2013	Portugal	*Opuntia fícus-indica* and *Opuntia robusta*	Antitumor	Antiproliferative effect of *Opuntia spp*. toward human colorectal cancer cell line HT29
Chahdoura et al.	2015	Portugal	*Opuntia macrorhiza* (Engelm.) and *Opuntia microdasys*	Antioxidant	Highantioxidant effect

After analysis of all manuscript, it can be confirmed these results were obtained from experimental approach. The countries where studies were performed are Mexico (3 studies),Portugal (2 studies), Brazil, Germany, United State of America, Netherlands, Republic of Korea and South Korea (1 study for each one). Many species from *Opuntia spp* genus were utilized, highlighting the *O. macrorhiza* and *O. fícus-indica.*

In studies containing antioxidant evaluation, all of them demonstrate great potential for this activity. In the study of Cardador-Martínez et al. [11], it was evaluated the antioxidant activity of peel and seeds from *Opuntia spp* genus. The antioxidant capacity was higher in the peel than in the seeds and the authors conclude that cactus pear by-products can be exploited as source of natural antioxidants.

In study conducted in Brazil, by Valente et al. [12],reports the antiradical activity of Brazilian *Opuntia monacantha* Haw. (Cactaceae) cladodes. The antioxidant activity of the fractions was assessed by measuring their ability to scavenge DPPH radicals. In this study was possible to identify that ethyl acetate and *n*-butanol fractions showed better antioxidant activity, however lower than the positive controls employed(quercetin and ascorbic acid).

Osorio-Esquivel et al. [13] conducted the antioxidant study with methanolic extract and different semi-purified fractions from *Opuntia joconostle*. It was evaluated by the DPPH method. By comparing methanolic extract and fractions containing phenolic compounds and fraction containing *β*-cyanines, it was observed that the radical-scavenging activity decreased in the following order *β*-cyanines> phenolic compounds >methanolic extract. For the manuscript conclusion, the authors assert that the compounds for this species show interesting antioxidant activity.

Chahdoura et al. [14] performed a study with *O. macrorhiza* (Engelm.) and *O. microdasys* (Lhem.), with the DPPH radical-scavenging activity method. The manuscript conclusion was that *O. macrorhiza* showed higher antioxidant activity than *O. microdasys*. Higher antioxidant activity was observed in the seeds of *O. macrorhiza* and may be associated with higher levels of phenolic compounds found in the specie.

Moussa-Ayoub et al. [15] realized a study with *Opuntia macrorhiza.* The authors used the methods of determination of antioxidant activity using electron paramagnetic resonance spectroscopy (EPR) and using trolox equivalent antioxidant capacity assay (TEAC). The results shows high antioxidant activities of the extracts from *O. macrorhiza* pulp and peel, with both extracts causing degradation of more than 80% of synthetic radical Fremy's. Both utilized methods were applied for comparison and due the similar radical scavenging mechanism, results of the TEAC assay correlated really well with EPR.

Cayupán; Ochoa; Nazareno[16] conducted a study with *O. megacantha.* The antioxidant capacity was measured by DPPH method and 2,2′-Azinobis-[3-ethylbenzothiazoline-6-sulphonic acid] radical cation (ABTS) method. The results found that cactus fresh fruits have moderate free-radical scavenging capacity, and the values are similar to those of citric and other seasonal fruits.

Madrigal-Santillán et al. [17] realized a study with species from *Opuntia spp* genus, and the authors used DPPH radical scavenging activity to measure the antioxidant activity. Results showed that three varieties of prickly pear juice have an antioxidant potential that depends on the concentration and the best range capacity corresponded to the red-purple juice. In addition, the authors suggest that antioxidant capacity of the juice may be involved in the anticlastogenic effect.

Kim et al. [18] conducted an antioxidant and antiproliferative study about *O. humifusa.* The authors used DPPH and ABST method to antioxidant activity and MTT assay to antiproliferative activity. The results shows that a higher antioxidant activity was observed in the acetone extract in both DPPH and ABTS assays, respectively. The methanolic extracts were also good radical scavengers. In the study, bioactive compounds show to be a good source of antioxidants and to have anti-proliferative effects. The most potent extract was ethyl acetate, which inhibit both SW480 and MCF7 cells.

Castillo et al. [19] studied the antimicrobial activity of *Opuntia spp* genus. In this study, it was demonstrated the antimicrobial activity against *Rhizoctonia solani* Kühn fungus, and the authors reported that *Opuntia spp* shows the lowest mycelia inhibition effects (<30%). In the study of Hayek and Ibrahim [20], they utilized *Opuntia matudae* species, and the results shows that xoconostle pears have significant inhibitory effect on the growth of *E. coli* O157:H7. The xoconostle extract concentration is directly associated with a slower growth rate and bacterial populations reductions and these results indicate that the inhibitory effect of xoconostle extract is concentration dependent.

Castillo et al. study the antimicrobial activity of *Opuntia ficus-indica* against *Campylobacter jejuni* and *C. coli.* The extracts of plant species shows a good activity at minimal bactericidal concentration against *Campylobacter jejuni* and *C. coli.*, with a minimal bactericidal concentration of 0.4 mg mL^{-1}, showing a potential for controlling *Campylobacter jejuni* contamination in foods and diseases associated with this microorganism [21].

Also related to antitumor activity, Serra et al. [22] demonstrated that *Opuntia ficus-indica* and *Opuntia robusta* inhibited cancer (human colon carcinoma HT29 cell line) cell growth and induced cell cycle arrest in different checkpoints—G1, G2/M and S. The presence of compounds such as *β*-cyanines, flavonoids and phenolic acids (ferulic acid) could be responsible for cell cycle arrest.

In other study about the same activity, Hahm; Park & Son et al.[23]evaluated the *Opuntia humifusa* extracts in inhibition of growth of U87MG Human Glioblastoma Cells. The results shows that aqueous fractions from *O. humifusa* induce G1 arrest and non-apoptotic cell death as well as significant increases in reactive oxygen species (ROS) production in U87MG cells and inhibiting U87MG human glioblastoma cell proliferation.

The medicinal plants are a rich source for obtaining molecules therapeutically interesting for the new drug discovery. Many species are used empirically, without scientific support for efficacy and safety, it may occurs because there is a gap between the supply of plants and the limited research around the world. Thus, this is considered a factor of great encouragement to the studies with these plants, aiming their uses as an important pathway for the development of new active molecules [24].

Brazil has been developing important researches in the advanced knowledge of the medicinal properties of the plants used by population. Another observation is that there are programs and policies that encourage the inclusion of this type of therapy in the Unified Health System, which shows the pursuit of offering full and humanized care [25]. Thus, studies that prove the biological activities of plants are important for ensuring safety and effective uses of medicinal plants.

CONCLUSION

These studies are important because they reinforce the use of this genus in folk medicine, and relate those to three important biological activities (antioxidant, antimicrobial and antitumor), of the genus. Besides others may be related, such as anti-inflammatory, wound healing, anticlastogenic activity, among others.

New studies aiming to others biological activities may be developed, and the present study provides support for these new researches that can propose more perspectives considering the use of the genus *Opuntia spp* in the discovery of drugs and products targeted to areas of health and biotechnology.

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