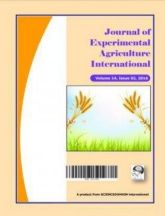

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Endophytic Fungi Associated with the Crown-of-friar Cactus (*Melocactus zehntneri* Britton & Rose) in the Semiarid Region of Brazil

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Authors' contributions

This work was carried out in collaboration between all authors. Author JTAS elaborated the study in the field and also in the laboratory. Authors RSSG and GGB were responsible for the laboratory and writing analyses of the work. Author LCN guided all research. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The objective of this study was to identify the occurrence of endophytic fungi associated with the crown-of-friar cactus (*Melocactus zehntneri* Britton & Rose) in the Brazilian Semi-arid region.
Methodology: The plants were collected in the municipality of Taperoá, State of Paraíba, Brazil and sent to the Phytopathology Laboratory, belonging to the Department of Plant Science and Environmental Sciences, the Federal University of Paraíba in the city of Areia, Paraíba, Brazil. Based on the indirect isolation of the symptomatic tissue fragments, fungal structures were examined under optical microscopy and compared with specialised literature. The removal of vegetative and reproductive structures of fungi, cultivated in BDA medium was carried out at a temperature of 25 ± 2°C and a photoperiod of 12 hours of light.
Results: Fungal genera namely, *Colletotrichum* sp., *Curvularia* sp., *Fusarium* sp., *Pestalotipsis*

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sp.e *Phomopsis* sp. were identified in de crown-of-friar cactus collected in the state of Paraíba. These genera cause diverse symptomatology in this cactus, negatively affecting the crown, base and root of the plant.
Conclusion: The fungal genera *Colletotrichum*, *Curvularia, Fusarium*, *Pestalotipsis* and *Phomopsis* were found on *M. zehntneri* plants collected in the state of Paraíba, Brazil.

Keywords: Cactacea; pathogens; sanity.

1. INTRODUCTION

The *Caatinga* biome dominates the semiarid region of northeastern Brazil and is characterised as a complex set of vegetal physiognomies, with an ample number of arboreal, arbustive and herbaceous species [1]. However, phytosanitation issues have been studied little in this biome, and there is a need for strategic planning to avoid the loss of biodiversity due to the high degree of human interference in the form of agriculture, livestock farming and extractive activities [2].

Cacti play a fundamental role in the ecology of the *Caatinga*. The genus *Melocactus* spp. has 37 xerophilic species that occur from Mexico to the state of Rio de Janeiro, with the highest concentration found in the northeastern, region of Brazil, which is considered as the centre of primary diversity for the genus [3]. The *Caatinga* biome is home to several species of *Melocactus*. *M. zehntneri*, which is commonly known as the crown-of-friar cactus or Turk's cap cactus, and is widely used by the local population in cooking, folk medicine [4], decorative landscaping and as fodder [5].

The crown-of-friar is a conical globose cactus with a defined centre, up to 22 cm high; has edges in a number, of 10, surrounded by acolytes arranged in groups of 5 to 7. Its flowers are red, and its fruit is a pinkish almond-shaped berry [6]. This cactus stands out as an alternative fodder for dry seasons in the Brazilian Semi-Arid, mainly for goats and sheep for their good palatability. Before supplying, the removal of their thorns is necessary [7].

Like *M. zehntneri*, other cacti are infected by fungal pathogens, such as the prickly pear (*Opuntia ficus-indica*), on which 15 fungal genera have been found, including *Fusarium*, *Colletotrichum* and *Pestalotiopsis* [8]. Few studies have been conducted on the aetiology and epidemiology of diseases affecting the crown-of-friar cactus caused by pathogenic fungi. Therefore, the present paper aimed to identify the occurrence of endophytic fungi associated with the species.

2. MATERIALS AND METHODS

Plants were collected from the municipality of Taperoá, which is located in the central region of the state of Paraíba, Brazil, in the micro-region known as the Western Cariri (coordinates: 739,959EW and 9,202,794NS-MC-39) at an altitude of 532 meters. The climate is rainy tropical with a dry summer. The rainy season begins in January/February and ends in September, but can extend into October. After collection, the material was sent to the Phytopathology Lab or the Phytotechnic and Environmental Science Department of the Federal University of Paraíba.

M. zehntneri plants with typical symptoms of infection were cleaned and kept at room temperature (25 ± 2ºC). After 48 hours, the plants presenting symptoms or signs of fungi were submitted to the direct preparation of slides, followed by visualisation of the mycelial and conidial structures with the aid of the optical microscope. For the unidentified lesions, tissue fragments (1 cm^2) were removed with the aid of a sterile surgical blade, where part of the infected tissue present in the cladodes was removed.

They were then disinfected in 70% alcohol solution for 30 seconds, 1% sodium hypochlorite for 1 minute. Tissue fragments were sampled with the aid of a sterile surgical scalpel, removing a part of the infected tissue from the crown, base and root of the plant. After this process, the fragments were plated in potato-dextrose-agar (PDA) medium at 25°C with a 12-hour photoperiod in biochemical oxygen demand (BOD).

After seven days of incubation, the identification of fungi was performed beginning with the spatial separation of the pathogen promoted by the host tissues with the aid of an optical stereomicroscope. The structures were compared to descriptions found in the literature

[9] for the determination of the occurrence of fungi associated with *M. zehntneri*.

3. RESULTS AND DISCUSSION

Under field conditions, necrosis of a dark colouration and yellowish spots appeared in the regions of the crown, base and root of infected plants, with the consequent shedding of spines, which serve as a defence mechanism against animal herbivory (Fig. 1).

Fig. 1. Crown-of-friar cactus plants (*Melocactus zehntneri* Britton & Rose), collected in the municipality of Taperoá, State of Paraíba, showing symptoms of aculeous fall (thorns) and foraging of plants by animals

According to [10], environmental factors play a fundamental role in the epidemiological development of diseases. The predominance of high temperatures combined with low humidity throughout a large part of the year favours a number of diseases and their causal agents. Freire FCO [11] identified more than ten diseases caused by pathogens on the mandacaru cactus (*Cereus jamacaru*), particularly rot, caused by *Lasiodiplodia theobromae*, which initiates infection at the apex of the plants, causing the darkening of infected tissues, followed by rot. The author stresses that, despite its apparent rusticity, the mandacaru and other native cacti of the *Caatinga* can be infected by numerous pathogens.

Fungal spores from *Colletotrichum* sp., *Pestalotipsis* sp. and *Fusarium* sp. were predominant in different regions of the crown, base and root of the plant (Fig. 2A, B, C and D). It is possible that some of these structures can cover injured areas, which is normal for the genus *Colletotrichum*.

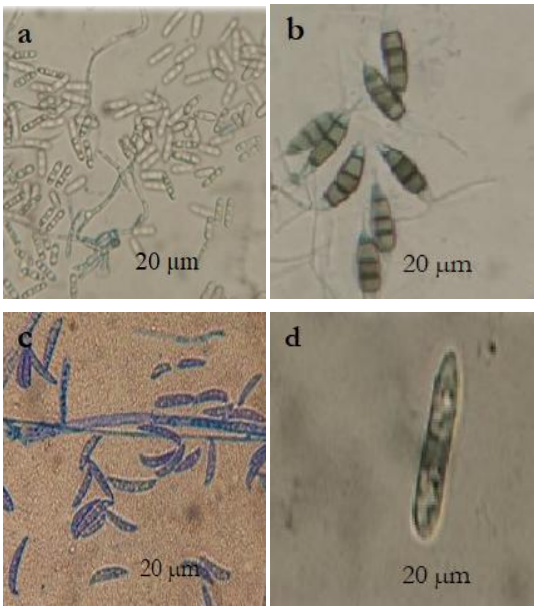

Fig. 2. Fungus conidia associated with crown-of-friar cactus (*Melocactus zehntneri* Britton & Rose), where (A) Colletotrichum sp. (B) Pestalotipsis sp. (C) Fusarium sp. (D) Colletotrichum sp.

The dominance of these fungi reduced the diversity of microbial agents. According to Suryanarayanan et al. [12], this is a common occurrence when plants in dry zones of the world are evaluated mainly due to environmental factors, such as low precipitation and low vegetation density. However, these findings diverge from [13], who reported high endophyte richness on different cactus species in the dry

tropical Brazilian forest, attributing the findings to the high diversity of plants in the *Caatinga*.

Besides *Colletotrichum*, *Pestalotiopsis* and *Fusarium*, the genera *Curvularia* and *Phomopsis* were also identified. [14] reported the presence of *Colletotrichum* sp., *Fusarium* sp., *Nodulisporium* sp. and *Phomopsis* sp. colonising mandacaru and the xique-xique (*Pilosocereus gounellei*) under natural conditions of the *Caatinga*.

The microflora was more intense in the regions of the crown and base of the plant, with a predominance of the genera *Fusarium* and *Pestalotiopsis*. However, only *Fusarium* was familiar to the infected regions of the crown, base and root. The infected areas of the plant acquire a soft rot appearance and yellowish colouration, causing an exudate denominated gummosis and the shedding of spines, such that these areas become defenceless against animal herbivory. In areas where extensive livestock farming predominates, infected plants can suffer irreversible damage due to the foraging of animals, especially in periods of drought, when the herbaceous and arbustive strata become scarcer.

The genus *Colletotrichum* was found in regions of the crown and roots of the plants. This fungus causes the darkening of the organs of the plant and photosynthetic areas, and the injured area is subsequently covered with a mass of dark spores. After a few days, the injury increases and the plant tissue becomes hard and dry [15]. Barbosa et al. [16] reported that this pathogen causes injury to the surface of the cladodes in the prickly pear cactus, with a tendency to concentrate at the edges in the form of depressed, dark spots and the emergence of fructifications (acervuli) in the injured area in the form of salient black dots.

4. CONCLUSION

The fungal genera *Colletotrichum*, *Curvularia, Fusarium*, *Pestalotipsis* and *Phomopsis* were found on *M. zehntneri* plants collected in the state of Paraíba, Brazil. These genera cause diverse symptoms in cacti, which underscores the need for further studies on the potential effect of these pathogens on *M. zehntneri.*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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