Figure 1. Images of some ecosystems of Nuevo León.

Mycodiversity of Nuevo León: BASIDIOMYCETES SECRETS AND WONDERS

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Nuevo León, a state in northern Mexico, is home to many ecosystems despite its predominantly semi-arid climate. The variety of altitudes and climatic conditions gives rise to a wealth of flora and fauna distributed in oak and pine forests, grasslands, deserts, and xeric scrublands (Figure 1).

Basidiomycetes are a diverse group of fungi distinguished by their characteristic form of sexual reproduction, which involves spores in structures called basidia. These fungi play a fundamental role in ecosystems, contributing to the decomposition of organic matter and facilitating the recirculation of nutrients. However, their influence extends beyond forests and soils, as their biotechnological potential has attracted the interest of scientists and innovative companies around the world.

Mexico has a great diversity of fungi, with more than 200,000 species, of which only 5% have been studied (Aguirre-Acosta *et al.*, 2014). Within this diversity, 1,408 species belong to the group of macrofungi (Valenzuela *et al.*, 2023). Specifically for basidiomycetes, at least 40,000 species have been reported worldwide, grouped according to their lifestyle or habitat into saprobes in grass/forest litter, decaying wood, yeasts, ectomycorrhizas, and plant parasites (Figure 2).

By 2030, more than 54,000 species of basidiomycetes will have been discovered, representing 1.4 to 4.2 million species worldwide (He *et al.*, 2022). In Mexico, 1,486 species have been inventoried, although this number does not accurately reflect the absolute number present (Aguirre-Acosta *et al.*, 2014; Cifuentes, 2008). In Nuevo León and Tamaulipas, 186 species of basidiomycetes belonging to 125 genera have been described (Ocañas *et al.*, 2023). This suggests the possibility of obtaining new isolates of native basidiomycetes in the region, with potential biotechnological application.

Role in nature

Basidiomycetes are fungi that live in nature and play an essential role in forests and other ecosystems. Its primary function is to aid in the decomposition of dead organic matter, such as fallen leaves and old tree trunks. This role is essential because the decomposition of organic matter releases essential nutrients for plant growth. Some fungi form a kind of "friendship" with plant roots called symbiosis, which helps plants absorb more water and nutrients from the soil, making them healthier and more robust (Smith & Read, 2010).

These fungi are also important in the forest food chain. Many animals, such as insects, birds, and other fungi, depend on them as a food source. Others can produce special chemicals called secondary metabolites, that can be beneficial to humans. For example, some of these metabolites have medicinal properties and are used to manufacture medicines (Alberti *et al.*, 2020).

Figure 2. Specimens of basidiomycetes from Nuevo León

Nuevo León Mushrooms: A Treasure for Biotechnology

In northeastern Mexico, Dr. Guadalupe Gutiérrez Soto, and her research team from the Facultad de Agronomía, UANL have discovered a hidden treasure in the basidiomycetes native to the region. Since 2011, they have been exploring the great potential of these fungi for various biotechnological applications, such as the production of enzymes for use in the food, livestock, and environmental sectors, as well as the production of antimicrobial, antifungal, and antioxidant metabolites.

To this end, more than 74 fungal species have been studied, and ten have been selected that stand out in the production of enzymes with notable operational and functional properties were selected. Among these is *Trametes maxima* CU1 (Figure 3), whose laccase enzyme has shown capacity in the degradation of synthetic dyes used in the textile industry (in addition to water contaminated with color), whose versatility (in combination with carbohydrate-active enzymes produced by the same fungus) has allowed the production of enzymatic cocktails. These cocktails have been used as digestive enhancers in rabbits, and the physical-chemical properties of bread have shown promising results. It has also been used in the valorization of agricultural waste (such as citrus peels, walnuts, grasses, agave bagasse, etc.) for the recovery of bioactive compounds and biomaterials (such as fibers with prebiotic activity[1]), thus contributing to the processes circular bioeconomy[2]. In this sense, *Tametes hirsuta* CS5 has also shown outstanding performance in the decolorization of synthetic dyes and in the recovery of agricultural wastes.

Figure 3. Different species of fungi that have shown high biotechnological potential

Pynoporus sanguineus CS2 This fungus produces a combination of enzymes that make it an ideal candidate for use as a digestive aid in poultry production, as its enzymes can help animals digest their food better, which can improve their health and productivity. It has also been used to recycle agricultural waste.

Ganoderma resinaceum CS27 strain has recently been studied, the results of which showed the ability to colonize agroindustrial substrates (such as critical shells, walnuts, and agave bagasse) in a semi-solid system, allowing the recovery of supernatants with lignocellulosic enzymes and bioactive metabolites, in addition to biotransformed fibers with prebiotic activity.

Macrolepiota sp. CS185 has been studied for producing antifungal compounds for application in agricultural production systems for the control of pathogenic fungi and in preparing bioactive coatings for fruits.

In summary, there is a great diversity of fungi in the state of Nuevo León with great potential to be used in various biotechnological applications. Therefore, many researchers are working to develop new products and processes that take advantage of the properties of these fungi.

References

1. Secretaría de Medio Ambiente del Estado de Nuevo León. (2023). Flora y fauna. Revisado en Noviembre 2023 de https://www.nl.gob.mx/campanas/conoce-las-riquezas-naturales-de-nuevo-leon.

2. Smith, S. E., & Read, D. J. (2010). Mycorrhizal symbiosis. Academic press.

3. Alberti, F., Kaleem, S., & Weaver, J. A. (2020). Recent developments of tools for genome and metabolome studies in basidiomycete fungi and their application to natural product research. Biology Open, 9(12), bio056010.

4. Aguirre-Acosta E, Ulloa M, Aguilar S, et al. Biodiversidad de hongos en México. Revista mexicana de biodiversidad (2014) 85:76-81. https://doi.org/10.7550/rmb.33649

5. He MQ, Zhao RL, Liu DM, et al. Species diversity of Basidiomycota. Fungal diversity (2022) 114(1):281-325. https://doi.org/10.1007/s13225-021-00497-3

6. Cifuentes J. 2008. "Hongos". Catálogo taxonómico de especies de México. In Capital natural de México, Vol. 1: conocimiento actual de la biodiversidad. Conabio, México. CD1.

[1] These fibers act as food for the "good" bacteria that live in the intestines, especially Bifidobacterium and Lactobacillus.

[2] Bioeconomy is based on using biological resources to create sustainable economic and social value.