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Biocultural understanding of medicinal plants in Mexico

Comprensión biocultural de plantas medicinales en México

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Abstract:

Mexico's climatic diversity promotes a wide variety of flora and fauna. The use of plants with medicinal properties in Mexico has an ancestral history dating back to pre-Hispanic times, where healers and medicinal plant connoisseurs played key roles in ethnobiology. Pioneers such as Roberto Escalante and Efraím Hernández X have shaped ethnobotany in Mexico, exploring human-plant relationships from anthropological and biological perspectives. Ethnobotany continues to contribute to drug discovery and development, connecting traditional knowledge with modern scientific advances, where medicinal plants may have beneficial properties in diverse therapeutic areas, underscoring their potential as valuable resources in pharmaceutical and medical research. The objective of this manuscript is to share the brief history of medicine in Mexico and the pharmacological potential of plants, highlighting the relevance of investigating and taking advantage of their chemical compounds in the development of new pharmacological treatments.

Keywords:

Mexico, Biodiversity, Ethnobotany, Traditional knowledge, Drug discovery, Traditional medicine.

Resumen:

La diversidad climática de México, promueve una amplia variedad de flora y fauna. El uso de plantas con propiedades medicinales en México tiene una historia ancestral que se remonta a la época prehispánica, donde curanderos y conocedores de plantas medicinales desempeñan roles clave en la etnobiología. Pioneros como Roberto Escalante y Efraím Hernández X han moldeado la etnobotánica en México, explorando las relaciones entre el ser humano y las plantas desde perspectivas antropológicas y biológicas. La etnobotánica sigue contribuyendo al descubrimiento y desarrollo de medicamentos, conectando el conocimiento tradicional con los avances científicos modernos, donde las plantas medicinales pueden tener propiedades beneficiosas en diversas áreas terapéuticas, lo que subraya su potencial como recursos valiosos en la investigación farmacéutica y médica. El objetivo de este manuscrito es compartir brevemente la historia de la medicina en México y el potencial farmacológico que tienen las plantas, subrayando la relevancia de investigar y aprovechar sus compuestos químicos en el desarrollo de nuevos tratamientos farmacológicos.

Palabras Clave:

México, Biodiversidad, Etnobotánica, Conocimiento tradicional, Descubrimiento de fármacos, Medicina tradicional..

INTRODUCTION

Mexico boasts a remarkable climatic variability, courtesy of its latitudinal location and intricate topography. Mexico's location brings together the fauna and flora life from two previously isolated regions, specifically North America and South America.[1] This combination of factors results in Mexico having a wide range of habitats, leading to a diverse and rich array of biological life.[2]

Mexico's biodiversity possesses approximately 70% of the global variety of flora and fauna, a large part of which are endemic species, meaning that they are exclusive to the country. In terms of vascular plants, it is estimated that between 50% and 60% of known species are endemic.[1] Vascular plants are home to the angiosperm and gymnosperm (seed and flowering plants)[3] groups, which are essential mainly in food, material resources and medicine from the chemical compounds of their secondary metabolism.

The National Commission for the Knowledge and Use of Biodiversity (CONABIO) has cataloged between 21,073 and 23,424 of such plants in the country, however, according to the latest data reported by biologists from the National Autonomous

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University of Mexico (UNAM), Mexico currently has more than 25 thousand vascular plants.[4] This number places Mexico within the list of countries with more plants worldwide, as can be seen in Table 1. In addition, the Mexican Institute of Social Security has recognized around 4 thousand species for their medicinal properties, representing 15% of the Mexican flora; however, only 5% have been subjected to phytochemical studies.[13,14]

Table 1. *Main countries with the most vascular plants worldwide.*

Position	Country	Species of vascular plants	Reference
1	Brazil	36,400	[5]
2	China	27,150	[6]
3	Colombia	24,528	[7]
4	Mexico	23,385	[8]
5	South Africa	21,250	[9]
6	Peru	19,147	[10]
7	Australia	19,324	[11]
8	Indonesia	19,232	[12]
9	Ecuador	17,548	[10]
10	Myanmar	16,000	[12]

MEDICINAL PLANTS: A BRIEF HISTORY

The supply of plants has generated diverse uses, including medicinal purposes, which are part of the culture and traditions of Mexico, even from pre-Hispanic times.[14] Herbal knowledge from ancient Mesoamerican civilizations, such as the Aztecs, Mayas and Tarahumaras, used flora and fauna in traditional medicine before the arrival of the Spaniards.[15]

The 'Cosmovision' or worldwide, understood as the way a culture perceives and organizes its view of the world and reality, provides a social interpretation of various phenomena.[16] Ethnobiology, primarily based on people's worldviews, explores multiple perspectives in interpreting the world, examining the connection between cultural perception and understanding of organisms or natural phenomena. On the other hand, ethnobotany studies the interrelationships established between humans and plants, over time and in different environments.[17]

Thanks to the records we have about the ways to use medicinal plants, it is now known that they can be used in various ways, such as poultices, infusions, dry powders, oils, alcoholic extracts, etc.[18,19] There are also other pre-Hispanic medico-religious practices that are considered sacred, where plants are also included, whose worldview is that the person can be cured from these ceremonies since the Aztecs believed that some divinities sent diseases and other gods cured them.[20] The difference with religious practices consists in the initiation rituals, in which permission must be requested through offerings, as shown in Figure 1, to the cardinal points [21], the Earth and deities depending on the purpose.

In the 16th century, the Spaniards were astounded by the profound knowledge and application of medicinal plants by indigenous peoples to treat illnesses. [22] Fray Diego de Landa, a Spanish Franciscan friar, expressed admiration, stating, "*They have as many trees and of every service and benefit, it is astounding...*" referring to the numerous natural resources that indigenous peoples utilized, such as trees and medicinal plants.[23]

Figure 1. Initiation ritual before a contemporary Temazcal (a closed stone structure for steam baths with aromatic plants). Permission is requested from the four cardinal points and Mother Earth to begin the ceremony. The image shows elements such as the Pirul plant and volcanic rocks surrounding the offering, copal resin in the center, pure chocolate, and an herbal infusion in the center.

The "Maní Auto-da-fé" was an event held in 1562 in the town of Maní in the Yucatán Peninsula, Mexico, during the colonial period. 'Auto de fe' in Latin, means "act of faith" in Spanish and refers to a public religious ceremony intended to condemn and punish those who were considered heretics or who practiced activities contrary to Catholic doctrine.[24]

During the Maní Auto-da-fé, vigorous actions were taken against indigenous religious and cultural practices. Fray Diego de Landa and other representatives of the Catholic Church condemned the beliefs and cultural expressions of the Maya indigenous people, leading to the burning of numerous Mayan codices—pre-Columbian manuscripts containing valuable information about the culture and history of the Maya.[24]

As Spanish dominance solidified in New Spain, the influence of the Catholic Church prohibited the treatment of diseases through traditional knowledge, deeming them magical and superstitious elements. This resulted in the punishment of many individuals and led to the clandestine practice of this knowledge.[25]

ETHNOBOTANY IN MEXICO

In Mexico, ethnobotanical research and teaching are mainly led by biologists[27], however, who led the ethno-scientific study

models for the first time in Mexico, was the anthropologist and linguist Roberto Escalante, taking up Conklin's methodology which was based on the total contextualization of the cosmovisions coming from the ethnicity, group or culture of study; He stated: "The researcher must place himself within the culture of a people and, for this, the first thing to do is to place himself within its language, which molds the various sectors of the culture."[27] Emphasizing that the most important thing was to reduce the ambiguities of the language, to avoid misunderstandings.

Another pioneer was Efraím Hernández X, who belonged to the National School of Agronomy of Chapingo (currently Autonomous University), his knowledge provided by biologists, helped him to consider the link between nature and man.[28]

Some Mexican researchers looked to the United States for models, it was found that the approaches developed there were not directly applicable to the specific problems of Mexico. In the United States, ethnobotanists are biologists focused on economic botany, while in Mexico they seek an understanding of the cosmovision, uses and customs of humans towards plants.[27] Although U.S. researchers use Mexico as a field of study, the perspectives are not usually the same, because there is often a lack of knowledge of the sociological, cultural and socio-ecological-economic context of Mexico.[26]

CREATION OF THE NATIONAL MEDICAL INSTITUTE (CURRENT NATIONAL HERBARIUM OF MEXICO)

Mexican ethnobotany underwent a significant phase during independent Mexico, marked by the establishment of the National Medical Institute (NMI) in 1890. Its mission was to conduct scientific research on medicinal plants, building upon the medical-botanical studies of previous centuries.[28]

This distinguished Institute played a pivotal role in ethnobotanical research, leaving a noteworthy scientific legacy reflected in various publications in renowned journals of the time, such as "La Naturaleza" and "Anales del Instituto Médico Nacional".[29,30]

The NMI played a fundamental role in the study of medicinal plants in Mexico, organizing itself into five specialized sections in key areas such as natural history, the study of their phytochemistry (metabolite composition), physiology, clinical therapeutics, climatology and medical geography.[30]

However, its trajectory came to an abrupt end. In 1914, Venustiano Carranza ordered the closure of the National Medical Institute due to political conflicts of interest.[29]

In 1915, its collections were integrated into the Directorate of Biological Studies, founded by Alfonso Luis Herrera.[31,32] Numerous researchers from the National Medical Institute joined the new institution, including Roberto Medellín, Eduardo Armendáriz, Juan Manuel Noriega, Miguel Cordero, and Carlos R. Herrera, those who continued their work, writing various articles about the use and chemical analysis of plants.[32]

Maximino Martínez, a student of Alfonso Luis Herrera, is considered one of the pioneers of Mexican ethnobotany. Since its founding in 1915, Martínez was responsible for organizing the Herbarium, inheriting collections from the National Medical Institute and two natural history museums in Mexico City. The Directorate of Biological Studies faced criticism and disappeared in 1929. All its materials and research books were transferred to the Institute of General and Medical Biology, which is now part of the Faculty of Biology at the UNAM.[29]

Despite its closure, the legacy of the National Medical Institute persists. The institution began the creation of an herbarium, which later in 1974 evolved into the current National Herbarium of Mexico. This herbarium not only preserves valuable botanical specimens but also represents an essential part of ethnobotanical knowledge in the country.[31]

HERBARIUM OF THE MEXICAN SOCIAL SECURITY INSTITUTE (IMSS)

This herbarium houses approximately 16,000 specimens from around 3,500 species of medicinal plants. Its formation was grounded in field and ethnobotanical research with healers and individuals possessing local herbal knowledge.[33] In addition to continuing the search for medicinal plants initiated at the National Medical Institute, the IMSS herbarium plays a crucial role by offering courses aimed at physicians with positivist approaches, promoting the understanding and appreciation of diverse medical systems in Mexico.[33,34] Currently, the herbarium is located in the basement of the Convention Center building at the National Medical Center in the Doctores neighborhood.[35]

NEW PERSPECTIVE

Today, with advances in modern science, various medications owe their discovery and development to ethnobotany.[36] This assertion is based on the fact that active compounds isolated from previously empirically known plants are probably safer than those derived from plant species with no history of human use.[37] For the discovery and development of novel, safe, and affordable medications, ethnopharmacological knowledge proves invaluable as it is backed by an experimental foundation.[38]

Although initial success was achieved with combinatorial chemistry in medicine, this approach was later proven to be less effective in terms of overall success rates. Thus, the search for biomolecules from natural products became highly appealing.[37]

From the 19th century, humanity has derived many medications from plants. The isolation of morphine, for example, was the first pure natural compound derived from *Papaver soNMIferum*, which marked the beginning of the era of drug discovery in 1803.[39] The acetylsalicylic acid was based on the natural compound salicin, isolated from *Salix alba*, introduced by Bayer in 1899. Paclitaxel was extracted from *Taxus brevifolia*, used in the treatment of lung, ovarian and breast cancer.[40] Artemisinin, used against malaria, comes from the traditional Chinese plant *Artemisia annua*. Galanthamine is a natural alkaloid obtained from *Galanthus nivalis*, used in Alzheimer's disease.

Tiotropium, derived from atropine from *Atropa belladonna*, is used in chronic obstructive pulmonary disease (COPD).[40]

The first pharmaceutical laboratory established in 1885 in Germany, was a turning point for many pharmaceutical manufacturing companies that previously operated as wholesalers.[41] This period was the initiator of commercial drug production, generating a transformation in the way diseases were addressed. Consequently, there was a change in mentality towards the practices of traditional medicine, where the perception of plants went from being positive to being considered negative, relegating them and even considering them illegal.[41]

CONCLUSION

Ethnobotany investigates the connection between humans and plants, revealing knowledge and cultural practices passed down through generations. This discipline allows us to understand the symbiotic relationship between people from various cultures and their natural resources, forming an integral part of their cultural identity. "curanderos" or “herbalists” preserve ancestral knowledge that can guide future scientific research on medicinal plants. Ethnobotany becomes relevant by providing valuable information from empirical practices for the research and development of treatments and drugs derived from natural products. The collaboration between anthropology and biology promotes a future where the relationship between humans and medicinal plants is understood, highlighting the importance of safeguarding biocultural diversity, essential for the identity of a nation.

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