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Review Article

Different Nanoparticles of Tinospora Cordifolia (Giloy), and its Application

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A B S T R A C T

The utilisation of Tinospora cordifolia, commonly known as "Giloy," extends beyond traditional medicinal practices, with a focus on exploring its potential in nanoparticle synthesis and applications. This botanical marvel, rich in bioactive compounds, has been extensively studied for its diverse pharmacological effects, including immunomodulation, anti-inflammatory, and analgesic properties. However, its role in regulating lead toxicity has not been previously explored.

This article presents a comprehensive investigation into the synthesis of different nanoparticles of Tinospora cordifolia, including silver, copper, iron, zinc, and gold nanoparticles. The synthesis methods involve the plant extract and metal precursors, resulting in varied nanoparticle characteristics. The potential applications of these nanoparticles are explored, highlighting their catalytic degradation capabilities, antimicrobial, antifungal, and analgesic properties.

Specifically, the greenly synthesised copper nanoparticles exhibit notable catalytic degradation activity against hazardous dyes. Copper oxide nanoparticles display antimicrobial and antifungal activities, with promising effects against gram-negative and gram-positive bacteria, as well as pathogenic fungi. Silver nanoparticles exhibit remarkable antibacterial and antifungal activities against multidrug-resistant strains and demonstrate inhibitory effects against Clamydomonas reinhardtii.

Moreover, the article delves into the potential of these nanoparticles for addressing lead toxicity. The study focuses on investigating how the aqueous extract from the stem and leaves of Tinospora cordifolia affects lead-induced haematological alterations, providing a novel perspective on the plant's therapeutic applications.

Keywords: Nanoparticles, Giloy, Tinospora, Synthesised, Copper.

Introduction

Tinospora cordifolia, commonly known as "Guduchi" or "Giloy," is a versatile and widely studied medicinal plant that holds significant importance in traditional medicine systems, particularly Ayurveda.[1] This botanical marvel belongs to the family Menispermaceae and is indigenous to the Indian Subcontinent, where it has been used for centuries for its numerous therapeutic properties. Tinospora cordifolia is a deciduous, climbing shrub characterised by its heart-shaped leaves and slender, twining stems. It is commonly found in the tropical and subtropical regions of India, Sri Lanka, and Myanmar. Tinospora cordifolia is

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rich in bioactive compounds such as alkaloids, glycosides, diterpenoid lactones (berberine, palmatine, and columbin), and polysaccharides.[2]

These compounds contribute to its diverse pharmacological effects. Tinospora cordifolia has a long history of use in traditional Indian medicine, where it is considered an important Rasayana (rejuvenative) herb. It has been used to treat various ailments, including fever, diabetes, arthritis, digestive disorders, and skin diseases. Tinospora cordifolia enhances the immune system's response, making it valuable in the management of infections and autoimmune conditions. Its antioxidant properties help protect cells from oxidative damage. Tinospora cordifolia exhibits potent anti-inflammatory effects, making it beneficial in conditions characterised by inflammation.[3]

It may help regulate blood sugar levels. The herb supports liver health and protects against liver damage. Some studies suggest potential benefits for neurodegenerative conditions. Due to its diverse pharmacological properties, Tinospora cordifolia has gained attention in the modern medicine and herbal supplement industries. It is used in various formulations, including capsules, powders, and tinctures, for conditions such as immune support, diabetes, and general health promotion.[1]

The extract from Tinospora cordifolia was found to significantly increase the pain threshold in two different tests: the hotplate test and the tail flick test. These tests are commonly used to assess an animal's response to pain stimuli. The increase in pain threshold suggests that the extract may have analgesic (pain-relieving) properties. Importantly, the effect was dose-dependent, meaning that higher doses of the extract led to a greater increase in pain threshold. In the acetic acid-induced writhing test, the extract produced a significant inhibition of the writhing reaction. This test is often used to assess the analgesic or anti-inflammatory effects of substances. Inhibition of writhing suggests that the extract may have anti-inflammatory or analgesic properties, as it reduced the pain response caused by the injection of acetic acid.[4]

These findings collectively suggest that the extract from Tinospora cordifolia has potential pain-relieving properties, as evidenced by its ability to increase pain threshold and reduce writhing responses in experimental animals. However, further research would be needed to understand the underlying mechanisms and to determine whether these effects translate to therapeutic benefits in humans. Additionally, it's important to consider the safety and potential side effects of using such extracts for pain management.[4]

The water extract from the stem of Neem-Giloy was found to exhibit statistically significant and dose-dependent mild analgesic activity. This suggests that the extract has the potential to provide mild pain-relief effects. The term "dose-dependent" implies that as the dosage of the extract increases, the analgesic activity becomes more pronounced.[4]

Additionally, the study found that the extract potentiated the analgesic (pain-relieving) effect of morphine. This means that when the water extract from Neem-Giloy was used in combination with morphine, the overall pain relief achieved was greater than that achieved with morphine alone. This synergy between the extract and morphine could have clinical implications for improving pain management. These findings suggest that the water extract from the stem of Neem-Giloy may have potential applications in mild pain management and may enhance the effectiveness of opioid analgesics like morphine when used in combination. However, it's important to conduct further research to understand the mechanisms behind these effects, determine the optimal dosages, and assess the safety and potential side effects of using this extract in conjunction with other pain medications.[4]

Tinospora cordifolia is recognised in Ayurveda as 'Amrita' or the 'Nectar of Immortality.' This name is attributed to the plant's reputed ability to confer qualities such as youthfulness, vitality, and longevity. Traditional medicine systems, like Ayurveda, often attribute specific health benefits to medicinal plants.[5]

The passage mentions that Tinospora cordifolia is being studied for its immunomodulatory properties. Immunomodulation refers to the capacity of certain compounds to influence various aspects of the immune system, including cytokine production (cell-signaling proteins), mitogenicity (the ability to induce cell division), and the stimulation and activation of immune effector cells. These properties are significant because they can have implications for immune health and disease prevention. Tinospora cordifolia is described as a rasayana drug.[5]

In Ayurveda, rasayana refers to a category of substances or therapies that are believed to promote overall health, longevity, and vitality. These substances are often associated with rejuvenation and maintaining optimal health.[5]

Tinospora cordifolia is recognised as an important medicinal plant with various traditional uses. However, despite its known medicinal properties, there has been no prior research on its role in regulating lead toxicity.[6]

Lead is highlighted as a common environmental pollutant known to cause health problems upon exposure. This introduction underscores the significance of studying the effects of lead exposure on health and the need for potential remedies. The passage mentions that previous studies on the regulation of lead toxicity have primarily focused on chelating agents and antioxidants such as vitamin C and vitamin E. It is noted that some of these conventional treatments may have toxic side-effects or disadvantages.[6]

Due to the limitations and potential drawbacks of conventional treatments, there is a growing interest in exploring the therapeutic potential of plant-based products or medicinal plants in reducing lead poisoning. The primary goal of the study is to investigate how the aqueous extract from the stem and leaves of Tinospora cordifolia affects lead-induced haematological alterations. Haematological alterations refer to changes in blood composition, which can be indicative of lead poisoning.[6]

Synthesis of different nanoparticles of Tinospora Cordifolia

Silver Nanoparticles (AgNPs) of Tinospora Cordifolia.

The common protocol for the collection of silver nanoparticles from Tinospora cordifolia is that a portion of the plant extract was prepared, presumably from Tinospora cordifolia, and a solution of silver nitrate (AgNO3) was prepared. This serves as the silver precursor solution. The plant extract was mixed with the AgNO3 solution. The resulting mixture had a greenish color. The mixture, containing the extract and silver nitrate, was incubated for 24 hours. The incubation was carried out in a rotary shaker set at 200 rpm. The temperature during incubation was maintained at 26°C. Over the course of the 24-hour incubation period, the colour of the mixture changed from light green to dark brownish. This colour change is an indicator of the reduction of silver ions (Ag+) to form silver nanoparticles (AgNPs).[7]

Copper Nanoparticles (CuNPs) of Tinospora Cordifolia

CuO NPs were created by mixing Tinospora Cordifolia leaf extract into a solution of Cu (NO3)2 at room temperature. The Cu (OH)2 colloids were obtained by stirring the mixture. The outcome was then formed by being heated at 450°C.

CuO was found to be present along with granules that were a dark blue color.[8]

Iron Nanoparticles (FeNPs) of Tinospora Cordifolia

At a temperature of around 50–60 ºC, the obtained plant extract was added to ferric chloride. A difference in colour, first brownish yellow, then pale yellow, then dark blue, after a specific amount of time, suggests the synthesis of Fe NPs.[9]

Zinc Nanoparticles (ZnNPs) of Tinospora Cordifolia

Aqueous zinc acetate dihydrate was added to distilled water using the "green synthesis method" while being constantly stirred. Aqueous leaf extract was added to the indicated solution after 10 minutes of stirring at various sets. The same solution became a pale white aqueous solution when NaOH was added to bring the pH level to 12. After that, it spent two hours in a magnetic stirrer. Then, to remove the contaminants, the light-coloured precipitate was removed and repeatedly cleaned with distilled water and ethanol. After drying at 60 °C in a vacuum oven for the next day, a pale white powder of ZnO nanoparticles was produced.[10]

Gold nanoparticles of Tinospora cordifolia.

At room temperature, AuNP was created by adding 1 ml of Tinospora aqueous leaf extract to a solution of HAuCl4. By examining how the colour of colloids shifted from yellow to light red, AuNP production was discovered.[11]

Applications of nanoparticles of Tinospora cordifolia

The greenly synthesised copper nanoparticles synthesised from Tinospora cordifolia were examined for their catalytic degradation capabilities and their effectiveness against four hazardous dyes, namely Eosin yellowish, Safranin, reactive orange, and direct green.

The analysis of the result indicates that these synthesized CuNPs of Tinospora cordifolia exhibit notable catalytic degradation activity, particularly demonstrating significant potential against eosin yellowish dye. Additionally, they demonstrate effective degradation efficiency when applied to safranin dye and exhibit promising degradation activity against reactive dye.[12]

Antimicrobial

Cupric oxide nanoparticles synthesised using Tinospora cordifolia displayed anti-microbial activity against grammeme-negative and grammeme-positive pathogenic bacteria at different concentrations. Significant inhibitions have been detected against E. coli, S. aureus, and S. typhi. However, S. pyogenes showed comparatively less inhibition.

Antifungal

Cupric oxide nanoparticles of Tinospora cordifolia have also exhibited antifungal properties against pathogenic fungi. The agar-well diffusion method was employed to assess the antifungal potential of Tinospora cordifolia CuONPs. Across various concentration gradients, these nanoparticles have shown effective antifungal activity against Candida albicans and Aspergillus oryze, while their impact on Aspergillus niger appeared to be less prominent.[13]

The biosynthesised silver nanoparticles of Tinospora cordifolia were examined for their antibacterial properties. These nanoparticles were assessed for their antibacterial activity against a range of bacteria, including S. aureus, B. subtilis, P. vulgaris, and K. pneumonia, using the well diffusion method.

The results reveal that grammeme-negative bacteria exhibited a larger inhibition zone compared to grammeme-positive ones, attributed to differences in their cell wall structures. Evidently, the silver nanoparticles synthesised from the leaf powder extract of Tinospora cordifolia displayed toxicity towards multidrug-resistant microorganisms. This study highlights the promising potential of these Ag nanoparticles from Tinospora cordifolia in the domain of biomedical sciences.[14]

Silver nanoparticles synthesised from Tinospora cordifolia showed remarkable antibacterial activity against a total of twenty multidrug-resistant strains of pseudomonas aeruginosa originating from burn patients. These AgNPs of Tinospora cordifolia exhibited excellent antimicrobial activity at different concentrations.[15]

The silver nanoparticles of Tinospora cordifolia leaf extract demonstrated inhibitory effects against Clamydomonas reinhardtii in three different assays, with the maximum inhibition zone observed in the agar-well diffusion technique. The results strongly suggest that the synthesised silver nanoparticles from Tinospora cordifolia effectively suppressed the growth of C. reinhardtii.[16]

Application of zirconium oxide nanoparticles derived from Tinospora cordifolia as a multifaceted agent with antibacterial properties against Basillus subtilis, Pseudomonas aeruginosa, and Streptococcus mutans, as well as antifungal efficiency against Aspergillus fumigatus and Aspergillus niger. These nanoparticles were assessed for their potential using the well diffusion method. The most substantial zones of inhibition were observed in the cases of B. subtilis, P. Aeruginosa, E. coli, and S. mutans, showcasing the remarkable activity of Tinspora cordifolia zirconium oxide nanoparticles. Additionally, these nanoparticles also demonstrated notable antifungal properties against A. fumigatus and A. niger.[17]

The copper nanoparticles synthesised using the leaf extract of Tinospora cordifolia exhibited remarkable antibacterial and antifungal activity against a broad spectrum of various pathogens, including Lactobasillus sp., Staphylococcus aureus and streptococcus mutan, along with antifungal activity against Candida albicans, as evidenced by the presence of distinct zones of inhibition. It can be figured out that these nanoparticles of Tinospora cordifolia excel at combating gramme-positive bacteria. The bioactive compounds serving as capping and stabilising agents on the nanoparticle surface play a crucial role in conferring their antimicrobial attributes.[18]

Copper oxide nanoparticles were biofabricated using Tinospora cordifolia leaf extract and tested against the chloroquine-resistant malaria parasite plasmodium falciparum, as well as evaluated for their antiviral competence against the malaria vector Anopheles stephensi and the dengue vector Aedes aegypti.

The resulting copper oxide nanoparticles mediated by Tinospora cordifolia demonstrated significant antiplasmodium effects, particularly against the chloroquine-resistant strain of plasmodium falciparum. Additionally, these Tinospora cordifolia copper oxide nanoparticles exhibited enhanced larvicidal activity against both Anopheles stephensi and Aedes aegypti mosquitoes. These findings suggest that Tinospora cordifolia aqueous leaf extract could serve as an excellent reducing agent for synthesizing nanoparticles.[19]

Conclusion

In conclusion, the exploration of Tinospora cordifolia, or Giloy, extends its traditional medicinal significance to the realm of nanotechnology. The synthesis of various nanoparticles, including silver, copper, iron, zinc, and gold, showcases the adaptability of this botanical marvel in yielding diverse nanomaterials with unique properties. These nanoparticles, synthesised using eco-friendly methods, exhibit promising characteristics, making them potential candidates for a range of applications.

The catalytic degradation capabilities of copper nanoparticles against hazardous dyes, along with their antimicrobial and antifungal activities, highlight their multifaceted potential. Similarly, silver nanoparticles exhibit remarkable antibacterial and antifungal properties, showcasing effectiveness against multidrug-resistant strains and specific microorganisms.

Moreover, the study introduces a novel dimension by investigating the potential of Tinospora cordifolia in mitigating lead-induced haematological alterations, shedding light on its role in addressing environmental toxicity. This novel perspective emphasises the versatility of Tinospora cordifolia, not only in traditional medicine but also in emerging areas such as environmental health.

The research findings suggest that Tinospora cordifolia holds promise in the field of nanomedicine, offering solutions for catalysis, antimicrobial and antifungal interventions, and even contributing to environmental detoxification. However, while these preliminary results are encouraging, further research is essential to understand the mechanisms behind these effects, optimise dosages, and evaluate safety concerns.

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