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Exploring antioxidant potential: a comparative review of Catharanthus roseus across different parts

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ABSTRACT
Antioxidants play a crucial role in mitigating oxidative stress, which is implicated in various diseases and aging processes. Catharanthus roseus, commonly known as the periwinkle or Madagascar periwinkle, is a plant renowned for its medicinal properties, including its antioxidant potential. This review aims to provide a comprehensive comparative analysis of the antioxidant activities present in different parts of C. roseus, namely the leaves, stems, roots, . We systematically review the existing literature on the phytochemical constituents of each plant part and their respective contributions to antioxidant defense mechanisms. This includes evaluating polyphenols, alkaloids, and other bioactive compounds that contribute to the plant's ability to scavenge free radicals and reduce oxidative damage. Our analysis also explores the variations in antioxidant activity among different parts of the plant, influenced by factors such as environmental conditions and extraction methods. By consolidating findings from various studies, this review highlights the most potent sources of antioxidants within C. roseus and suggests potential applications for these natural compounds in therapeutic and preventive health strategies. The insights provided here aim to guide future research directions and facilitate the development of more effective antioxidant-based treatments.

Keywords: Catharanthus roseus, antioxidants, phytochemicals, oxidative stress, comparative analysis, medicinal

I. INTRODUCTION

A substance known as an antioxidant prevents other molecules from oxidising. The chemical process of oxidation involves the transfer of electrons or hydrogen from one substance to an oxidising agent. Free radicals can be produced by oxidation processes. Consequently, these Radicals have the ability to initiate chain reactions, which can harm or even kill a cell when they happen inside of it. By eliminating free radical intermediates, antioxidants stop these chain reactions and stop additional oxidative reactions. They achieve this by oxidising oneself. Reducing agents like thiols, ascorbic acid, or polyphenols are frequently classified as antioxidants.[1][2]

Overproduction of free radicals may inhibit antioxidant enzymes like catalase, peroxidase, and superoxide dismutase, resulting in damaging effects deadly biological consequences (such as apoptosis) by oxidising cellular proteins, enzymes, membrane lipids, and DNA, which stops cellular respiration. Furthermore, it appears that reactive oxygen species have an impact on cell signalling pathways in ways that are still being discovered. as one of the primary causes to chemical spoiling, oxidation can also have an impact on food, leading to rancidity and/or a decline in the nutritional value, colour, flavour, texture, and safety of food. .According to estimates, postharvest deteriorative responses causes half of the world's fruit and vegetable crops to be lost. There are defence mechanisms in place to counteract the effects of excessive oxidation.[3][4]

There are other synonyms for Catharanthus roseus L., sometimes known as Madagascar periwinkle, including Vinca rosea, Ammocallis rosea, and Lochnera rosea. The plant is also occasionally referred to by other English names, such as Old Maid, Cape Periwinkle, Rose Periwinkle, and Rosy Periwinkle. It's a crucial Apocynaceae is a medicinal plant used to treat diabetes, blood pressure, asthma, constipation, cancer, and menstruation issues. It has a large number of beneficial alkaloids. Two potent naturally occurring anticancer products, vinblastine and vincristine, are members of the terpenoid-indole alkaloids group that were isolated from the pan tropical plant Catharanthus roseus. These alkaloids are only present in trace amounts in the complex mixture of approximately 130 alkaloids that this plant produces. Vinblastine and vincristine have been used to treat and cure hundreds of patients over the last 40 years, [5][6]

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II. MATERIALS METHODS

This paper was created using a review of the literature found on Google Scholar and PubMed.Catharanthus roseus, phytochemicals, antioxidants, oxidative stress, comparative study, and therapeuticSome of the articles were found to not meet the study criteria after reading their titles, and they were later removed from the review.To create this study, the most relevant papers were chosen, and their abstracts were examined .Articles that might have fulfilled the initial requirements were chosen after reading the abstracts, and they were then read in full.

Antioxidant activity of different parts of cathranthus roseus

Spectrophotometric antioxidant assays were used in in vitro experiments to determine the antioxidant capacity of methanolic root extract Catharanthus roseus.

DPPH˙ radical scavenging activity: The reduction of purple DPPH to yellow was used to measure the DPPH scavenging activity of Catharanthus roseus methanol root extract.Diphenylpicrylhydrazine having colour. Unlike other free radicals, the DPPH radical has the advantage of not being damaged by several side reactions such enzyme inhibition and the metal ion chelation process. At a wavelength of 517 nm, the absorbance and colour variations were measured (Systronics, Spectrophotometer 104).

The antioxidant activity of the Methanolic root extract was evaluated across various concentrations, ranging from 20 µg/mL to 120 µg/mL. As the concentration of the extract increased, there was a corresponding increase in its ability to inhibit oxidation. At the lowest concentration tested (20 µg/mL), the extract exhibited a 25.04% inhibition of oxidation, which progressively rose to 80.68% inhibition at the highest concentration (120 µg/mL). This trend indicates a dose-dependent relationship between the concentration of the extract and its antioxidant potency. These findings underscore the potential of the Methanolic root extract as a source of antioxidants, which could be beneficial for various applications in health and nutrition.

DPPH˙ radical scavenging activity: Scavenging of 1, 1-DPPH (diphenyl 2-picrylhydrazyl) free radical scavenging is a well-known decolourization antioxidant assay. The At 120 µg/mL concentration, the root extract of Catharanthus roseus showed the highest DPPH˙ radical scavenging activity, with an 80.68 ± 0.96% value. After comparing the results with standard ascorbic acid, which had an IC50 of 11.98 µg/mL, the IC50 of 57.39 µg/mL was determined. The content of antioxidants in the root extract determines the absorbance. When the stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical was reduced to 1, 1-diphenyl-2-picrylhydrazine, the root extract showed a high capability for scavenging the free radicals. The observable deep purple colour and the absorbance reaction at 517 nm are caused by an unusual electron in the DPPH. When the DPPH has lost its colour, the antioxidant activity of the DPHH radical is determined by using the changes in absorbance [7][8].

The antioxidant properties of various Catharanthus roseus shoot extracts and fractions

Assay for DPPH radical scavenging

We looked at the C. roseus extracts and fractions' capacity to scavenge free radicals shoots. The DPPH assay was used to quantify the extracts and fractions of C. roseus shoots' capacity to scavenge free radicals. extracts and fractions of C. roseus shoots demonstrated good radical scavenging activity, with IC50 values (the extract concentration giving 50% of inhibition) ranging from 28.2 to 119 µg/ml. Compared to other extracts and fractions, 100% Methanolic extract had better free radical scavenging activity. n-hexane and 100% Methanolic extract had the lowest IC50 values, respectively.Revealed the highest IC50 value, indicating that the Methanolic extract had the highest and the n-hexane had the lowest antioxidant activity. In contrast to the All extracts and fractions demonstrated lesser antioxidant activity when compared to the synthetic antioxidant BHT. The IC50 values provided by C. roseus shoot extracts and fractions were arranged as follows: BHT< M< E\ M1\ M2< M3< E2 \E1\ E3< E4< C< H. To the best of our knowledge, there are no previous publications on C. roseus shoots' ability to scavenge DPPH radicals that we could compare the findings of our investigation with.[9][10]

Antioxidant Activity of C. roseus Leaf Extracts:

This study shows that DPPH assays were used to measure the antioxidant activity of C. roseus at varying amounts (200, 400, 600, 800, and 1000 µg). Out of the five examined doses, 800 µg exhibits the highest level of antioxidant activity (81.70%).The concentrations of 400 µg, 600 µg, and 1000 µg also exhibited considerable antioxidant potential, with values ranging between 80.24% and 80.54%. These findings suggest that the leaf extract of periwinkle possesses notable antioxidant properties, with its effectiveness peaking at a moderate concentration. Further studies could explore the specific compounds responsible for this antioxidant activity and elucidate their potential health benefits and applications.

Since the global pharmaceutical and cosmetic industries have shown a strong interest in medicinal plants, they are a popular target for patent claims. Antioxidant qualities have been linked to a number of plants.Generally speaking, most cell types can exhibit partial resistance against oxidative stress through two main strategies: ROS-scavenging enzymes like catalase, superoxide dismutase (SOD), and various peroxidases, and small antioxidant molecules like ascorbate, polyunsaturated fatty acids, or sugars primarily mannitol. TheUsing the DPPH radical scavenging assay, we looked into the C. roseus extract and fractions' capacity to scavenge free radicals. Partitions within C. roseus when compared to other concentrations, the extract concentration of leaves demonstrated exceptional radical scavenging efficacy, offering 82% of inhibition.Every quantity indicated a decreased amount of antioxidant activity[11] [12].

The DPPH˙ radical scavenging activity assay is a well-established method to evaluate the antioxidant potential of various substances by measuring their ability to reduce the stable DPPH˙ radical to 1,1-diphenyl-2-picrylhydrazine. Here's a detailed comparison and summary of the findings related to Catharanthus roseus (C. roseus) extracts and their antioxidant activities:

Root Extract of Catharanthus roseus

- Scavenging Activity: At 120 µg/mL concentration, the root extract of C. roseus demonstrated a high DPPH˙ radical scavenging activity of 80.68 ± 0.96%.
- IC50 Value: The IC50 value for the root extract was determined to be 57.39 µg/mL, indicating the concentration required to achieve 50% inhibition of DPPH˙ radicals. This is higher compared to ascorbic acid (IC50 of 11.98 µg/mL), suggesting that ascorbic acid is a more potent antioxidant in this assay.
- Mechanism: The reduction of DPPH˙ to 1,1-diphenyl-2-picrylhydrazine indicates the root extract's capability to scavenge free radicals effectively[9].

Shoot Extracts and Fractions of Catharanthus roseus

- IC50 Values: The IC50 values for various extracts and fractions of C. roseus shoots ranged from 28.2 to 119 µg/mL. This range indicates that different fractions exhibit varying degrees of antioxidant activity.
- Best Performing Extract: The 100% Methanolic extract showed the best free radical scavenging activity, with the lowest IC50 values, suggesting higher antioxidant potential. Conversely, n-hexane extract had the lowest IC50 values among fractions, indicating it had lower antioxidant activity compared to the methanolic extract.
- Comparison with BHT: All extracts and fractions demonstrated lower antioxidant activity compared to the synthetic antioxidant BHT (butylated hydroxytoluene). The IC50 values of the extracts and fractions, from highest to lowest antioxidant activity, are arranged as: BHT < M < E\M1\M2 < M3 < E2\E1\E3 < E4 < C < H.[7]

Leaf Extracts of Catharanthus roseus

- Doses Examined: The antioxidant activity of leaf extracts was tested at various concentrations (200, 400, 600, 800, and 1000 µg).
- Optimal Dose: The 800 µg dose exhibited the highest antioxidant activity with 81.70% inhibition of DPPH˙ radicals.
- Trend: Antioxidant activity generally increased with higher concentrations, reaching its peak at 800 µg, after which no significant improvement was observed with higher doses.[11]

Comparisons

1. Root vs. Shoot Extracts:
- The root extract of C. roseus showed high scavenging activity with an IC50 of 57.39 µg/mL, which is significant but less potent compared to ascorbic acid.
- Among shoot extracts and fractions, the 100% Methanolic extract showed the best radical scavenging activity, whereas n-hexane extracts had lower antioxidant activity. This suggests that the type of solvent used for extraction impacts the antioxidant potential of the extracts [7] [9].

2. Leaf Extracts:
- The leaf extracts displayed the highest antioxidant activity at 800 µg, suggesting effective radical scavenging at this concentration. Lower and higher concentrations showed reduced activity, indicating an optimal dose for antioxidant effectiveness[11].

3. General Observations:
- All extracts and fractions of C. roseus exhibited antioxidant activity, though less effective compared to BHT. The variations in IC50 values highlight the importance of extraction methods and concentrations in determining the antioxidant potential of plant extracts.

In conclusion, Catharanthus roseus exhibits promising antioxidant properties, particularly in its Methanolic extract and at specific concentrations of leaf extracts. This highlights its potential use in pharmaceutical and cosmetic industries for its antioxidant benefits. Further research could explore optimization of extraction methods and concentration to maximize the antioxidant efficacy of this plant.

III. CONCLUSION

In this comparative review of the antioxidant potential of Catharanthus roseus across its different plant parts, several key insights emerge that highlight both the significance and variability of this medicinal plant's bioactivity. Variability in Antioxidant Activity: Our review underscores the considerable variability in antioxidant activity among the different parts of Catharanthus roseus. The leaves consistently demonstrate the highest antioxidant potential, followed by the, stems, and roots. This variation can be attributed to differences in the concentration and types of phytochemicals present in each plant part.

Phytochemical Contributions: The antioxidant capacity of Catharanthus roseus is largely influenced by its phytochemical composition, including alkaloids, flavonoids, and phenolic compounds. Leaves are particularly rich in these antioxidants, which contribute to their superior free radical scavenging activity. Understanding the specific contributions of these compounds to the antioxidant potential can guide future research and applications.

Therapeutic Implications: The high antioxidant potential of the leaves suggests their potential utility in combating oxidative stress-related conditions and diseases. Additionally, the variations observed across plant parts open avenues for exploring targeted use of specific plant parts based on their antioxidant profiles.

Future Research Directions: There is a need for more detailed studies to identify and quantify the individual antioxidant compounds in each plant part. Further research should focus on the mechanisms through which these compounds exert their antioxidant effects and explore the synergistic interactions among them. Additionally, studies on the impact of environmental factors on the antioxidant potential of different plant parts would provide deeper insights into optimizing the use of Catharanthus roseus for medicinal purposes.

Sustainability and Conservation: As we explore the antioxidant potentials, it is also crucial to consider sustainable harvesting and conservation practices. Protecting the biodiversity of Catharanthus roseus and ensuring responsible use of its various parts will support long-term availability and efficacy. In summary, Catharanthus roseus presents a promising source of antioxidants with varying potentials across its different parts. By advancing our understanding of these variations and their implications, we can better harness the plant's therapeutic potential while promoting sustainable practices**.**

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