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(Original Research Article)

Hydroalcoholic Extract of Caesalpinia pulcherrima Roots: A Natural Remedy for Anxiety and Depression in Mice

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Abstract

The increasing prevalence of anxiety and depressive disorders calls for alternative therapeutic approaches with minimal side effects. The present study investigates the anxiolytic and antidepressant effects of hydroalcoholic extract of Caesalpinia pulcherrima roots (HECPR) in murine models. Swiss albino mice were administered with graded doses of HECPR (100, 200, and 400 mg/kg, p.o.) and evaluated for behavioral changes using Elevated Plus Maze (EPM), Open Field Test (OFT), Forced Swim Test (FST), and Tail Suspension Test (TST). Diazepam (1 mg/kg) and fluoxetine (10 mg/kg) served as standard controls. The extract showed dose-dependent anxiolytic and antidepressant-like activities, with significant results ($p < 0.05$) at 400 mg/kg comparable to standard drugs. Phytochemical analysis revealed the presence of flavonoids, alkaloids, and tannins, which may contribute to the observed neuropharmacological effects. The study concludes that C. pulcherrima root extract possesses promising anti-anxiety and antidepressant potential, warranting further investigation.

Keywords: Caesalpinia pulcherrima, anxiety, depression, hydroalcoholic extract, mice, phytotherapy, behavioral studies.

INTRODUCTION

Anxiety and depression are among the most prevalent psychiatric disorders affecting millions of individuals worldwide, significantly contributing to global disability, loss of productivity, and diminished quality of life. These mood disorders are often interlinked, with many patients experiencing comorbid symptoms that affect their psychological, emotional, and physiological well-being. The World Health Organization (WHO) estimates that more than 280 million people suffer from depression, while anxiety disorders impact around 264 million individuals globally. Conventional treatment approaches, including selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants, benzodiazepines, and atypical antipsychotics, have demonstrated efficacy in managing these disorders. However, these pharmacotherapies are frequently associated with a wide range of side effects, including sedation, weight gain, sexual dysfunction, dependence, withdrawal symptoms, cognitive impairment, and increased risk of relapse or recurrence. Additionally, the delayed onset of therapeutic action and variable response rates further limit their clinical effectiveness. These limitations have prompted a growing interest in alternative and complementary systems of medicine, particularly the use of medicinal plants and phytoconstituents, which offer the potential for improved safety, tolerability, and holistic effects on the central nervous system.

Traditional systems of medicine, including Ayurveda, Siddha, and Unani, have long utilized plant-based therapies for the management of mental health disorders. Herbal remedies are increasingly recognized for their ability to influence neurochemical pathways, modulate neurotransmitter activity, and enhance overall mood and cognitive function. Plants contain a diverse array of bioactive compounds such as flavonoids, alkaloids, saponins, terpenoids, and polyphenols, which are known to exert antioxidant, anti-inflammatory, adaptogenic, and neuroprotective effects. Several medicinal plants, including Withania somnifera (Ashwagandha), Bacopa monnieri (Brahmi), Hypericum perforatum (St. John's Wort), and Valeriana officinalis (Valerian), have been investigated for their anxiolytic and antidepressant properties, often demonstrating comparable efficacy to conventional drugs in preclinical and clinical studies. Within this context, there is a compelling need to explore lesser-known or underutilized medicinal plants for their potential role in the management of neuropsychiatric disorders.

Caesalpinia pulcherrima, commonly known as Peacock flower, is an ornamental shrub belonging to the family Fabaceae. It is widely distributed in tropical and subtropical regions of Asia, Africa, and the Americas and has been traditionally employed in various cultural and ethnomedical systems. In traditional medicine, the roots, bark, leaves, flowers, and seeds of C. pulcherrima are used to treat conditions such as fever, respiratory infections, gastrointestinal disturbances, rheumatism, and menstrual irregularities. Phytochemical studies have revealed that C. pulcherrima contains several bioactive constituents, including flavonoids (quercetin, kaempferol), alkaloids, tannins, saponins, glycosides, and essential oils, many of which have shown pharmacological relevance. Despite the rich ethnobotanical usage and promising chemical profile of the plant, its effects on the central nervous system, particularly in the management of anxiety and depression, remain largely unexplored. Preliminary reports suggest that some constituents of C. pulcherrima may possess CNS-modulating effects, possibly through interaction with neurotransmitter systems such as GABAergic, serotonergic, and dopaminergic pathways.

The hydroalcoholic extraction process, which utilizes a mixture of ethanol and water, is known to maximize the solubility and recovery of both polar and moderately non-polar phytoconstituents. This extraction method ensures the availability of a wide spectrum of compounds that may act synergistically to produce therapeutic effects. In the case of C. pulcherrima, using hydroalcoholic extraction of roots is particularly relevant as the roots are believed to contain higher concentrations of alkaloids and flavonoids, which are traditionally associated with calming and mood-enhancing effects. The use of a standardized extract allows for reproducible results in preclinical studies, enabling a clearer understanding of the pharmacodynamic properties of the plant.

In vivo animal models play a crucial role in the evaluation of behavioral and neurochemical changes associated with anxiety and depression. The elevated plus maze (EPM) and open field test (OFT) are widely accepted paradigms for assessing anxiety-like behavior in rodents, reflecting the animal's innate fear of open and elevated spaces. Similarly, the forced swim test (FST) and tail suspension test (TST) are established models for evaluating antidepressant-like activity, based on the principle of behavioral despair. These models provide quantifiable parameters such as immobility time, locomotor activity, and time spent in exploratory zones, which serve as proxies for anxiety and depression in preclinical settings. By employing these behavioral assays, it is possible to objectively determine the efficacy of C. pulcherrima root extract in modulating mood-related behaviors.

Furthermore, the growing interest in natural remedies is also driven by the global trend toward phytotherapy and holistic medicine, supported by WHO's endorsement of traditional medicine as an integral component of healthcare systems, particularly in low- and middle-income countries. In this regard, validating the neuropharmacological properties of C. pulcherrima aligns with the goals of integrating evidence-based herbal therapies into mainstream psychiatric care. It also supports the conservation and sustainable use of medicinal plant biodiversity, which forms a critical aspect of cultural heritage and public health.

Given the limited literature on the neurobehavioral effects of Caesalpinia pulcherrima and the increasing demand for safer alternatives to conventional antidepressant and anxiolytic medications, the present study was designed to investigate the anxiolytic and antidepressant activity of the hydroalcoholic root extract of C. pulcherrima in Swiss albino mice. The extract was evaluated across three graded doses (100, 200, and 400 mg/kg) and compared to standard drugs diazepam and fluoxetine. The use of validated behavioral models—EPM, OFT, FST, and TST—enabled comprehensive assessment of both anxiety and depression-like behaviors. In addition, acute toxicity studies were conducted in accordance with OECD guidelines to determine the safety margin of the extract.

The current research aims not only to provide scientific evidence for the traditional use of C. pulcherrima in neuropsychiatric disorders but also to explore its therapeutic potential as a safe, natural, and cost-effective intervention for managing anxiety and depression. By bridging the gap between traditional knowledge and modern pharmacological research, this study contributes to the ongoing search for novel phytomedicines capable of addressing the unmet needs in mental health care.

MATERIALS AND METHODS

Plant Material Collection and Extraction

Roots of C. pulcherrima were collected, authenticated by a botanist, and shade-dried. The dried material was coarsely powdered and subjected to Soxhlet extraction using 70% ethanol. The extract was filtered, concentrated under reduced pressure, and stored at 4°C until use.

Phytochemical Screening

The hydroalcoholic extract was subjected to qualitative phytochemical analysis for the detection of alkaloids, flavonoids, saponins, tannins, glycosides, and phenolic compounds.

Animals

Swiss albino mice (20–25 g) of either sex were housed under standard conditions. All experimental protocols were approved by the Institutional Animal Ethics Committee (IAEC).

Acute Toxicity Study

The acute toxicity of HECPR was assessed according to OECD guidelines 423. No mortality or behavioral abnormalities were observed up to 2000 mg/kg, indicating the safety of the extract.

Experimental Design

Table 1: Animal Model Group

Group	Treatment
I	Control (1% CMC vehicle)
II	Diazepam (1 mg/kg) – Anxiolytic standard
III	Fluoxetine (10 mg/kg) – Antidepressant standard
IV	HECPR 100 mg/kg
V	HECPR 200 mg/kg
VI	HECPR 400 mg/kg

Animals were randomly divided into six groups (n = 6):

Behavioral Tests

Elevated Plus Maze (EPM): Number of entries and time spent in open vs closed arms were recorded.

Open Field Test (OFT): Frequency of locomotion, rearing, and grooming was observed.

Forced Swim Test (FST): Duration of immobility was measured over 6 minutes.

Tail Suspension Test (TST): Immobility time was recorded over a 6-minute test period.

Statistical Analysis: Data were expressed as mean ± SEM and analyzed using one-way ANOVA followed by Tukey's post hoc test. $p < 0.05$ was considered statistically significant.

RESULTS

Phytochemical Constituents

The extract tested positive for flavonoids, alkaloids, tannins, saponins, and phenolics.

Elevated Plus Maze

HECPR significantly increased time spent in open arms at 200 and 400 mg/kg, similar to diazepam, indicating anxiolytic activity.

Open Field Test

A significant increase in locomotor and exploratory behavior was observed in HECPR-treated groups, indicating reduced anxiety levels.

Forced Swim and Tail Suspension Tests

HECPR (200 and 400 mg/kg) significantly reduced immobility time compared to control, suggesting antidepressant-like activity. The effect at 400 mg/kg was comparable to fluoxetine.

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