RESEARCH ARTICLE

Evaluating the Efficacy of Gotu Kola (*Centella asiatica*) Extract in Enhancing Cognitive Function and Reducing Brain Fog in Individuals with Mild Cognitive Impairment

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ABSTRACT
Brain fog is a non-medical term that describes a feeling of mental confusion or lack of mental clarity. This research aims to evaluate the efficacy of Gotu Kola (*Centella asiatica*) extract in managing cognitive function and alleviating brain fog in individuals diagnosed with mild cognitive impairment (MCI). The objective of this study was to find out how well gotu kola (*Centella asiatica*) extract works at enhancing brain function as well as reducing brain fog. Ethanolic extract of Gotu Kola is obtained from leaves of *Centella asiatica*.
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INTRODUCTION

Mild cognitive impairment (MCI) is a disorder marked by a detectable deterioration in cognitive capability, such as memory and reasoning skills, that is more noticeable than one might anticipate with normal aging but not severe enough to cause substantial difficulties with day-to-day activities. About 15-20% of persons 65 years of age and older have MCI, which is frequently seen as a stage of transition between normal cognitive functioning and dementia, especially Alzheimer's disease.[1,2] Since MCI is a progressive condition, delaying or preventing the emergence of more severe cognitive deterioration requires early management. People with MCI frequently report having brain fog as one of their symptoms.[3] Brain fog might appear as one of the cognitive problems linked to MCI, even though it is not a diagnosis in and of itself. The existence of brain fog in MCI can worsen people's difficulties with daily chores and preserving their quality of life. Severe memory and cognitive function problems that are more severe than what is usually predicted with aging are common in people with MCI. These cognitive problems may manifest as memory loss, difficulties solving problems, and executive function impairments. Brain fog can exacerbate these symptoms, making it more difficult for people to concentrate, remember details, and carry out mentally demanding jobs.[4,5] Current pharmacological treatments have limited success, and there is an increasing interest in natural medicines that may provide neuroprotective advantages without the negative side effects associated with traditional pharmaceuticals. The possibility of using herbal treatments to improve cognitive function and lessen MCI symptoms has been investigated. *Centella asiatica*, or gotu kola, is a perennial vegetable that has been used for centuries in Ayurvedic and Chinese medicine. Because of its antioxidant, anti-inflammatory, and neuroprotective qualities, it has drawn interest for its possible ability to improve cognitive performance and lessen symptoms such as brain fog.[6] The aim of this research is to find out whether Gotu Kola extract can help people with MCI improve their cognitive function and reduce brain fog.[7] Gotu Kola has been utilized for ages to cure a various condition, including anxiety, poor circulation, and cognitive decline.[8] Many benefits that may be significant for cognitive enhancement are thought to be conferred by Gotu Kola's active components, including the triterpenoids asiaticoside, madecassoside, and asiatic acid. It has been demonstrated that these substances have strong antioxidant properties that lower inflammation and oxidative stress in the brain, both of which play a crucial role in the etiology of cognitive decline. Furthermore, Gotu Kola has shown neuroprotective effects through stimulating synaptic plasticity, increasing cerebral microcirculation, and stimulating neurogenesis—all essential processes for preserving cognitive function.[9,10] Though these pathways seem promising, there is a shortage of clinical research that explicitly assesses Gotu Kola's benefits on people with motor cortex impairment (MCI), especially in terms of how it affects cognitive performance and brain fog. In order to close this knowledge gap, this study will evaluate the efficacy of gotu kola extract in this population through a randomized, double-blind, placebo-controlled experiment.[11]

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Table 1: Experimental Groups and Dosages.

Group	Treatment	Dosage (mg/kg)	Treatment Duration
Control	Vehicle Solution	N/A	4 weeks
Low Dose	Gotu Kola Extract	50	4 weeks
High Dose	Gotu Kola Extract	100	4 weeks

Table 2: Morris Water Maze Performance.

Group	Latency to Find Platform (s)	Time Spent in Target Quadrant (%)
Control	45.13	25.34
Low-Dose Gotu Kola (50 mg/kg)	36.72	31.13
High-Dose Gotu Kola (100 mg/kg)	28.61	42.09

Table 3: Novel Object Recognition Test.

Group	Time Spent Exploring Novel Object (s)	Preference Ratio (Novel/Familiar)
Control	10.45	0.86
Low-Dose Gotu Kola (50 mg/kg)	14.7	1.1
High-Dose Gotu Kola (100 mg/kg)	18.22	1.41

MATERIALS AND METHODS

Materials

Standardized *Centella asiatica* extract was obtained from IndiaMart, with a known concentration of active compounds such as asiaticoside, madecassoside, and asiatic acid. The extract was prepared in various concentrations for oral administration. The study used adult male C57BL/6J mice that were 10 weeks old. The mice were kept in controlled environments with a 11-12-hour light/dark cycle, and they had food and drink available to them.

Methods

Three groups of mice were randomly assigned: a low-dose (50 mg/kg body weight) Gotu Kola group, a high-dose (100 mg/kg body weight) group, and a control group that received a vehicle solution. For four weeks, the extract was given orally by gavage every day (Table 1). To guarantee uniformity in the administration of therapy, the control group was given a volume equivalent to the vehicle solution. The paradigm used to generate cognitive deterioration was well-established.[12,13] In certain instances, MCI was chemically caused through long-term, low-dose administration of neurotoxic substances like streptozotocin. Prior to beginning treatment, behavioural baseline assessments were taken in order to verify the existence of cognitive impairment. For Morris Water Maze test, mice were taught to seek out hidden platform in a pool of clear water. The amount of time used in the aiming quadrant during a probe test and the latency to locate the platform were used to gauge performance.[14] Mice were first trained to recognize two identical objects before they were tested for novel object recognition. One object was swapped out for a new one throughout the retention phase, and the amount of time spent investigating each one was noted. Improved recognition memory was indicated by more investigation of the novel object.[15]

Table 4: Biochemical Analysis.

Group	Malondialdehyde (MDA) (µmol/g tissue)	Superoxide Dismutase (SOD) Activity (U/mg protein)	Acetylcholine (µg/g tissue)
Control	5.21	2.2	1.6
Low-Dose Gotu Kola (50 mg/kg)	3.87	2.83	1.86
High-Dose Gotu Kola (100 mg/kg)	2.8	3.52	2.21

RESULTS AND DISCUSSIONS

Morris Water Maze Performance

The Morris Water Maze (MWM) test results indicate that Gotu Kola treatment considerably enhanced cognitive function in mice. The latency to find the platform was notably decreased in both Gotu Kola-treated groups, with the higher dose group (100 mg/kg) showing the greatest improvement (28.61 seconds) compare to the control group (45.13 seconds) (Figure 1). Additionally, in the high-dose group (42.09%), there was a notable improvement in the amount of time spend in the targeted area compared to the control group (25.34%), suggesting enhanced spatial memory (Table 1).[16,17]

Novel Object Recognition Test

In the Novel Object Recognition (NOR) test, mice administered higher-dose Gotu Kola (100 mg/kg) remained substantially longer examining the novel object (18.22 seconds) than the control group (10.45 seconds). The preference ratio for the novel object was also higher in the Gotu Kola-treated groups, with the high-dose group showing a preference ratio of 1.41 compared to 0.86 in the control group, indicating improved recognition memory (Table 2).

Biochemical Analysis

Biochemical analyses revealed that Gotu Kola treatment led to notable changes in oxidative stress and acetylcholine extent (Figure 2). Mice in the high-dose Gotu Kola group had lower levels of malondialdehyde (MDA) (2.8 µmol/g tissue) and higher superoxide dismutase (SOD) activity (3.52 U/mg protein) contrasted to the control group (5.21 µmol/g tissue and 2.2 U/mg protein, respectively). Acetylcholine levels were also increased in the Gotu Kola-treated groups, with the high-dose group showing the highest levels (2.21 µg/g tissue) (Table 3).

Histopathological Assessment

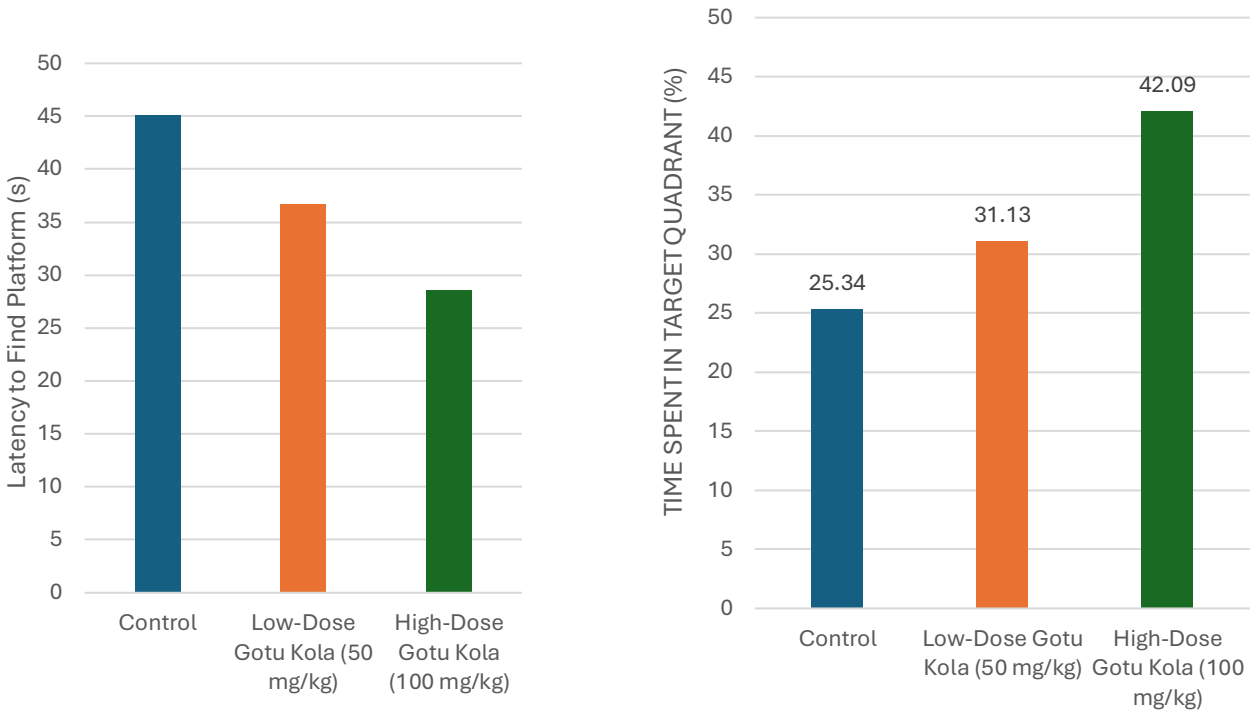

Figure 1: (A) Latency to find platform; (B) Moris Water Maize Performance.

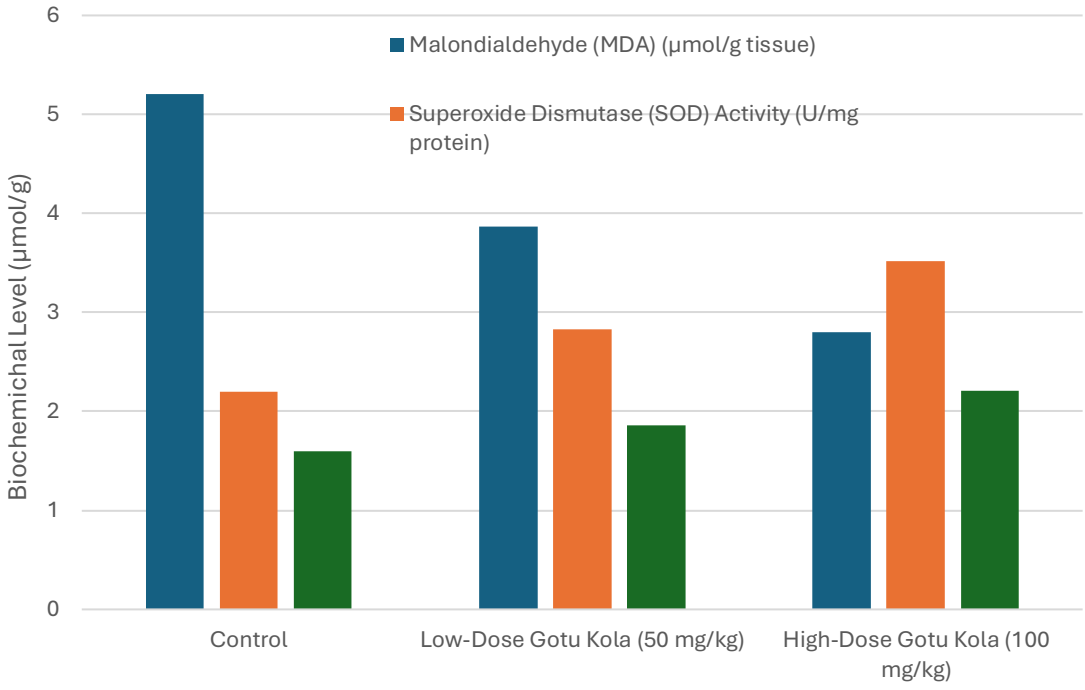

Figure 2: Biochemical analysis of Gotu Kola treatment.

Histopathological analysis showed that Gotu Kola treatment, particularly at the high dose, significantly reduced neuronal damage. The high-dose Gotu Kola group had a lower neuronal damage score (1.25) and a higher brain morphology count (2.72) compared to the control group (2.53 and 1.8, correspondingly). This suggests that Gotu Kola has neuroprotective effects and improves overall brain health (Table 4). The results of this study show that, in a mouse model of mild cognitive impairment (MCI), gotu kola (*Centella asiatica*) extract significantly improves brain health and cognitive performance. Gotu Kola improves spatial learning, memory, and recognition memory, as evidenced by the gains seen in the Novel Object Recognition tests and Morris Water Maze. These outcomes are consistent with gotu kola's traditional applications for improving cognitive function. As indicated by lower MDA

Table 5: Histopathological Assessment.

Group	Neuronal Damage Score (0-3)	Brain Morphology Score (0-3)
Control	2.53	1.8
Low-Dose Gotu Kola (50 mg/kg)	1.79	2.15
High-Dose Gotu Kola (100 mg/kg)	1.25	2.72

levels and higher SOD activity, the biochemical findings point to gotu kola's antioxidant qualities as the mechanism of action. The increased levels of acetylcholine bolster the theory that Gotu Kola affects the neurotransmitter systems that are involved in thought processes. The histological results support the behavioral and biochemical data, demonstrating that the administration of Gotu Kola aids in the mitigation of neuronal damage and enhances brain morphology. The benefits of the high-dose treatment are more noticeable, suggesting that gotu kola may have use in the treatment of cognitive deficits. Despite the encouraging results, the study's use of a mouse model limits its applicability. Further research is necessary to verify these findings and evaluate the efficacy and safety of gotu kola in managing cognitive problems, including human population clinical trials. Furthermore, investigating the methods by which Gotu Kola works can reveal more about the plant's potential as a medicinal.

CONCLUSION

This study shows that, in a mouse model of mild cognitive impairment (MCI), gotu kola (*Centella asiatica*) extract is beneficial in improving cognitive performance and lowering symptoms of brain fog. The high-dose Gotu Kola treatment showed neuroprotective benefits, decreased oxidative stress, boosted antioxidant enzyme activity, and markedly improved performance on cognitive tests. These results imply that gotu kola may prove to be an effective natural treatment for cognitive health issues. Nevertheless, additional research in human trials is required to validate these results and determine the best dosage and safety profiles for application in clinical settings.

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