

Anxiolytic and antidepressant potentials of the trichomes of *Mucuna pruriens*

Mercy Omolola Olukoya

olukoya27@gmail.com

Adeleke University

Majeedat Aramide Afolabi-Balogun

Fountain University

Kafayat Folasade Nafiu

Fountain University

Wasiu Sanusi

Fountain University

Suliat Iyabode Abdulahi

Fountain University

Samuel Adetunji Onasanwo

University of Ibadan

Nusrah Bolatito Afolabi-Balogun

Fountain University

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Abstract

Background The medicinal plant *Mucuna pruriens*, is well known for its neuropharmacological properties but there is a dearth of literature information about how the trichomes specifically affect anxiety and depression. This study aimed to evaluate the behavioural, neurochemical, and histopathological potentials and the anxiolytic as well as the antidepressant potential of *M. pruriens* trichome extracts in male Wistar rats.

Method *Mucuna pruriens* pods were collected at Gbolasere Farms in Sagamu, Ogun State, Nigeria. The sample was identified and authenticated; a specimen was deposited at the Herbarium section with voucher specimen number IFE 18235. Forty-two (42) male Wistar rats were divided into seven groups, after which they received treatment with 200 μ L or 400 μ L doses of either aqueous or methanolic *M. pruriens* trichome extracts. The tail suspension and open field tests were used to investigate the anxiolytic and antidepressant qualities. Immunohistochemical analysis was used to quantify serotonin expression in brain and skin tissues, while histological evaluations assessed potential structural modifications.

Results Rats treated with extract exhibited a significant increase in grooming frequency ($p < 0.05$), indicating reduced anxiety-like behaviour. Rearing activity was also elevated, further supporting an anxiolytic effect. All extract-treated groups showed significantly shorter immobility time in the tail suspension test ($p < 0.05$), indicating antidepressant-like action. While brain serotonin levels showed a dose-dependent decrease in the range 141.12–212.33 μ L, the expression of serotonin by the skin tissue peaked in the 400 μ L aqueous extract group (143.91 μ L). Serotonin receptor modulation was validated by histopathological investigation, which did not reveal any signs of neurotoxicity.

Conclusion This study has shown trichomes of *Mucuna pruriens* to exhibit strong antidepressant and anxiolytic properties, most likely due to serotonergic regulation. These results in the study highlight their potential as natural remedies for mood disorders, which calls for more pharmacological research.

Background

Mucuna pruriens (L.) DC, colloquially referred to as velvet bean, has been known for centuries within traditional medicine for its therapeutic capabilities, particularly with respect to its anxiolytic and antidepressant attributes. Native to the tropical climates of Africa and Asia, this leguminous species encompasses bioactive constituents, most notably L-DOPA, an amino acid that serves as a precursor to dopamine, which is integral to neurotransmission and significantly influences affective states [1, 2]. The application of *Mucuna pruriens* within Ayurvedic medicine underscores its historical relevance as a natural intervention for a variety of health complications, inclusive of psychological disorders [3, 2]. Despite the medicinal applications of the plant, there is need to understand the secondary metabolites in the plant and getting a link of *Mucuna pruriens* with the management of anxiety and depression. Investigations into the phytochemical composition of *Mucuna pruriens* reveal a complex array of secondary metabolites such as alkaloids, flavonoids, and additional phytochemicals, which may play a

role in its anxiolytic and antidepressant properties [2]. The plant's trichomes, frequently neglected in studies, act as sites for chemical synthesis, indicating their potential significance in both the plant's defense mechanisms and therapeutic applications [4, 5]. Several studies indicate that these metabolites could enhance the bioactivity of *Mucuna pruriens*, thereby facilitating the management of anxiety and depression through modulation of biochemical pathways [6, 7].

Recent research has started to illuminate the anxiolytic and antidepressant effects associated with *Mucuna pruriens*. For example, interventions utilizing *Mucuna pruriens* have been correlated with enhancements in mood and decreases in anxiety, implying its dopaminergic activity as a likely mechanism of action [8, 2]. Animal studies have demonstrated that extracts from *Mucuna pruriens* can provoke behavioural alterations indicative of reduced anxiety and ameliorated depression-like symptoms, suggesting that its bioactive components may synergistically contribute to improved mental health [8].

Moreover, the potential of *Mucuna pruriens* as a therapeutic agent for anxiety and depression aligns with the ongoing endeavor to amalgamate traditional wisdom with contemporary scientific inquiry [9, 2]. This integration of methodologies substantiates historical applications and facilitates the development of novel therapeutic strategies that exploit phytochemical entities. Research assessing the efficacy and safety of formulations derived from *Mucuna pruriens* has started to endorse their incorporation into clinical settings, particularly within integrative health paradigms [10, 3]. Investigations reveal that the intricate interactions among the diverse chemical constituents of *Mucuna pruriens* could offer neuroprotective benefits, potentially alleviating symptoms of anxiety and depression effectively [8, 11].

As the global incidence of anxiety and depression escalates, the exploration of alternative therapies such as *Mucuna pruriens* becomes increasingly critical. The expanding corpus of evidence emphasizes the urgent need for comprehensive research into the therapeutic applications and underlying mechanisms of *Mucuna pruriens* [3, 12]. Furthermore, there exists a significant demand for progress in pharmacological research and the formulation of standardized products to guarantee the reliable delivery of its medicinal benefits. *Mucuna pruriens* presents a potential avenue for more research given the complexity of anxiety and depression, especially through well planned randomized controlled studies to confirm its safety and effectiveness in a range of populations [2].

Mucuna pruriens has promising antidepressant and anxiolytic abilities, backed by a wealth of historical evidence and a growing corpus of scientific studies. Combining modern research with traditional medical expertise improves our comprehension of this plant and opens up new avenues for therapeutic validation in the future. As we work to solve the worldwide mental health issue with creative, nature-derived solutions, it will be crucial to elucidate the functions of the chemicals present in *Mucuna pruriens*, especially those in its trichomes.

Methodology

Source and Authentication of *Mucuna pruriens*

The source of the *Mucuna pruriens* pods was Gbolasere Farms in Sagamu, Ogun State, Nigeria. The voucher specimen number IFE 18235 was given to the botanical identification after it was verified at the Herbarium, Department of Botany, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria [13].

Experimental Animals

The study employed male Wistar rats that weighed 120 ± 20 g and were 7 ± 1 weeks old. The animals were kept in typical laboratory settings, with a 12-hour light/dark cycle, a temperature of $22 \pm 2^\circ\text{C}$, and a relative humidity of $55 \pm 5\%$. They were given unlimited access to water and regular pelletised feed. The Ethical Committee for Animal Experimentation at the University of Lagos, Nigeria, examined and approved all experimental procedures in compliance with the National Institutes of Health's (NIH) recommendations for the use and care of laboratory animals [14].

Extraction and Phytochemical Characterization of *Mucuna pruriens* Trichomes

Mucuna pruriens pods were carefully scraped of their trichomes, and the bioactive components were extracted by macerating the trichomes in methanol and distilled water at a ratio of one gramme per 100 mL of solvent. During the 96 hour extraction procedure, the temperature was kept at $27 \pm 2^\circ\text{C}$ and the agitation was kept constant at 130 rpm. After filtration, the extract was concentrated at reduced pressure at 40°C using a rotary evaporator, the extracts were kept at 4°C prior to further analysis [15].

Phytochemical Analysis

The presence of secondary metabolites was evaluated through qualitative phytochemical screening using standard procedures, such as Wagner's test for alkaloids, ferric chloride (FeCl_3) tests for tannins and phenolic acids, Trim-Hill test for terpenoids, sodium hydroxide (NaOH) test for flavonoids, and a chloroform and sulphuric acid (H_2SO_4) test for steroids [16].

Animal Grouping and Treatment

Forty-two (42) male Wistar rats were randomly assigned into seven experimental groups ($n = 6$ per group):

- **Group 1:** Control (no treatment)
- **Group 2:** Methanol control (vehicle)
- **Group 3:** Water control (vehicle)
- **Group 4:** 200 μL aqueous extract
- **Group 5:** 400 μL aqueous extract
- **Group 6:** 200 μL methanolic extract
- **Group 7:** 400 μL methanolic extract

Behavioral Assessments

The open field test was used to evaluate exploratory behaviour, locomotor activity, and anxiety-related responses. In order to measure exploratory and anxiety-like behaviors, rats were kept in a circular arena with a diameter of 40 cm for five minutes. The number of line crossings, rearing, and grooming activities were noted and examined [17]. Using the tail suspension test, the extracts' antidepressant potential was assessed. The total amount of time the rats were immobile was measured after they were each suspended by their tails for six minutes. A decrease in immobility time was thought to have an effect similar to that of antidepressants [18].

Toxicity Studies

To determine whether the extracts were safe, both acute and sub-acute dermal toxicity tests were performed. A single application of the extract was used to treat acute dermal toxicity, and the animals were observed for symptoms such as lethargy, diarrhoea, tremors, and discoloured fur [19]. Applying the extracts topically for 14 days in a row allowed for the assessment of sub-acute dermal toxicity. According to Rhiauani *et al.* [20], major organs were removed for histopathological analysis, and blood samples were obtained for biochemical analysis.

Immunohistochemical Analysis

After being collected and preserved in 10% neutral buffered formalin, skin and brain samples were subjected to tissue processing and staining. The tissues underwent processing before being sectioned at a thickness of 5 μ m and embedded in paraffin. After sections were deparaffinized, endogenous peroxidase activity was inactivated by treating them with 0.3% hydrogen peroxide (H_2O_2). The brain and skin tissue sections were treated with specific antibodies that target important neurochemical markers. Also, immunoreactivity was observed under a light microscope and staining intensity was measured to evaluate neurochemical changes brought on by extract application [21].

Statistics

The collected datasets were analysed using Microsoft Excel and Graphpad Prism 5.0. Variations within the datasets were illustrated using bar charts with error bars representing the standard error of mean (SEM), followed by the Turkey-Kramer post-hoc test. Differences between groups were assessed through Analysis of Variance (ANOVA). Statistical significance was determined at 95% confidence interval with a p-value threshold of 0.05.

Results

Phytochemical Composition of *Mucuna pruriens* Extracts

Phytochemical screening confirmed the presence of bioactive compounds such as phenolic acids, flavonoids, tannins, alkaloids and steroids in both extracts. Terpenoids and proteins are absent in the methanolic extract and present in the aqueous extracts (Table 1).

Behavioral Assessments

In the open field test, rats treated with *Mucuna pruriens* trichome extracts exhibited no substantial exploratory behaviour, as evidenced by an insignificant difference in line crossings by the animals exposed to 200 µL Aqueous Extract, 200 µL Methanolic Extract, 400 µL Aqueous Extract and 400 µL Methanolic Extract as compared to all the controls (methanol, water and positive control). (Fig. 1). Grooming frequency was increased in treated groups suggesting an anxiolytic state, the effect of the aqueous extract on the grooming by the animal were significantly different to both C and Cw. The result of 400 µL ME is significantly different to Cm, 200 µL AE is significant to 400 µL ME, while 400 µL AE to 400 µL ME and 200–400 µL ME. The significance was taken at 95%. (Fig. 2). The number of times the animals reared which is when they stood on their hind leg was significantly higher in the treated group which shows that the treatment with the extract elicited an apprehensive behaviour that is related to anxiolytic outcomes (Fig. 3). In the tail suspension test, immobility duration was significantly decreased in extract-treated groups compared to controls, supporting antidepressant-like activity (Fig. 4).

Table 1
Secondary metabolite constituted by methanolic and aqueous extract of trichome of *Mucuna pruriens*

Phytochemicals	Samples	
	ME of <i>Mucuna pruriens</i>	AE of <i>Mucuna pruriens</i>
Phenolic Acids	++	++
Flavonoids	++	++
Tannins	++	++
Alkaloids	++	++
Terpenoids	∅	++
Steroids	++	++
Proteins	∅	++
*ME: Methanolic Extract, AE: Aqueous Extract, ++=Present, ∅ =Absent		

Neurochemical and Histopathological Analysis of Brain and Skin Tissues

Serotonin expression in the epidermis of the skin and brain of the experimental animals observed as shown in **Plates 1–2** and Table 2 shows the serotonin staining intensity. The expression of serotonin of the skin is higher in 400 µL AE (143.913) as compared to the controls while there was reduction in the expression of serotonin of the brain in 200 µL ME, 400 µL ME, 200 µL AE and 400 µL AE (212.333, 160.273, 157.963 and 141.120 µL respectively) as compared to methanol and water controls.

Table 2
Serotonin staining intensity of skin and brain in
methanolic and aqueous extracts of trichomes of
Mucuna pruriens

Sample	Brain (µL)	Skin (µL)
Control	116.741	146.070
Control methanol	157.305	208.640
Control water	141.929	212.333
Methanol extract (200 µL)	138.871	160.273
Methanol extract (400 µL)	132.695	157.963
Aqueous extract (200 µL)	117.394	153.285
Aqueous extract (400 µL)	143.913	141.120

Discussion

The results of this study provide substantial evidence to validate the anxiolytic and antidepressant properties of the trichomes derived from *Mucuna pruriens*. The phytochemical profile of these trichomes, notably flavonoids and phenolic compounds, implies a plausible mechanism underlying their neuropharmacological effects. These phytochemicals are recognized for their interactions with neurotransmitter systems, particularly the serotonergic and gabaergic pathways, which are pivotal in the regulation of mood [22, 23]. In considering that flavonoids demonstrate neuroprotective characteristics, it is conceivable that the anxiolytic and antidepressant effects identified in this study are associated with their capacity to modulate oxidative stress and neuroinflammatory responses [24].

In the behavioural evaluations, encompassing the open field test and the tail suspension test, indicated significant decreases in anxiety and depression-related behaviours in rats administered with aqueous and methanolic extracts of *Mucuna pruriens* trichomes. The observed increase in exploratory behaviour during the open field test and the diminished immobility in the tail suspension test suggest the presence of anxiolytic and antidepressant effects, respectively. These observations are consistent with earlier investigations regarding *Mucuna pruriens* seeds, which have been shown to influence neurotransmitter activity [8, 2].

The serotonergic system emerges as a crucial target for *Mucuna pruriens* trichomes, as indicated by the enhanced serotonin levels in the brains of treated subjects. This aligns with previous studies illustrating that the phytochemicals present in *Mucuna pruriens* can restore serotonin and catecholamine concentrations, thereby producing antidepressant-like effects [25, 26]. Moreover, the involvement of phenolic compounds and oligosaccharides in modulating the gut-brain axis may further elucidate the behavioural modifications observed, reinforcing the association between *Mucuna pruriens* and mood regulation [27, 28].

Conclusion

The findings of this study have provided persuasive evidence that the trichomes of *Mucuna pruriens* exhibit anxiolytic and antidepressant effects. The presence of bioactive constituents, particularly flavonoids and phenolic compounds shows that these impacts may be mediated through the modulation of the serotonergic system, antioxidant mechanisms, and interactions within the gut-brain axis. While the results of this study underscore the potential of *Mucuna pruriens* as a natural alternative for addressing mood disorders, additional research is essential to elucidate its specific mechanisms of action and to determine safe and effective dosages for therapeutic applications. Future investigations along the line of this research should focus on the pharmacokinetics of these bioactive compounds and their interactions with conventional psychotropic medications to evaluate possible synergistic effects or contraindications.

Declarations

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Author contributions

M. O. wrote the manuscript and conducted the study with M. A. under the guidance of S. A; N. B. conceptualized and supervised the study. S. I. co-supervised the study. K. F. carried out the phytochemical screening. W. S. statistically analyzed the data from the study.

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Data availability

All data generated or analyzed during this study are included in this research article

Ethical approval and consent to participate

The Ethical Committee for Animal Experimentation at the University of Lagos, Nigeria, examined and approved all experimental procedures in compliance with the National Institutes of Health's (NIH) recommendations for the use and care of laboratory animals

Clinical trial number

Not applicable

Consent for publication

Not applicable

Competing interest

The authors declare no competing interests.

Consent to participate

Not applicable

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Plates

Plates 1 and 2 are available in the Supplementary Files section

Figures

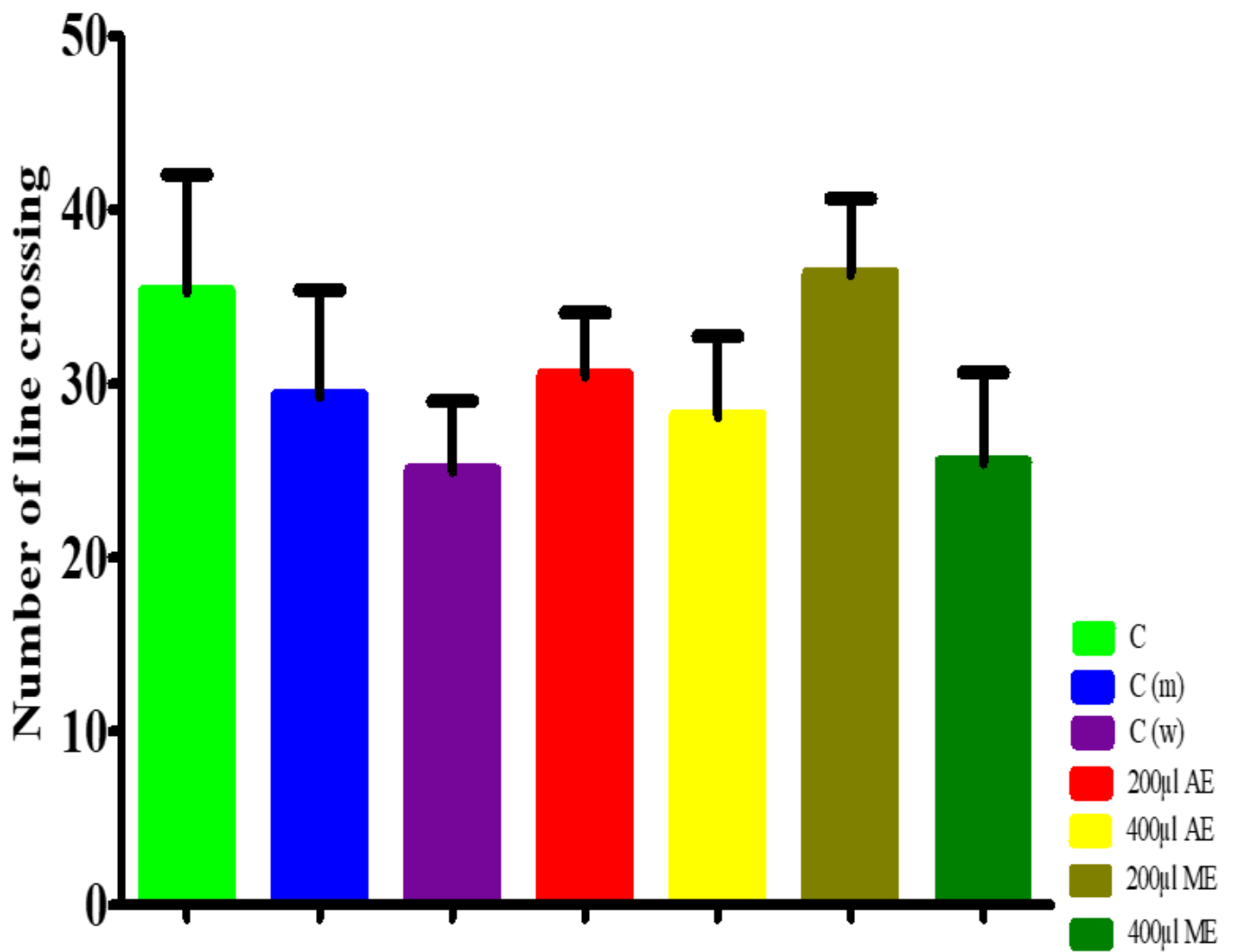


Figure 1

Effect of the aqueous and methanolic extracts of the trichome of *Mucuna pruriens* on the number of line crossed in open field test. Values were expressed as mean $\pm$ SEM., n=6, no significant difference ($p < 0.05$).

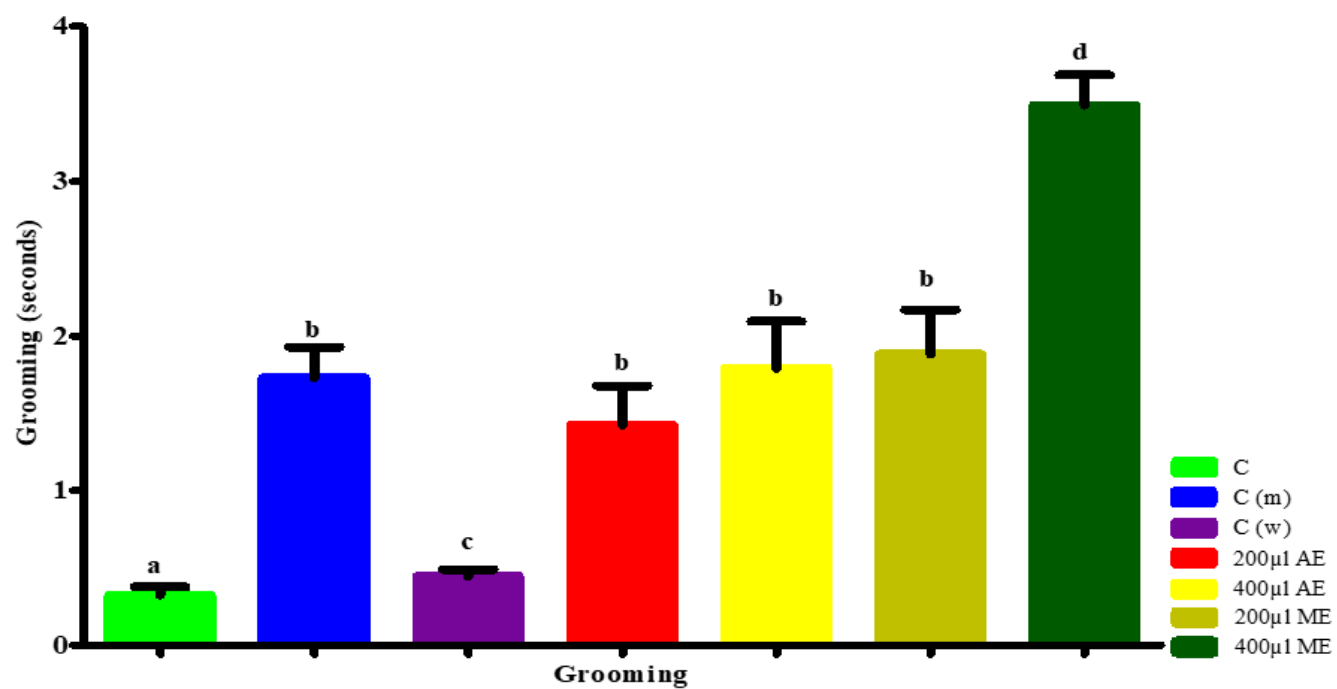


Figure 2

Effect of the aqueous and methanolic extracts of the trichome of *Mucuna pruriens* on the grooming. Values were expressed as mean $\pm$ SEM., n=6. Superscripts represent significant difference among the column.

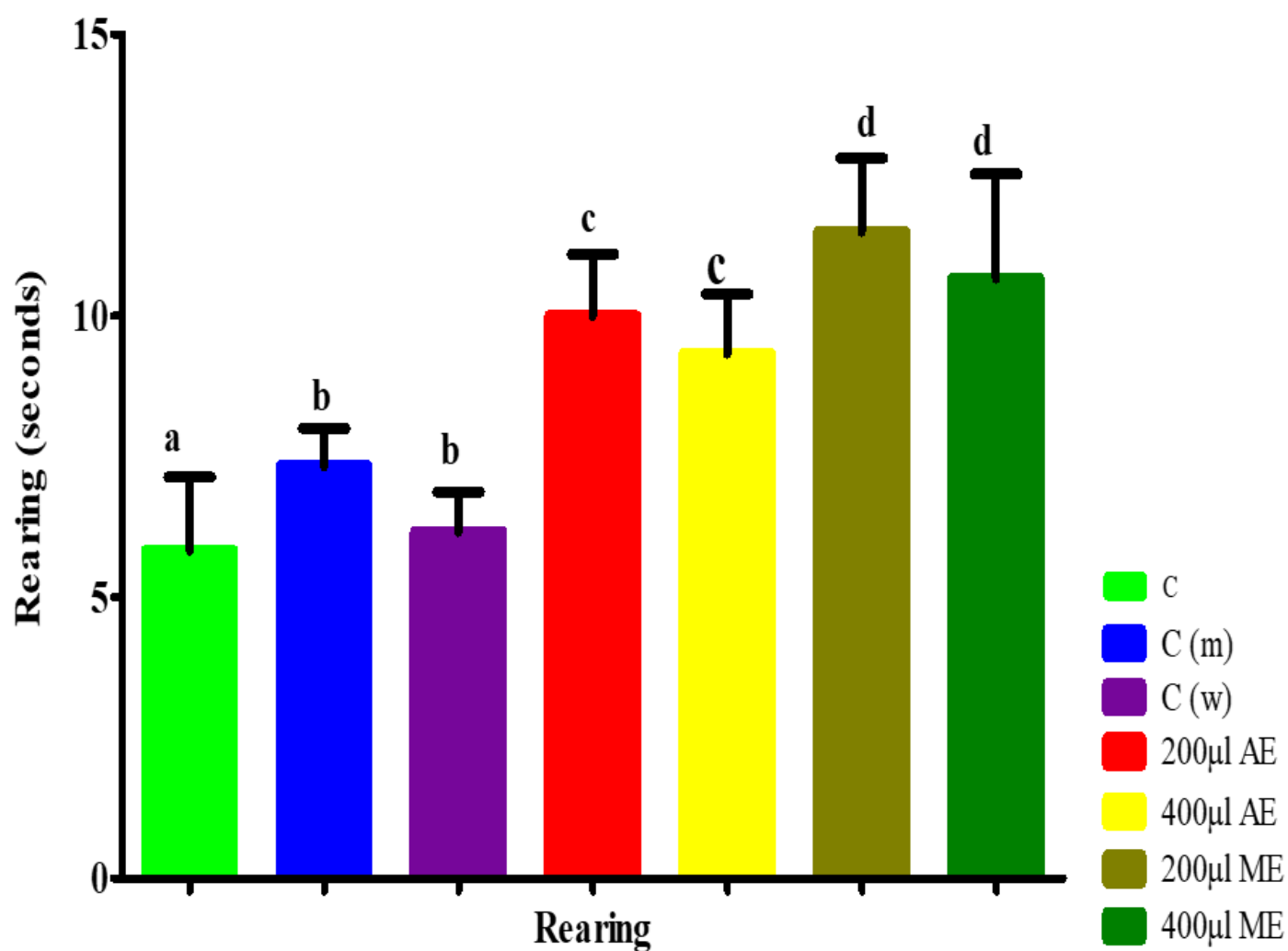


Figure 3

Effect of the aqueous and methanolic extracts of the trichome of *Mucuna pruriens* on the number rearing. Values were expressed as mean $\pm$ SEM., n=6. Superscripts represent significant difference among the column.

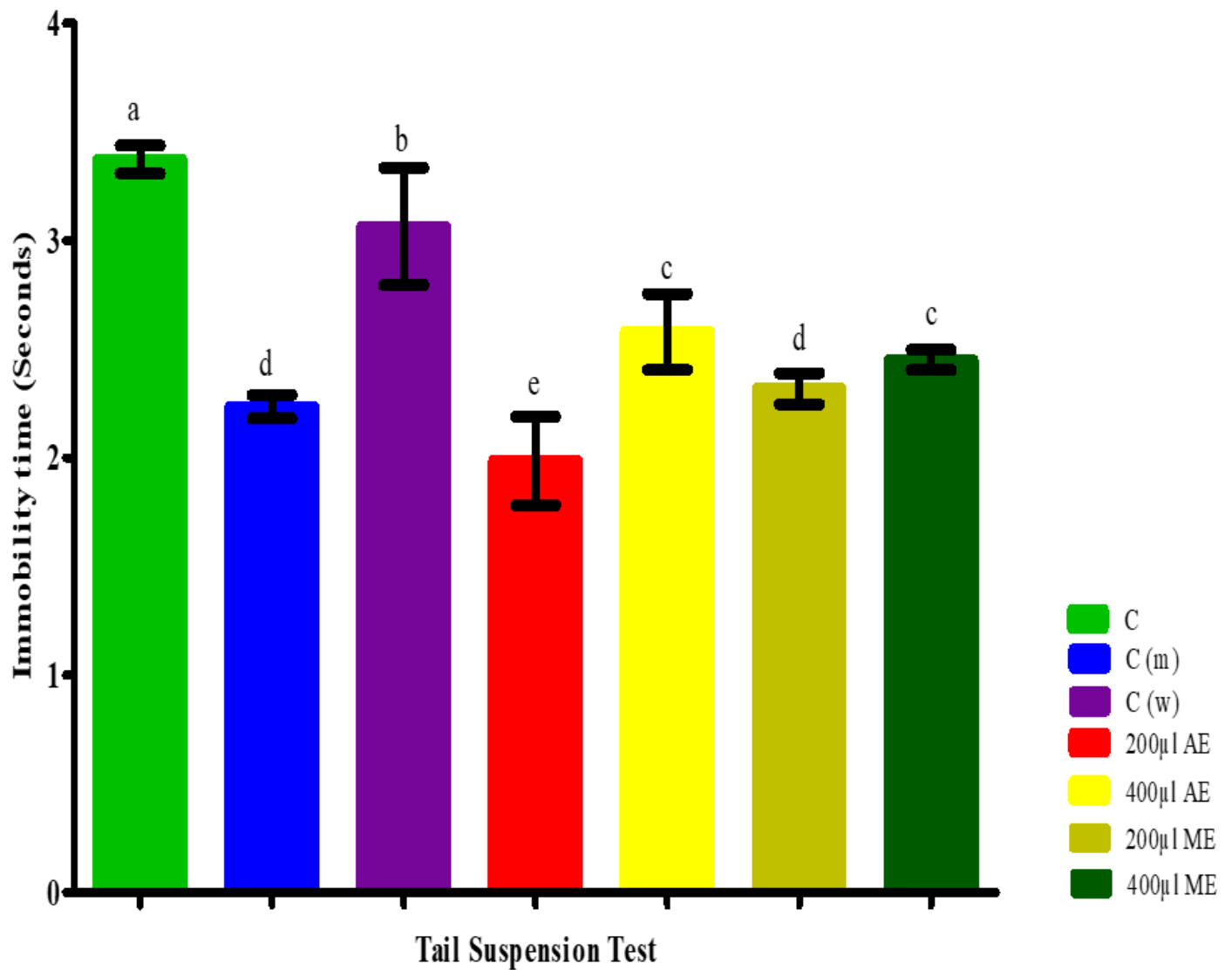


Figure 4

Effect of the aqueous and methanolic extracts of the trichome of *Mucuna pruriens* on the immobility time in tail suspension test. Values were expressed as mean $\pm$ SEM., n=6. Superscripts represent significant difference among the column.

Supplementary Files

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- [Plates.docx](#)