

Effects of Aloe vera Extract on Hematological Parameters of Male Albino Wistar Rats Exposed to Monosodium Glutamate

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Abstract

This study investigated the potential of *Aloe vera* extract to mitigate the hematological toxicity induced by monosodium glutamate (MSG) in male Wistar albino rats. Although MSG is classified as "generally recognized as safe" (GRAS) by regulatory bodies, high-dose or chronic consumption has been linked to systemic effects in animal studies, including disturbances in blood parameters. The research aimed to determine the effects of MSG on key hematological indices, such as packed cell volume (PCV), red blood cell (RBC) count, white blood cell (WBC) count, hemoglobin (Hb) concentration, and hematocrit levels. The study found that MSG exposure caused a significant decline in these parameters in the induced-untreated group compared to the control group, indicating anemia and potential immune suppression. Conversely, *Aloe vera* has been shown to have hematoprotective properties in various models of chemical-induced toxicity. In this study, the co-administration of *Aloe vera* extract demonstrated a dose-dependent ameliorative effect, restoring the compromised blood parameters towards normal ranges. The medium and high dose *Aloe vera* treatments showed the most significant improvement. The low-dose *Aloe vera* treatment also showed some level of improvement with increased PCV, RBC count, HB concentration, (MCHC), platelet count excluding MCV and MCH which failed to improve. The protective effects are likely due to the antioxidant and hematopoietic properties of *Aloe vera*'s bioactive compounds, which help counteract MSG-induced oxidative damage and support blood cell production. These findings validate the potential of *Aloe vera* as a natural agent for mitigating the adverse hematological effects of dietary additives like MSG.

Keywords: Aloe vera; Hematological parameters; Wistar rat; Monosodium glutamate

1. Introduction

The physiological equilibrium of living organisms is constantly challenged by dietary habits, environmental exposures, and chemical agents. Among these agents, monosodium glutamate (MSG) is particularly noteworthy as a widely used flavor enhancer. MSG, the sodium salt of glutamic acid, imparts the savory "umami" taste and is prevalent in numerous processed foods, snacks, and restaurant meals. MSG was first isolated in 1908 by Kikunae Ikeda from kombu seaweed for its flavor-enhancing properties, and since then, its industrial production and global utilization have expanded dramatically (EFSA, 2017). Regulatory agencies such as the U.S. Food and Drug Administration (FDA) and European Food Safety Authority (EFSA) classify MSG as "generally recognized as safe" (GRAS) when consumed within typical dietary limits. However, safety designations are conditional, and emerging research suggests that high-dose or chronic consumption may produce systemic effects (EFSA, 2017).

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Aloe vera, commonly known as "true aloe," is a succulent plant species renowned for its extensive medicinal and cosmetic applications. Originating from the Arabian Peninsula, aloe vera has been cultivated globally and naturalized in various regions, adapting to diverse environmental conditions. The gel extracted from its leaves is rich in beneficial compounds such as acemannan, vitamins A, C, and E, and essential minerals like calcium and zinc (Boudreau & Beland, 2016).

Aloe vera's therapeutic properties are well-documented, with applications ranging from soothing sunburns and promoting wound healing to reducing inflammation (Dal'Beloet *et al.*, 2016). Its anti-aging properties also contribute to improved skin elasticity and reduced fine lines, making it a popular ingredient in skincare products. With over 400 species within the Aloe genus, Aloe vera stands out as one of the most utilized plants worldwide, valued for its multifaceted health and skincare benefits (Sánchez-Machado *et al.*, 2017).

The plant's versatility and efficacy have led to its incorporation in various products, from topical creams and gels to dietary supplements. Its natural healing properties make it a sought-after ingredient in both traditional and modern medicine. Aloe vera's gel is also known for its moisturizing properties, helping to hydrate the skin and maintain its natural barrier function. Additionally, it has been used to treat various skin conditions, including acne, eczema, and psoriasis.

As research continues to uncover the full potential of aloe vera, its popularity is expected to endure, solidifying its place as a staple in health and wellness. The plant's ability to provide relief from skin irritations, promote digestive health, and support immune function makes it a valuable addition to any health regimen. Its widespread use and acceptance across different cultures and industries underscore its significance as a natural remedy.

As MSG is known to induce oxidative stress and systemic inflammation, and Aloe vera exhibits promising hematoprotective effects, it is plausible that Aloe vera could mitigate MSG-induced hematotoxicity. Male Wistar albino rats are selected as experimental subjects due to their widespread acceptance in toxicological and pharmacological research and physiological relevance to humans.

This study focuses on evaluating critical hematological parameters PCV, RBC, WBC, hemoglobin under MSG exposure, with and without Aloe vera co-administration. Findings will shed light on MSG's systemic impacts and inform whether Aloe vera extract offers protective benefits.

Although MSG is widely accepted as safe under normal consumption levels by regulatory agencies, animal studies suggest that chronic or high-dose exposure may disrupt key hematological parameters. Research indicates that high-dose MSG administration can elevate total white blood cell counts and lymphocyte percentages, while reducing granulocyte percentage, MCH, and MCHC changes consistent with impaired erythropoiesis and altered immune function (Khodier, 2020). Conversely, *Aloe vera* has demonstrated hematoprotective potential in various rodent models, including toxin-induced anemia and drug-induced organ damage. In phenylhydrazine-induced anemia, Aloe vera gel improved red blood cell indices and hemoglobin levels (Akhter *et al.*, 2024). Other studies highlight *Aloe vera*'s capacity to support PCV and maintain hematological homeostasis (Aghaa, 2023; Rozani&Kusbaryanto, 2019).

Despite these findings, there is no comprehensive research examining *Aloe vera*'s ability to counteract MSG-induced hematological disturbances in a single controlled study. This gap in literature leaves unanswered questions regarding the potential efficacy of Aloe vera as a natural intervention against MSG-associated blood disorders.

Therefore, the problem this study addresses is the insufficient understanding of MSG's dose-dependent impact on hematological parameters and the unexplored potential of Aloe vera extract in mitigating these effects.

2. Materials And Methods

2.1. Study Location

This experiment was carried out at the Biological laboratory Institute of Management and Technology (IMT), Enugu state, Nigeria 6° 51' 24"N 7° 23'45"E. The laboratory is equipped with the necessary facilities for hematological analysis ensuring that the experimental procedure met the standard protocols. The temperature of the laboratory and humidity level were maintained, providing optimal conditions for the experiment.

2.2. Materials

The following material/equipments were used for the experiment: *Aloe vera*, bovine serum albumin (BSA), grinder, Ethylene-diamine-tetracetic acid (EDTA) bottle, rat cages, laboratory equipment (filter paper, rotary evaporator, syringe, needle, centrifuge, spectrophotometer)

2.3. Experimental Animals

Twenty-four male albino rats (between 120g-125g body weight) were used in this study. The rats were procured from University of Nigeria Nsukka (UNN) and were allowed to acclimatize for 2 weeks under standard laboratory conditions with free access to commercial rat feed and water at the animal house of power tech analytical and scientific research laboratory before commencement of the experiment.

2.4. Experimental Design

The study employed a completely randomized experimental design to investigate the ameliorative effects of *Aloe vera* extract against monosodium glutamate-induced hematotoxicity in rats. The study consisted of five groups: Group 1 (blank control), Group 2 (negative control), Group 3 (low-dose monosodium glutamate extract-treated), Group 4 (medium-dose monosodium glutamate extract-treated) and Group 5 (high-dose monosodium glutamate extract-treated) Each group comprised four rats, and the study duration spanned for 28 days.

During the course of the experiment all samples were induced with 2.42g of monosodium glutamate. All animals were allowed free access to feed and water ad libitum. Standard laboratory protocols for animal studies were maintained.

2.5. Collection of Serum Sample

Twenty-four hours after treatment blood was collected from the eye through an ocular puncture from each animal and put into dry test tubes. The blood was allowed to stand for about 15 minutes to clot and further spun in a centrifuge to separate serum.

2.6. Hematological Analysis

A hematological analysis was performed to evaluate the effects of monosodium glutamate (MSG) exposure and the potential ameliorative properties of *Aloe vera* extract on the blood of male Wistar albino rats. This analysis focused on key hematological parameters such as Packed Cell Volume (PCV), Red Blood Cell (RBC) count, White Blood Cell (WBC) count, Mean Corpuscular Volume (MCV), Platelet Count and hemoglobin (Hb) concentration using the method applied by Archibong (2014).

The blood samples were collected from each rat via ocular puncture 24 hours after the final treatment. The blood was placed in tubes containing Ethylene-diamine-tetracetic acid (EDTA) to prevent clotting and preserve the blood cells for accurate measurement. Standard laboratory protocols for animal studies and hematological analysis were maintained throughout the process.

2.7. Statistical Analysis

All the statistical analysis were processed using the Statistical Package of Social Science (SPSS) for the window (version 16). The value of the measured parameters were expressed as mean $\pm$ SEM. Two-way analysis of variance (2-way ANOVA) was used to determine the effects of different petroleum product on blood parameters studied and the difference between means were separated using Duncan's multiple range tests. Test for significance was considered at 0.05 probability level.

3. Results

3.1. Effects of *Aloe vera* on the Hematological Parameters

The table below shows that MSG exposure caused significant hematological alterations in rats. The induced-untreated group recorded a sharp decline in WBC ($7.65 \pm 2.89 \times 10^9/L$), RBC ($7.88 \pm 0.09 \times 10^{12}/L$), Hb (126 ± 14.14 g/L), and PCV ($46.25 \pm 1.48\%$), compared to the control group with WBC (15.3 ± 0.14), RBC (8.37 ± 0.23), Hb (151 ± 1.41), and PCV (55.1 ± 3.25). Platelets dropped from 703 ± 14.14 to 528.50 ± 57.28 , while MCV, MCH, and MCHC also decreased. *Aloe vera* treatment improved these parameters dose-dependently. The low-dose group recorded RBC (9.77 ± 0.06), Hb (175 ± 5.66), and PCV (59.45 ± 1.20); the medium dose showed RBC (9.01 ± 0.79), Hb (162.5 ± 2.12), PCV (62.3 ± 1.84),

while the high dose achieved the highest PCV (66.5 ± 0.34) and improved MCHC (256.50 ± 26.16) results. These results indicate that *Aloe vera* mitigates MSG-induced hematological damage.

Table 1 Effects of different Aloe vera concentration on hematological parameters of male wistar albino rats

Sampled ID	WBC ($10^9/L$)	RBC ($10^{12}/L$)	Hb (g/l)	PCV (%)	X10 (platelet)	MCV fl/cell	MCH Pg/cell	MCHC (g/l)
Control	15.3 ± 0.14^a	8.37 ± 0.23^a	151 ± 1.41^a	55.1 ± 3.25^a	703 ± 14.14^a	71.75 ± 2.47^a	17.55 ± 1.06^a	259.00 ± 2.83^a
Induced-untreated	7.65 ± 2.89^b	7.88 ± 0.09^b	126 ± 14.14^b	46.25 ± 1.48^b	528.50 ± 57.28^b	60.30 ± 1.84^b	13.25 ± 1.06^b	246.50 ± 7.78^b
Low Aloe 10%	9.55 ± 0.35^c	9.77 ± 0.06^c	175 ± 5.66^c	59.45 ± 1.20^{ac}	$741. \pm 0.56^c$	65.35 ± 0.65^c	17.02 ± 0.46^c	264.5 ± 0.45^c
Medium Aloe 50%	7.9 ± 0.42^b	9.01 ± 0.79^c	162.5 ± 2.12^c	62.3 ± 1.84^{ac}	651.50 ± 43.43^{ac}	63.10 ± 4.79^c	17.50 ± 0.42^{ac}	273.50 ± 20.51^d
High Dose Aloe 100%	7.7 ± 0.2^b	8.22 ± 0.45^b	158 ± 0.34^c	66.5 ± 0.34^{ac}	604.00 ± 97.58^{bc}	68.30 ± 7.49^{ac}	17.35 ± 0.21^{ac}	256.50 ± 26.16^{ab}

Values are expressed as Mean $\pm$ standard error (Mean $\pm$ SEM). Values with different superscripts (a, b, c) across the same column are significantly different at $p < 0.05$

4. Discussion

The present study evaluated the ameliorative effects of *Aloe vera* extract on hematological parameters in Wistar albino rats exposed to MSG. Findings demonstrated that MSG significantly impaired RBC count, Hb concentration, PCV, platelet count, MCV, MCH, and MCHC, alongside reduced WBC levels in the induced-untreated group compared to the control. These alterations are consistent with previous studies showing that high-dose MSG induces oxidative damage to erythrocyte membranes, disrupts hematopoiesis, and alters immune cell profiles (Khodier, 2020; Al-Marzook et al., 2021). Reduced RBC and Hb levels suggest anemia, while lower PCV and MCHC indicate diminished oxygen transport efficiency. The decreased WBC count may reflect immune suppression, a finding that aligns with dose-dependent leukopenia reported by Oyetunji et al. (2018) under chronic MSG exposure.

Aloe vera supplementation produced significant restorative effects across treatment groups, with improvements observed in RBC, Hb, PCV, MCV, and MCHC. The low-dose group showed pronounced increases in RBC and Hb, suggesting rapid hematopoietic stimulation. The medium dose enhanced RBC and Hb but produced slightly lower PCV than the high dose, which recorded the highest PCV and MCHC values. These variations may be attributed to dose-dependent bioactive compound activity. *Aloe vera*'s therapeutic effects are likely linked to its rich content of acemannan, flavonoids, vitamins (A, C, E, B-complex), and minerals (iron, zinc), which possess antioxidant and immunomodulatory properties (Matei et al., 2025; Akhter et al., 2023). These compounds reduce lipid peroxidation, stabilize erythrocyte membranes, and enhance erythropoiesis.

The observed platelet recovery in *Aloe vera*-treated groups suggests that the extract may also support thrombopoiesis. Enhanced MCV and MCHC values in treatment groups imply improved red cell quality and hemoglobinization, essential for effective oxygen delivery. This corroborates findings by Mandalingam et al. (2024), who reported that *Aloe vera* normalizes hematological profiles in chemically induced toxicity models through its anti-inflammatory and antioxidant mechanisms.

Overall, the study confirms that MSG exposure compromises hematological health, while *Aloe vera* exerts a protective and restorative influence. The ameliorative effects were dose-dependent, with high-dose *Aloe vera* producing the greatest overall improvement in hematological indices. These findings not only support the traditional use of *Aloe vera* in managing blood-related disorders but also provide empirical evidence for its application in mitigating dietary additive-induced toxicity.

5. Conclusion

This study demonstrated that monosodium glutamate induces significant hematological alterations, including reductions in RBC count, Hb concentration, PCV, platelet count, MCV, MCH, and MCHC, alongside decreased WBC count, indicating anemia and possible immune suppression. *Aloe vera* extract exhibited dose-dependent ameliorative effects, restoring hematological indices toward normal ranges. The high-dose treatment yielded the most notable improvements, suggesting that *Aloe vera*'s antioxidant, anti-inflammatory, and hematopoietic properties counteract MSG-induced oxidative damage and support blood cell production. These findings validate *Aloe vera*'s potential as a natural therapeutic agent for mitigating hematotoxic effects of dietary additives.

Recommendations

Moderation in MSG consumption should be encouraged to prevent hematological toxicity. Incorporating *Aloe vera* into diets or therapeutic regimens may offer protective benefits against oxidative stress-related blood disorders. Further research should focus on clinical trials to validate these findings in humans and determine optimal dosing strategies.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that this study was carried out in accordance with relevant institutional, national, and international ethical guidelines and regulations

The authors declare that there are no conflict of interest regarding the publication of this manuscript

All experimental procedures involving animals were carried out in compliance with institutional guidelines for the care and use of laboratory animals

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