Dayak Onion (*Eleutherine palmifolia*) Extract Reduces MSG-Induced Obesity in Mice

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ABSTRACT

This study evaluated the anti-obesity effects of Dayak onion (*Eleutherine palmifolia*) extract in MSG-induced obese mice. Twenty-five male mice were divided into five groups: negative control (CMC-Na), positive control (MSG, 4 mg/g BW), and three groups receiving MSG plus Dayak onion extract at 30, 60, or 120 mg/kg BW for 52 days. Body weight was measured weekly, and abdominal fat (retroperitoneal, epididymal, peritoneal) was weighed using a digital scale on day 53. One-way ANOVA with Duncan's post hoc test analyzed differences ($p<0.05$). MSG increased body weight (40.8 ± 1.1 g) and fat compared to the negative control (31.2 ± 0.5 g). Dayak onion extract dose-dependently reduced body weight (T1: 38.2 ± 0.6 g; T2: 36.0 ± 0.9 g; T3: 32.3 ± 0.6 g) and fat, with the 120 mg/kg dose nearing control levels. Flavonoids and anthraquinones in the extract likely drive these effects, suggesting Dayak onion's potential as a natural anti-obesity agent. Human studies are needed to confirm these findings.

Keywords: Dayak Onion, obesity, monosodium glutamate, natural therapy

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INTRODUCTION

Obesity has become a pressing global health issue, characterized by excessive body fat accumulation that significantly increases the risk of metabolic disorders such as cardiovascular diseases and type 2 diabetes (Jirawat and Srisuk, 2024). The rising prevalence of obesity is driven by multiple factors, including dietary patterns, sedentary lifestyles, and environmental influences (Goel *et al.*, 2024). Notably, the consumption of monosodium glutamate (MSG), a common flavor enhancer, has been linked to weight gain and increased visceral fat deposition in animal models, primarily through its disruption of hypothalamic appetite regulation and metabolic homeostasis (Bayram *et al.*, 2023; Kayode *et al.*, 2023). This association underscores the need for effective interventions to counteract MSG-induced obesity and its associated health risks.

Natural compounds with anti-obesity properties have gained considerable attention as potential therapeutic agents (Athista *et al.*, 2023). Plant-based extracts, rich in bioactive compounds such as flavonoids, alkaloids, and anthraquinones, have shown promise in modulating lipid

metabolism and reducing fat accumulation (Kumar *et al.*, 2022). These compounds often exert their effects through antioxidant, anti-inflammatory, and anti-adipogenic mechanisms, offering a safer alternative to synthetic drugs (Zhang *et al.*, 2023). Among these, Dayak onion (*Eleutherine palmifolia*), a traditional medicinal plant indigenous to Indonesia, has emerged as a candidate due to its diverse phytochemical profile and reported pharmacological benefits (Kamarudin *et al.*, 2021). Its traditional use for metabolic disorders and pilot studies showing anti-obesity effects make it a strong candidate for investigation (Fauzi *et al.*, 2019). However, its dose-dependent efficacy against MSG-induced obesity remains underexplored.

This study hypothesizes that Dayak onion extract reduces body weight and abdominal fat in MSG-induced obese mice by targeting lipid metabolism and adipogenesis pathways. Previous research on similar extracts showed reduced weight and fat via suppressed lipogenesis and enhanced fat oxidation (Kumar *et al.*, 2022). Despite these findings, the dose-dependent effects of Dayak onion extract on MSG-induced obesity have not been thoroughly investigated. Such research is critical to establishing the therapeutic potential of this plant and optimizing its application in obesity management. This study addresses this gap by evaluating the impact of varying doses of Dayak onion extract on body weight and abdominal fat in MSG-induced obese mice (*Mus musculus*).

By elucidating the anti-obesity effects of Dayak onion extract, this research aims to contribute to the development of natural, evidence-based interventions for obesity. The findings could provide valuable insights into the plant's bioactive compounds and their mechanisms of action, potentially paving the way for its integration into functional foods or nutraceuticals. Ultimately, this study seeks to advance the understanding of Dayak onion as a viable therapeutic agent for mitigating MSG-induced obesity, offering a novel approach to addressing a significant public health challenge.

METHODS

Preparation of MSG and Dayak Onion Extract

Monosodium glutamate (MSG) suspension was prepared by dissolving MSG crystals in distilled water to achieve a dose of 4 mg/g body weight (BW) (Rao *et al.*, 2023). Dayak onion (*Eleutherine palmifolia*) extract was obtained from dried bulbs, which were thinly sliced, sun-dried, and pulverized into a fine powder. The powder was subjected to maceration in 96% ethanol, with the solvent level maintained approximately 1 cm above the powder surface, and stirred periodically. The mixture was filtered using flannel cloth, and the residue was re-macerated until the filtrate appeared clear. Maceration was conducted over three 24-hour cycles, with daily solvent replacement. The filtrate was concentrated using a rotary evaporator at 40°C and 40 rpm until no further evaporation occurred, followed by additional evaporation in a water bath. The resulting extract was weighed and administered orally at doses of 30, 60, and 120 mg/kg BW, dissolved in 0.5% carboxymethylcellulose sodium (CMC-Na) (Jayanti and Raudah, 2021).

Animal Treatment and Experimental Design

Twenty-five male mice (11 weeks old, about 20 g each) were used in this study, following a completely randomized design (CRD) with five treatment groups, each replicated five

times. Group C- received 0.5% CMC-Na orally (negative control), while Group C+ was administered MSG at 4 mg/g BW orally (positive control). Groups T1, T2, and T3 received MSG at 4 mg/g BW followed by Dayak onion extract at 30, 60, and 120 mg/kg BW, respectively, administered orally one hour after MSG. This dose is based on research conducted on Dayak onion extract (Jayanti and Raudah, 2021) and MSG (Luqman *et al.*, 2022). The mice underwent a 7-day acclimatization period, followed by a 52-day treatment phase.

On day 53, the mice were anesthetized via atlanto-occipital cervical dislocation, followed by aorta rupture for organ harvesting. Abdominal fat, comprising retroperitoneal, epididymal, and peritoneal fat, was collected, placed in a plastic container, and weighed using a TN series digital mini scale (accuracy: 0.01 g). Abdominal fat was expressed as a percentage (% w/w) of body weight. Body weight was measured weekly at 09:00 a.m. before feeding, using a Harnic digital scale (Firdaus *et al.*, 2024).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. One-way analysis of variance (ANOVA) was performed to assess differences among treatment groups, with a significance threshold of $p<0.05$. When significant differences were detected, Duncan's multiple range test was applied for post hoc analysis.

RESULT AND DISCUSSION

The effects of Dayak Onion (*Eleutherine palmifolia*) extract on body weight and abdominal fat in monosodium glutamate-induced obese mice are presented in Table 1, Table 2, Figure 1 and Figure 2.

The effects of Dayak onion (*Eleutherine palmifolia*) extract on body weight and abdominal fat in monosodium glutamate (MSG)-induced obese mice are presented in Tables 1 and 2. Initial body weights were similar across all treatment groups ($p>0.05$), ranging from 21.5 ± 0.4 g to 21.9 ± 0.6 g. Over the 52-day treatment period, significant differences in body weight were observed ($p<0.05$). The positive control group (C+), receiving only MSG, exhibited the highest final body weight (40.8 ± 1.1 g), significantly greater than the negative control group (C-, 31.2 ± 0.5 g). Treatment groups receiving Dayak onion extract (T1, T2, T3) showed a dose-dependent reduction in body weight compared to C+. Group T1 (30 mg/kg BW) had a final body weight of 38.2 ± 0.6 g, T2 (60 mg/kg BW) 36.0 ± 0.9 g, and T3 (120 mg/kg BW) 32.3 ± 0.6 g, with T3 showing no significant difference from C- ($p>0.05$). Weekly measurements indicated that body weight gain was significantly lower in T3 from week 3 onward compared to C+ and T1 ($p<0.05$).

Abdominal fat accumulation, expressed as a percentage of body weight, also varied significantly among groups ($p<0.05$). The C+ group displayed the highest retroperitoneal (2.49 ± 0.13%), epididymal (6.11 ± 0.30%), and peritoneal (2.17 ± 0.09%) fat percentages. In contrast, the C- group had the lowest fat percentages (retroperitoneal: 1.07 ± 0.22%; epididymal: 3.05 ± 0.37%; peritoneal: 0.99 ± 0.14%). Among the treatment groups, T3 (120 mg/kg BW) exhibited significantly reduced fat accumulation (retroperitoneal: 1.70 ± 0.20%; epididymal: 4.74 ± 0.42%; peritoneal: 1.46 ± 0.15%) compared to C+ and T1 ($p<0.05$), though still higher than C- ($p<0.05$). Groups T1 and T2 showed moderate reductions in fat percentages, with T2 (60 mg/kg BW) demonstrating lower peritoneal fat (1.61 ± 0.11%)

compared to T1 (1.90 ± 0.12%) ($p<0.05$). These findings indicate that Dayak onion extract, particularly at 120 mg/kg BW, effectively mitigates MSG-induced body weight gain and abdominal fat accumulation in a dose-dependent manner.

Table 1. Change of body weight in mice (*Mus musculus*) exposed to monosodium glutamate and treated with different doses of Dayak Onion extract (Mean ± SD)

Treatment	Body Weight (g)			
	Initial	Week 3	Week 6	Final
C-	$21.7^{a} \pm 0.4$	$25.6^{a} \pm 0.6$	$27.3^{a} \pm 0.6$	$31.2^{a} \pm 0.5$
C+	$21.9^{a} \pm 0.6$	$30.2^{d} \pm 0.8$	$34.9^{c} \pm 0.9$	$40.8^{d} \pm 1.1$
T1	$21.5^{a} \pm 0.4$	$29.1^{cd} \pm 0.6$	$32.7^{b} \pm 0.9$	$38.2^{c} \pm 0.6$
T2	$21.7^{a} \pm 0.6$	$27.8^{bc} \pm 0.8$	$31.6^{b} \pm 0.5$	$36.0^{b} \pm 0.9$
T3	$21.7^{a} \pm 0.5$	$26.5^{ab} \pm 0.7$	$28.4^{a} \pm 0.8$	$32.3^{a} \pm 0.6$

Note: different superscript (a,b,c,d) showed significant differences ($p<0.05$).

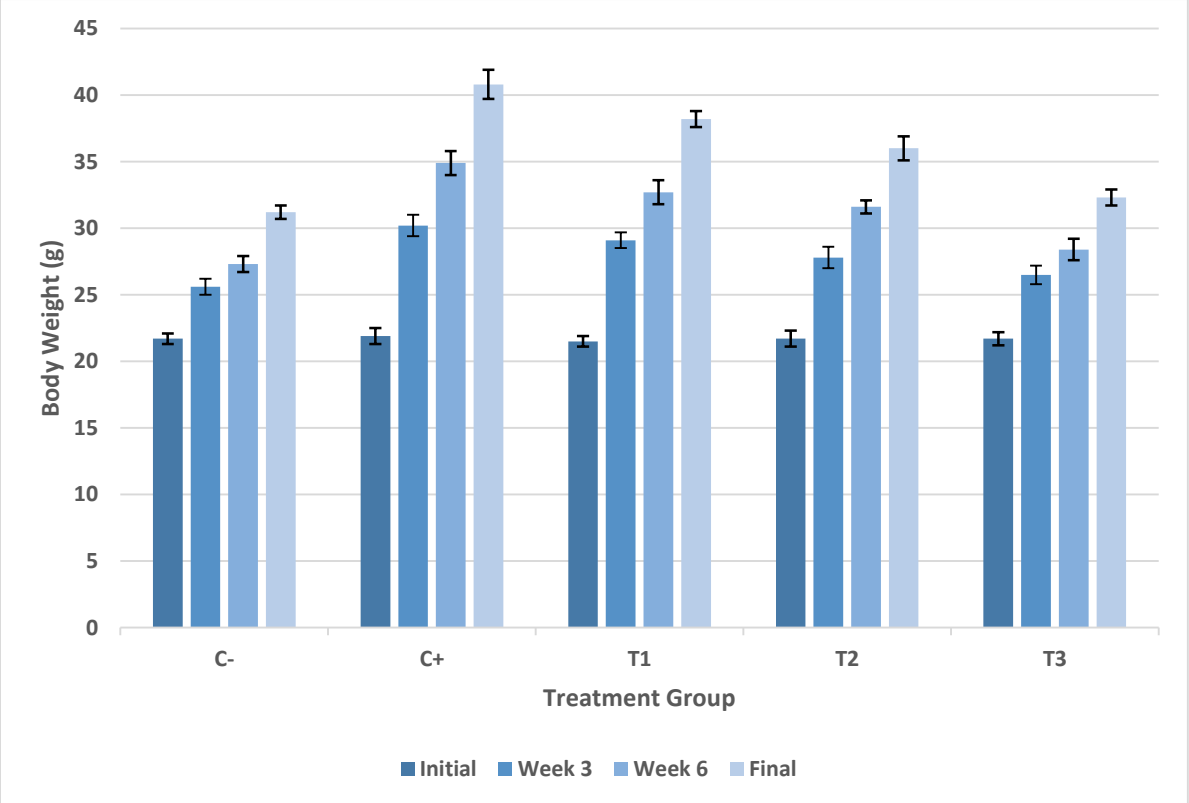

Figure 1. Mice (*Mus musculus*) body weight (g) exposed to monosodium glutamate and treated with different doses of Dayak Onion extract.

Table 2. Abdominal fats in mice (*Mus musculus*) exposed to monosodium glutamate and treated with different doses of Dayak Onion extract (Mean ± SD)

Treatment	Fat (%)		
	Retroperitoneal	**Epididymal**	**Peritoneal**
C-	1.07^{a} ± 0.22	3.05^{a} ± 0.37	0.99^{a} ± 0.14
C+	2.49^{c} ± 0.13	6.11^{d} ± 0.30	2.17^{d} ± 0.09
T1	2.44^{c} ± 0.14	6.01^{cd} ± 0.32	1.90^{c} ± 0.12
T2	2.37^{c} ± 0.13	5.53^{c} ± 0.25	1.61^{b} ± 0.11
T3	1.70^{b} ± 0.20	4.74^{b} ± 0.42	1.46^{b} ± 0.15

Note: different superscript (a,b,c,d) showed significant differences ($p<0.05$).

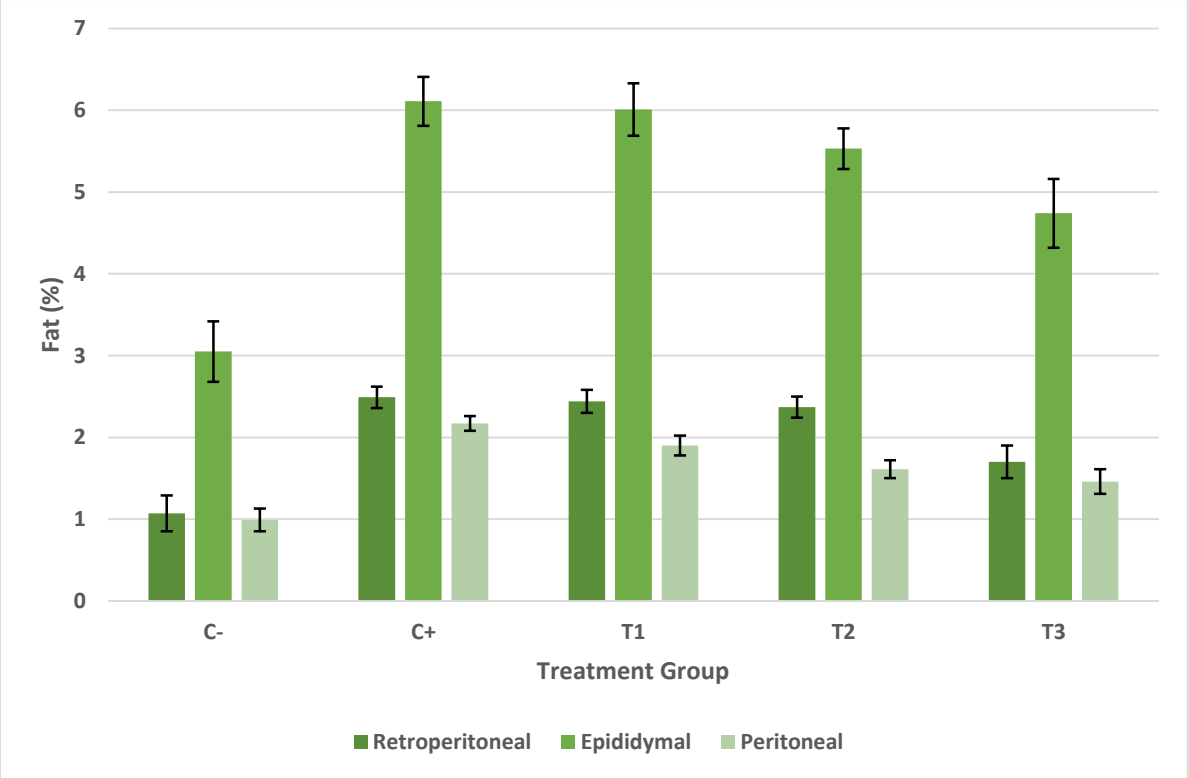

Figure 2. Mice (*Mus musculus*) abdominal fat (%) exposed to monosodium glutamate and treated with different doses of Dayak Onion extract.

This study investigated the effects of Dayak onion (*Eleutherine palmifolia*) extract on body weight and abdominal fat accumulation in monosodium glutamate (MSG)-induced obese male mice. The results demonstrate that Dayak onion extract, administered at doses of 30, 60, and 120 mg/kg body weight (BW), significantly reduced body weight gain and abdominal fat

deposition in a dose-dependent manner compared to the positive control group (C+), which received only MSG. In this study, food intake was not measured or controlled, which limits the ability to determine whether the observed reductions in body weight and abdominal fat were due to appetite suppression, metabolic effects, or a combination of both. Future studies should monitor food consumption to elucidate the extract's impact on appetite regulation. Notably, the highest dose (120 mg/kg BW, T3) resulted in final body weights and abdominal fat percentages that were comparable to the negative control group (C-), suggesting a potent anti-obesity effect. These findings align with previous research highlighting the therapeutic potential of plant-based extracts rich in bioactive compounds for obesity management (Kumar *et al.*, 2022; Kamarudin *et al.*, 2021; Boix-Castejón *et al.*, 2023).

The significant body weight gain observed in the C+ corroborates prior studies linking MSG consumption to obesity in animal models. MSG is known to disrupt hypothalamic regulation of appetite and metabolism, leading to increased food intake and fat accumulation (Banerjee *et al.*, 2021; Kayode *et al.*, 2023). The dose-dependent reduction in body weight in the treatment groups suggests that Dayak onion extract counteracts these effects, likely through its bioactive compounds, including flavonoids, alkaloids, and anthraquinones (Fauzi *et al.*, 2019). These compounds have been reported to modulate lipid metabolism and suppress adipogenesis (Permatasari *et al.*, 2024; Kumar *et al.*, 2022). The T3 group's body weight, which was not significantly different from the C- group, indicates that the 120 mg/kg BW dose may effectively mitigate MSG-induced weight gain, potentially by inhibiting lipid storage or enhancing fat metabolism.

Abdominal fat accumulation, comprising retroperitoneal, epididymal, and peritoneal fat, was significantly higher in the C+ group compared to the C- group. This is consistent with MSG's role in promoting visceral fat deposition, a key feature of metabolic syndrome (Kayode *et al.*, 2023). The treatment groups exhibited a dose-dependent reduction in abdominal fat, with the T3 group showing the most pronounced effect. These reductions are likely attributable to the anti-obesity properties of Dayak onion's phytochemicals, particularly flavonoids and anthraquinones, which have been shown to inhibit pancreatic lipase and reduce lipid absorption (Permatasari *et al.*, 2024). The significant decrease in epididymal fat in T3 compared to C+ suggests that Dayak onion extract may preferentially target visceral fat, a critical factor in obesity-related complications. The significant reduction in visceral fat, particularly epididymal fat in the T3 group, is clinically more relevant than total body weight loss in obesity research, as visceral fat accumulation is strongly associated with insulin resistance, cardiovascular disease, and metabolic syndrome (Kumar *et al.*, 2022).

The mechanisms underlying these effects may involve multiple pathways. Flavonoids, abundant in Dayak onion, are known to enhance insulin sensitivity, reduce inflammation, and inhibit adipocyte differentiation, thereby limiting fat accumulation (Arwati *et al.*, 2018; Sutapa *et al.*, 2021; Permatasari *et al.*, 2024). Anthraquinones, another key component, have been reported to modulate lipid metabolism by inhibiting key enzymes such as pancreatic lipase and HMG-CoA reductase, which are involved in fat and cholesterol synthesis (Upadhyay, 2021). Additionally,

alkaloids may contribute to appetite suppression and thermogenesis, further reducing body weight gain (Horvath and Wolfrum, 2020). The dose-dependent response observed in this study suggests that higher concentrations of these bioactive compounds (as in the 120 mg/kg BW dose) enhance their therapeutic efficacy, potentially through synergistic interactions among the phytochemicals.

The in vitro findings from Permatasari *et al.* (2024) provide further insight into the molecular mechanisms of Dayak onion extract. Their study demonstrated that *Eleutherine bulbosa* (a closely related species) extract inhibits pancreatic lipase, α-glucosidase, and α-amylase, and downregulates the expression of proteins such as MAPK8, PPARG, HMGCR, CPT-1, and GLP-1 in 3T3-L1 preadipocytes. Future research should conduct in vivo studies to measure the expression of molecular markers such as MAPK8, PPARG, HMGCR, CPT-1, and GLP-1 in MSG-induced obese mice treated with Dayak onion extract to confirm the inhibition of lipid metabolism and adipogenesis pathways suggested by in vitro studies (Permatasari *et al.*, 2024). These proteins are critical regulators of lipid metabolism, glucose homeostasis, and inflammation, suggesting that Dayak onion extract may target multiple facets of obesity and metabolic syndrome.

Although the current study did not assess these molecular markers, the observed reductions in body weight and abdominal fat align with these mechanisms, particularly the inhibition of lipid metabolism and adipogenesis. The proposed molecular mechanisms, including inhibition of pancreatic lipase, α-glucosidase, and downregulation of MAPK8, PPARG, HMGCR, CPT-1, and GLP-1, are hypothetical in the context of this study, as no molecular markers were directly assessed. The observed reductions in body weight and fat align with these mechanisms but require further validation.

CONCLUSION

This study demonstrates that Dayak onion (*Eleutherine palmifolia*) extract significantly reduces body weight gain and abdominal fat accumulation in MSG-induced obese mice in a dose-dependent manner, with the 120 mg/kg BW dose showing the most pronounced effects. These findings highlight the potential of Dayak onion extract as a natural therapeutic agent for obesity management, likely due to its rich content of flavonoids, anthraquinones, and alkaloids, which modulate lipid metabolism and adipogenesis. Additional research is needed to validate these findings in other obesity models (e.g., high-fat diet or genetic models) and through human clinical trials to confirm Dayak onion extract's efficacy and applicability in obesity management. Future studies should evaluate potential side effects and long-term safety of Dayak onion extract, particularly at higher doses, to ensure its suitability as a therapeutic agent without adverse health impacts.

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Author Contribution

Aldin Akbar Rahmatullah: Conceptualization, Methodology, Writing- Original draft preparation, Supervition, Validation. Nurrohmah Ratnaningtyas, Putra Indrajaya, Ahmad Thoriqul Firdaus: Data curation, Software. Anggreani Desi Ramadhani Rahajeng: Visualization, Investigation. Rosid Hidayat, Yosfiansya Fernandi Shaffirudin, Haikal Akmal Zahli,

Muhamad Naufal Irkhamy: Writing-Reviewing and Editing.

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Approval

This study received ethical clearance (No. 1.KEH.081.07.2022) from the Animal Care and Use Committee, Faculty of Veterinary Medicine, Airlangga University, ensuring compliance with ethical standards for animal research.

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