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RESEARCH ARTICLES

Ekstrak Etanol Kayu Bajakah *(Spatholobus littoralis Hassk.)* terhadap Konsentrasi Tirosinase dan Berat Badan Tikus yang Diinduksi dengan Dosis Tinggi D-galaktosa

Ethanol Extract of Bajakah Wood (Spatholobus littoralis Hassk.) on Tyrosinase Concentration and Body Weight in Rats Induced with High-Dose D-galactose

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Abstract

The aging process is associated with the accumulation of oxidative stress that damages cellular function. D-galactose is used to induce aging-like conditions in animal models. Bajakah wood extract (Spatholobus littoralis Hassk.), which is traditionally used, is known to contain bioactive compounds with antioxidant activity. This study aimed to elucidate the effects of ethanol extract from Bajakah wood (Spatholobus littoralis Hassk.) on tyrosinase concentration and body weight in rats subjected to high-dose D-galactose induction. This laboratory experimental study used 36 male Sprague Dawley rats induced with D-galactose (500 mg/kgBW). The rats were divided into six groups: normal control, negative control, positive control (vitamin C 50 mg/kgBW), and three treatment groups that received Bajakah ethanol extract at doses of 25, 50, and 100 mg/kgBW. Body weight was monitored weekly for 8 weeks, and tyrosinase levels were analyzed at the end of the study. The negative control group showed fluctuations in body weight and the highest tyrosinase levels. Administration of Bajakah extract, particularly at a dose of 100 mg/kgBW, significantly reduced tyrosinase concentrations (p-value < 0,05) and resulted in a more stable weight gain profile compared to the negative control group. Bajakah wood ethanol extract showed an inhibitory effect on tyrosinase and improved weight stability in the D-galactose-induced rat model. These findings support the potential of this extract as a plant-based therapeutic agent for disorders related to oxidative stress and aging.

Keywords: *antioxidant properties, bajakah wood, D-galactose*

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Abstrak

Proses penuaan dikaitkan dengan akumulasi stres oksidatif yang merusak fungsi sel. D-galaktosa digunakan untuk menginduksi kondisi mirip penuaan pada model hewan. Ekstrak kayu Bajakah (Spatholobus littoralis Hassk.), yang secara tradisional digunakan, diketahui mengandung senyawa bioaktif dengan aktivitas antioksidan. Penelitian ini bertujuan untuk menjelaskan efek ekstrak etanol dari kayu Bajakah (Spatholobus littoralis Hassk.) terhadap konsentrasi tirosinase dan berat badan pada tikus yang diinduksi dengan D-galaktosa dosis tinggi. Studi eksperimental laboratorium ini menggunakan 36 tikus jantan Sprague Dawley yang diinduksi dengan D-galaktosa (500 mg/kgBW). Tikus dibagi menjadi enam kelompok: kontrol normal, kontrol negatif, kontrol positif (vitamin C 50 mg/kgBW), dan tiga kelompok perlakuan yang menerima ekstrak etanol Bajakah dengan dosis 25, 50, dan 100 mg/kgBW. Berat badan dipantau setiap minggu selama 8 minggu, dan kadar tirosinase dianalisis pada akhir penelitian. Kelompok kontrol negatif menunjukkan fluktuasi berat badan dan kadar tirosinase tertinggi. Pemberian ekstrak Bajakah, khususnya pada dosis 100 mg/kgBW, secara signifikan mengurangi konsentrasi tirosinase (*p-value* < 0,05) dan menghasilkan profil peningkatan berat badan yang lebih stabil dibandingkan dengan kelompok kontrol negatif. Ekstrak etanol kayu Bajakah menunjukkan efek penghambatan pada tirosinase dan meningkatkan stabilitas berat badan pada model tikus yang diinduksi D-galaktosa. Temuan ini mendukung potensi ekstrak ini sebagai agen terapeutik berbasis tumbuhan untuk gangguan yang berkaitan dengan stres oksidatif dan penuaan.

Kata Kunci: sifat antioksidan, kayu bajakah, D-galaktosa

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Highlight:

- Ethanol extract of Bajakah wood significantly reduces tyrosinase concentration, effectively suppressing melanogenesis-related enzymatic activity.
- Treatment with the extract mitigates D-galactose-induced oxidative damage, maintaining stable body weight and improving metabolic balance in rats.
- The presence of flavonoids (catechins, daidzein, and luteolin) enables the extract to scavenge reactive oxygen species (ROS) and directly inhibit tyrosinase at its active site.

INTRODUCTION

The investigation of natural extracts as therapeutic agents has gained increasing scientific attention, particularly in the context of aging and oxidative stress (Ahmed, 2025; Nowak-perlak et al., 2025). Aging is closely associated with the accumulation of oxidative damage caused by excessive production of reactive oxygen species (ROS), leading to cellular dysfunction and degeneration of physiological systems. Among various natural resources, Bajakah wood (*Spatholobus littoralis Hassk.*) has emerged as a promising source of bioactive compounds with potential antioxidant and anti-aging properties (Yang et al., 2024).

In recent years, Bajakah wood has become a trending topic in Indonesia, especially following reports of its traditional use by the Dayak communities of

Kalimantan for enhancing stamina and treating various chronic conditions. This growing public and scientific interest highlights the importance of validating traditional knowledge through experimental and mechanistic studies, thereby integrating local wisdom with modern biomedical research (Nastiti and Nugraha, 2022). S. littoralis, a member of the Spatholobus genus, was first documented in 1842 by the German botanist Justus Karl Hasskarl and has since been recognized for its rich phytochemical profile (Fitriani et al., 2020).

D-galactose is a monosaccharide commonly used to induce oxidative stress and simulate aging-related changes in animal models. Chronic administration of high-dose D-galactose disrupts normal metabolic processes, leading to oxidative stress, inflammation, mitochondrial dysfunction, and tissue degeneration, which closely resemble natural aging phenomena (Bo-Htay et al., 2020; Homolak et al., 2021; Yamamoto et al., 2023). Experimental evidence indicates that D-galactose exposure is associated with cognitive decline, body weight alterations, skin thinning, hair depigmentation, and impaired metabolic regulation (Ajayi et al., 2021; Ambikar and Mohanta, 2021). These effects are largely mediated by excessive ROS generation, lipid peroxidation, and reduced antioxidant defenses, ultimately triggering cellular apoptosis and tissue damage (Han et al., 2021).

Furthermore, elevated levels of D-galactose promote the formation of advanced glycation end-products (AGEs), which exacerbate oxidative stress and inflammatory responses. AGEs interact with their receptors (RAGE), activating downstream signaling pathways such as ERK and CREB, leading to increased expression of microphthalmia-associated transcription factor (MITF) and enhanced tyrosinase activity in melanocytes (Chen et al., 2022). As tyrosinase is a key enzyme in melanin synthesis, its upregulation is closely linked to skin aging, hyperpigmentation, and other age-related dermatological changes. In addition, D-galactose-induced metabolic disruption affects body weight regulation and inflammatory cytokine profiles, contributing to systemic aging-related disorders (Kumar et al., 2022).

The therapeutic potential of Bajakah wood ethanol extract is particularly relevant in counteracting these pathological processes. Phytochemical analyses have demonstrated that S. littoralis contains a variety of bioactive compounds, including flavonoids and phenolic acids such as catechins, epicatechin, gallic acid, daidzein, and luteolin, which exhibit strong antioxidant, anti-inflammatory, photoprotective, and anti-aging activities (Sianipar et al., 2023). These compounds are known to scavenge free radicals, inhibit ROS-producing enzymes such as NADPH oxidase and xanthine oxidase, and protect cellular components from oxidative damage (Sari and Nawawi, 2023). The strong antioxidant capacity of red Bajakah wood has been confirmed by low IC_{50} values, reported at 36.21 ppm for the bark and 26.29 ppm for the wood, indicating very high radical-scavenging activity (Fitriani et al., 2020).

In the context of aging and metabolic dysregulation, tyrosinase activity may also reflect broader metabolic changes beyond pigmentation, as it is influenced by oxidative status and inflammatory signaling pathways. Modulation of tyrosinase activity, therefore, may serve as an indicator of improved oxidative balance and metabolic health (Han et al., 2021; Jung et al., 2021). Consequently, investigating the effects of Bajakah wood ethanol extract on tyrosinase concentration and body weight regulation in a D-galactose-induced aging model is scientifically relevant.

In summary, this study aimed to elucidate the effects of ethanol extract from Bajakah wood (*Spatholobus littoralis Hassk.*) on tyrosinase concentration and body weight in rats subjected to high-dose D-galactose induction. By integrating traditional Indonesian medicinal knowledge with experimental evidence, this research seeks to

support the development of plant-based therapeutic strategies for mitigating oxidative stress, metabolic imbalance, and aging-related disorders.

METHODS

This study is a randomized controlled laboratory experiment designed to evaluate the effect of red bajakah wood (*Spatholobus littoralis Hassk.*) ethanol extract on tyrosinase levels and body weight in D-galactose-induced rats (Agnesia et al., 2023; Liberty, 2024). The study used 36 male Sprague Dawley rats aged 7–8 weeks with a body weight of 170–200 g obtained from the Parasitology & Animal Laboratory, Health Biology Laboratory Center, Bogor City, West Java. The rats were acclimatized for 7 days before treatment, and only healthy, active rats with normal appetite were included in the study. The sample size was determined using Federer's formula with a minimum of four rats per group, then increased to six rats per group to anticipate sample loss.
Red bajakah wood ethanol extract was prepared by processing 500 g of bajakah wood simplisia using the maceration method with 96% ethanol solvent at a material to solvent ratio of 1:10 (w/v) for three times 24 hours, then the filtrate was concentrated using a rotary evaporator at 50°C.

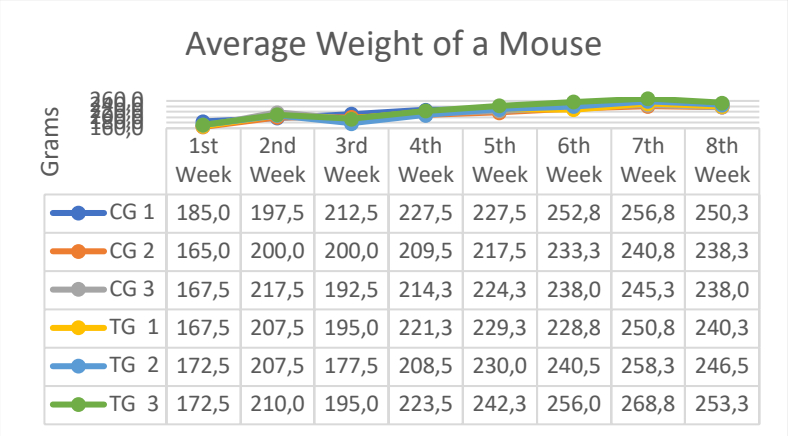
Aging induction was performed by administering D-galactose at a dose of 500 mg/kg body weight suspended in 0,5% Na-CMC and given for 8 weeks. The rats were divided into six groups, namely the normal group (0,9% NaCl), negative control (D-galactose), positive control (D-galactose + vitamin C 50 mg/kg BW), and three treatment groups that received D-galactose and bajakah wood ethanol extract at doses of 25, 50, and 100 mg/kg BW. The extract and vitamin C were administered orally using a gastric tube from week 5 to week 8. The rats were kept individually in a controlled environment with a room temperature of 35–37°C, adequate ventilation and lighting, and ad libitum feed and drinking water. The rats' body weight was measured weekly, and at the end of the study, blood and skin tissue samples were taken for tyrosinase level analysis and histological examination. All research procedures were approved by the Research Ethics Committee of the YARSI University Research Institute with approval number No. 270/KEP-UY/EA.10/VIII/2024.

RESULTS AND DISCUSSION

Analysis of average rat body weight

Figure 1 shows the analysis of the average body weight of rats from different groups during the eight weeks of observation. In the first week, group 1 had the highest average body weight of 185,0 grams, while group 2 had the lowest average of 165,0 grams. As time passed, the average body weight of the rats in all groups increased. In the second week, group 3 recorded the highest average body weight of 217,5 grams, followed by groups 4 and 5 which each had an average of 207,5 grams. However, in the third week, group 3 experienced a decrease in body weight to 192.5 grams, while groups 1 and 4 showed a steady increase. Entering the fourth week, all groups showed a significant increase in body weight, with group 1 reaching 227,5 grams and group 6 recording an average of 223,5 grams. In week five, group 6 showed the most significant growth with an average body weight of 242,3 grams, making it the group with the highest body weight in that week. In week six, group 6 again recorded the highest average of 256,0 grams, followed by group 5 with 240,5 grams. However, in the seventh week, group 6 retained the top spot with an average of 268,8 grams, while group 2 decreased to 240,8 grams.

As seen **in** Figure 1, in the eighth week, the average body weight of group 6 decreased slightly to 253,3 grams, but remained higher than the other groups. Overall, the results from this table show that although there was variation in body weight growth between groups, group 6 consistently showed better growth than the other groups, while group 2 experienced greater fluctuations in body weight throughout the observation period. This could indicate different responses to the treatments given to each group.



	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	8th Week
CG 1	185,0	197,5	212,5	227,5	227,5	252,8	256,8	250,3
CG 2	165,0	200,0	200,0	209,5	217,5	233,3	240,8	238,3
CG 3	167,5	217,5	192,5	214,3	224,3	238,0	245,3	238,0
TG 1	167,5	207,5	195,0	221,3	229,3	228,8	250,8	240,3
TG 2	172,5	207,5	177,5	208,5	230,0	240,5	258,3	246,5
TG 3	172,5	210,0	195,0	223,5	242,3	256,0	268,8	253,3

Figure 1. Average weight of a mouse

Description:
Control Group 1 (CG 1): Blank control (subcutaneously injected with 0.9% NaCl for up to 7 weeks)
Control Group 2 (CG 2): Negative Control (injected D-galactose dose of 500 mg/kg BW subcutaneously for 7 weeks, in the 4th week given NaCl 0.9% saline orally)
Control Group 3 (CG 3): Positive Control (injected D-galactose dose 500 mg/kg BW subcutaneously, and vitamin C dose 50 mg/kg BW orally)
Treatment Group 1 (TG 1): Treatment Group 1 (injected D-galactose dose 500 mg/kg BW subcutaneously and EEKBM dose 25 mg/kg BW orally)
Treatment Group 2 (TG 2): Treatment Group 2 (injected D-galactose dose 500 mg/kg BW subcutaneously and EEKBM dose 50 mg/kg BW orally)
Treatment Group 3 (TG 3): Treatment Group 3 ((injected D-galactose dose 500 mg/kg BW subcutaneously and EEKBM dose 100 mg/kg BW orally)

Tyrosinase concentration analysis

From Table 1, presents a comparison of treatment effects on various measured parameters among different treatment groups in rats. The data includes the number of subjects (N), mean values, standard deviations (SD), and results from a One-Way ANOVA analysis, along with post-hoc comparisons between treatment groups. The treatment groups (TG 1 to TG 6) consist of different interventions, with TG 1 showing a mean of 146.483 and a significant p-value of 0.034, indicating a statistically significant difference compared to other groups. Notably, TG 2 exhibited the highest mean value of 193.794, with multiple significant post-hoc comparisons *(p-values < 0,05)* against TG 3, TG 4, TG 5, and TG 6, suggesting that this treatment was particularly effective. In contrast, TG 3 had a mean of 125.196, with no significant differences observed in post-hoc tests, indicating a lack of effectiveness relative to other treatments. The remaining groups, TG 4, TG 5, and TG 6, displayed mean values ranging from 138.110 to 148.205, with TG 4 and TG 5 showing no significant differences in post-hoc comparisons.

Overall, the results (Tabel 1) highlight the varying efficacy of the treatments administered, with TG 2 demonstrating the most pronounced effects, while TG 3, TG 4, TG 5, and TG 6 exhibited less significant outcomes. This analysis underscores the importance of evaluating treatment effects in preclinical studies to identify potential therapeutic interventions.

Table 1. Comparison of treatment effects on measured parameters among different treatment groups in rats

Treatment Group	N	Mean	SD	One Way Anova *(p-value)*	Post-Hoc					
					TG 1	TG 2	TG 3	TG 4	TG 5	TG 6
TG1	4	146,483	41,809	*0,034**		0,020*	0,268	0,927	0,937	0,658
TG2	4	193,794	30,582				0,002*	0,025*	0,024*	0,008*
TG3	4	125,196	15,831					0,232	0,237	0,497
TG4	4	148,205	29,556						0,990	0,594
TG5	4	147,980	7,328							0,602
TG6	4	138,110	17,788							

Source: Primary data result, 2024

From Figure 2, illustrates the average tyrosinase levels across six different groups, comprising three control groups (CG1, CG2, CG3) and three treatment groups (TG1, TG2, TG3), with the y-axis representing tyrosinase activity in units of umol/L. The data reveals significant variability in tyrosinase activity among the groups, with CG2 exhibiting the highest average activity, followed by TG1 and TG2. In contrast, TG3 demonstrates the lowest average tyrosinase activity, indicating a notable difference in response to treatment. Overall, the results suggest that the treatment groups (TG1, TG2, TG3) generally exhibit lower tyrosinase activity compared to the control groups (CG1, CG2, CG3), highlighting the potential impact of the treatments on enzyme activity.

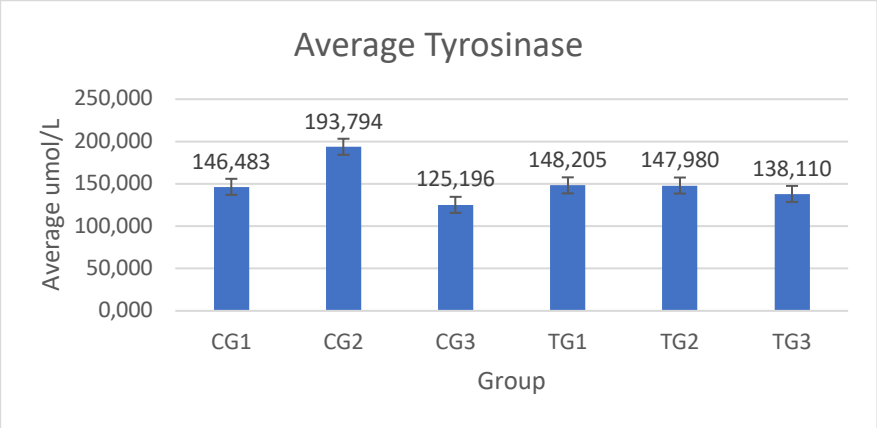


Figure 2. Average tyrosinase levels in different groups

Description:
CG1 (Control Group 1)
CG2 (Control Group 2)
CG3 (Control Group 3)
TG1 (Treatment Group 1)
TG2 (Treatment Group 2)
TG3 (Treatment Group 3)

Effects of ethanol extract of red bajakah wood on body weight in D-galactose–induced rats

Changes in body weight were monitored weekly for eight weeks to evaluate the metabolic effects of D-galactose induction and ethanol extract of red Bajakah wood (*Spatholobus littoralis Hassk.*) administration. As shown in Figure 1, all groups exhibited an overall increase in body weight over time; however, notable differences were observed among treatment groups. In the early phase of D-galactose induction, the negative control group (CG2) demonstrated greater body weight fluctuations, including a stagnation or decrease in weight during the third week, whereas treatment groups receiving Bajakah extract showed more stable weight trajectories.

D-galactose administration at high doses (500 mg/kg BW) is known to disrupt metabolic homeostasis by inducing oxidative stress, mitochondrial dysfunction, and neuroinflammation, which may impair nutrient absorption and energy utilization, ultimately leading to weight loss or unstable weight gain (Homolak et al., 2023; Kartika et al., 2023). Oxidative damage to central nervous system structures involved in appetite regulation can reduce food intake and increase lipolysis, contributing to body weight loss. Moreover, D-galactose has been reported to interfere with glucose metabolism and promote malabsorption through redox imbalance and increased reactive oxygen species (ROS) production (Cai et al., 2022).

In the present study, rats receiving ethanol extract of red Bajakah wood exhibited improved body weight stability from weeks 4 to 7, suggesting a protective metabolic effect of the extract. This improvement may be attributed to the antioxidant properties of bioactive compounds in Bajakah wood, which help restore redox balance, protect mitochondrial function, and enhance metabolic efficiency. Similar findings have been reported in D-galactose-induced aging models treated with antioxidant compounds such as ellagic acid and eugenol, which were shown to improve body weight recovery by increasing endogenous antioxidant enzyme activity (El-Far et al., 2022). The slight reduction in body weight observed in week 8 across groups is likely due to fasting prior to blood and tissue collection, rather than treatment-related metabolic decline. Overall, these findings indicate that ethanol extract of red Bajakah wood may mitigate D-galactose-induced metabolic disturbances and support body weight regulation through antioxidant-mediated mechanisms.

Effects of ethanol extract of red bajakah wood on tyrosinase concentration

Tyrosinase concentration analysis revealed significant differences among experimental groups *($p < 0,05$)*, as presented in Table 1 and Figure 2. The negative control group (CG2), which received D-galactose only, exhibited the highest tyrosinase levels, confirming that D-galactose induction enhances melanogenic activity. This effect is consistent with previous studies demonstrating that D-galactose promotes the formation of advanced glycation end-products (AGEs), which activate the RAGE–ERK–CREB signaling pathway, leading to increased expression of microphthalmia-associated transcription factor (MITF) and subsequent upregulation of tyrosinase during melanogenesis (Chen et al., 2022).

In contrast, treatment groups receiving ethanol extract of red Bajakah wood showed significantly lower tyrosinase concentrations, particularly at higher extract doses, indicating a dose-dependent inhibitory effect. This inhibition is closely linked to the presence of flavonoid compounds such as catechins, daidzein, luteolin, and apigenin, which are known competitive inhibitors of tyrosinase. Mechanistically, flavonoids inhibit tyrosinase by binding to the copper-containing active site of the enzyme through hydrogen bonding and metal-chelation interactions, thereby preventing the oxidation of L-tyrosine and L-DOPA to dopaquinone, a critical step in melanin

synthesis (Hossain et al., 2021; Istiqomah and Safitri, 2021). By blocking this catalytic process, flavonoids effectively suppress excessive melanin production associated with oxidative stress and aging.

Furthermore, the antioxidant capacity of Bajakah wood extract plays a complementary role in tyrosinase inhibition. By scavenging ROS and reducing oxidative stress, the extract limits AGE formation and downstream signaling pathways that stimulate melanogenic gene expression. This dual action direct enzymatic inhibition and indirect suppression of oxidative signaling explains the pronounced reduction in tyrosinase levels observed in treatment groups. Similar inhibitory effects have been reported for flavonoid-based cosmetic and therapeutic agents, including taketin, naringenin, and formononetin, which share structural features with compounds found in S. littoralis (Sianipar et al., 2023).

Collectively, these results demonstrate that ethanol extract of red Bajakah wood not only counteracts D-galactose-induced metabolic dysregulation, as reflected by improved body weight stability, but also effectively inhibits tyrosinase activity through flavonoid-mediated mechanisms. This integrated antioxidant and enzyme-inhibitory action highlights the potential of Spatholobus littoralis as a natural therapeutic agent for managing oxidative stress–related aging, pigmentation disorders, and metabolic dysfunction.

CONCLUSIONS

This study demonstrates that the ethanol extract of Bajakah wood (*Spatholobus littoralis* Hassk.) effectively inhibits tyrosinase activity and stabilizes body weight in D-galactose-induced rats. At an optimal dose of 100 mg/kg BW, the extract significantly reduces tyrosinase levels, mitigating oxidative stress-induced aging and melanogenesis. These benefits are attributed to antioxidant flavonoids, specifically catechins, daidzein, and luteolin, which scavenge reactive oxygen species and directly interact with the enzyme's active site. Consequently, Bajakah wood extract shows strong potential as a natural therapeutic agent for managing age-related skin and metabolic disorders, though further research is required to clarify its molecular mechanisms.

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CONFLICT OF INTEREST

The author(s) declare that they have no conflict interest

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