

EFFECT OF PURPLE CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA* L.) EXTRACT ON SERUM SGPT LEVELS IN MALE WISTAR RATS TREATED WITH A HIGH-FAT DIET AND CCl_4

Luh Komang Wiranindra Patni Mulyana Utami¹, I Gusti Ayu Dewi Ratnayanti², I Gusti Nyoman Sri Wiryawan², I Wayan Sugiritama^{2*}

¹Bachelor of Medicine Program, Faculty of Medicine, Udayana University, Denpasar, Bali, Indonesia

²Departement of Histology, Faculty of Medicine, Udayana University, Denpasar, Bali, Indonesia

e-mail: wiranindrapatni@gmail.com

*Corresponding Author e-mail: sugiritamafk@unud.ac.id, ratnayanti@unud.ac.id

ABSTRACT

Background: Non-alcoholic fatty liver disease (NAFLD) represents a growing global health concern and is marked by progressive liver injury, which partly mediated by oxidative stress. Purple cabbage (*Brassica oleracea* var. *capitata* L.) contains high levels of anthocyanins, bioactive compounds recognized for their potential protective effects on the liver. This study aimed to assess the effect of purple cabbage extract serum glutamic pyruvic transaminase (SGPT) levels in male Wistar rats exposed to a high-fat diet and carbon tetrachloride (CCl_4). **Methods:** This experimental investigation utilized 24 male Wistar rats that were randomly assigned to four groups (n = 6). The negative control group (P0) received a high-fat diet in combination with CCl_4 induction. The intervention groups were administered purple cabbage extract at doses of 100 mg/kg BW (P1), 200 mg/kg BW (P2), and 400 mg/kg BW (P3) for six consecutive weeks alongside the same induction protocol. SGPT levels were analyzed at the completion of the treatment period. **Results:** The negative control group (P0) exhibited the highest mean SGPT concentration (74.52 ± 11.451 U/L). Administration of purple cabbage extract resulted in a dose-related decline in SGPT levels, with mean values of 57.90 U/L (P1), 47.78 U/L (P2), and 38.56 U/L (P3). Statistically significant reductions were observed in the P2 (p = 0.006) and P3 (p = 0.002) groups, whereas the decrease in P1 did not reach significance (p = 0.055). **Conclusion:** Purple cabbage extract exerted a dose-dependent hepatoprotective effect, as demonstrated by reductions in SGPT concentrations in Wistar rats with liver injury induced by a high-fat diet and CCl_4 exposure.

Keywords: CCl_4 , hepatoprotective, high-fat diet, purple cabbage extract, SGPT.

INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is a chronic liver condition defined by excessive lipid accumulation within hepatocytes occurring independently of substantial alcohol intake. Over the past two decades, the prevalence of NAFLD has risen markedly, leading to its recognition as a significant global public health concern. Current estimates indicate that roughly one-quarter of the general population is affected, and the incidence continues to grow, with approximately 3.6 million new cases reported each year. In Asian populations, prevalence rates vary widely, ranging from about 5% to 40%. In Indonesia, a previous investigation documented a prevalence of nearly 30% in the general population.¹ In NAFLD, inflammation of hepatocytes can progress to Non-Alcoholic Steatohepatitis (NASH). The prevalence of NASH among patients with NAFLD who underwent liver biopsy was reported to be around 59.10%.² NAFLD is not only regarded as a primary liver disease but is also recognized as a lifestyle-related condition associated with physical

inactivity and excess nutrition that lead to obesity, thereby increasing NAFLD prevalence.^{3,4}

The natural history of NAFLD is closely linked to insulin resistance, inflammation, and oxidative stress.⁵ Oxidative stress contributes to hepatic inflammation, which in turn impairs hepatocyte function. One commonly used test to assess liver function is the measurement of Serum Glutamic Pyruvic Transaminase (SGPT). An elevated serum SGPT is a frequent finding in NAFLD cases.^{6,7}

Given the role of oxidative stress in NAFLD pathogenesis, antioxidant administration represents a potential preventive strategy to halt NAFLD progression.⁸ Antioxidants can neutralize free radicals and thereby mitigate oxidative stress. Natural sources of antioxidants are widely available in our environment; examples of antioxidant agents demonstrated to affect NAFLD include aloe vera leaf, moringa leaf, and roselle flower.^{9,10}

Anthocyanins are a subclass of flavonoids that function as natural pigments found in red, purple, and orange vegetables, flowers, and fruits.¹¹ Flavonoids act as antioxidants, preventing

oxidative stress by donating electrons to stabilize free radical species. Purple cabbage is a notable source of anthocyanins; its anthocyanin content has been reported as 1,111–1,780 mg per 100 g.¹²

Currently, many indigenous Indonesian natural materials exhibit antioxidant properties. The use of these natural products offers the advantage of affordability while potentially providing health benefits. Therefore, this study aims to evaluate the effect of purple cabbage extract on serum SGPT levels in male Wistar rats subjected to a high-fat diet and CCl₄ induction.

OBJECTIVE

This study aimed to evaluate the effect of purple cabbage extract on serum SGPT levels in male Wistar rats exposed to a high-fat diet and CCl₄.

MATERIALS AND METHODS

An experimental study employing a post-test only control group design was conducted. Twenty-four male Wistar rats (*Rattus norvegicus*), aged 12–14 weeks and weighing 180–200 g, were procured from a certified laboratory animal facility and acclimatized for one week before experimentation. The rats were kept in pairs within plastic cages (30 × 20 × 20 cm) lined with rice-husk bedding, under controlled environmental conditions at a temperature of 24–27°C and a 12-hour light–dark cycle. After an acclimatization period, the animals were randomly allocated into four groups (n = 6) using Microsoft Excel: one negative control group (P0) and three treatment groups administered ethanolic purple cabbage extract at doses of 100, 200, and 400 mg/kg body weight (P1–P3). The inclusion, exclusion, and withdrawal criteria were implemented in accordance with the established study protocol.

The ethanolic extract of purple cabbage (*Brassica oleracea* var. *capitata* L.) was produced by oven-drying the plant material at 50°C, grinding it into a fine powder, and macerating the powder in 95% ethanol at a 1:5 ratio for 24 hours at ambient temperature. The resulting filtrate was passed through Whatman filter paper and concentrated by solvent evaporation to generate the crude extract. Dose selection was based on existing literature indicating 200 mg/kg as a reference value, with lower and higher doses (100 and 400 mg/kg) included to evaluate dose dependency.

Hepatic injury induction and extract administration were conducted simultaneously over six weeks. A high-fat diet was formulated from duck egg yolk (1.5 g), pork fat (6 g), cooking oil (6 g), and standard feed (86.5 g) per 100 g of mixture, and provided at 18 g per rat daily. Carbon tetrachloride (CCl₄), diluted in olive oil at a 1:4 ratio, was administered intraperitoneally twice weekly (0.2 mL/kg). The P0 group received standard feed, 1 mL of 1% CMC-Na by oral gavage in the morning, and simultaneous high-fat diet and CCl₄ induction. Groups P1–P3 received the same induction protocol along with daily oral administration of purple cabbage extract in 1% CMC-Na at doses of 100, 200, or 400 mg/kg body weight for six weeks. All final measurements, including serum SGPT, were undertaken on day 43.

At the conclusion of the experiment, blood samples were obtained from the tail or saphenous vein after warming the sampling site. The samples were transferred into microcentrifuge tubes and centrifuged at 3,000 rpm for 10–15 minutes to separate the serum. SGPT concentration was quantified using a colorimetric enzymatic method with absorbance measured at 546 nm and values calculated based on a standard calibration curve. Statistical analysis was conducted using SPSS software, incorporating descriptive statistics, the Shapiro–Wilk test to assess data normality, and Levene’s test to evaluate variance homogeneity. Group comparisons were performed using One-Way ANOVA followed by Games–Howell post-hoc analysis when applicable, or appropriate non-parametric tests when statistical assumptions were not satisfied. The sample size was calculated using the resource equation method, yielding a total of 24 animals (6 per group).

All procedures adhered to institutional ethical standards and were approved by the Ethics Committee of the Faculty of Medicine, Udayana University (Ethics Approval No.: 1473/UN14.2.2.VII.14/LT/2025). The animal subjects were sourced from a certified provider accredited by the same committee.

RESULT

The study involved twenty-four male Wistar rats (*Rattus norvegicus*) that fulfilled the predefined inclusion criteria, namely an age of 12–14 weeks, body weight between 180 and 200 g, and a veterinarian-confirmed healthy condition. To induce a liver injury model resembling non-alcoholic fatty liver disease (NAFLD), the animals received a daily oral high-fat diet combined with intraperitoneal injections of CCl₄ administered twice weekly for six weeks.

After the induction period, the rats were divided into one negative control group and three treatment groups that were given increasing doses of purple cabbage extract at 100, 200, and 400 mg/kg body weight. The study procedures were carried out at several facilities within Udayana University: extract preparation was conducted in the Agricultural Technology Laboratory, animal care and interventions were performed in the Histology Laboratory of the Faculty of Medicine, and SGPT measurements were analyzed in the Biochemistry Laboratory of the same faculty. Data analysis was conducted using SPSS. The following sections describe the study results, encompassing descriptive analyses, evaluation of statistical assumptions, and hypothesis testing outcomes.

Descriptive Analysis of Serum SGPT Levels

Descriptive analysis was performed to summarize the distribution and characteristics of serum SGPT values across all treatment groups. The parameters evaluated included sample size (N), mean, standard deviation (SD), and the minimum and maximum measurements, as presented in Table 1.

Based on the data in Table 1, the negative control group (P0) which received only the high-fat diet and CCl₄ induction without administration of purple cabbage extract displayed the highest mean SGPT level (74.52 ± 11.451

U/L). In comparison, all treatment groups showed progressively lower SGPT values in accordance with increasing extract dosage. Group P1 (100 mg/kg BW) recorded a mean of 57.90 ± 2.974 U/L, group P2 (200 mg/kg BW) had a mean of 47.78 ± 3.873 U/L, and group P3

(400 mg/kg BW) exhibited the lowest mean value (38.56 ± 2.197 U/L). These descriptive findings suggest that the administration of purple cabbage extract is associated with a reduction in serum SGPT concentrations in a dose-dependent manner.

Table 1. Descriptive Statistics of Serum SGPT Levels in Male Wistar Rats Across All Treatment Groups

Group	N	Mean (U/L)	Standard Deviation	Minimum (U/L)	Maximum (U/L)
P0 (Control)	6	74.52	11.451	64	96
P1 (100 mg/kg BW)	6	57.90	2.974	54	62
P2 (200 mg/kg BW)	6	47.78	3.873	43	52
P3 (400 mg/kg BW)	6	38.56	2.197	35	41

Assumption Testing Results

Assumption testing was conducted prior to hypothesis testing to ensure the validity of applying parametric statistical analysis. The prerequisite tests performed in this study included the normality test and the homogeneity of variance test.

The normality test was carried out to determine whether the serum SGPT data in each treatment group were normally distributed. Considering that the number of samples per group was small ($n = 6$), the Shapiro–Wilk test was used. The criterion for interpretation was that if the significance value (p) exceeded 0.05, the data were considered to follow a normal distribution. The results, presented in Table 2, indicated that significance values for all treatment groups (P0, P1, P2, and P3) were greater than 0.05. Thus, it was concluded that the serum SGPT data in all four groups were normally distributed.

The homogeneity of variance test aimed to evaluate whether the variance among the treatment groups was homogeneous. Levene's Test of Homogeneity of Variance was applied, with the decision criterion that a significance value (p) greater than 0.05 indicates homogeneous variance across groups. The results of Levene's test, also presented in Table 2, revealed a significance value of 0.047, which was lower than 0.05.

The results of Levene's test showed a significance value of 0.047, which is lower than 0.05. This indicates that the variances of serum SGPT levels across the treatment groups were not homogeneous (heteroscedasticity). This violation of the homogeneity assumption serves as the basis for selecting a more robust post hoc test in the subsequent analysis stage.

Table 2. Results of the Shapiro–Wilk Normality Test and Levene's Homogeneity Test

Test	Group	Statistic	Sig. (p-value)	Interpretation
Normality (Shapiro–Wilk)	P0	0.854	0.169	Normal
	P1	0.957	0.800	Normal
	P2	0.858	0.183	Normal
	P3	0.907	0.414	Normal
Homogeneity (Levene's Test)	-	3.167	0.047	Not Homogeneous

Hypothesis Testing Results

Hypothesis testing was performed to evaluate whether the mean serum SGPT levels differed significantly across the four experimental groups. Given that the data met the assumption of normality, a One-Way Analysis of Variance (ANOVA) was applied.

As summarized in Table 3, the One-Way ANOVA yielded an F-value of 35.615 with a corresponding

significance level of $p < 0.001$. Since the p-value was below the threshold of 0.05, the null hypothesis (H_0) which proposed that no differences existed in mean SGPT values among the groups was rejected. This result confirms that at least one group exhibited a statistically significant difference in serum SGPT levels compared with the others.

Table 3. Results of the One-Way ANOVA for Serum SGPT Levels Across Treatment Groups

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Between Groups	4268.234	3	1422.745	35.615	< 0.001
Within Groups	798.949	20	39.947	-	-
Total	5067.183	23	-	-	-

Post Hoc Games–Howell Test

To identify specifically which groups exhibited significant differences in mean values, a post hoc analysis was conducted. Based on the homogeneity test results indicating non-homogeneous variances, the Games–Howell post hoc test was applied. The comparison results among groups are presented in Table 4.

Table 4. Results of the Games–Howell Post Hoc Test for Serum SGPT Level Comparison Across Groups

Group Comparison	Mean Difference (I–J)	Std. Error	Sig. (p-value)	Interpretation
P0 vs P1	16.626	4.830	0.055	Not Significant
P0 vs P2	26.744	4.935	0.006	Significant
P0 vs P3	35.957	4.760	0.002	Significant
P1 vs P2	10.117	1.993	0.003	Significant
P1 vs P3	19.331	1.509	< 0.001	Significant
P2 vs P3	9.213	1.818	0.004	Significant

The post hoc analysis showed that the difference in mean serum SGPT levels between the control group (P0) and the lowest-dose treatment group (P1) was not statistically significant ($p = 0.055$). In contrast, significant differences were identified between the control group and the medium-dose group (P2) ($p = 0.006$), as well as the high-dose group (P3) ($p = 0.002$). Significant pairwise differences were also evident across all treatment groups: between P1 and P2 ($p = 0.003$), P1 and P3 ($p < 0.001$), and P2 and P3 ($p = 0.004$).

DISCUSSION

Success of Hepatic Injury Induction by a High-Fat Diet and CCl_4

The initial step of this study was to confirm that the experimental animal model, male Wistar rats, successfully developed hepatic injury. The control group (P0), which received a high-fat diet and CCl_4 injections without purple cabbage extract, demonstrated the highest mean serum SGPT level (74.52 U/L) compared with the treatment groups. This elevated SGPT level is a biochemical indicator of hepatocellular damage.^{13,14}

The increase in SGPT is consistent with the pathogenesis of nonalcoholic fatty liver disease (NAFLD) described in the two-hit theory. Administration of a high-fat diet acts as the first hit, inducing steatosis and mitochondrial dysfunction, which consequently increases the production of reactive oxygen species (ROS). The subsequent administration of carbon tetrachloride (CCl_4) serves as the second hit. CCl_4 is a hepatotoxic compound metabolized by the hepatic cytochrome P450 system into highly reactive free radicals, specifically trichloromethyl and trichloromethyl peroxy radicals.¹⁵

These radicals trigger lipid peroxidation of hepatocyte membranes, causing membrane damage, loss of cellular integrity, and leakage of intracellular enzymes such as SGPT into the bloodstream.⁵ Thus, the elevated SGPT level in group P0 confirms that the six-week induction protocol successfully established a model of oxidative stress induced liver injury for evaluating the hepatoprotective effects of purple cabbage extract.¹⁶

Dose-Dependent Hepatoprotective Effect of Purple Cabbage Extract

The principal outcome of this research is that purple cabbage extract effectively mitigated the elevation of serum SGPT levels in rats subjected to high-fat diet feeding and CCl_4 induction.

This hepatoprotective effect demonstrated a clear dose-response relationship, with higher extract doses corresponding to greater reductions in SGPT concentrations. The mean SGPT values followed a decreasing trend across the treatment groups: P1 at 57.90 U/L, P2 at 47.78 U/L, and P3 at 38.56 U/L.

Post hoc analysis further clarified this dose response relationship. The comparison between P0 and P1 ($p = 0.055$) showed that the 100 mg/kg body weight dose did not provide a statistically significant protective effect. This suggests the presence of a therapeutic threshold, with 100 mg/kg being below the minimum effective concentration required to counteract substantial oxidative stress.^{17,15}

In contrast, doses of 200 mg/kg (P2) and 400 mg/kg (P3) significantly reduced serum SGPT levels compared to P0. Significant differences between P1 and P2, P2 and P3, and P1 and P3 support the presence of a graded response, indicating that higher concentrations of active compounds in the extract produce proportionally greater hepatoprotection. The 400 mg/kg dose (P3) proved to be the most effective, lowering SGPT close to the normal range (10–45 U/L). This finding is consistent with other studies reporting that the protective effects of natural antioxidants are often dose-dependent.^{9,18}

Antioxidant Mechanisms Underlying the Hepatoprotective Effect

The hepatoprotective effect observed in this study can be explained by the antioxidant mechanisms of bioactive compounds present in purple cabbage. Purple cabbage is rich in anthocyanins, a subclass of flavonoids. Anthocyanins and other flavonoids are potent antioxidants that protect cells from oxidative damage through several pathways.

A primary mechanism is the ability of these antioxidants to scavenge and interrupt the chain reactions of superoxide anions, thereby preventing hepatocellular injury. By neutralizing free radicals, anthocyanins interrupt lipid peroxidation chains, maintaining the integrity and fluidity of hepatocyte membranes.¹⁴ Their chemical structure enables them to donate hydrogen atoms or electrons to highly reactive radicals, such as trichloromethyl radicals produced during CCl_4 metabolism.⁸ This prevents

membrane disruption and subsequent leakage of SGPT into circulation.

Flavonoids have also been reported to augment the body's intrinsic antioxidant mechanisms by promoting the activity of enzymes including superoxide dismutase (SOD) and glutathione peroxidase.¹⁹ Consequently, the hepatoprotective effect of purple cabbage extract is likely mediated not only through its direct free radical scavenging capacity but also through its ability to reinforce endogenous hepatic antioxidant defenses.

CONCLUSION AND RECOMMENDATION

Based on the data analysis and corresponding interpretation, this study concludes that purple cabbage (*Brassica oleracea* var. *capitata* L.) extract exhibits a hepatoprotective effect that increases with dosage. The 400 mg/kg body weight treatment yielded the greatest reduction in serum SGPT levels, with the 200 mg/kg body weight dose producing a moderate yet significant decrease. In contrast, the 100 mg/kg body weight dose did not show a statistically meaningful difference from the control group, suggesting that a minimum effective dose is required to elicit measurable protective activity within this experimental model.

Future research is recommended to broaden the scope of biomarkers used to assess hepatoprotection, incorporating additional liver function markers such as SGOT, ALP, GGT, bilirubin, and oxidative stress indicators including MDA and endogenous antioxidant enzyme activity (SOD, glutathione peroxidase). Further studies should also include histopathological examination of liver tissue to provide direct microscopic evidence of reductions in steatosis, inflammation, and necrosis, thereby strengthening biochemical findings. Moreover, more detailed dose optimization studies with narrower dose intervals are advised to accurately determine both the minimum effective dose and the optimal therapeutic dose of purple cabbage extract for hepatoprotection.

ACKNOWLEDGEMENTS

The author extends sincere gratitude to all individuals whose support and contributions made this study possible. Special appreciation is also expressed to the supervisors and examiners for their sustained guidance, valuable feedback, and encouragement throughout the course of this research.

LIMITATION

This study recognizes several limitations that may influence the interpretation of its results and inform directions for future investigations. First, hepatic injury was assessed solely through SGPT levels. A more robust evaluation would incorporate additional biochemical indicators, including SGOT, alkaline phosphatase (ALP), and bilirubin, as well as specific markers of oxidative stress such as malondialdehyde (MDA) or antioxidant enzyme activities like superoxide dismutase (SOD).

Second, this study did not include histopathological evaluation of liver tissue. While SGPT measurements offer functional information, microscopic examination remains the definitive method for identifying and grading steatosis, inflammation, necrosis, and fibrosis. Third, the sample size of six rats per group, although meeting the resource equation criteria, is relatively small and may limit statistical power and generalizability.²⁰ Fourth, the discussion of antioxidant mechanisms is inferential and based on existing literature. This study did not isolate active compounds or directly measure the antioxidant activity of the extract, which limits the ability to confirm the mechanisms proposed.

REFERENCES

1. Siregar AS, Esher C, Sugeng C, Waleleng BJ. Hubungan Skor Controlled Attenuation Parameter , Nilai Transient Elastography , Dan Skor Fibrosis - 4 Dengan Nilai Estimasi Laju Filtrasi Glomerulus Pada Pasien Non Alcoholic Fatty Liver Disease. 2024;12(1):551–6.
2. Sarwanti M, Stephanie M, Kodariah R. Peran CD44 Pada P`Rogresivitas Non Alcoholic Steatohepatitis. Maj Patol Indones. 2020;29(2):71–81.
3. Rengkung NP, Waleleng BJ, Palar S. Gambaran Penyakit Perlemakan Hati Non-Alkoholik Pada Pasien Hipertensi Yang Mempunyai Sgpt Meningkat. E-Clinic. 2015;3(1):1–4.
4. Setiawan SI, Juferdy K. Pilihan Tatalaksana Penyakit Perlemakan Hati Non-Alkohol (Non-Alcoholic Fatty Liver Disease/ NAFLD). Cermin Dunia Kedokt. 2021;48(3):173–5.
5. Jurnalis YD, Sayoeti Y, Elfitrimelly E. Peran Antioksidan Pada Non Alcoholic Fatty Liver Disease (NAFLD). J Kesehat Andalas. 2014;3(1):15–20.
6. Reza F, Mahatvavirya RW. Hubungan Derajat Perlemakan Hati Non Alkoholik Menggunakan Pemeriksaan Indeks Hepatorenal Software Image J Pada Ultrasonografi Dengan Peningkatan Kadar Serum Glutamik Pyruvik Transminase Di Rsup Dr. Hasan Sadikin Bandung. Prim (Prima Med Journal). 2023;8(2):56–62.
7. Simanjuntak S, Simanjuntak SGU, Pasaribu S. Hubungan Sindrom Metabolik Dengan Non-Alcoholic Fatty Liver Disease (NAFLD). J Kedokt Methodist. 2021;15(1):66–74.
8. Karlina A. Review Literatur : Efektivitas Tumbuhan Yang Mengandung Senyawa Flavonoid Sebagai Antioksidan Yang Berpotensi Sebagai Hepatoprotektor. Biocaster J Kaji Biol. 2023;3(1):40–5.

9. Zofania TA, Yulianti R, Hardini N. Efek Antioksidan Ekstrak Bunga Rosella (*Hibiscus Sabdariffa* L.) Terhadap Proteksi Hepar Tikus Putih Galur Wistar Yang Diinduksi Etanol 20%. *J Pharmacopolium*. 2020;3(2):79–84.
10. Mamta Sagar, Sandeep Tripathi, Rajendra Dhar. A Comparative Study of Serum ALT Levels In Metabolic Syndrome Patients With and Without NAFLD. *Int J Sci Res Arch*. 2023;10(2):490–6.
11. Sugiritama IW, Adiputra IN. Potensi Antosianin Dalam Manajemen Menopause. *J Kesehat Andalas*. 2019;8(1):158.
12. Ganesha GHI, Linawati NM, Satriyasa BK. Pemberian Ekstrak Etanol Kubis Ungu (*Brassica Oleraceae* L.) Menurunkan Kadar Malondialdehid dan Jumlah Makrofag Jaringan Paru Tikus yang Terpapar Asap Rokok. *J Ilm Medicam*. 2020;6(1):1–9.
13. Kunsah B, Samsudin RR. Aktivitas Antioksidan Kulit Jeruk Pacitan (*Citrus sinensis* L.) Terhadap Kadar SGOT dan SGPT *Rattus norvegicus* Dengan Paparan Logam Berat Timbal (Pb). *JPSCR J Pharm Sci Clin Res*. 2022;7(3):357.
14. Ifadah RA, Wiratara PRW, Afgani CA. Ulasan Ilmiah : Antosianin dan Manfaatnya untuk Kesehatan. *J Teknol Pengolah Pertan*. 2022;3(2):11–21.
15. Suriani, Firawati, Pertiwi S. Uji Aktivitas Hepatoprotektor (*Brassica oleracea* var. *Capitata* L.) terhadap Uji Hewan Kelinci (*Oryctolagus cuniculus*) yang diinduksi Karbon Tetraklorida (CCl4). *J Chem Inf Model*. 2013;53(9):1689–99.
16. Fadillah N, Sultan J, No A, Sari G, Rappocini K, Makassar K, et al. Uji Efektivitas Infusa Daun Kubis (*Brassica oleracea*) terhadap Respons Nyeri Mencit Jantan Putih : Inovasi Herbal Menuju Terapi Alternatif Aman Universitas Muhammadiyah Makassar , Indonesia hewan coba . Celah ini menunjukkan adanya kebutuhan mendesak un. 2025;3.
17. Fernando A, Rahmadhani AW, Susanti E. Pengaruh Proses Pengeringan Terhadap Kadar Total Fenolik Dan Flavonoid Ekstrak Metanol Kubis Ungu(*Brassicaoleraceae*L). *J Penelit Dan Pengkaj Ilm Eksakta*. 2023;2(1):102–9.
18. Bagus I, Ode C, Natha M, Ganesha IGH, Linawati NM, Kamasan IG, et al. Non-alcoholic fatty liver disease. 2024;22(1):26–32.
19. Dewi Agustini NP, Anita Dewi NLKA, Megawati F, Wulandari R. Obat Herbal Berbasis Bukti Untuk Hepaprotektor. *Usadha*. 2022;2(1):73–91.
20. A WN, Z WM. Sample Size Calculation in Animal Studies Using Resource Equation Approach. 2017;24(5):101–5.

