JPPIPA 11(1) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effectiveness of Bougainvillea (Bougainvillea spectabilis willd) Extract on Reducing Blood Glucose in Hypercholesterolaemia White Rats

Muhammad Fakhrul Hardani[1], Baharuddin Hamzah[2], Ririen Hardani[1], Magfirah[2*], Sitti Rahmawati[2], Purnama Ningsih[2]

[1] Pharmacy Study Program, Faculty of Mathematics and Science, Tadulako University, Palu, Indonesia.
[2] Chemistry Education Study Program, Faculty of Teacher Training and Education, Tadulako University, Palu, Indonesia.

Received: August 15, 2024
Revised: November 18, 2024
Accepted: January 25, 2025
Published: January 31, 2025

Corresponding Author:
Magfirah
Magfirah89@gmail.com

DOI: 10.29303/jppipa.v11i1.9762

Abstract: Bougainvillea leaves are often used by the public as a treatment by drinking boiled water, but their use as a blood sugar-lowering agent is not supported by scientific data. The purpose of this study was to determine the effect of reducing blood glucose levels and to determine the dose of extract that is effective in in white rats. The plant's herbal extract was prepared using the reflux method with 90% ethanol solvent. This study uses a laboratory experimental method to compare blood glucose levels in white rats before and after administration of herb extract at doses of 100, 200, and 300 mg/kg BW orally using high-fat feed induction and streptozotocin. Blood glucose levels were measured using a glucometer, and mice were declared positive for diabetes with fasting blood sugar levels above 126 mg/dL. The number of test animals used in this study was 30 mice, divided into 6 groups. A randomized block design was used as the research design. The study's findings revealed that administering Bougainville spectabilis willd herb extract at doses of 100, 200, and 300 mg/kg BW can reduce blood glucose in test animals with an effective dose of 200 mg/kg BW

Keywords: Bougainvillea Extract; Blood Glucose; Hypercholesterolemia model; White rats

Introduction

The consequences of untreated diabetes mellitus (DM) can include macrovascular disorders and microvascular damage (retinopathy, nephropathy, and neuropathy), caused by metabolic disorders, oxidative stress, and inflammation (American Diabetes Association (ADA), 2022; Paul et al., 2020).

The use of natural ingredients as an alternative therapy for DM is increasingly popular because of the minimal negative effects they cause. Research results show that the bioactive substances found in Bougainvillea spectabilis include steroid, flavonoid, tannin, saponin and phenolic compounds, which are the cause of the plant's therapeutic properties (Kaushik et al., 2023; Singh & Singh, 2024). Recent research on the bougainvillea plant also shows antimicrobial, anti-inflammatory and antifungal properties (Abarca-Vargas & Petricevich, 2018; Saxena et al., 2023).

The antioxidant activity of bougainvillea from its flavonoid and phenolic compound content can help reduce oxidative damage in diabetic situations (Abo-Elghiet et al., 2023a; Chauhan et al., 2016a). Bougainvillea can also be a treatment option to control diabetes because flavonoids have been shown to increase insulin sensitivity, increase glucose absorption, and protect pancreatic β-cells from oxidative damage (Russo et al., 2019). In addition, tannins and saponins

How to Cite:
Hardani, M. F., Hamzah, B., Hardani, R., Magfirah, Rahmawati, S., & Ningsih, P. (2025). The Effectiveness of Bougainvillea (Bougainvillea spectabilis willd) Extract on Reducing Blood Glucose in Hypercholesterolaemia White Rats. ***Jurnal Penelitian Pendidikan IPA*, *11*****(1), 842–847.**
https://doi.org/10.29303/jppipa.v11i1.9762

found in Bougainvillea spectabilis can control blood sugar levels by preventing the intestines from absorbing carbohydrates after eating (Alam et al., 2022b) .

In this study, we investigated the effect of Bougainvillea spectabilis extract in lowering blood glucose levels in a hypercholesterolemic rat (Rattus norvegicus). White rats were selected as being regarded as a dependable animal model for investigating metabolic impacts owing to their physiological parallels to humans. Rats possess metabolic systems analogous to humans, rendering them appropriate for investigating the impacts of antidiabetic and lipid-lowering medications, including bougainvillea extract, on blood glucose and cholesterol levels (Chauhan et al., 2016b; Joshi et al., 2011). Moreover, mice and other rodents are frequently regarded as more acceptable than larger animals owing to their diminutive size and brief lifetime (Alam et al., 2022a). This study will enrich the research data showing that plant-based therapies can be used therapeutically to treat DM.

Method

This study employed a laboratory experimental method to compare the blood glucose levels of white mice before and after administering bougainvillea (Bougainvillea spectabilis willd) at doses of 100 mg/kg BW, 200 mg/kg BW, and 300 mg/kg BW orally. Bougainvillea herb is extracted using the reflux method then tested to identified chemical compound. The test animals must be uniformly weighted, specifically weighing between 150 and 200 grammes and aged between 2-3 months, to minimize biological variation and ensure a relatively uniform response. All test animals were then checked for blood glucose levels before being induced with high cholesterol feed and streptozotocin. The provision of high-fat feed for 4 weeks was continued with streptozotocin induction of 30 mg/kg BW to create hypercholesterolemic-diabetic animal conditions. Blood glucose levels were measured using a glucometer, declaring mice positive for diabetes with fasting blood sugar levels above 126 mg/dL.

Testing of bougainvillea herb extract on reducing blood glucose levels used 30 test animals divided into 6 groups, namely the normal control group, the 0.5% NaCMC negative control group, the metformin positive control group, and 3 treatment groups with dose variations, namely 100, 200, and 300 mg/kg BW. The RAK (randomized block design) research design was used. The obtained observation data analyzed using the Anova statistical test at a 95% confidence level. It is to ascertain whether the variations in the treatment concentration are significant or insignificant, and then we apply the Duncan test to identify the treatment concentration that yields a meaningful effect.

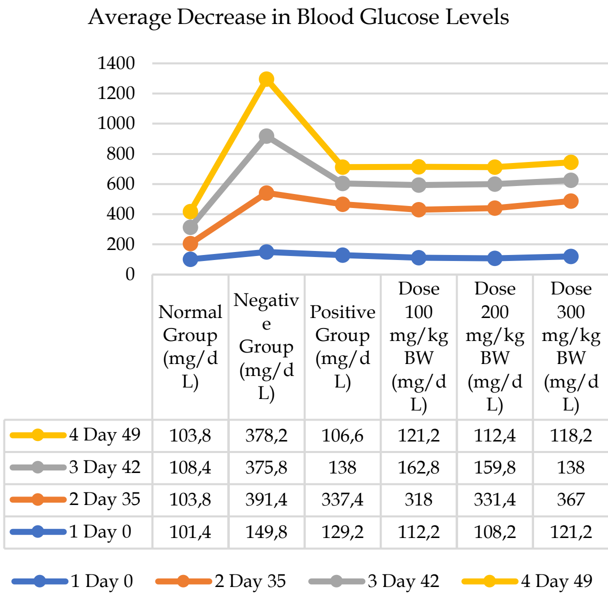
Result and Discussion

The results of chemical compound identification tests in bougainvillea extract for the presence of alkaloids, flavonoids, saponins, tannins, polyphenols and steroids, data can be seen on Table 1.

Table 1. Identification Tests of Chemical Compounds in Bougainvillea Extract

Test of	Result	Description
Alkaloid	Positive (+)	A yellow precipitate is formed which indicates the presence of alkaloids.
Flavonoid	Positive (+)	Yellow to brownish in color and a precipitate form which indicates the presence of flavonoids.
Saponin	Positive (+)	Foam formed up to 3 cm and lasted for 1 minute, indicating the presence of saponin.
Tanin	Positive (+)	Black in color indicates the presence of tannins
Polyphenol	Positive (+)	Green Blue Color
Steroid	Negative (-)	-

Based on the results of measuring the blood glucose concentration of mice after being induced with streptozotocin and high-fat feed, compared to the blood glucose concentration of mice after being given bougainvillea spectabilis extract for 14 days, the average blood glucose level data were obtained and shown on Figure 1.



	Normal Group (mg/dL)	Negative Group (mg/dL)	Positive Group (mg/dL)	Dose 100 mg/kg BW (mg/dL)	Dose 200 mg/kg BW (mg/dL)	Dose 300 mg/kg BW (mg/dL)
4 Day 49	103,8	378,2	106,6	121,2	112,4	118,2
3 Day 42	108,4	375,8	138	162,8	159,8	138
2 Day 35	103,8	391,4	337,4	318	331,4	367
1 Day 0	101,4	149,8	129,2	112,2	108,2	121,2

Figure 1. Average Decrease in Blood Glucose Levels

Testing of bougainvillea extract on reducing blood glucose levels using 30 test animals divided into 6 groups, namely the normal control group, the 0.5% NaCMC negative control group, the metformin positive control group, and 3 treatment groups with dose variations of 100, 200, and 300 mg/kg BW. All test animals were then checked for blood glucose levels before being induced with high cholesterol feed and streptozotocin. Then 5 groups of mice were given a high-fat diet consisting of feed composition (80%), lard (15%), and duck egg yolk (5%) for 4 weeks.

On day 0, the average blood glucose levels for the normal group; negative group; positive group; bougainvillea extract group with doses of 100, 200, and 300 mg/kg BW were 101.4; 149.8; 129.2; 112.2; 108.2; 121.2 mg/dL, respectively. The results of the one-way ANOVA statistical test for all groups showed no significant difference in blood glucose levels of male white mice, with a probability value of 0.247 ($p > 0.05$). This indicates that the blood glucose levels of all test animals at the beginning of the study were homogeneous, likewise in other experiments using fermented oat instead of bougainvillea extract (Algonaiman et al., 2022).

On the 35th day, the average blood glucose levels for the normal group; negative group; positive group; extract group with doses of 100, 200, and 300 mg/kg BW were respectively 103.8; 391.4; 337.4; 318; 331.4; and 367 mg/dL, which showed that the blood glucose levels of the positive group, negative group, and extract group were higher than the healthy group. This indicates that blood glucose levels in test animals increased, except for the normal group. The results of the one-way ANOVA statistical test of all groups on the 35th day showed a significant difference in blood glucose levels after treatment on the 38th day. The results of the post-hoc test LSD analysis of blood glucose levels showed that the negative group, positive group, and extract group were significantly different from the normal group. This proves that there was a significant increase in blood glucose levels in the negative group, positive group, and extract group after being given high cholesterol feed and streptomycin induction as stated in other research (Jiang et al., 2022) that when blood sugar levels rise due to insulin deficiency, hyperglycemia can affect the expression of genes involved in protein breakdown and synthesis.

On the 42nd day, the average blood glucose levels for the normal group, negative group, positive group, and extract group with doses of 100, 200, and 300 mg/kg BW were 108.4; 375.8; 138; 162.8; 159.8; and 138 mg/dL, respectively, indicating that the blood glucose levels of the positive group and the extract group decreased. The results of the one-way Anova statistical test of all groups on the 42nd day obtained a probability value of 0.000 ($p<0.005$). This shows that there is a significant difference in blood glucose levels after treatment on the 42nd day among all groups. We continued the data analysis using the post-hoc test to elucidate the real differences between groups. The results of the post-hoc test LSD analysis of blood glucose levels showed that the positive group and the extract group were significantly different from the negative group, but not significantly different from the normal group. These findings support other research that that bougainvillea herb extract affect reducing blood glucose levels (Abo-Elghiet et al., 2023b; Sarswati Prakash et al., 2022), in this case, with doses of 100 mg/kg BW, 200 mg/kg BW, and 300 mg/kg BW.

On the 49th day, the average blood glucose levels for the normal group, negative group, positive group, and extract group doses of 100, 200, and 300 mg/kg BW were respectively 103.8; 378.2; 106.6; 121.2; 112.4; and 118.2 mg/dL, indicating that the blood glucose levels of the positive group and the extract group decreased to normal levels. The results of the one-way Anova statistical test of all groups on the 49th day, obtained a probability value of 0.000 ($p <0.005$). This demonstrates a significant difference in blood glucose levels after treatment on the 49th day among all groups.

The decrease in blood glucose levels is caused by bioactive compounds in bougainvillea herb extract, such as flavonoids, saponins, tannins, and polyphenols (Kumar et al., 2022). The compounds that play a role in decreasing blood glucose levels are flavonoids (Hussain et al., 2020) which are good reducing compounds because they can capture free radicals such as ROS (reactive oxygen species) or RNS (reactive nitrogen species) through electron transfer and inhibition of peroxidation reactions (Chiorcea-Paquim, 2023; Mandal et al., 2022; Sarkar et al., 2022). Flavonoids are known to be able to work directly on pancreatic beta cells, by triggering the activation of the cAMP signal cascade and strengthening insulin secretion sensitized by glucose (AL-Ishaq et al., 2019; Dias Soares et al., 2017). Polyphenols bind to free radicals by donating hydrogen atoms of polyphenol aromatic hydroxyl (-OH) and remove them from the body through the excretion system, preventing the conversion chain from superoxide to hydrogen superoxide and reducing oxidative stress (Jain & Singhai, 2011). Saponins have the effect of lowering blood glucose levels by inhibiting glucose transport in the gastrointestinal tract and stimulating insulin secretion in pancreatic B cells (Afzal et al., 2023). Tannins function as astringents and chelation agents, shrink the epithelial membrane of the small intestine thereby reducing the absorption of food juice, thereby inhibiting the absorption of sugar and preventing blood sugar levels from rising too high. (Sutjiatmo et al., 2013).

Conclusion

The extract of bougainvillea (Bougainvillea spectabilis Willd) contains secondary metabolites, which affect reducing blood glucose levels in male white rats (Rattus norvegicus) fed high cholesterol and streptozotocin induction with an effective dose to reduce blood glucose levels in test animals of 200 mg/kg BW

Acknowledgments
We express our deepest gratitude to DIPA Tadulako University year 2024 for funding this research

Author Contributions
Muhammad Fakhrul Hardani, Baharuddin Hamzah, Riren Hardani: Concept and design, analysis and interpretation, writing and drafting of the manuscript, securing funding, obtaining funding, technical or material support, critical supervision, final approval, data collection, data analysis, interpretation, and overall responsibility. Magfirah: drafting of the manuscript. Sitti Rahmawati, Purnama ningsih and Magfirah: Critical revision of the manuscript, technical or material support, supervision, and final approval

Funding
This research was funded by The DIPA Tadulako University Year 2024

Conflicts of Interest
The authors declare no conflict of interest

References

Abarca-Vargas, R., & Petricevich, V. L. (2018). Bougainvillea: A Review on Phytochemistry, Pharmacology, and Toxicology. *Evidence-Based Complementary and Alternative Medicine*, *2018*(1). https://doi.org/10.1155/2018/9070927

Abo-Elghiet, F., Ahmed, A. H., Aly, H. F., Younis, E. A., Rabeh, M. A., Alshehri, S. A., Alshahrani, K. S. A., & Mohamed, S. A. (2023a). D-Pinitol Content and Antioxidant and Antidiabetic Activities of Five Bougainvillea spectabilis Willd. Cultivars. *Pharmaceuticals*, *16*(7), 1008. https://doi.org/10.3390/ph16071008

Abo-Elghiet, F., Ahmed, A. H., Aly, H. F., Younis, E. A., Rabeh, M. A., Alshehri, S. A., Alshahrani, K. S. A., & Mohamed, S. A. (2023b). D-Pinitol Content and Antioxidant and Antidiabetic Activities of Five Bougainvillea spectabilis Willd. Cultivars. *Pharmaceuticals 2023, Vol. 16, Page 1008*, *16*(7), 1008. https://doi.org/10.3390/PH16071008

Afzal, M. U., Pervaiz, M., Ejaz, A., Bajwa, E., Naz, S., Saeed, Z., Ullah, S., Gillani, S. S., Kan, R. R. M., & Younas, U. (2023). A comprehensive study of the sources, extraction methods and structures of the Saponin compounds for its antidiabetic activity. *Biocatalysis and Agricultural Biotechnology*, *54*, 102913. https://doi.org/10.1016/j.bcab.2023.102913

Alam, S., Sarker, M. M. R., Sultana, T. N., Chowdhury, M. N. R., Rashid, M. A., Chaity, N. I., Zhao, C., Xiao, J., Hafez, E. E., Khan, S. A., & Mohamed, I. N. (2022a). Antidiabetic Phytochemicals From Medicinal Plants: Prospective Candidates for New Drug Discovery and Development. *Frontiers in Endocrinology*, *13*, 800714. https://doi.org/10.3389/FENDO.2022.800714

Alam, S., Sarker, Md. M. R., Sultana, T. N., Chowdhury, Md. N. R., Rashid, M. A., Chaity, N. I., Zhao, C., Xiao, J., Hafez, E. E., Khan, S. A., & Mohamed, I. N. (2022b). Antidiabetic Phytochemicals From Medicinal Plants: Prospective Candidates for New Drug Discovery and Development. *Frontiers in Endocrinology*, *13*. https://doi.org/10.3389/fendo.2022.800714

Algonaiman, R., Alharbi, H. F., & Barakat, H. (2022). Antidiabetic and Hypolipidemic Efficiency of Lactobacillus plantarum Fermented Oat (Avena sativa) Extract in Streptozotocin-Induced Diabetes in Rats. *Fermentation 2022, Vol. 8, Page 267*, *8*(6), 267. https://doi.org/10.3390/FERMENTATION8060267

AL-Ishaq, R. K., Abotaleb, M., Kubatka, P., Kajo, K., & Büsselberg, D. (2019). Flavonoids and Their Anti-Diabetic Effects: Cellular Mechanisms and Effects to Improve Blood Sugar Levels. *Biomolecules*, *9*(9), 430. https://doi.org/10.3390/biom9090430

American Diabetes Association (ADA). (2022). Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes. *Diabetes Care*, *45*(Supplement_1), S17–S38. https://doi.org/10.2337/dc22-S002

Chauhan, P., Mahajan, S., Kulshrestha, A., Shrivastava, S., Sharma, B., Goswamy, H. M., & Prasad, G. B. K. S. (2016a). Bougainvillea spectabilis Exhibits Antihyperglycemic and Antioxidant Activities in Experimental Diabetes. *Journal of Evidence-Based Complementary & Alternative Medicine*, *21*(3), 177–185. https://doi.org/10.1177/2156587215595152

Chauhan, P., Mahajan, S., Kulshrestha, A., Shrivastava, S., Sharma, B., Goswamy, H. M., & Prasad, G. B. K. S. (2016b). Bougainvillea spectabilis Exhibits Antihyperglycemic and Antioxidant Activities in Experimental Diabetes. *Journal of Evidence-Based*

Complementary & Alternative Medicine, *21*(3), 177–185. https://doi.org/10.1177/2156587215595152

Chiorcea-Paquim, A. M. (2023). Electrochemistry of Flavonoids: A Comprehensive Review. *International Journal of Molecular Sciences 2023, Vol. 24, Page 15667*, *24*(21), 15667. https://doi.org/10.3390/IJMS242115667

Dias Soares, J., Pereira Leal, A. B., Silva, J., Almeida, JacksonR. G. S., & de Oliveira, H. (2017). Influence of flavonoids on mechanism of modulation of insulin secretion. *Pharmacognosy Magazine*, *13*(52), 639. https://doi.org/10.4103/pm.pm_87_17

Hussain, T., Tan, B., Murtaza, G., Liu, G., Rahu, N., Saleem Kalhoro, M., Hussain Kalhoro, D., Adebowale, T. O., Usman Mazhar, M., Rehman, Z. ur, Martínez, Y., Akber Khan, S., & Yin, Y. (2020). Flavonoids and type 2 diabetes: Evidence of efficacy in clinical and animal studies and delivery strategies to enhance their therapeutic efficacy. *Pharmacological Research*, *152*, 104629. https://doi.org/10.1016/J.PHRS.2020.104629

Jain, N. K., & Singhai, A. K. (2011). Protective effects of Phyllanthus acidus (L.) Skeels leaf extracts on acetaminophen and thioacetamide induced hepatic injuries in Wistar rats. *Asian Pacific Journal of Tropical Medicine*, *4*(6), 470–474. https://doi.org/10.1016/S1995-7645(11)60128-4

Jiang, Y., Feng, C., Shi, Y., Kou, X., & Le, G. (2022). Eugenol improves high-fat diet/streptomycin-induced type 2 diabetes mellitus (T2DM) mice muscle dysfunction by alleviating inflammation and increasing muscle glucose uptake. *Frontiers in Nutrition*, *9*, 1039753. https://doi.org/10.3389/FNUT.2022.1039753/BIBTEX

Joshi, B. N., Bhat, M., Kothiwale, S. K., Tirmale, A. R., & Bhargava, S. Y. (2011). Antidiabetic Properties of Azardiracta indica and Bougainvillea spectabilis: In Vivo Studies in Murine Diabetes Model. *Evidence-Based Complementary and Alternative Medicine : ECAM*, *2011*, 561625. https://doi.org/10.1093/ECAM/NEP033

Kaushik, D., Kumar, M., Proestos, C., Oz, F., Gupta, P., Kumar, A., Kundu, P., Kaur, J., kumar, V., Anjali, A., & Xiang, J. (2023). A narrative review on the anti-inflammatory efficacy of Bougainvillea spectabilis Willd. and its various applications. *Journal of Agriculture and Food Research*, *12*, 100570. https://doi.org/10.1016/j.jafr.2023.100570

Kumar, M., Kaushik, D., Kaur, J., Proestos, C., Oz, F., Kumar, A., Anjali, A., Elobeid, T., Terzioğlu, M. E., & Xiao, J. (2022). Assessment of Anti-Obesity Potential and Techno-Functional Properties of Bougainvillea spectabilis Willd. Bracts. *Separations 2022, Vol. 9, Page 399*, *9*(12), 399. https://doi.org/10.3390/SEPARATIONS9120399

Mandal, M., Sarkar, M., Khan, A., Biswas, M., Masi, A., Rakwal, R., Agrawal, G. K., Srivastava, A., & Sarkar, A. (2022). Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) in plants– maintenance of structural individuality and functional blend. *Advances in Redox Research*, *5*, 100039. https://doi.org/10.1016/J.ARRES.2022.100039

Paul, S., Ali, A., & Katare, R. (2020). Molecular complexities underlying the vascular complications of diabetes mellitus – A comprehensive review. *Journal of Diabetes and Its Complications*, *34*(8), 107613. https://doi.org/10.1016/j.jdiacomp.2020.107613

Russo, B., Picconi, F., Malandrucco, I., & Frontoni, S. (2019). Flavonoids and Insulin-Resistance: From Molecular Evidences to Clinical Trials. *International Journal of Molecular Sciences*, *20*(9), 2061. https://doi.org/10.3390/ijms20092061

Sarkar, C., Chaudhary, P., Jamaddar, S., Janmeda, P., Mondal, M., Mubarak, M. S., & Islam, M. T. (2022). Redox Activity of Flavonoids: Impact on Human Health, Therapeutics, and Chemical Safety. *Chemical Research in Toxicology*, *35*(2), 140–162. https://doi.org/10.1021/ACS.CHEMRESTOX.1C00348/ASSET/IMAGES/MEDIUM/TX1C00348_0009.GIF

Sarswati Prakash, B., Bhawana, K., Pooja, N., Vishwadeepak, K., & Divya, N. (2022). Pretreatment Of Albino Rats With Poly Herbal Extract Of Andrographis Paniculata, Bougainvillea Spectabilis And Cinnamomum Tamala For Protection Against Streptozotocin Induced Diabetes Mellitus Pretreatment Of Albino Rats With Poly Herbal Extract Of Andrographis Paniculata, Bougainvillea Spectabilis And Cinnamomum Tamala For Protection Against Streptozotocin Induced Diabetes Mellitus. *NeuroQuantology*, *20*(10), 4022–4033. https://doi.org/10.14704/nq.2022.20.10.NQ55393

Saxena, N., Chudasama, Y., Chawada, H., Kumar, C., Sanyal, D., Dasgupta, S., & Chaturvedi, A. K. (2023). Antibacterial And Antifungal Properties Of Bougainvillea Spectabilis Andtecoma Stans Plant Extracts Against Human Pathogens. *Journal of Survey in Fisheries Sciences*. https://doi.org/10.53555/sfs.v10i3.2602

Singh, H., & Singh, H. (2024). Comprehensive Review:- Bougainvillea Spectabilis 1*. *World Journal of Pharmaceutical Research*, *13*. https://doi.org/10.20959/wjpr202411-32660

Sutjiatmo, A. B., Sukandar, E. Y., Sinaga, R., Hernawati, R., & Vikasari, S. N. (2013). Efek Antikolesterol Ekstrak Etanol Daun Cerme (Phyllanthus acidus (L.) Skeels) Pada Tikus Wistar Betina. *Kartika Jurnal Ilmiah Farmasi*, *1*(1). https://doi.org/10.26874/kjif.v1i1.1