



Original Article

## Herbal combination therapy of coriander and red ginger extracts to improve hematological profiles in hyperlipidemia: in vivo study

Puspitasari <sup>1✉</sup>, Andika Aliviameita <sup>1</sup>, Anggun Puspita <sup>1</sup>, Syahrul Ibnu Mubaroq Ramadhan <sup>1</sup>

<sup>1</sup> Faculty of Health Science, Universitas Muhammadiyah Sidoarjo, East Java, Indonesia

### ARTICLE INFORMATION

Received: May 19, 2025

Revised: June 25, 2025

Accepted: June 25, 2025

### KEYWORDS

Hyperlipidemia; Erythrocyte Count; Hemoglobin Levels; Hematocrit Levels

### CORRESPONDENCE

Phone: +6281333060714

E-mail: puspitasari@umsida.ac.id

### ABSTRACT

**Background:** Herbal therapies offer promising alternatives for managing hyperlipidemia-induced hematological disorders. This study focuses on the combined effects of *Coriandrum sativum* L. (coriander) and *Zingiber officinale* var. *rubrum* (red ginger) extracts on hematological profiles in hyperlipidemic conditions. While prior studies mainly investigated these extracts individually, their combined therapeutic potential remains underexplored.

**Objective:** To evaluate the effects of coriander and red ginger extracts, individually and in combination, on erythrocyte count, hemoglobin level, and hematocrit in rats with induced hyperlipidemia.

**Methods:** An experimental pre-test–post-test control group design was conducted on male *Rattus norvegicus*. Hyperlipidemia was induced by a high-fat diet and 0.01% PTU for 15 days. Rats were divided into four groups: hyperlipidemia control, red ginger extract (875 mg/kgBW), coriander extract (900 mg/kgBW), and a 1:1 combination. Hematological parameters were measured on days 16 and 32. Data were analyzed using two-way ANOVA.

**Results:** Coriander and red ginger extracts significantly improved erythrocyte count, hemoglobin concentration, and hematocrit levels in hyperlipidemic rats ( $p = 0.000$ ).

**Conclusions:** Combined administration of coriander and red ginger extracts effectively enhances hematological profiles in hyperlipidemia, supporting their potential as an alternative herbal therapy.

## INTRODUCTION

Globalization has led to significant changes across various aspects of life, particularly in consumption patterns and lifestyle behaviors.<sup>1</sup> Hyperlipidemia, defined by elevated levels of blood lipids such as total cholesterol, low-density lipoprotein (LDL), and triglycerides, alongside reduced high-density lipoprotein (HDL) levels, is a significant risk factor for atherosclerosis and coronary heart disease.<sup>2</sup> As a non-communicable disease, hyperlipidemia ranks among the top ten causes of death worldwide.<sup>3</sup> This trend is also evident in Indonesia, where non-communicable diseases account for 73% of total mortality, with 26% of these deaths occurring in the adult population.<sup>4</sup>

Indonesia is home to more than 38,000 plant species, approximately 55% endemic.<sup>5</sup> Several plants, including *Coriandrum sativum* L. and *Zingiber officinale* Roxb. var. *rubrum*, possess potential for traditional medicinal use. Coriander seeds (*Coriandrum sativum* L.), a member of the

Umbelliferae family, have long been utilized as culinary spices and traditional remedies. These seeds are rich in bioactive compounds such as linalool, geraniol, camphor, geranyl acetate, flavonoids, saponins, and tannins, which exhibit antioxidant and hypolipidemic properties that contribute to the reduction of blood cholesterol and triglyceride levels.<sup>6</sup>

Red ginger (*Zingiber officinale* Roxb. var. *rubrum*), a rhizomatous herb from the Zingiberaceae family, also contains a wide array of bioactive constituents, including alkaloids, flavonoids, polyphenols, saponins, steroids, tannins, fiber, carbohydrates, vitamins, carotenoids, minerals, and potent antioxidants such as gingerol, shogaol, and essential oils. These components help mitigate oxidative stress, a key factor in dyslipidemia and endothelial damage of blood vessels.<sup>7</sup>

Previous studies have reported that administration of red ginger extract at a dose of 875 mg/kg body weight can regulate hematocrit levels and positively influence

<https://doi.org/10.30595/medisains.v23i3.26399>

©(2025) by the Medisains Journal. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. More information is available at [Attribution-NonCommercial 4.0 International](https://creativecommons.org/licenses/by-nc/4.0/).

erythrocyte count.<sup>8</sup> Other findings also indicate that red ginger inhibits LDL accumulation, lowers triglyceride levels, and prevents a decline in HDL levels.<sup>9</sup> Additionally, coriander seed extract at a concentration of 0.225% in feed has been shown to maintain erythrocyte count and increase hemoglobin and hematocrit levels.<sup>10</sup>

This study is unique in its investigation of the combined effects of *Coriandrum sativum L.* and *Zingiber officinale Roxb. var. rubrum* on hematological profiles and hyperlipidemia in experimental animals. While previous research has evaluated each extract individually, this study introduces a new approach by combining both, aiming to achieve synergistic effects in reducing blood lipid levels, enhancing hematological parameters, and protecting vascular integrity.

This study evaluates hematological parameters including erythrocyte count, hematocrit, and hemoglobin levels in hyperlipidemic conditions by administering *Coriandrum sativum L.* and *Zingiber officinale Roxb. var. rubrum*. The findings are expected to contribute to developing herbal-based therapeutic strategies for hematological disorders associated with hyperlipidemia and support the achievement of Sustainable Development Goal (SDG) 3: Good Health and Well-being.

## METHOD

### Study Design

This study employed an experimental design using a pretest-posttest control Group Only approach.<sup>11</sup>

### Study Site

The research was conducted from March to April 2025 at the Animal Experimentation Laboratory and the Clinical Pathology Laboratory of the D4 Medical Laboratory Technology Program, Faculty of Health Sciences, Universitas Muhammadiyah Sidoarjo, located at Jl. Mojopahit 666B, Sidoarjo, Indonesia.

### Material

The materials used included red ginger rhizomes, coriander seeds, distilled water, 70% ethanol, BR II standard feed pellets, propylthiouracil (PTU), egg yolk, cooking oil, and 24 male Wistar rats aged 2–3 months. Equipment comprised animal cages, food and water containers, blenders, hematocrit capillary tubes, a Hematology Analyzer (Medonic M Series), Point-of-Care Testing (POCT) devices, a rotary evaporator, and drying ovens.

### Plant Extraction Process

Red ginger rhizomes and coriander seeds were first thoroughly washed to remove impurities. The red ginger was thinly sliced to a 1–4 mm thickness and sun-dried until fully dehydrated. The dried ginger slices and coriander seeds were ground into a fine powder using a blender. Two hundred grams of each powder was macerated separately in 1,200 mL of 70% ethanol for six days, stirring for 15

minutes twice daily. After the first extraction, the filtrate was separated using filter paper, and the remaining residue was subjected to a second maceration using the same volume of ethanol for another six days. The combined filtrates were concentrated using a rotary evaporator at 40°C to remove the solvent. The resulting thick extract was stored in labeled beakers and refrigerated until use.<sup>8</sup>

## In Vivo Procedure

### Animal Preparation

Male Wistar rats (*Rattus norvegicus*), aged 2–3 months, weighing 100–200 grams, and in a healthy condition without physical defects, were used in this study. The animals were acclimatized for 7 days in standard laboratory conditions, housed in cages, and provided with BR II pellets and distilled water ad libitum.

### Experimental Procedure

After acclimatization, the rats were randomly assigned to four treatment groups. To induce hyperlipidemia, all rats were fed a high-fat diet and given 0.01% propylthiouracil (PTU) in drinking water for 15 days. On day 16, blood samples were collected from the orbital vein using hematocrit capillary tubes. Cholesterol levels were measured using a Point-of-Care Testing (POCT) device, while erythrocyte count, hemoglobin concentration, and hematocrit were analyzed using a Hematology Analyzer (Medonic M Series).

Following the initial blood collection, all rats were switched to standard feed and distilled water. The hyperlipidemic control group received no further intervention. Treatment Group 1 received red ginger extract (*Zingiber officinale Roxb. var. rubrum*) at 875 mg/kg body weight (BW), Group 2 received coriander seed extract (*Coriandrum sativum L.*) at 900 mg/kg BW, and Group 3 received a combination of both extracts in a 1:1 ratio. The treatment was administered daily until day 32. On the final day, after a 6-hour fasting period, blood was again collected from the orbital vein for post-treatment analysis of erythrocyte count, hemoglobin level, and hematocrit).

### Statistical Analysis

Data analysis was conducted by first testing for normality using the Shapiro–Wilk test and assessing homogeneity of variances with Levene's test. Once both assumptions were satisfied, a two-way ANOVA was performed, followed by Duncan's post hoc test to determine significant differences between groups.

### Ethical Consideration

The Health Research Ethics Committee of Nahdlatul Ulama University Surabaya reviewed and approved this study protocol, as evidenced by the ethical clearance certificate No. 0102/EC/KEPK/UNUSA/2025.

## RESULTS

The study showed that administration of red ginger and coriander extracts improved hematological parameters. The combination group (red ginger + coriander) achieved the highest hemoglobin concentration (within the normal range of 13.5–17.4 g/dL) and was the only group with hematocrit values reaching the normal range (37.6–51%). Mean values are shown in Table 1.

**Table 1.** Hematological Profiles Before and After Treatment

Variable	Before Treatment	After Treatment
<b>Mean Erythrocyte Count (<math>\times 10^6/\mu\text{L}</math>) <math>\pm</math> SD</b>		
Control Groups	5.63 $\pm$ 0.50	5.53 $\pm$ 0.61
Red Ginger Extract	6.48 $\pm$ 0.44	6.54 $\pm$ 0.39
Coriander Extract	7.37 $\pm$ 0.25	7.33 $\pm$ 0.42
Combination (Red Ginger + Coriander)	7.27 $\pm$ 0.47	7.40 $\pm$ 0.34
<b>Hemoglobin Levels (g/dL) <math>\pm</math> SD</b>		
Control Groups	12.2 $\pm$ 0.72	11.2 $\pm$ 0.93
Red Ginger Extract	12.6 $\pm$ 0.68	12.5 $\pm$ 0.56
Coriander Extract	13.2 $\pm$ 0.66	13.8 $\pm$ 0.74
Combination (Red Ginger + Coriander)	13.5 $\pm$ 1.13	14.4 $\pm$ 1.31
<b>Hematocrit Levels (%) <math>\pm</math> SD</b>		
Control Groups	31.1 $\pm$ 2,71	30.9 $\pm$ 2.40
Red Ginger Extract	33.6 $\pm$ 1,65	33.5 $\pm$ 1.89
Coriander Extract	36.8 $\pm$ 3,47	37.2 $\pm$ 1,93
Combination (Red Ginger + Coriander)	35.3 $\pm$ 2,89	38.9 $\pm$ 3.40

ANOVA showed a significant effect ( $p < 0.001$ ), indicating differences in the treatment groups' erythrocyte count, hemoglobin, and hematocrit. Duncan's post hoc test (Tables 2–4) showed clear differences between the treatment groups. For erythrocyte count (Table 2), the hyperlipidemia control group had the lowest value, while the red ginger group showed a slight increase. The coriander and red ginger + coriander combination groups had the highest values and did not differ significantly from each other, indicating that both were more effective than red ginger alone.

The control was again the lowest for hemoglobin levels (Table 3), and red ginger slightly increased. At the same time, coriander and the combination were higher, reaching values close to the physiologically normal range. A similar trend was observed for hematocrit (Table 4), where the combination produced the highest value within the normal range, coriander was intermediate, red ginger was slightly lower, and the control remained the lowest. Overall, the combination extracts had the most consistent effect in improving all three hematological parameters, followed by coriander, while red ginger alone provided only limited improvement.

**Table 2.** Duncan's Post Hoc Result in Erythrocyte Count

Groups	Subset		
	1	2	3
Control Groups	5.7350		
Red Ginger Extract		6.5133	
Coriander Extract			7.3508
Combination (Red Ginger + Coriander)			7.3417
Sig.	1.000	1.000	0.961

**Table 3.** Duncan's Post Hoc Result in Hemoglobin Levels

Groups	Subset		
	1	2	3
Control Groups	11.7083		
Red Ginger Extract		12.6250	
Coriander Extract			13.5833
Combination (Red Ginger + Coriander)			13.9833
Sig.	1.000	1.000	0.363

**Table 4.** Duncan's Post Hoc Result in Hematocrit Levels

Groups	Subset	
	1	2
Control Groups	31.1833	
Red Ginger Extract	35.5833	
Coriander Extract		37.0333
Combination (Red Ginger + Coriander)		37.1833
Sig.	0.055	0.902

## DISCUSSION

### Erythrocyte Count

The findings of this study showed that the number of erythrocytes increased in the red ginger extract group and the combination group, while the number decreased in the coriander extract group and in the hyperlipidemia control group. The most significant increase occurred in the combination group, indicating a synergistic effect of the two extracts. Flavonoids in red ginger function as powerful antioxidants that protect erythrocyte membranes and stimulate erythropoietin production, while coriander seeds help reduce the hemolytic activity of saponins. Together, these components increase antioxidant activity and promote effective erythropoiesis.<sup>12-15</sup>

The decrease in erythrocyte count in the hyperlipidemia control group is associated with elevated blood lipid levels that trigger oxidative stress,<sup>16</sup> an imbalance between reactive oxygen species production and antioxidant defenses, leading to cellular damage.<sup>17</sup> Erythrocytes are highly susceptible to oxidative injury due to the presence of polyunsaturated fatty acids in their membranes and the autooxidation of hemoglobin,<sup>18</sup> which compromises membrane elasticity and oxygen carrying capacity.<sup>19</sup> In male white rats, erythrocyte levels can also be affected by dietary quality, age, developmental stage, sex, and endogenous erythropoietin levels.<sup>10</sup> Similarly, the reduced erythrocyte count observed in treatment group 2 is likely caused by the saponin content of coriander seed extract. Excessive saponin intake may induce hemolysis by disrupting erythrocyte membranes and forming indigestible

protein saponin complexes, thereby decreasing protein bioavailability, impairing erythropoiesis, and negatively impacting systemic growth and health.<sup>10</sup>

The results of this study indicate that the active compounds in coriander seed extract and red ginger play an important role in increasing the number of erythrocytes in rats with hyperlipidemia. The combination of the two extracts gave better results than when used separately, especially in protecting erythrocytes from damage due to oxidative stress and facilitating the process of red blood cell formation. This finding is in line with previous studies showing that the combination of flavonoids and other herbal compounds can help improve blood parameters, such as the number of erythrocytes, hemoglobin levels, and hematocrit, especially under conditions of oxidative stress.<sup>20</sup>

### **Hemoglobin Levels**

The results indicated that hemoglobin levels increased in the coriander extract group and the combination group, but decreased in the red ginger extract group and in the hyperlipidemia control group. The highest increase occurred in the combination group, believed to result from the synergistic combination of bioactive compounds in red ginger and coriander. Flavonoids serve as antioxidants that protect red blood cells from oxidative damage, while iron is essential for hemoglobin synthesis. Moreover, flavonoids can bind  $Fe^{3+}$  ions and convert them to  $Fe^{2+}$ , reducing free radical formation and further protecting cells. This synergy supports hemoglobin formation and contributes to a significant increase in its levels. In comparison, the increase observed in treatment group 2 is attributed to the flavonoids in coriander seeds, which act as antioxidants by donating hydrogen atoms in redox reactions and binding free metal ions. These actions help reduce oxidative stress and improve cellular conditions, thereby supporting hemoglobin production.<sup>21</sup>

The decrease in hemoglobin levels in the hyperlipidemia control group was caused by the continuous rupture of red blood cells due to oxidative stress. Oxidative stress occurs when the number of free radicals in the body exceeds the ability of the antioxidant system to neutralize them. This condition can damage various tissues, organs, and cells, including red blood cells (erythrocytes). If erythrocytes are damaged and experience hemolysis, the hemoglobin in them will come out of the cells. As a result, hemoglobin levels in the blood decrease.<sup>22</sup> Hemoglobin, a vital protein within erythrocytes, not only facilitates the transport of oxygen and carbon dioxide but also plays a crucial role in maintaining blood pH through its buffering capacity.<sup>10</sup>

The decrease in hemoglobin levels in treatment group 1 is thought to be caused by the tannin compound content in red ginger. Tannins have the ability to bind important minerals such as iron, zinc, and calcium, which can inhibit the absorption of iron in the digestive tract. Iron itself is the main component in hemoglobin synthesis. Therefore, interference with iron absorption can reduce the availability

of iron needed for the formation of hemoglobin, thereby causing a decrease in hemoglobin levels in the blood.<sup>23</sup>

### **Hematocrit Levels**

The results also showed that hematocrit levels increased in the combination group, with values reaching the normal range. The coriander extract group also showed an increase, although not optimal. Conversely, hematocrit decreased in the red ginger extract group and in the hyperlipidemia control group. The most significant improvement was found in the combination group, indicating that synergy between the two extracts provided the strongest protective effect on erythrocytes. This combination utilizes the synergy between the antioxidant content in both plants, which work together to improve the oxidative balance in the body. By reducing oxidative stress more effectively, this combination can protect erythrocytes from damage and hemolysis. This protection of erythrocytes contributes to an increase in the number of red blood cells, which ultimately leads to an increase in hematocrit values.

The increase in hematocrit levels in treatment group 2 is thought to be caused by flavonoid compounds contained in coriander seeds. Flavonoids have strong antioxidant activity, which can increase hemoglobin and hematocrit levels through a free radical scavenging mechanism. This mechanism occurs through electron donation from flavonoids to free radicals, thereby preventing oxidative damage to cells, including erythrocytes. In addition, flavonoids help maintain the integrity of erythrocyte membranes, reduce membrane fragility, and prevent hemolysis due to oxidative stress. By protecting erythrocytes from damage, the number and quality of red blood cells can be maintained, thus having a positive impact on increasing hematocrit values.<sup>24</sup>

The decrease in hematocrit levels in the hyperlipidemia control group was caused by erythrocyte rupture (hemolysis) due to oxidative stress. Oxidative stress damages the membrane and hemoglobin of erythrocytes, causing a decrease in the number of red blood cells and hemoglobin levels. Since hematocrit is the percentage of erythrocyte volume to total blood volume, the decrease in the number of erythrocytes and hemoglobin levels directly causes a decrease in hematocrit values.<sup>25</sup>

The decrease in hematocrit levels in group 1 is thought to be caused by the saponin content in red ginger extract. Although there are flavonoid compounds and vitamin C that have an important role as antioxidants, the negative effects of saponins cannot be prevented. Saponins are known to cause hemolysis, which in turn reduces the number of erythrocytes and hemoglobin levels, and has a direct impact on decreasing hematocrit values. In addition, saponins can bind proteins and interfere with the absorption of nutrients from feed, which also contributes to decreasing hematocrit values.<sup>10</sup>

The results of this study suggest that oxidative stress associated with hyperlipidemia can lead to a reduction in

hematocrit levels through erythrocyte damage. Administration of red ginger extract alone has not been effective and actually maintains the condition because of the saponin content which is hemolytic. Coriander seed extract provides partial protection through flavonoid antioxidant activity, but it is not optimal. The combination of the two has proven to be the most effective in increasing hematocrit levels to normal values, thus potentially becoming a promising phytotherapy strategy to overcome hematological disorders due to oxidative stress.

The weakness of this study lies in the treatment of red ginger extract and coriander seeds which are still mostly done separately. Therefore, further research is needed to examine the simultaneous combination of both extracts and reveal their synergistic effect on all hematological parameters.

## CONCLUSIONS AND RECOMMENDATION

The combination of *Zingiber officinale var. rubrum* and *Coriandrum sativum L.* extracts significantly improves erythrocyte count, hemoglobin level, and hematocrit in hyperlipidemic rats. These findings support the potential of the combination of extracts as an additional therapy for hyperlipidemia and its contribution to achieving SDG 3. Further research is recommended to evaluate its effects on other hematological parameters more comprehensively to strengthen the scientific basis and its potential application in the health sector.

## ACKNOWLEDGEMENTS

The researcher would like to thank Majelis Pendidikan Tinggi Penelitian dan Pengembangan (Diktilitbang) Pimpinan Pusat Muhammadiyah. This research received funding from the RisetMu Batch VIII grant with contract letter 0258.453/I.3/D/2025.

## REFERENCES

- Pangondian A, Athaillah A, Chandra P, Renaldi R. Edukasi pemanfaatan pengawetan bahan alam dengan metode simplisia pada siswa SMP Pahlawan Medan. *Jukeshum J Pengabdian Masyarakat*. 2023;3(2):291-295. <http://dx.doi.org/10.51771/jukeshum.v3i2.651>
- Maharianingsih NM, Meliani NPM, Putri D. Pengaruh puasa Ramadhan terhadap kadar lipid pada masyarakat hiperlipidemia di Denpasar Utara. *Pharm J Islam Pharm*. 2024;8(1). <http://dx.doi.org/10.21111/pharmasipha.v8i1>
- Putri EC, Situngkir D. Edukasi mengenai hiperlipidemia dan hiperglikemia serta cara mengatasinya pada pekerja bongkar muat. *J Abdi Masy Indones*. 2022;2(3):815-820. <http://dx.doi.org/10.54082/jamsi.332>
- Lestari R, Warseno A, Trisetyaningsih Y, Rukmi DK, Suci A. Pemberdayaan kader kesehatan dalam mencegah penyakit tidak menular melalui Posbindu PTM. *J Pengabdian Kepada Masy*. 2020;4(1):48. <http://dx.doi.org/10.24269/adi.v4i1.2439>
- Suedy SWA, Rahadian R, Sunarno, et al. Baseline keanekaragaman flora pada area yang dikelola PT Pertamina (Persero) MOR IV Fuel Terminal Boyolali. *J Binawakya*. 2020;15(2):4073-4084. <http://dx.doi.org/10.33758/mbi.v15i2.802>
- Susanti DA, Hidayati S, Firdaus AW, Pangesti DY, Milyunier FMP. Pengaruh perbedaan metode ekstraksi terhadap aktivitas antibakteri ekstrak etanol biji ketumbar (*Coriandrum sativum*) pada *Staphylococcus aureus*. *J Farmamedika*. 2024;9(1):97-104. <http://dx.doi.org/10.47219/ath.v9i1.297>
- Fajriyani A, Hastuti S, Sarjito. Pengaruh serbuk jahe pada pakan terhadap profil darah, pertumbuhan, dan kelulushidupan ikan patin (*Pangasius sp.*). *J Aquacult Manag Technol*. 2017;6(4):39-48.
- Djara ANR. Pengaruh kombinasi ekstrak jahe merah (*Zingiber officinale Roxb. var. rubrum*) dan ketumbar (*Coriandrum sativum L.*) terhadap hemoglobin dan hematokrit tikus putih jantan (*Rattus norvegicus*) hiperlipidemia. Skripsi. Universitas Nusa Cendana; 2022. [http://skripsi.undana.ac.id/index.php?p=show\\_detail&id=7993](http://skripsi.undana.ac.id/index.php?p=show_detail&id=7993)
- Oktoviani O, Djatmiko EM, Taurina H, Versita R. Effect of dried red ginger (*Zingiber officinale var. rubrum*) on LDL, triglycerides, and HDL. *Anjani J Med Sci Health Stud*. 2022;1(2):68-74. <http://dx.doi.org/10.37638/anjani.v1i2.454>
- Irawan A, Setiyatwan H, Mayasari N. Gambaran jumlah eritrosit, kadar hemoglobin, dan nilai hematokrit puyuh Padjadjaran yang diberi ekstrak biji ketumbar (*Coriandrum sativum L.*) dalam ransum. *J Nutr Ternak Trop Ilmu Pakan*. 2023;5(1):23. <http://dx.doi.org/10.24198/jnttip.v5i1.47535>
- Hartono. Metodologi Penelitian. Pekanbaru, Indonesia: Zanafa Publishing; 2019.
- Nurrahman N, Mariyam M. Status hematologi, kadar IgG dan IgA tikus yang mengonsumsi berbagai variasi jumlah tempe kedelai hitam. *Agritech*. 2019;39(3):215. <http://dx.doi.org/10.22146/agritech.26118>
- Tana S, Yunita AR, Suprihatin T. Profil hematologi tikus putih (*Rattus norvegicus*) setelah pemberian turmeric gummy candy. *Buletin Anat Fisiol*. 2024;9(1):20-28. <http://dx.doi.org/10.14710/baf.9.1.2024.20-28>
- Aiba S, Manalu W, Suprayogi A, Maheshwari H. Gambaran nilai hematologi tikus putih betina dara pada pemberian tombong kelapa. *Acta Vet Indones*. 2016;4(2):74-81. <http://dx.doi.org/10.29244/avi.4.2.74-81>
- Atmaja YND, Siswanto S, Erwanto E, Hartono M. Profil hematologi (eritrosit, hemoglobin, dan PCV) ayam kampung betina yang diberi sambilan. *J Riset Inov Peternak*. 2023;7(2):237-243. <http://dx.doi.org/10.23960/jrip.2023.7.2.237-243>
- Joneri R, Manalu JL, Dewi R, Arieselia Z. Penurunan kadar malondialdehid pada tikus putih jantan hiperlipidemia oleh pemberian ekstrak etanol bajakah tampala. *Damianus J Med*. 2024;23(1):35-41. <http://dx.doi.org/10.25170/djm.v23i1.4562>
- Bettiol A, Galora S, Argento FR, et al. Erythrocyte

- oxidative stress and thrombosis. *Expert Rev Mol Med.* 2022;24:e25. <http://dx.doi.org/10.1017/erm.2022.25>
18. Gunawan SA, Suartha IN, Dharmawan NS. Total eritrosit, kadar hemoglobin, nilai hematokrit, dan indeks eritrosit anjing dermatitis atopik pascaterapi eco enzyme. *J Veteriner.* 2024;25(1):93-102. <http://dx.doi.org/10.19087/jveteriner.2024.25.1.93>
  19. Cakrawala J, Buliani IM, Mustakim A, et al. Analisis struktur jumlah sel darah untuk pembelajaran mahasiswa farmasi. *J Cakrawala Pendid Biol.* 2025;2(1):64-73. <http://dx.doi.org/10.61132/jucapenbi.v2i1.142>
  20. Zhang L, Gong AGW, Riaz K, et al. A novel combination of four flavonoids derived from Astragali Radix relieves symptoms of cyclophosphamide-induced anemia in rats. *FEBS Open Bio.* 2017;7(3):318-323. <http://dx.doi.org/10.1002/2211-5463.12146>
  21. Setyarini E, Kuswahyuliawan E, Hermayanti D, Sidharta B. Effect of okra extract (*Abelmoschus esculentus*) on erythrocyte count and hemoglobin levels in anemic rats induced by sodium nitrite. *Arteri J Ilmu Kesehatan.* 2023;4(3):133-137. <http://dx.doi.org/10.37148/arteri.v4i3.254>
  22. Arif NL, Humaira V, Abeiasa MS. Effect of graded cassava leaf extract (*Manihot esculenta*) on hemoglobin and hematocrit levels in mice exposed to D-allethrin. *J Medisains Kesehatan.* 2023;4:53-60. <https://doi.org/10.59963/jmk.v4i2.203>
  23. Maulidia A, Jatmiko SW. Effect of coffee on blood parameters in alloxan-induced diabetic Wistar rats. *J Kedokt Kesehat.* 2021;17(1):35-43. <http://dx.doi.org/10.24853/jkk.17.1.35-43>
  24. Mahdalena D, Armaita, Maifita Y. Antioxidant activity of dragon tail leaf flavonoids (*Rhaphidophora pinnata*) on hematocrit and hemoglobin levels in male albino mice exposed to cigarette smoke. *As-Shiha J Med Res.* 2020;1(1):12-20.
  25. Jumalang F, Rotty LWA, Panda AL. Hematocrit and hemoglobin profiles in acute myocardial infarction patients at Prof. Dr. R. D. Kandou Hospital. *e-CliniC.* 2015;3(1):282-288. <http://dx.doi.org/10.35790/ecl.3.1.2015.6831>