EFFECTIVENESS OF CINNAMOMUM BURMANNII BARK OIL IN PNEUMONIA : TIME, DOSAGE, AND EVALUATION

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ABSTRAK

Pneumonia adalah infeksi atau peradangan akut pada jaringan paru yang disebabkan oleh mikroorganisme, seperti bakteri, virus, parasit, jamur, dan paparan bahan kimia atau kerusakan fisik pada paru-paru. Namun, penyakit ini sering menyerang orang dengan sistem kekebalan tubuh yang lemah, terutama anak-anak dan orang lanjut usia. Minyak Kulit Kayu *Cinnamomum burmannii* (CbBO) telah menunjukkan potensi sebagai agen antibakteri dan antiinflamasi, dengan efektivitas yang dipengaruhi oleh faktor-faktor seperti lokasi pertumbuhan, usia kulit kayu, dan waktu pemberian. Penelitian ini bertujuan untuk membandingkan efek antiinflamasi CbBO yang diberikan pada hari pertama dan kedua pasca-inokulasi. Desain eksperimen menggunakan 45 tikus Wistar jantan (usia 3-4 bulan, berat badan 200-250g) yang dibagi menjadi dua kelompok utama, masing-masing dengan subkelompok yang menerima perlakuan berbeda: kontrol standar, kontrol negatif, levofloxacin, dan dosis CbBO yang bervariasi. Pneumonia diinduksi dengan inokulasi intranasal *Klebsiella pneumoniae*. Gejala klinis, ekspresi IL-6 pada jaringan paru dan serum, foto toraks, serta histopatologi dievaluasi. Perbedaan signifikan terlihat pada gejala klinis (p: 0,000), ekspresi IL-6 (p: 0,011 untuk hari pertama, p: 0,048 untuk hari kedua), foto toraks (p: 0,002 untuk hari pertama, p: 0,001 untuk hari kedua), dan histopatologi (p: 0,002 untuk hari pertama, p: 0,001 untuk hari kedua). Hasil ini menunjukkan bahwa CbBO lebih efektif dalam mengurangi peradangan ketika diberikan pada hari pertama pasca-inokulasi, yang menunjukkan potensi CbBO dalam meningkatkan penanganan pneumonia.

Kata kunci : minyak kulit kayu cinnamomum burmannii, gejala klinis, interleukin 6, radiografi toraks, waktu

ABSTRACT

Pneumonia is an acute infection or inflammation of the lung tissue caused by microorganisms, such as bacteria, viruses, parasites, or fungi, or exposure to chemicals or physical damage to the lungs. However, this disease often affects individuals with weakened immune systems, particularly children and the elderly. Cinnamomum burmannii Bark Oil (CbBO) has shown potential as an antibacterial and anti-inflammatory agent, with its effectiveness influenced by factors such as the growth location, age of the bark, and timing of administration. This study aimed to compare the anti-inflammatory effects of CbBO administered on the first and second days post-inoculation. The experimental design used 45 male Wistar Mice (3-4 months old, weighing 200-250g), divided into two main groups, each with subgroups receiving different treatments: standard control, negative control, levofloxacin, and varying doses of CbBO. Pneumonia was induced through intranasal inoculation of Klebsiella pneumoniae. Clinical symptoms, IL-6 expression in lung tissue and serum, chest X-rays, and histopathology were evaluated. Significant differences were observed in clinical symptoms (p: 0.000), IL-6 expression (p: 0.011 for day one, p: 0.048 for day two), chest X-rays (p: 0.002 for day one, p: 0.001 for day two), and histopathology (p: 0.002 for day one, p: 0.001 for day two). The results suggest that CbBO is more effective in reducing inflammation when administered on the first day post-inoculation, demonstrating its potential in improving pneumonia management.

Keywords *: cinnamon burman bark oil, time, symptom clinical, radiography thorax, interleukin 6*

INTRODUCTION

Several studies have been conducted in vitro and in vivo on the efficacy of *Cinnamomum burmannii* Bark Oil (CbBO) as an antibacterial and anti-inflammatory. *Cinnamomum burmannii* Bark Oil contains Cinnamaldehyde and Eugenol in reasonably high concentrations and is effective as an anti-inflammatory. The anti-inflammatory effect of CbBO can reduce Interleukin 6 (IL-6) and Interleukin 1β, which can automatically improve clinical symptoms and radiographically repair lesions in the thorax, as well as histopathologically reduce inflammation in the lungs of mice with Pneumonia (Arisma et al., 2022; Davoudi & Ramazani, 2024) following several factors That influence the effectiveness of *Cinnamon burmannii* Bark Oil: Factor Internal : quality material standard (skin wood sweet), content compound active (cynamaldehyde, eugenol, linalool), age plant, the type and variety of wood are sweet. Factor External: place growing (climate, soil, environmental conditions), weather conditions (rain, heat, cold), soil quality (fertility, pH), use of pesticides and fertilizers. Process Factors: drying method, processing method, storage, solvent quality. Chemical Factors: chemical composition, concentration cynamaldehyde, level Eugenol. Factor Biological: dose, time giving, interactions with other drugs (Do Nascimento et al., 2020; Fajar, Ammar, Hamzah, Manurung, & Abduh, 2019).

This study aimed to identify significant differences in the timing of CbBO administration based on clinical parameters, symptoms, IL-6 levels in both lungs and blood, thoracic radiography, and the degree of histopathological lung inflammation in pneumonia mice. The time of CbBO administration helps determine the extent of healing in pneumonia mice by observing the decrease in scores of the examined parameters. Pneumonia caused by bacterial infection remains a significant cause of morbidity and mortality worldwide, and the increasing prevalence of antibiotic resistance has encouraged the exploration of alternative or adjunctive therapies derived from natural products. Among these, *Cinnamomum burmannii* Bark Oil (CbBO) has attracted considerable attention because of its dual antibacterial and anti-inflammatory properties (Guo et al., 2024; Majdawati, Reviono, Hartono, Handayani, & Soetrisno, 2024b). In vitro and in vivo studies have demonstrated that CbBO is capable of inhibiting the growth of various pathogenic bacteria and modulating key inflammatory pathways involved in lung injury. These effects are primarily attributed to its main bioactive constituents, particularly cinnamaldehyde and eugenol, which are present in relatively high concentrations and are known to exert decisive antimicrobial and immunomodulatory actions (Guo et al., 2024; Majdawati et al., 2024).

The anti-inflammatory activity of CbBO is closely linked to its capacity to suppress the production of pro-inflammatory cytokines such as interleukin-6 (IL-6) and interleukin-1β (IL-1β). Both cytokines play a central role in the pathogenesis of Pneumonia by amplifying neutrophil recruitment, increasing vascular permeability, and promoting tissue damage in the lungs. The reduction of IL-6 and IL-1β levels is therefore expected to alleviate clinical symptoms, improve gas exchange, and facilitate the structural recovery of the lung parenchyma. Experimental models of bacterial Pneumonia have shown that modulation of these cytokines is associated with improvement in clinical scores, resolution of opacities on thoracic radiography, and lower histopathological inflammation scores in lung tissue (Guo et al., 2024; Majdawati et al., 2024b). These findings support the potential use of CbBO as an adjuvant therapy to enhance host recovery in Pneumonia.

However, the biological activity of *Cinnamomum burmannii* bark oil is not uniform and can be influenced by numerous factors. Internal factors include the quality of the raw material (bark standard), content of active compounds (cinnamaldehyde, eugenol, linalool), plant age, and species or variety of the cinnamon tree. External factors comprise the growing environment (climate, altitude, and surrounding ecology), weather conditions (rainfall, temperature, and

humidity), soil characteristics (fertility and pH), and the use of pesticides or fertilizers, all of which may alter the phytochemical profile of the bark. Additionally, process-related factors such as the drying method, extraction technique, storage conditions, and solvent quality can further influence the concentration and stability of the active compounds. At the chemical level, the overall composition of the oil, the exact concentration of cinnamaldehyde, and the relative proportion of eugenol are critical determinants of pharmacological potency. Biological factors—particularly the dose administered, timing of administration, and possible interactions with other drugs—also influence the therapeutic response and safety profile of CbBO (Guo et al., 2024; Zhao, Cao, Zhang, Nie, & Li, 2021)

Given this complexity, it is essential not only to establish that CbBO is effective, but also to determine how the timing of its administration affects therapeutic outcomes in Pneumonia. Early intervention may attenuate the cytokine surge and prevent extensive lung damage, whereas delayed administration might result in suboptimal control of inflammation. Therefore, this study was designed to evaluate the impact of different timing schedules of CbBO administration on multiple outcome parameters in a mice model of bacterial Pneumonia. Specifically, we aimed to assess differences in clinical symptom scores, IL-6 levels in lung tissue and blood, thoracic radiography findings, and histopathological degrees of lung inflammation according to whether CbBO was administered earlier or later in the course of infection. Clarifying the optimal timing of CbBO therapy is expected to provide essential insights into its role as an adjunctive treatment for Pneumonia and its potential translation into clinical practice.

METHOD

This study is an experimental (laboratory, biomedical) research with a post-test group design. This study aims to assess the effects of *Cinnamomum burmanni* Bark Oil (CbBO) as an anti-inflammatory agent in a pneumonia model using 25 male Wistar Mice, aged 6-8 weeks, weighing 200-250 grams. The Mice were intranasally inoculated with a solution of *Klebsiella pneumoniae* bacteria obtained from patient isolates at the Yogyakarta City Regional General Hospital (RSUD Kota Yogyakarta). The research was conducted at the Biosafety Level 3 (BSL-3) laboratory of the Institute of Life Sciences and Engineering, Airlangga University (LIHTR UNAIR), Surabaya. The *Cinnamomum burmanni* Bark Oil (CbBO) was prepared using the hydrodistillation method at the UGM Pharmaceutical Biology Laboratory. Cinnamon bark was obtained from the Merapi Farma Plantation, Jalan Kaliurang, Paakem, Hargobinangun, Yogyakarta.

The independent variable in this study is the dose of CbBO administered to the pneumonia model mice at different doses. The dependent variables observed include clinical symptoms, IL-6 expression in lung tissue and serum, chest radiographs, and lung histopathology. Clinical symptoms, including body temperature and general condition of the animals, were visually examined. Chest radiography was performed at the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Airlangga University (RSHP-FKH UNAIR). Molecular examination for IL-6 was conducted at the Tropical Diseases Institute (ITD) UNAIR. The data obtained are presented as mean ± standard deviation (Mean ± SD). Bacterial count and IL-6 data were analyzed using the Kruskal-Wallis test and post hoc tests. Non-parametric CXR data were analyzed using the chi-square test. All statistical analyses were performed using SPSS IBM 22 software on an ASUS ZenBook 14 laptop. Differences between groups were considered statistically significant if $p < 0.05$. Data graphs were generated using Excel 2016.

Ethical approval for the study was obtained from the Muhammadiyah University Yogyakarta ethics committee (Ethical Clearance Ref. No.: KE/FK/0342/EC/2023). The study adhered to ethical guidelines and ensured the well-being of the animals. The results of this study

will provide valuable insights into the potential of CbBO as an anti-inflammatory agent for treating Pneumonia and other inflammatory conditions.

RESULTS

Table 1. Results Clinical Symptom, Inspection Interleukins 6, and Radiography Wistar Mice Thorax Pneumonia Day 1 and 2

The Samples		CbBO Dose	Clinical Symptom		IL-6 Lung		CXR Score		Lung Histopathology	
Day 1	Day 2		Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
001	001	0	0	0	1.300	1.300	0	0	0	0
002	002	0	0	0	1.500	1.500	0	0	1	1
003	003	0	0	0	7.404	7.404	0	0	1	1
004	004	0	0	0	5.315	5.315	0	0	1	1
005	005	0	0	0	4.500	4.500	0	0	0	0
N1A	N2A	0	3	4	5.149	5.365	3	3	2	3
N1B	N2B	0	3	4	5.514	6.405	3	3	2	4
N1C	N2C	0	3	4	7.300	6.500	3	3	2	3
N1D	N2D	0	3	4	7.000	7.000	1	3	3	3
N1E	N2E	0	3	4	6.000	7.200	3	3	2	3
P1.a	P6.a	P3.a	3	4	5.149	4.353	3	2	3	3
P1.b	P6.b	P3.d	3	4	6.286	8.365	3	3	3	3
P1.c	P6.c	P3.e	3	4	6.200	6.538	0	1	2	3
P1.d	P6.d	P4.a	3	4	6.150	6.419	3	2	4	2
P1.e	P6.e	P4.b	3	4	6.000	6.500	3	3	4	1
P2.a	P7.a	Levo	2	2	3.902	6.969	0	2	2	1
P2.b	P7.b	Levo	2	2	5.471	6.888	0	0	2	1
P2.c	P7.c	Levo	2	2	3.012	4.941	1	0	1	1
P2.d	P7.d	Levo	2	2	4.732	6.005	0	0	1	1
P2.e	P7.e	Levo	2	2	4.100	4.800	1	0	1	3
P3.a	P8.a	0,36	1	3	5.248	3.868	3	2	2	1
P3.b	P8.b	0,36	1	3	6.718	7.170	1	0	2	2
P3.c	P8.c	0,36	1	3	4.387	6.152	3	0	2	2
P3.d	P8.d	0,36	1	3	5.451	6.801	1	0	2	2
P3.e	P8.e	0,36	1	3	5.500	6.500	1	0	2	2
P4.a	P9.a	0,72	1	2	5.117	4.271	1	0	3	1
P4.b	P9.b	0,72	1	2	5.754	4.998	1	0	2	2
P4.c	P9.c	0,72	1	2	5.964	6.176	1	1	4	2
P4.d	P9.d	0,72	1	2	5.351	4.548	1	1	3	2
P4.e	P9.e	0,72	1	2	3.500	6.050	0	2	2	2
P5.a	P10.a	1,14	2	2	7.745	7.094	3	2	2	2
P5.b	P10.b	1,14	2	2	7.186	5.583	1	0	3	1
P5.c	P10.c	1,14	2	2	7.980	9.542	1	1	2	2
P5.d	P10.d	1,14	2	2	6.134	5.975	0	0	2	1
P5.e	P10.e	1,14	2	2	6.000	5.000	0	0	2	1

Clinical Symptom

Figure 1 shows the clinical symptoms of Pneumonia in mice in the treatment group given CbBO on the first and second days. The graph indicates that the condition is improving. Treatment was administered on the first day post-inoculation of *Klebsiella pneumonia* compared to those given on day 2, especially in groups P3 and P4 when administered CbBO at 0.36 and 0.72 µL/200 grams BB TW.

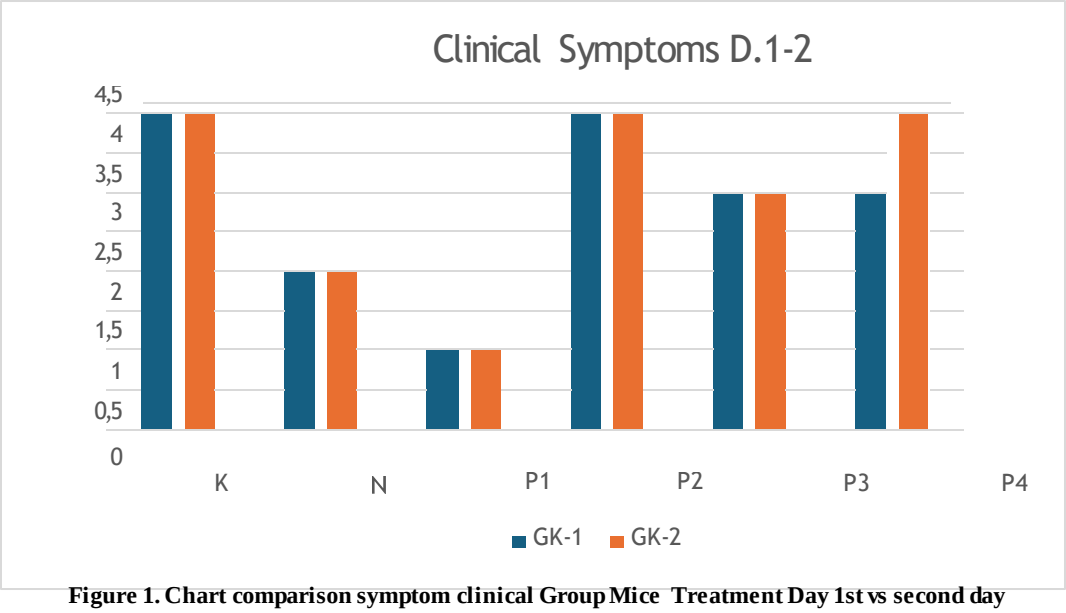


Figure 1. Chart comparison symptom clinical Group Mice Treatment Day 1st vs second day

Group P2 was given Levofloxacin 13.5 mg/200 grams of TW body weight and showed good improvement in clinical symptoms, similar to the control group, namely Wistar Mice. Which Healthy. Group P3, which received a CbBO dose of 0.36 µL/200 grams BB TW on the first and second days, exhibited the same clinical improvement as the positive control and was superior to the negative control. Group P4 showed improvement in the administration of CbBO at 0.72 µL/200 grams of TW body weight on the first day, which was comparable to group P3. Clinical symptoms on the second day were also better, similar to the administration of standard drugs in group P2. Group P4 showed worsening clinical symptoms after receiving a CbBO dose of 0.72 µL/200 grams of TW body weight, with further worsening of clinical symptoms.

Interleukin 6

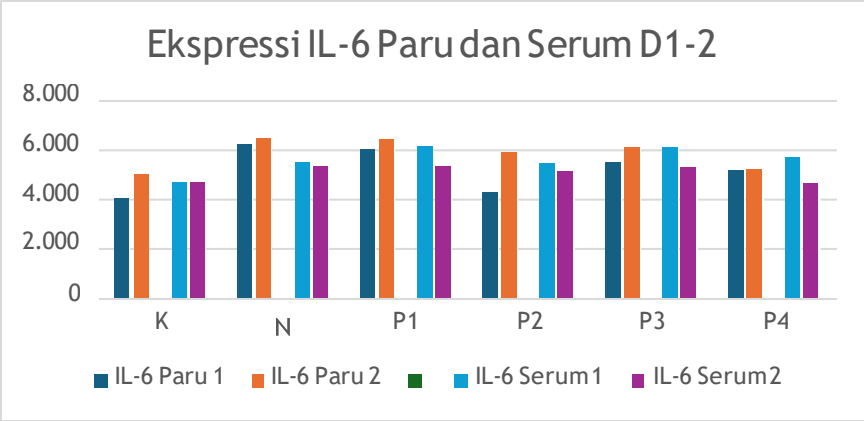


Figure 2. Chart Comparison Expression IL-6 in group mice treatment from Network sample lungs compared to serum in administration treatment, starting on day 1, compared to day 2

In the treatment group receiving standard medication (P2), IL-6 levels in lung tissue were lower compared to day 2. In contrast, the expression of IL-6 in serum showed a higher level on day 2, after receiving the standard medication. Group P3 and P4, which received CbBO doses of 0.36 and 0.72 µL/200-gram BW TW in lung tissue and serum, showed a decrease. Group P4 Lung and serum IL-6 levels on the second day were lower than those of group P2.Standard on the second day, higher. Group P3 and P4, which received CbBO doses of 0.36 and 0.72 µL/200-gram BW TW in lung tissue and serum, showed a decrease. Group P4 Lung

and serum IL-6 levels on the second day were lower than those of group P2.

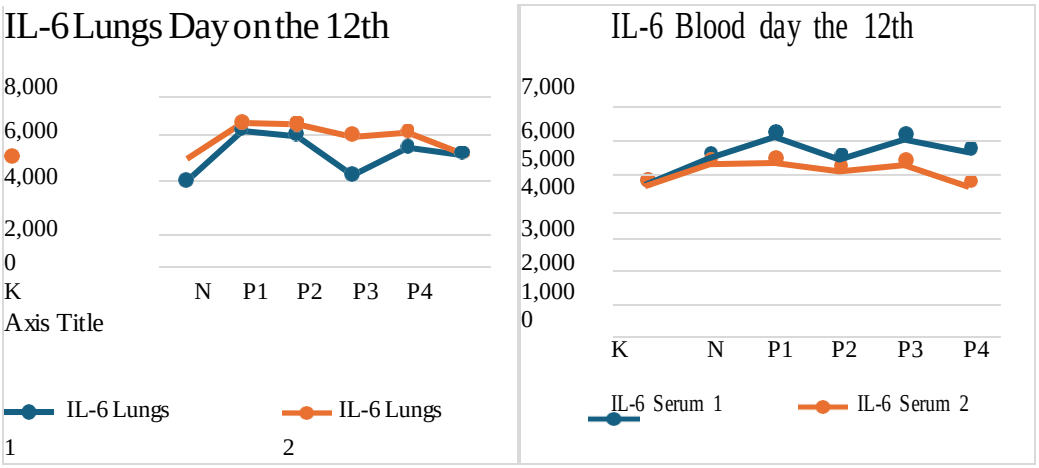


Figure 3. IL-6 levels in lungs on Day 2 are the second-highest compared to on Day 1. IL-6 serum 2nd more low from day to- 1

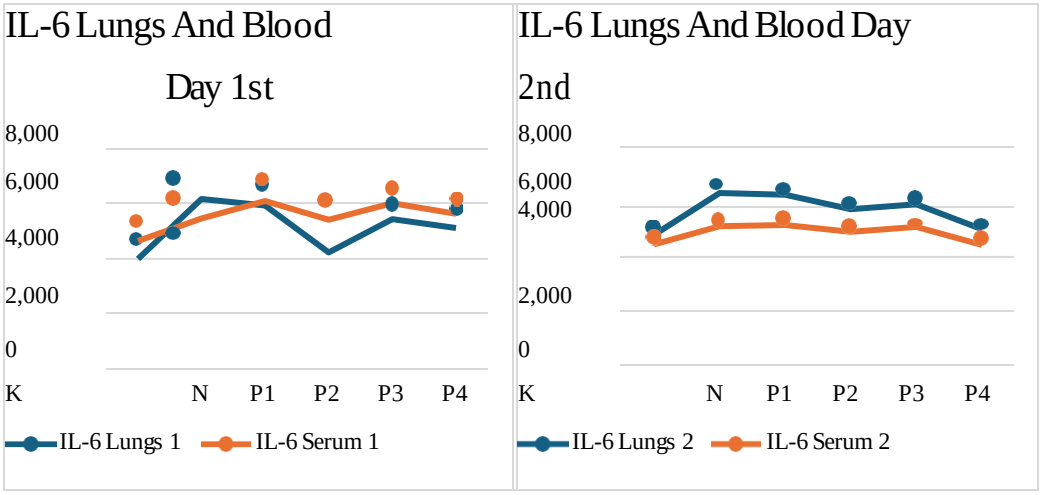


Figure 4. On day 1st, IL-6 serum compared to more lungs, And on Day 2nd, IL-6 serum lower

Generally, giving CbBO on days one and two shows significant differences between the groups given CbBO and those not given CbBO. Groups P3 and P4 showed a decline in the expression of IL-6 in network lungs and blood. At dose P4, 0.72 µL/200-gram BB TW, the level of IL-6 was shown, which is lower compared to the standard drug administered on day 2 of administration. IL-6 levels in lung tissue and blood on day 1 of CbBO administration decreased from group P3 to P4, but remained above those in group P2 (standard drug administration). The degree of damage to the lungs based on the lesion radiography, the thorax shows a more severe condition on Day 2 than on Day 1st. Giving CbBO on days 1 and 2 shows that the degree is lower than without giving CbBO (Group P3, P4 compared to Group control negative/N). Giving CbBO optimally at a dose of 0.36 µL/200-gram BW TW on day 2 (same as group P2/standard drug administration). Group P4 day first showed a degree lower compared to group P3, and Day 2 showed a more severe degree of lesion compared to group P3, although in general, it shows optimization giving CbBO on group P3 and P4 compared to the group without CbBO (group N)

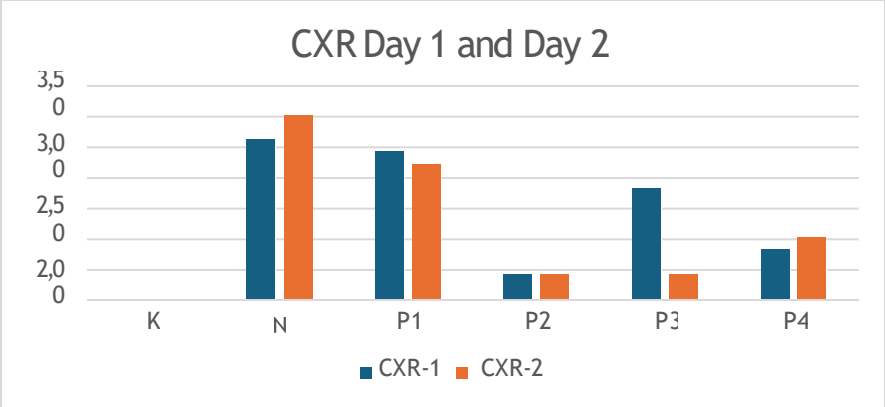


Figure 5. Chart Comparison Lesion Radiography Thorax on Group Mice Treatment on Day 1 compared to Day 2

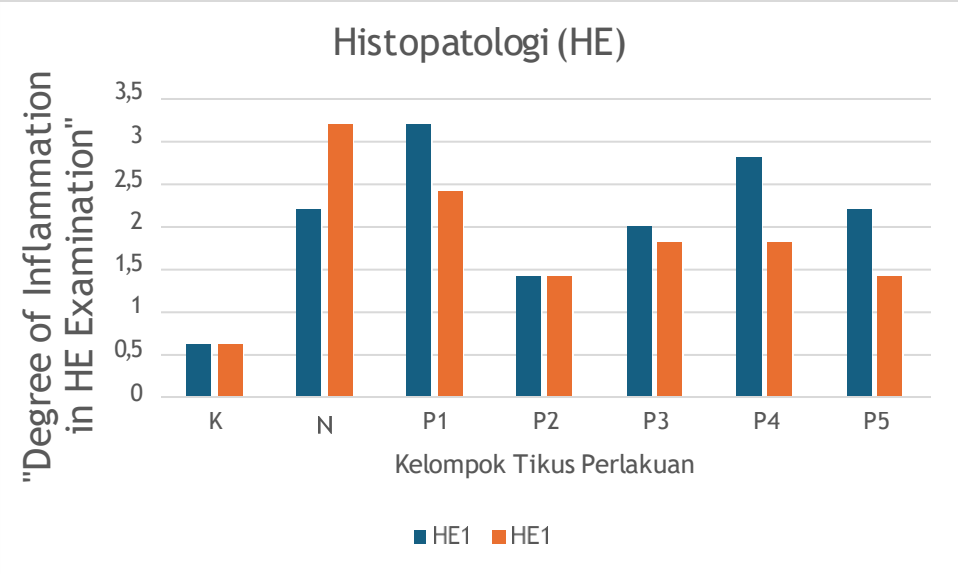


Figure 6. Chart comparison of the degree of inflammation in the network of lungs in the group treated mice on day 1, compared to day 2

DISCUSSION

Here is a summary of the effectiveness of Cinnamomum burmannii oil as an anti-inflammatory in pneumonia mice: 1. Reduction of IL-1β: *Cinnamomum burmannii* oil significantly reduces IL-1β levels. On Day 1st (42.1%) and Day 2nd (55.6%) post-inoculation. 2. Repair Lung histopathology: administration of *Cinnamomum burmannii* oil on days 1 and 2 reduced leukocyte infiltration, edema, and hemorrhage in lung tissue. 3. Reduction in the Degree of Thoracic Radiography Lesions: *Cinnamomum burmannii* oil reduced the degree of thoracic radiography lesions on day 1 (30.4%) and day 2 (51.2%). Anti-inflammatory Mechanism 1. Inhibits the production of pro-inflammatory cytokines (IL-1β, TNF-α). 2. Activates anti-inflammatory pathways (IL-10, COX-2). 3. Reduces the expression of inflammatory genes. Differences between Day 1 and Day 2: 1. Day 1: Anti-inflammatory effects are more potent in reducing IL-1β and repairing the histopathology of lungs. 2. Day 2nd: Effect anti-inflammatory more strongly on reduction in the degree of thoracic radiographic lesions (Budiastuti, Nurcholida, Primaharinastiti, & Sukardiman, 2021).

Group P2, which received levofloxacin at 13.5 mg/200 g body weight, showed clinical improvement nearly comparable to that of the healthy control group (K), and thus can be considered to reflect the response to standard pneumonia therapy. Interestingly, group P3,

treated with CbBO at a dose of 0.36 µL/200 g body weight on both day 1 and day 2, exhibited clinical improvement comparable to P2 and clearly superior to the negative control group. These findings support the notion that CbBO possesses anti-inflammatory and antibacterial activity against *Klebsiella pneumoniae* (Majdawati et al., 2024)**.** Group P4, which received CbBO at a dose of 0.72 µL/200 g body weight, also showed a reduction in clinical symptom scores from day 1 to day 2. By day 2, the severity of clinical symptoms in P4 was comparable to that of group P2, suggesting a dose-dependent response that remains beneficial without evidence of clinical deterioration at this dose. At the mechanistic level, recent studies have reported that *Cinnamomum burmannii* Bark Oil is rich in cinnamaldehyde and eugenol, which can inhibit NF-κB activation, reduce the production or expression of pro-inflammatory cytokines such as IL-6 and IL-1β, and exert antibacterial activity against respiratory pathogens, including K. pneumoniae. (Majdawati et al., 2024b; Miller et al., 2025) The pattern of declining clinical symptom scores from GK-1 to GK-2 in groups P3 and P4 supports the hypothesis that CbBO may serve as a potential adjuvant or alternative therapy for bacterial Pneumonia, particularly when administered early in the course of infection. Nevertheless, these findings require further confirmation using biochemical parameters (IL-6, IL-1β), chest radiographic assessment (CXR), histopathological evaluation, and more comprehensive toxicity testing.

According to the "Pulmonary and Serum IL-6 Expression D1–D2" figure 2-4, pulmonary and serum IL-6 levels in the healthy control group (K) remain low and relatively stable between day 1 and day 2. In contrast, the negative control (N) and vehicle (P1/Na CMC) groups display persistently elevated IL-6 concentrations in both lung tissue and serum on days 1 and 2, reflecting ongoing pulmonary inflammation in the absence of effective therapy. In the standard treatment group (P2, levofloxacin 13.5 mg/200 g body weight), pulmonary IL-6 levels decrease; however, serum IL-6 on day 2 is still higher than on day 1, indicating that systemic inflammation has not been fully controlled. A different pattern is observed in groups P3 and P4, which receive CbBO at doses of 0.36 and 0.72 µL/200 g body weight, respectively: IL-6 levels in both lung tissue and serum show a consistent decline from day 1 to day 2, and in P4, day-2 pulmonary and serum IL-6 values are even lower than those in P2. These data suggest that the anti-inflammatory effect of CbBO on IL-6 is at least comparable to, and possibly greater than, that of standard therapy in this model. This finding is clinically relevant, as multiple studies have demonstrated a strong positive correlation between serum IL-6 levels and pneumonia severity and outcomes. A reduction in IL-6 is generally associated with clinical improvement and a lower risk of mortality. (Yudhawati & Yuniawati, 2021)

At the mechanistic level, these findings are in line with recent studies showing that *Cinnamomum burmannii* Bark Oil (CbBO) in a murine *Klebsiella pneumoniae* pneumonia model can reduce bacterial load, suppress NF-κB/p65 activation, and significantly decrease pulmonary IL-6 expression compared with both the negative control and the Na CMC group, with the most pronounced effects observed at doses of 0.36–0.72 µL/200 g body weight (Majdawati et al., 2024b). This oil is rich in cinnamaldehyde and eugenol, which have been shown to inhibit activation of the NF-κB and MAPK pathways and to reduce the production of key pro-inflammatory cytokines (IL-6, IL-1β, and TNF-α) in various models of pulmonary and systemic inflammation (Oliveira et al., 2024). Accordingly, the pattern of decreasing pulmonary and serum IL-6 levels in groups P3–P4 supports the notion that early administration of CbBO not only attenuates local pulmonary inflammation but also dampens the systemic inflammatory response. This positions CbBO as a potential adjuvant or alternative therapeutic option for bacterial Pneumonia, particularly in the era of rising antibiotic resistance. Nevertheless, these findings still require confirmation through robust statistical analyses and correlation with clinical symptom scores, chest radiographic (CXR) data, and histopathological findings before CbBO can be considered for broader clinical application.

Based on the "Day-1–2 CXR" figure 5, the extent of lung damage in the healthy control

group (K) remains at a score of 0 on both observation days. In contrast, the negative control group (N) shows high chest radiographic lesion scores that further increase on day 2, indicating progressive Pneumonia in the absence of effective therapy. The vehicle group (P1) exhibits only minimal radiographic improvement. In the standard treatment group (P2, levofloxacin), CXR scores remain very low from day 1, reflecting reasonable control of inflammation and lung injury. The CbBO-treated groups display a distinct pattern. In P3 (0.36 µL/200 g body weight), CXR scores decrease markedly from day 1 to day 2, approaching those observed in P2, indicating substantial improvement of pulmonary radiographic lesions. In P4 (0.72 µL/200 g body weight), CXR scores are already low on day 1 but show a slight increase on day 2, although they remain clearly better than in the negative control group. Overall, these findings suggest that CbBO, particularly at a dose of 0.36 µL/200 g body weight, can ameliorate lung radiographic lesions to a level comparable to standard therapy. In contrast, the absence of CbBO (group N) is associated with the progression of radiographic lung damage.

These results are in line with recent in vivo studies reporting that *Cinnamomum burmannii* Bark oil can reduce bacterial load, suppress NF-κB activation, and decrease IL-6 levels, thereby contributing to the improvement of chest radiographic findings in murine models of Pneumonia (Majdawati et al., 2024). Other studies investigating cinnamon oil and its bioactive constituents have likewise shown a reduction in inflammatory cell infiltration and pulmonary edema in acute lung injury models, which is mirrored by improvement in radiological findings following treatment (Liu et al., 2024; Zhao et al., 2021). Accordingly, the reduction in CXR scores observed in group P3, together with the persistently low scores in P4 and P2, supports the notion that effective interventions, whether CbBO or levofloxacin, can halt the progression of lung injury and accelerate the resolution of pneumonia lesions.

According to Figure 6, the degree of pulmonary tissue inflammation (HE-1 and HE-2) in the healthy control group (K) remains very low on both day 1 and day 2. In contrast, the negative control group (N) shows an increase in inflammation scores from day 1 to day 2, indicating ongoing Pneumonia in the absence of treatment. In the vehicle group (P1), the degree of inflammation remains high, with only slight improvement on day 2, suggesting that NaCMC alone is insufficient to control lung tissue damage. In the treated groups, both the standard drug (P2/levofloxacin) and CbBO (P3–P5) showed a decrease in inflammatory scores between day 1 and day 2. The most pronounced reductions are observed in P4 and P5, whose day-2 scores approach those of P2 and are markedly lower than those of group N. Overall, these findings are consistent with the summary data indicating that CbBO administration on days 1 and 2 reduces leukocyte infiltration, edema, and hemorrhage in the lung parenchyma and improves the histopathological appearance.

These findings are in line with recent in vivo studies demonstrating that *Cinnamomum burmannii* bark oil (CbBO) can reduce the expression of pro-inflammatory cytokines (IL-6, TNF-α) by inhibiting the NF-κB pathway. This mechanism helps prevent the progression of lung tissue damage in murine pneumonia models and is accompanied by improvements in both histopathological scores and CXR findings (Majdawati, Reviono, Hartono, Handayani, & Soetrisno, 2024) Other studies on cinnamon essential oil have likewise demonstrated a significant reduction in IL-6 levels, accompanied by improvement in lung injury indices in acute lung injury models. These effects are mediated, at least in part, by the modulation of the TLR4/MyD88/NF-κB pathway and an increase in anti-inflammatory cytokines, such as IL-10 (Liu et al., 2024). A meta-review on cinnamon oil has highlighted that the combination of cinnamaldehyde and eugenol plays a pivotal role in suppressing inflammatory gene expression, reducing inflammatory cell infiltration, and accelerating the resolution of tissue lesions across various disease models(Pagliari et al., 2023). The decline in HE scores in groups P2–P5, particularly on day 2, supports the notion that CbBO exerts a histologically relevant anti-inflammatory effect and may serve as a potential adjuvant therapy in bacterial Pneumonia.

CONCLUSION

Symptoms are clinical, with IL-6 expression, radiography of the thorax, and a degree of inflammation indicated by HE in the group of mice given treatment (CbBO) on Day 1 at a lower level than on Day 2. There is a significant difference between the administration of CbBO and the group not given CbBO, as indicated by a p-value test of less than 0.05. Interleukin 6 is numerical data, so a normality test with a p-value> 0.005 indicates that the data is not normally distributed. The statistical test performed was Kruskall Wallis, followed by Dunn's Post Hoc Test. The p-value was 0.011 on day 1 in lung tissue, and p: 0.048 in serum samples on day 2. Statistical Test Results: Clinical symptoms, Thoracic Radiography, and Histopathology (HE) are ordinal (categorical) data. The difference in CbBO administration in groups of mice was carried out using the Chi- square statistical test with results show difference Which significant symptom clinical mice pneumonia with mark p: 0.000 on day 1, and p: 0.000 in clinical symptoms on day 2, there was a significant difference between the groups of mice given CbBO with Which No given CbBO on CXR with p-value: 0.002 on day 1 and day 2. There are significant differences between groups of mice given CbBO and those not given CbBO in HE, with p-values of 0.002 on day 1 and 0.001 on day 2.

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