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Apigenin Extracts from *Myrmecodia pendans* and Their Potential Role in Coronary Heart Disease Mitigation

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Abstract. *Myrmecodia pendans* is an epiphytic plant indigenous to Papua that contains apigenin, a bioactive compound with antioxidant, anti-inflammatory, and vasodilatory properties. Apigenin has been widely associated with cardiovascular protection, particularly in the prevention of coronary heart disease (CHD), and represents an environmentally sustainable alternative to synthetic pharmacological therapy. This study evaluated the potential of apigenin derived from *M. pendans* as a natural therapy for mitigating the risk factors of CHD. A quantitative experimental design was applied using three treatment formulations, each with a fixed amount of *Coffea arabica* L. (12 g) brewed in 200 mL of water and different doses of *M. pendans*: Treatment I (6 g), Treatment II (9 g), and Treatment III (12 g). Physiological parameters, including blood pressure, heart rate, oxygen saturation, total cholesterol, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels, were assessed before and after administration. Treatment B produced the most significant improvements, reducing the blood pressure from 155/101 mmHg to 119/80 mmHg. Laboratory analyses further revealed an increase in HDL levels from 39 mg/dL to 45 mg/dL and a decrease in LDL levels from 140 mg/dL to 83 mg/dL. These findings suggest that apigenin extracted from *M. pendans* is a promising herbal therapeutic candidate for the prevention of coronary heart disease.

1 Introduction

In 2023, the World Health Organization (WHO) reported that cardiovascular disease (CVD) remains the leading global cause of mortality, accounting for approximately 17.9 million deaths each year [1]. Coronary heart disease (CHD) is the most prevalent form of CVD and is primarily caused by atherosclerosis, a pathological process characterized by the

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accumulation of low-density lipoprotein (LDL) cholesterol plaques within the coronary artery walls. In Indonesia, heart disease contributes to an estimated 650,000 deaths annually [2]. In Southwest Papua, the prevalence of heart disease was reported at 0.51% of the total population of 613,180 individuals [3].

Papua's unique biodiversity, including *Myrmecodia pendans*, offers promising resources for traditional medicine to mitigate CVD-related mortality. This plant has been traditionally used by local communities, boiled and ingested, to treat various ailments, including heart disease, diabetes, and tumours [4].

Several studies have reported that *Myrmecodia pendans* contains various bioactive constituents, including flavonoids, tannins, tocopherols, and essential minerals [5]. In addition, HPLC identification results indicated the presence of an apigenin substrate [6]. This phenolic compound has potential therapeutic and antioxidant effects that can increase the activity of the superoxide dismutase (SOD) enzyme, strengthen the body's defenses, and inhibit the formation of atherosclerotic plaques [7]. In addition, apigenin scavenges free radicals that induce oxidative stress, a critical factor in atherosclerosis progression [8]. To support the effectiveness of apigenin from *M. pendans*, this study combined caffeine and chlorogenic acid (CGA) from *Coffea arabica* L. cultivated in Wamena, Jayawijaya, Papua [9].

The combination of the two has the potential to prevent coronary heart disease and avoid negative environmental impact. Furthermore, the use of these herbal ingredients contributes to reducing excessive dependence on synthetic chemical drugs, supporting efforts to use natural resources sustainably and safely. Therefore, this study aimed to evaluate the effectiveness of apigenin derived from *Myrmecodia pendans* in combination with chlorogenic acid and caffeine from *Coffea arabica* L. in mitigating coronary heart disease (CHD). Additionally, this study emphasizes the contribution of innovation by utilizing local endemic plants, where the raw material *Myrmecodia pendans* was obtained from the Sorong mangrove forest, as an effort to responsibly and sustainably utilize the natural potential of Papua for the health of the community.

2 Experimental Method

This quantitative experimental study was conducted in Sorong, Southwest Papua Province, Indonesia, between March and September 2025. This study evaluated the combined effects of apigenin from *Myrmecodia pendans* and bioactive compounds from *Coffea arabica* L. on coronary heart disease (CHD) risk factors.

Raw *M. pendans* was harvested from the mangrove forests of Sorong. Following collection, the raw plants were cleaned and cut into smaller pieces (Figure 1A). To minimize the thermal degradation of bioactive compounds, the material was dried in a climate-controlled environment at 25°C with a relative humidity of 50% for 5 days [10, 11]. The temperature and humidity were strictly monitored using a thermohygrometer. The dried material was subsequently ground into uniform 60-mesh particles (Figure 1B) to preserve the integrity of the sensitive phytochemicals [12].

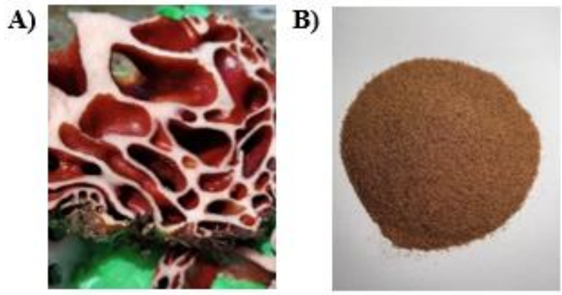


Fig. 1. *M. pendans* (A) Tuber and (B) Powder.

Ripe coffee cherries were selectively harvested and pulped to remove the exocarp of the cherries. The beans were washed and dried until their moisture content reached approximately 12% [13]. After hulling the parchment layer, the green beans were roasted at 210°C for 15 min to optimally develop characteristic aroma and flavor compounds (Figure 2A) [13, 14]. The beans were immediately cooled to halt the roasting reaction. Finally, the roasted beans were ground and refined using an 80-mesh sieve to ensure particle uniformity for consistent extraction (Figure 2B) [15].

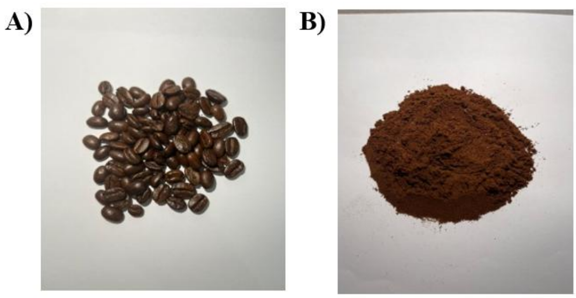


Fig. 2. *C. arabica* L. (A) Beans and (B) Powder

A clinical trial with an official ethical clearance number of DP.04.03/F.LIII.13. a/353/2026 from the Ethical Commission of Health Polytechnique of Sorong Papua was conducted involving 30 participants with CHD risk factors [16], specifically hypercholesterolemia, hypertension, tachycardia, and low oxygen saturation (SpO_2) [17],[18]. The subjects were divided into three treatment groups. The administration of the herbal preparation was calculated based on interspecies dose extrapolations. The Human Equivalent Dose (HED) was derived from an effective initial rat dose of 800 mg/kg BW [19]. The final human dosage was calculated using standard conversion guidelines (Rat Dose *x* Conversion Factor of 56.0).

All treatment groups received a constant base beverage consisting of 12 g of *C. arabica* L. brewed in 200 ml of water. The treatments differed solely in the dosage of *M. pendans* powder added to the base.

- **Treatment I:** 6 g *M. pendans*
- **Treatment II:** 9 g *M. pendans*
- **Treatment III:** 12 g *M. pendans*

The preparation was administered daily to all participants throughout the observation period. A schematic representation of the experimental steps is shown in Figure 3.
Physiological parameters were measured pre- and post-treatment to assess the cardiovascular and respiratory functions [20]. Blood pressure and heart rates were monitored using a digital sphygmomanometer [21]. Oxygen saturation was measured noninvasively using a pulse

oximeter. Lipid profiles were assessed by screening the total cholesterol using a portable analyzer (Easy Touch GCU 3-in-1). To ensure accuracy, LDL and HDL fractions were quantified via a comprehensive analysis at a certified clinical laboratory [22].

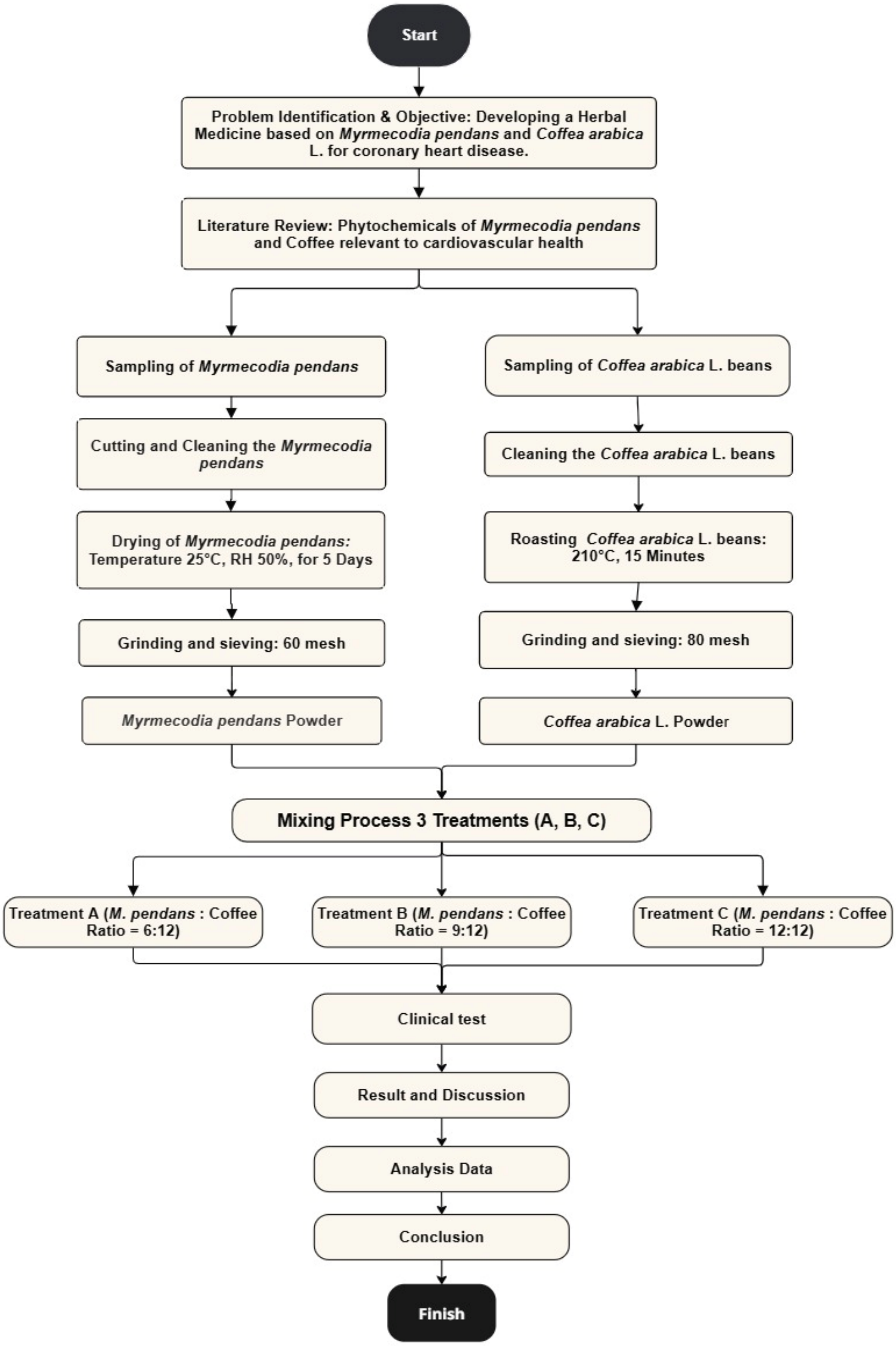
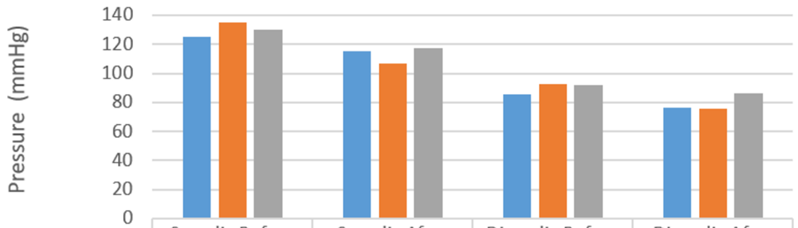


Fig. 3. Schematic Diagram of Experimental Method

3 Results and Discussion

Effects of the three treatments on blood pressure showed clear differences between systolic and diastolic levels before and after treatment. The blood pressure results for Treatment I are shown in Figure 4, with an average systolic decrease of 10.3 mmHg and a diastolic decrease of 9.2 mmHg. Treatment II proved to be the most effective in reducing systolic blood pressure, with a mean value reduction of 28.4 mmHg, as shown in Figure 4, with one subject showing a reduction from 155 mmHg to 119 mmHg. This response links higher concentrations of apigenin and polyphenols with increased vasodilator effects [23]. There was also an average diastolic decrease of 17.1 mmHg, with the highest reduction of diastolic blood pressure in one subject from 101 mmHg to 80 mmHg. However, Figure 4 showed Treatment III with an average systolic reduction of 12.5 mmHg, while Treatment III was the least effective in reducing diastolic pressure, with an average reduction of 5.1 mmHg. These results indicate that Treatment II is highly effective in reducing systolic and diastolic levels.



	Systolic Before	Systolic After	Diastolic Before	Diastolic After
Treatment A	125.3	115	85.9	76.7
Treatment B	135.4	107	92.8	75.7
Treatment C	130.2	117.7	91.9	86.6

Fig. 4. Average Blood Pressure Test Data: Treatment I, Treatment II, and Treatment III

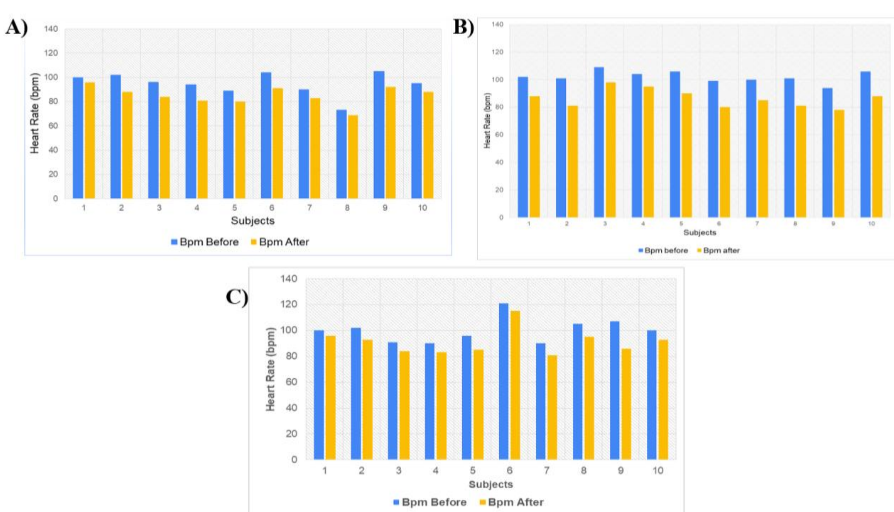


Fig. 5. Heart Rate Test Data (A) Treatment I, (B) Treatment II, and (C) Treatment III

The second parameter was the heart rate measurement. Treatment II showed the most significant results, with an average heart rate reduction of up to 15.8 bpm, with one participant showing the highest reduction from 109 bpm to 98 bpm, as shown in Figure 5(B). This effectiveness was much higher than that of Treatment I, as shown in Figure 5(A) and 5(B), which showed an average decrease of 9.4 bpm, and Treatment III (9.1 bpm), which provided a similar decrease. These findings indicate that Treatment II has the greatest potential for maintaining normal cardiac performance. Meanwhile, Treatments A and C provided benefits in calming the cardiovascular system.

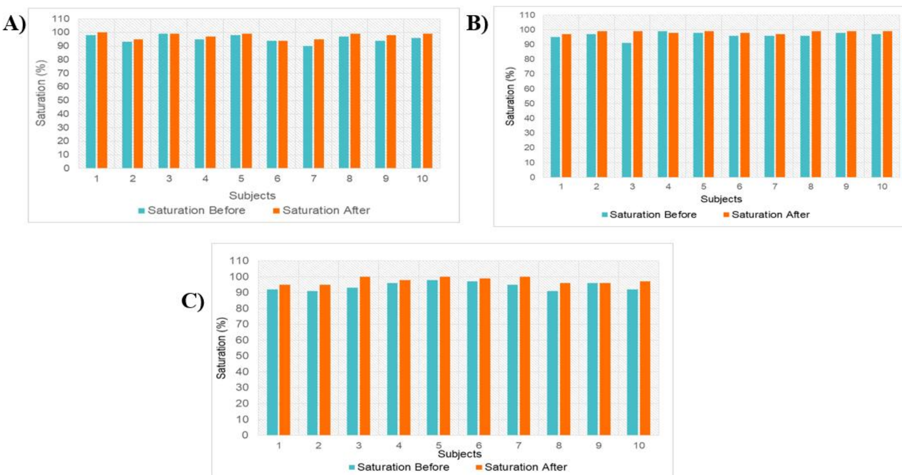


Fig. 6. Saturation Test Data (A) Treatment I, (B) Treatment II, and (C) Treatment III

The results of the oxygen saturation parameter test are shown in Figure 6(B). indicated that Treatment II showed the greatest average improvement of 3.5%, and one subject showed an increase from 91% to 95%. The results of Treatments A and C are shown in Figure 6(A) and 6(C), respectively. Both showed good performance with an increase of 2.1%, although the increase was lower than that of Treatment II. These data show that Treatment II is effective in facilitating better gas exchange or improving perfusion to tissues compared with treatments A and C., making it effective in improving lung function or circulation. This decrease in the average number of subjects responding to the high treatment indicates a saturation effect, where increasing the dose no longer increases the response because the vascular mechanism has reached its maximum capacity [24].

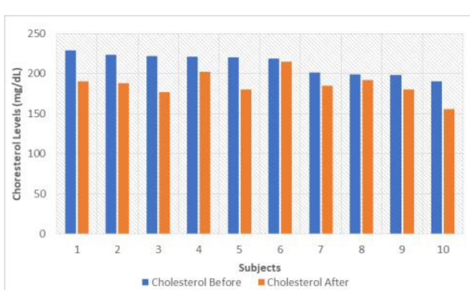


Fig. 7. Cholesterol Test Data

Based on the clinical test results across all measured parameters and post-consumption observations of the *Coffea arabica* L. and *Myrmecodia pendans* formulation, Treatment II was identified as the most effective and was not associated with any adverse effects in the subjects. Next, we performed a clinical test using Treatment II, which involved 10 subjects, by conducting observations based on total cholesterol parameters.

The outcomes of the cholesterol level assessment are illustrated in Figure 7. This indicates that all 10 subjects (100%) experienced a decrease in cholesterol levels, with an average decrease from 212.2 mg/dL before the intervention to 186.5 mg/dL after the test. The highest decrease was observed from 229 mg/dL to 190 mg/dL. The content of *M. pendans*, specifically apigenin, regulates cholesterol metabolism, contributing to this effect [25]. This shows that Coffee *arabica* L. treatment using *M. pendans* preparation plays a role in maintaining the equilibrium of cholesterol levels and cardiovascular health [26].

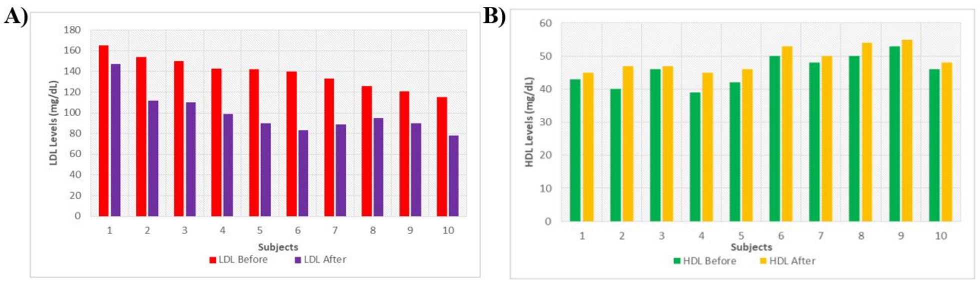


Fig. 8. Blood Laboratory Test Data (A) LDL Levels (B) HDL Levels

Subsequently, laboratory blood tests were performed on 10 subjects aged 40–51 years who exhibited risk factors for coronary heart disease, particularly elevated low-density lipoprotein (LDL) levels and suboptimal high-density lipoprotein (HDL) levels, defined as LDL concentrations above 100 mg/dL and HDL levels outside the normal range of 40–60 mg/dL [27]. Laboratory examinations were conducted at the Clinical Laboratory of the General Hospital in Indonesia over the treatment period with Treatment II Preliminary data from 10 representative subjects showed promising results, as shown in Figure 8.

LDL levels decreased in all 10 subjects (100%), with a mean value reduction from 138.9 mg/dL during the pre-test to 99.3 mg/dL after the intervention. In addition, one subject had a significant decrease from 140 mg/dL to 83 mg/dL, as shown in Figure 8 (A).

As presented in Figure 8 (B), HDL levels increased to normal range levels, with all 10 subjects (100%) showing an increase, with mean values rising from 45.7 mg/dL during the pre-test to 49 mg/dL in the post-test. Therefore, one participant showed an increase toward more optimal HDL levels from 39 mg/dL to 45 mg/dL.

Based on the evaluation of the three treatments (A, B, and C), Treatment II with 9 g of *M. pendans* proved to be the most effective dosage regimen. The results of this study show that the herbal substrate formulated from *M. pendans*, which combines apigenin with chlorogenic acid and caffeine from *C.arabica L.*, has significant potential to prevent and manage coronary heart disease risk factors [28]. These compounds inhibit LDL oxidation, a critical initial step in plaque formation [28]. Crucially, apigenin enhances the body's natural defence by increasing Superoxide Dismutase (SOD) activity, which helps prevent the formation of atherosclerotic plaques [29]. Overall, the findings confirm that apigenin exerts substantial antioxidant and cardioprotective effects, establishing its potential as a reliable and sustainable natural therapy for coronary heart disease. This dual action of lowering LDL and providing antioxidant defence positions Treatment II as an effective method for mitigating the leading cause of death in the region [30].

4 Conclusion

This study demonstrated that Treatment II with 9 g of *M. pendans* was the most effective dosage, contributing to clinical and biochemical recovery in coronary heart disease. Consistent effects were observed in all subjects (100%) who received the *Coffea arabica* L. and *Myrmecodia pendans* formulation, demonstrating significant improvements in blood pressure, heart rate, oxygen saturation, total cholesterol levels, low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Specifically, Treatment II resulted in the most significant reduction in blood pressure (155/101 mmHg to 119/80 mmHg) and heart rate (109 bpm to 98 bpm). Furthermore, a notable increase in oxygen saturation (from a low of 91% to 95%) and the largest individual reduction in total cholesterol (229 mg/dL to 190 mg/dL) were observed. Detailed lipid profiling confirmed these favorable changes, with LDL concentrations declining from 140 mg/dL to 83 mg/dL alongside a corresponding increase in HDL levels from 39 mg/dL to 45 mg/dL.

Therefore, these findings support the potential role of apigenin, a key bioactive compound in *Myrmecodia pendans*, as an adjunct herbal therapy for the prevention of coronary heart disease and the mitigation of cardiovascular disease burden in the region. Moreover, from an environmental science perspective, the use of locally cultivated *M. pendans* and *C. arabica* L. supports eco-sustainable biomedical innovation, reducing dependence on synthetic drugs that contribute to chemical waste and ecological degradation.

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