Effect of Blue Pea Flower (*Clitoria ternatea*) Infusion on Blood Pressure and Sleep Quality in Individuals with Prehypertension

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Abstract

Prehypertension is a condition in which blood pressure is above the normal range but has not yet reached the threshold for hypertension. This condition increases the risk of developing hypertension and cardiovascular diseases and is also associated with decreased sleep quality. One nonpharmacological approach that may help reduce blood pressure while improving sleep quality is the regular consumption of butterfly pea flower (*Clitoria ternatea*) infusion. Objective: This study aimed to analyze the effect of *Clitoria ternatea* infusion on blood pressure and sleep quality in individuals with prehypertension. This study employed a one-group pretest–posttest experimental design. A total of 34 participants with prehypertension were recruited using purposive sampling. Data were analyzed using the Wilcoxon Signed Rank Test. After the intervention, the mean systolic blood pressure decreased to 113.71 ± 8.09 mmHg and diastolic blood pressure to 73.00 ± 4.52 mmHg. The mean heart rate decreased to 73.97 ± 7.14 beats per minute, and the mean Pittsburgh Sleep Quality Index (PSQI) score improved to 4.41 ± 0.96. Statistical analysis showed significant reductions in systolic and diastolic blood pressure, heart rate, and a significant improvement in sleep quality, as indicated by a decrease in PSQI scores ($p < 0.001$). This study concludes that the administration of *Clitoria ternatea* infusion is associated with a reduction in blood pressure and an improvement in sleep quality among individuals with prehypertension.

Key words: *Clitoria ternatea*, Prehypertension, Sleep quality.

INTRODUCTION

Hypertension is one of the major global health problems, with its prevalence continuing to increase from year to year. Elevated blood pressure often develops without noticeable symptoms, causing many individuals to remain unaware of the condition until complications arise and clinical manifestations occur. Hypertension is a major risk factor for various cardiovascular diseases, including coronary heart disease, heart failure, stroke, and other cardiovascular disorders[1]. Prehypertension is defined as a condition in which blood pressure levels are higher than normal but have not yet reached the threshold for a diagnosis of hypertension[2]. Without early preventive measures, individuals with prehypertension have a higher risk of progressing to hypertension.

Elevated blood pressure is a multifactorial condition, with sleep quality being one of the contributing factors. Sleep is an essential component of human lifestyle, and sleep quality refers to an individual's level of satisfaction with the sleep experience[3]. Adequate sleep plays a crucial role in maintaining the balance between the sympathetic and parasympathetic nervous systems and is therefore closely involved in the regulation of the stress response. Poor sleep quality can disrupt this balance, increasing the risk of conditions such as hypertension and other comorbidities, as well as stimulating increased synthesis of the stress hormone cortisol[4,5].

Sleep disturbances can lead to an increase in reactive oxygen species (ROS), which in turn further impair sleep quality[6]. Excessive ROS production induces oxidative stress, resulting in endothelial damage and reduced nitric oxide (NO) production. ROS can also react directly with NO, decreasing its bioavailability and ultimately leading to impaired vasodilation of blood vessels[7]. In addition, ROS can trigger inflammatory responses that may affect blood pressure regulation and contribute to the development of hypertension.

Currently, prehypertension is not recommended to be treated with antihypertensive medications according to hypertension management guidelines, as it represents an early stage of blood pressure elevation and is generally managed through lifestyle modifications[8]. On the other hand, the long-term use of sleep medications to improve sleep quality—often observed in individuals with elevated blood pressure—is associated with risks such as dependence and cognitive impairment[9]. These conditions highlight the need for alternative approaches that are safer, more natural, and capable of providing dual benefits, namely reducing blood pressure while improving sleep quality. Nature-based interventions with relevant physiological activity, therefore, represent a promising option for the management of prehypertension[6].

The butterfly pea flower (*Clitoria ternatea*) has traditionally been used for health purposes due to its abundant bioactive compounds that provide various physiological benefits. *Clitoria ternatea* is known to contain high levels of antioxidants, including anthocyanins, flavonoids, saponins, alkaloids, triterpenoids, as well as vitamins A, C, and E[10,11]. Antioxidants play an important role in neutralizing free radicals, protecting the vascular endothelium from oxidative damage, and improving the regulation of the nervous and cardiovascular systems[12].

Several previous studies have demonstrated that *Clitoria ternatea* has the potential to reduce blood pressure while simultaneously improving sleep quality. Studies by Aprilia (2023) and Unja *et al.* (2024) reported that the consumption of *Clitoria ternatea* infusion significantly reduced blood pressure in individuals with hypertension.[11,13] Maneesai *et al.* (2021) also found that *Clitoria ternatea* extract effectively lowered blood pressure through antioxidant and vasodilatory mechanisms.[14] Furthermore, Solihati and Kusumastuti (2023) showed that the consumption of *Clitoria ternatea* infusion was able to reduce insomnia, an effect that is thought to be related to the flavonoid, anthocyanin, and alkaloid contents that act as antioxidants.[15] Based on these findings, this study was conducted to analyze the effect of *Clitoria ternatea* infusion on blood pressure and sleep quality in individuals with prehypertension.

METHODS

This study employed an experimental one-group pretest–posttest design, in which each subject underwent measurements of blood pressure, sleep quality, and heart rate before and after the intervention in the form of *Clitoria ternatea* simplicia infusion. The butterfly pea flower simplicia used in this study consisted of dried butterfly pea flowers, which were obtained through online purchase from a herbal store that holds a valid Home Industry Food Product (PIRT) license, thereby meeting food safety standards. The study population comprised all adults with prehypertension in Sunggal Subdistrict, and the sample was selected using purposive sampling. The inclusion criteria were adults aged ≥18 years with blood pressure in the prehypertensive range (120–139/80–89 mmHg), not currently using antihypertensive, sedative, or

hypnotic medications, and willing to participate in all stages of the study. The exclusion criteria included individuals with severe chronic diseases such as coronary heart disease, stroke, chronic kidney disease, chronic liver disease, diabetes mellitus, cancer, as well as those undergoing other herbal therapies that could potentially affect blood pressure or sleep quality.

The intervention was administered as an infusion of 1 gram of butterfly pea flower (*Clitoria ternatea* L.) *simplisia*, brewed in 200 ml of hot water. This was consumed once daily before lunch for seven consecutive days at the same time for all participants. Blood pressure measurements, PSQI questionnaire completion, and pulse rate assessments were conducted twice at pretest and posttest within the same timeframe (11:00–14:00) to minimize circadian physiological variations. Data analysis in this study utilized the Wilcoxon Signed-Rank Test because the data were not normally distributed.

RESULT

A total of 40 respondents who met the inclusion criteria were recruited at the beginning of the study, but 6 respondents dropped out because they did not complete the intervention on schedule, so a total of 34 subjects could be analyzed until the end of the study.

Table 1. Frequency Distribution of Subject Characteristics

	Frequency (n=34)	Percentage (100%)
Gender		
Male	7	20.6
Female	27	79.4
Age		
30-40	7	20.6
41-50	11	32.4
51-60	7	20.6
>60	9	26.5
Employment status		
Employed	14	41.2
Unemployed	20	58.8

Table 2. Comparison of Systolic and Diastolic Blood Pressure Before and After Intervention

Blood Pressure	Frequency (n)	Pretest ($\bar{x}$ ± SD)	Post-test ($\bar{x}$ ± SD)	*p*
Sistolic	34	130.85 ± 5.03	113.71 ± 8.09	<0.001
Diastolic		83.91 ± 4.22	73.00 ± 4.52	<0.001

Table 3. Comparison of the Heart Rate Before and After Intervention

Frequency (n)	Pretest ($\bar{x}$ ± SD)	Post-test ($\bar{x}$ ± SD)	*p*
34	79.91 ± 7.49	73.97 ± 7.14	<0.001

Table 4. Comparison of the Sleep Quality Before and After Intervention

Frequency (n)	Pretest ($\bar{x}$ ± SD)	Post-test ($\bar{x}$ ± SD)	*p*
34	7.24 ± 1.71	4.41 ± 0.96	<0.001

Notes: Sleep quality ≤ 5 = good; > 5 = poor

DISCUSSION

The characteristics of the study participants indicate that the majority were female, a group that is more susceptible to increased blood pressure, particularly during the perimenopausal and menopausal periods, due to a decline in estrogen levels, which plays a role in maintaining endothelial function and vascular vasodilation[16]. In addition, most of the subjects were in the age range of 41–50 years, which is a phase in which physiological changes in the cardiovascular system occur, such as decreased blood vessel elasticity, decreased heart function, and changes in baroreceptor sensitivity and hormonal regulation, all of which contribute to an increased risk of hypertension[17]. Employment status also plays a role, as unemployed participants tend to experience lower levels of physical activity and psychosocial stress, while employed participants are exposed to work-related stress, greater responsibilities, and disrupted sleep patterns that may elevate blood pressure. Both groups share a vulnerability to increased blood pressure and sleep

disturbances, although through different mechanisms[18,19].

The findings of this study demonstrate a significant decrease in both systolic and diastolic blood pressure among the participants after seven days of *Clitoria ternatea* infusion administration. This antihypertensive effect is associated with the bioactive compounds contained in *Clitoria ternatea*, particularly anthocyanins and flavonoids, which are known as natural antioxidants. These compounds help suppress ROS and free radical formation, inhibit inflammatory processes, reduce oxidative stress levels, and enhance nitric oxide (NO) levels and bioavailability in the vascular endothelium. NO functions as a vasodilator that widens blood vessels, thereby reducing peripheral resistance and contributing to the reduction of blood pressure[12,14,20-23]. These findings are supported by previous research. Maneesai *et al.* (2021) demonstrated that *Clitoria ternatea* extract can reduce blood pressure in hypertensive animal models through antioxidant and vasodilatory mechanisms[14]. Aprilia's (2023) Research with elderly hypertensive patients as the research sample showed the results of the analysis that there was an effect of giving *Clitoria ternatea* tea on blood pressure with a significant difference after the intervention ($p<0.001$)[13]. A study by Unja *et al.* (2024) also reported a significant effect of *Clitoria ternatea* tea administration on changes in blood pressure among individuals with hypertension ($p<0.001$)[11].

Clitoria ternatea exhibits antihypertensive effects that are associated with modulation of the renin–angiotensin–aldosterone system (RAAS), one of the primary physiological pathways involved in blood pressure regulation. Experimental studies in hypertensive rat models have demonstrated that administration of butterfly pea flower extract reduces angiotensin-converting enzyme (ACE) activity and plasma angiotensin II levels, as well as downregulates the expression of the angiotensin II type 1 receptor (AT_1R). These effects subsequently attenuate RAAS-mediated vasoconstriction and vascular resistance, leading to a reduction in blood pressure. In addition, flavonoid compounds, particularly anthocyanins, which are abundant in *Clitoria ternatea*, have been shown to inhibit ACE activity in vitro, indicating a direct potential to reduce the conversion of angiotensin I to angiotensin II. This mechanism is also associated with decreased oxidative stress and increased nitric oxide (NO) bioavailability, which collectively enhance endothelial function and promote vasodilation, thereby contributing to the observed blood pressure-lowering effects[24].

In addition to its effects on blood pressure, *Clitoria ternatea* infusion was also found to reduce heart rate. This indicates that the plant's effects extend beyond vascular modulation and may involve the regulation of sympathetic nervous system activity. The flavonoids, anthocyanins, triterpenoids, and alkaloids contained in *Clitoria ternatea* provide antioxidant, anxiolytic, and antidepressant activities through mechanisms involving the inhibition of inflammatory pathways, enhancement of the neurotransmitters GABA and serotonin, and modulation of dopamine within the central nervous system[25]. The resulting relaxation effect reduces stress and anxiety, lowers cortisol secretion, and enhances parasympathetic activity. These mechanisms collectively contribute to vasodilation of the peripheral blood vessels, thereby reducing peripheral vascular resistance, improving blood flow, and decreasing cardiac workload. This effect is protective for the cardiovascular system, as it reduces cardiac strain and improves hemodynamic balance[12,26,27].

The results of this study also show a positive change in the sleep quality of the study subjects after the intervention, as reflected in improved PSQI scores after the administration of the infusion. The participants reported greater ease in initiating sleep, longer sleep duration, reduced sleep disturbances, and feeling more refreshed upon waking. These improvements occurred because *Clitoria ternatea* was able to reduce oxidative stress and inflammation, provide a relaxing effect on the central nervous system, suppress sympathetic activity, increase parasympathetic activity, and reduce cortisol secretion, thus supporting individuals in achieving deep sleep and influencing sleep quality, which plays a crucial role in the recovery of cardiovascular and metabolic function[6,26,28]. Flavonoids and anthocyanins play an important role in promoting relaxation of the nervous system by modulating GABA receptors and increasing serotonin levels in the brain, thereby accelerating sleep onset and improving overall sleep quality, which in turn contributes to lowering blood pressure[26,29,30]. This finding is in line with research by Solihati and Kusumastuti (2023), which reported that consuming *Clitoria ternatea* beverages for 14 days produced a significant reduction in insomnia levels among post–COVID-19 patients ($p<0.001$)[15]. A study by Suna *et al.* (2025) reported that experimental animals exposed to chronic stress experienced improved sleep quality when given a combination of mulberry leaf (*Morus*

alba) extract and *Clitoria ternatea*. Statistical analysis showed a significant reduction in sleep latency ($p < 0.001$) and a significant increase in sleep duration ($p < 0.001$)[29].

Overall, the effects of *Clitoria ternatea* infusion can be understood as the result of synergistic interactions among antioxidant mechanisms, vasodilation, autonomic nervous system regulation, and neuromodulation. These combined mechanisms explain the observed reductions in blood pressure, decreases in heart rate, and improvements in sleep quality among the study participants. Thus, the findings of this study strengthen the evidence that *Clitoria ternatea* infusion provides benefits in lowering blood pressure while simultaneously improving sleep quality in individuals with prehypertension.

This study has several limitations. The one-group pretest–posttest design without a control group allows for the influence of external factors that cannot be fully controlled. The relatively short intervention duration of seven days, along with the limited sample size and the use of purposive sampling, also restricts the evaluation of long-term effects and the generalizability of the findings. In addition, sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), a subjective questionnaire that may be influenced by individual perceptions. The absence of physiological biomarker measurements, such as ACE activity, angiotensin II levels, cortisol, or oxidative stress markers, further limits an objective understanding of the mechanisms underlying the effects of *Clitoria ternatea*. Therefore, future studies are recommended to employ randomized controlled designs with longer intervention periods, larger sample sizes, and the inclusion of biomarker assessments to strengthen the evidence.

CONCLUSION

Based on the data analysis, the seven-day administration of *Clitoria ternatea* infusion was proven effective in lowering blood pressure, reducing heart rate, and improving sleep quality in prehypertensive subjects.

ETHICAL APPROVAL

This study received ethical approval from the Health Research Ethics Committee of Universitas Sumatera Utara (KEPK) under approval number 566/KEPK/USU/2025. The authors would like to express their gratitude to all participants who willingly took part in this study, as well as to the Sunggal Subdistrict authorities and all parties who contributed to the successful implementation of the research. The authors declare that there is no conflict of interest associated with this study.

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