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Ciplukan (*Physalis angulata* L.) Juice as a Functional Food to Lower Blood Pressure in Hypertension Patients

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Abstract

Functional foods rich in bioactive compounds, such as flavonoids, have gained attention for their potential role in managing blood pressure. *Physalis angulata* L., commonly known as Ciplukan, is a tropical fruit with a high quercetin content, a flavonoid known for its antioxidant and vasodilatory properties. This study aims to evaluate the application of Ciplukan juice as a nutritional therapy on blood pressure in patients with hypertension. The study used a quasi-experiment pretest-posttest control group design. The quercetin content in the Ciplukan juice was analyzed using the High-Performance Liquid Chromatography (HPLC) method at the Technical Implementation Unit (UPT) Integrated Laboratory Universitas Diponegoro. The sample in this study was 47 individuals with hypertension from Gambirsari Health Center, Surakarta, Indonesia. Subjects were randomly divided into control and treatment groups. The control group was given amlodipine per day and nutrition education. The intervention group received amlodipine, nutrition education, and 250 ml of Ciplukan juice per day. The research was conducted for 30 days. Data analysis used the Mann-Whitney and Wilcoxon test. The test results showed a significant difference in systolic and diastolic blood pressure between the control and treatment groups with a *p*-value of 0.000. The reduction in systolic blood pressure in the treatment group was 20.5 mmHg greater than the control group. The decrease in diastolic blood pressure in the treatment group was 10.8 mmHg greater than in the control group. Consuming Ciplukan juice 250 ml per day for 30 days was suggested to reduce blood pressure in hypertension effectively.

Keywords: diastolic blood pressure; fruit juice; medical plant; systolic blood pressure; quercetin

INTRODUCTION

Hypertension, or high blood pressure, is a leading cause of cardiovascular diseases and mortality worldwide. Approximately 1.28 billion adults globally suffer from hypertension, with nearly 46% unaware of their condition (WHO, 2023). Hypertension in Indonesia is 34.1%, and the prevalence in Surakarta City exceeds the national level of 37.80% (Riskesdas, 2018). The incidence of hypertension in Surakarta in 2023 was 67,355 cases, the most hypertension sufferers were in Banjarsari Sub-district with 21,567 cases, and the most hypertension sufferers were in Gambirsari Health Center with 6,751 cases (Health Service of Surakarta City, 2024). The increasing prevalence of hypertension is closely linked to unhealthy dietary habits,

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sedentary lifestyles, and obesity. If left untreated, hypertension can lead to severe complications such as stroke, heart failure, and kidney disease (Mills et al., 2020). In Indonesia, herbal medicine is widely regarded as a complementary and alternative treatment option for hypertension, and herbal remedies enhance these patients' overall health and well-being (Panjaitan et al., 2024).

In recent years, dietary interventions have gained significant attention in the management of hypertension. Functional foods and beverages rich in bioactive compounds are increasingly being explored as natural alternatives to synthetic antihypertensive drugs (Ajeigbe et al., 2021). Among these bioactive compounds, flavonoids, particularly quercetin, have demonstrated notable potential in lowering blood pressure through mechanisms such as enhancing endothelial function, increasing nitric oxide bioavailability, and reducing oxidative stress (Larson et al., 2021). The antioxidant and anti-inflammatory effects of quercetin may contribute to its antihypertensive effects and endothelial cell health. Quercetin and its metabolites inhibit the renin-angiotensin (RA) system and enhance nitric oxide production, reactive oxygen species generation, and vascular endothelial cell inflammation, which may contribute to improving endothelial dysfunction. Quercetin acts directly on vascular endothelial cells to block hypertension (Yamagata, 2024).

Physalis angulata L., commonly known as Ciplukan, is a tropical fruit widely distributed in Southeast Asia and South America. It has been traditionally used in herbal medicine for its anti-inflammatory, antioxidant, and antihypertensive properties (Muñoz et al., 2021). Ciplukan is a medicinal plant and its cultivation prospects are good for increasing growth, yield, and fruit quality (Yamika et al., 2023). Ciplukan contains significant amounts of quercetin, a potent flavonoid known to exert vasodilatory effects and improve cardiovascular health. Studies have shown that extracts from Ciplukan exhibit antihypertensive activity through various mechanisms, including inhibition of angiotensin-converting enzyme (ACE), reduction of oxidative stress, and modulation of nitric oxide pathways (Anh et al., 2021). Ciplukan is the fruit with the highest anti-inflammatory activity in *in vitro* tests, with a strong ability to lower nitric oxide (Castro et al., 2025). Ciplukan extracts and its processed products, such as juice (Iwansyah et al., 2022), kombucha (Rindiani and Suryani, 2023), tea (Habib and Suriyani, 2023), and yogurt (Agil et al., 2019), have shown significant benefits in a variety of medical conditions, including skin fibrosis (Dewi et al., 2019), diabetes mellitus (Dewi et al., 2018), hypertension (Husna et al., 2019), hypercholesterolemia (Reyes-Beltrán et al., 2015), and dyslipidemia (Rafika et al., 2022).

Ciplukan is a functional plant because it contains various chemical compounds that benefit health. In 100 g Ciplukan fruit in West Java Indonesia, contains phenol 44.46 mg GAE, flavonoids 1.30 mg, anthocyanins 0.32 mg, and carotene 8.48 ppm (Krisanty et al., 2023). The phytochemical content of ground cherries in Egypt is phenol (125.4 mg g DW^{-1}), flavonoids (6.39 mg g DW^{-1}), tannins (14.8 mg g DW^{-1}), alkaloids (3.37 g 100 g DW^{-1}), anthocyanins (6.68 µg 100 g FW^{-1}), and carotenoids (1.53 mg 100 g FW^{-1}) (El-Beltagi et al., 2019). Ciplukan in the northeastern region of Portugal is rich in fiber (5.16 g 100 g^{-1}), low in fat (0.49 g 100 g^{-1}), and low in energy (67.8 kcal 100 g^{-1}), contains vitamin C (32 mg 100 g^{-1}), γ-tocopherol, and essential minerals such as potassium, magnesium, and phosphorus (Añibarro-Ortega et al., 2025). In this study, Ciplukan will be served in the form of juice. Based on research by Luthfiyanti et al. (2023), Ciplukan juice has strong potential as a functional drink due to its rich content of bioactive compounds such as flavonoids, saponins, and essential minerals, which are beneficial for human health, particularly in managing hypertension and oxidative stress.

Hypertension is a growing health concern with significant socioeconomic burdens. Conventional antihypertensive drugs, such as ACE inhibitors and calcium channel blockers, are effective but often associated with adverse side effects, including dizziness, fatigue, and electrolyte imbalances (Maaliki et al., 2019). This necessitates the exploration of natural, plant-based alternatives that can offer similar benefits with fewer side effects. In previous studies, no one has tested the quercetin content in Ciplukan juice, while in this study, the quercetin content in 250 ml of ground cherry juice was tested. Ground cherry juice was also given to hypertensive patients for 30 days, while in previous studies, it was given to mice for 7 days. This research addresses the gap in scientific studies concerning the use of Ciplukan juice as a nutritional therapy for hypertension. This study

aims to evaluate the application of Ciplukan juice as a nutritional therapy on systolic and diastolic blood pressure in patients with hypertension in Gambirsari Health Center, Surakarta, Indonesia.

MATERIALS AND METHOD

Study design and participants

This research was quasi-experimental and used a pre-test and post-test with a control group design. The population in this study were hypertension sufferers at the Gambirsari Health Center, Surakarta City. Inclusion criteria subjects are (1) outpatients with primary diagnosis, blood pressure ≥ 140 mmHg and diastolic ≥ 90 mmHg, (2) age 45 to 65 years, (3) gender male and female, and (4) taking standardized drug amlodipine 5 mg. Subjects were excluded if 1) pregnant and 2) having complications from other diseases, such as cancer, stroke, heart failure, or kidney failure as known from anamnesis and medical records. The subjects of this research were 50 people who met the inclusion and exclusion criteria. Ciplukan fruit taken from Bandung Farm, West Java Indonesia. Three subjects dropped out because they were out of town and the subject was unwilling to continue, so the number of subjects who took part in this research until completion was 47, with details of 23 subjects in the control group and 24 subjects in the treatment group.

The quercetin content in the 250 ml Ciplukan juice was analyzed using High-Performance Liquid Chromatography (HPLC) at UPT Integrated Laboratory Universitas Diponegoro Semarang, Central Java, Indonesia. Testing for quercetin content in Ciplukan juice involved extracting 5 ml of juice with 25 ml of 70% methanol using ultrasonication at 30 ℃ for 20 minutes. The extract was stored at -20 ℃ for 24 hours and then filtered using a 0.45 µm membrane filter. A 20 µl aliquot of the filtrate was injected into a Shimadzu LC system equipped with a UV-Vis detector (SPD-20AV) and a Purospher® STAR C18 column (250 mm × 4.0 mm, 5 µm). The mobile phase consisted of methanol:acetonitrile:water (60:20:20, v/v), with a flow rate of 1.1 ml minute^{-1} and a column temperature of 30 ℃. Detection was performed at a wavelength of 254 nm.

Instruments and variables

The instruments used during the study were informed consent, respondent identity form, Ciplukan juice consumption compliance form, and pre-test and post-test sheets. Blood pressure was measured using a sphygmomanometer.

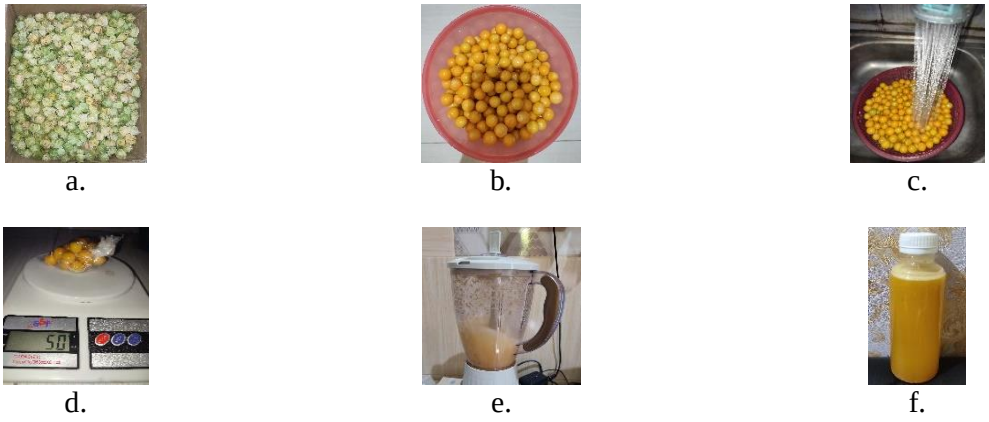
Treatment

This study used two groups: a control and a treatment group. The control group was given amlodipine once per day and received nutrition education. The intervention group received amlodipine, nutrition education, and 250 ml day^{-1} of Ciplukan juice. The allocation of participants into control and treatment groups was carried out using random sampling techniques. To prevent information exchange between groups, the researchers, assisted by enumerators, explained to participants and their families the importance of maintaining the confidentiality of the intervention to ensure the validity of the research results. The research was conducted over 30 days (November 2024).

The dose of Ciplukan juice used in this study was determined based on a conversion from animal (rats) dosage reported by Husna et al. (2019), with several modifications to the ingredients. The dose rats to humans used a formula based on Body Surface Area (BSA) normalization. In the animal study, 1.8 ml was administered to a 200 g rat, equivalent to 9 ml kg^{-1} body weight. Converting to a human dose resulted in 0.729 ml kg BW^{-1}. Assuming an average human body weight of 60 kg, the dose for humans was calculated as 43.74 ml day^{-1}.

To meet this dose, and given that 1 g of Ciplukan fruit produces approximately 0.9 ml of juice, the amount of fresh Ciplukan fruit required was calculated using the formula: human juice dose ÷ juice yield per g of fruit = 43.74 ml ÷ 0.9 ml g^{-1} = 48.6 g. This value was rounded to 50 g of fresh Ciplukan fruit.

There is no national standard for the production of ground cherry juice, but the manufacturing process is carried out with hygienic principles and based on general guidelines for making juice (Figure 1). The juice formulation consisted of 50 g of fresh Ciplukan fruit, 2 g of low-calorie sugar, and water, resulting in a final volume of 250 ml per serving per day. The juice preparation process included the following steps: (1) the fruits were separated from their calyces, (2) fresh and ripe fruits were selected, (3) the fruits were washed under running water to remove dirt and residues, (4) 50 g of fruit were weighed, (5) the fruits were blended with low-calorie sugar and water until a smooth pulp



a. b. c.

d. e. f.

Figure 1. Process of making Ciplukan juice; a. fresh Ciplukan fruits (ripe); b. clean fruits (removing the small green calyx at the bottom of each fruit); c. wash the fruits; d. weighing fruit; e. blend the Fruits; f. serve the juice

was formed, and (6) the resulting juice was poured into 250 ml bottles and stored, ready for consumption.

Ethical considerations

This research has received approval from the Research Ethics Commission of the Faculty of Medicine, Universitas Sebelas Maret, with letter number 204/UN27.06.11/KEP/EC/2024. The nurses responsible for measuring blood pressure were blinded to the participants' group allocation (intervention or control), ensuring that the measurements were conducted objectively and free from treatment-related bias. If any complications arise in the respondents, such as dizziness or feeling unwell, the attending physician at the health center will promptly conduct a medical examination. The researcher will fully cover any medical expenses incurred as a result of ensuring the safety and well-being of the participants.

Statistical analysis

Test of normality using the Shapiro-Wilk method. The comparative test for differences in mean blood pressure between the control and treatment groups used the Mann-Whitney U Test because there was data that was not normally distributed. A comparative test of differences in mean blood pressure before and after intervention in two paired groups using the Wilcoxon signed rank test for data that is not normally distributed. Statistical data analysis using SPSS 25.

RESULTS AND DISCUSSION

The characteristics of the respondents in this research are gender, age, nutritional status, education, history of hypertension, and smoking. Based on Table 1, in the control group and the Ciplukan juice group, the female gender is more dominant. These results are the same as research conducted by Islam et al. (2020). Women are more likely to suffer from hypertension because decreased estrogen after menopause can lead to decreased blood vessel elasticity, increased vascular resistance, and blood pressure (Visniauskas et al., 2023). The age of the subjects is more in the range of 51 to 60 years. After age 30, the rise in blood pressure in women is higher than in men (Vriend et al., 2024). The nutritional status that is more dominant based on the Asia-Pacific Body Mass Index (BMI) in both groups is obesity I. In obese individuals, sodium reabsorption is increased the kidneys and activation of the sympathetic nervous system, causing blood pressure to increase (Nawi et al., 2021).

The educational background of both groups was similar, with most participants having a high school education. Education affects hypertension, which is related to low health literacy. Lower levels of education are associated with an increased risk of hypertension and poor blood pressure (Sun et al., 2022). Educational interventions can help improve patient knowledge and adherence to lifestyle changes, which may improve blood pressure control (Tam et al., 2020). Most participants in both groups had no history of hypertension. Genetic factors contribute to the risk of hypertension, their influence is relatively small, and no single gene predominantly causes this condition (Singh et al., 2023). In both groups, the subjects who do not smoke are more

Table 1. Frequency distribution based on research subject characteristics in the control and Ciplukan juice groups

Subject characteristics	Control		Ciplukan juice		*p*-value
	n	%	n	%	
Gender					
Male	3	13.04	5	20.83	0.477[a]
Female	20	86.96	19	79.17	
Age (year)					
45-50	2	8.69	3	12.50	0.978[a]
51-60	13	56.53	13	54.17	
61-65	8	34.78	8	33.30	
Nutritional status (BMI)					
Normal	8	34.78	6	25.00	0.600[a]
Overweight	3	13.04	5	20.80	
Obesity I	10	43.48	10	41.70	
Obesity II	2	8.70	3	12.50	
Education					
No school	4	17.39	2	8.33	0.204[a]
Elementary school	8	34.78	6	25.00	
Junior high school	-		5	20.83	
High school	9	39.13	9	37.50	
College	2	8.70	2	8.33	
History of hypertension					
Father	1	4.35	1	4.17	0.762[a]
Mother	3	13.04	6	25.00	
Father and mother	7	30.43	7	29.17	
None	12	52.17	10	41.67	
Smoking					
Yes	2	8.70	1	4.20	
No	21	91.30	23	95.80	0.525[a]

Note: [a] = Chi-square test. Baseline participants = 25 control group and 25 Ciplukan juice group

dominant. Longitudinal study by Luehrs et al. (2021) followed participants for 30 years and found that systolic blood pressure did not differ significantly between consistent smokers and non-smokers.

The chi-square test results showing a *p*-value > 0.05 are the characteristics of the subjects based on gender, age, nutritional status, education, history of hypertension, smoking, systolic blood pressure, diastolic blood pressure, potassium intake, calcium intake, and magnesium intake. A *p*-value > 0.05 means that there is no significant difference in the characteristics of the subjects between groups, so both groups are considered homogeneous.

Ciplukan is a wild plant that grows abundantly around residential areas, fields, and rice fields. This fruit is processed into juice so the subjects can easily consume it. From the research results, this fruit is known as a superfruit because it has pharmacological activities such as antibacterial, anticancer, antiparasitic, anti-inflammatory, antifibrotic, and antidiabetic (Novitasari et al., 2024), especially as an antihypertensive (Laia, 2022). The 100 g of Ciplukan fruit contains 585 mg of potassium, 13 mg of calcium, 24 mg of magnesium, 1.20 g of flavonoids, and has an antioxidant activity of 19.06 mg ml^{-1} (Permatasari et al., 2024). According to a review by Ambarwati and Pujiati (2024), Ciplukan fruit contains flavonoids and saponins, which play a role in lowering blood pressure. Flavonoids can inhibit the activity of the ACE, which converts angiotensin I into II, a compound that causes vasoconstriction and increases blood pressure. By inhibiting ACE, flavonoids support vasodilation and the reduction of blood pressure (Chen et al., 2021).

The findings of this study (Table 2) show a significant difference (*p*-value: 0.000) in

systolic blood pressure in the control group between before and after treatment. In the Ciplukan juice group, there was also a significant difference in systolic blood pressure (*p*-value: 0.000) between before and after treatment in the form of 250 ml day^{-1} juice for 30 days. Based on the Mann-Whitney test, there was no significant difference in systolic blood pressure (*p*-value: 0.822) in the control and juice groups before treatment. For the results after being given treatment in the control group and Ciplukan juice, the statistical results showed that there was no significant difference in systolic blood pressure in the two groups (*p*-value: 0.434). However, the average difference in the decrease in systolic blood pressure in the juice group was greater (-20.5) than in the control (-15.8).

Table 3 shows significant difference (*p*-value: 0.036) in diastolic blood pressure in the control group before and after treatment. In the Ciplukan juice group, there was a significant difference in diastolic blood pressure (*p*-value: 0.000) between before and after treatment in the form of providing juice 250 ml day^{-1} for 30 days. Based on the Mann-Whitney test, there was no significant difference in diastolic blood pressure (*p*-value: 0.852) in the control and juice groups before treatment. After being given treatment in the control group and Ciplukan juice, the statistical results showed a significant difference in diastolic blood pressure in the two groups (*p*-value: 0.015). The results of the average difference in the decrease in diastolic blood pressure in the juice group were greater (-10.8) than in the control group (-4.2).

A greater reduction in blood pressure was observed in the group that consumed 250 ml day^{-1} of Ciplukan juice for 30 days. This effect was attributed to the additional potassium intake in the juice, amounting to 292 mg 250 ml^{-1} since 50 g of Ciplukan fruit was used per serving. The potassium content in Ciplukan juice helps reduce blood pressure by counteracting the effects of sodium in the body and aiding in blood vessel dilation (Filippini et al., 2020). Potassium in the Ciplukan juice can reduce blood pressure by increasing sodium and water excretion in the urine, similar to the mechanism of diuretics. High potassium intake increases its concentration in intracellular fluid, drawing fluid from the extracellular space and lowering blood pressure (Staruschenko, 2018).

Potassium in Ciplukan juice lowers both systolic and diastolic blood pressure by inhibiting the release of renin, thereby promoting sodium and water excretion. Renin circulates in the blood and catalyzes the conversion of angiotensinogen into angiotensin I. Angiotensin I is then converted into its active form, angiotensin II, by the enzyme ACE. Angiotensin II has a strong potential to raise blood pressure due to its vasoconstrictor properties and role in stimulating aldosterone secretion. Aldosterone increases blood pressure by promoting sodium retention. Potassium counteracts sodium and water retention, decreasing plasma volume, cardiac output, and blood pressure (Staruschenko, 2018). In addition, potassium maintains endothelial cell function by enhancing nitric oxide production, which contributes to lowering both systolic and diastolic

Table 2. Difference in systolic blood pressure before and after treatment

Group	Mean±SD systolic blood pressure subject (mmHg)			
	Before (pre-test)	After (post-test)	Δ	p^a
Control	149.7±10.7	133.9±15.1	-15.8	0.000
Ciplukan juice	151.3±13.8	130.8±29.5	-20.5	0.000
p^b	0.822	0.434		

Note: Δ = Mean difference before and after treatment; p^a = Wilcoxon statistic result; p^b = Mann-Whitneystatistic result

Table 3. Difference in diastolic blood pressure before and after treatment

Group	Mean±SD diastolic blood pressure subject (mmHg)			
	Before (pre-test)	After (post-test)	Δ	p^a
Control	92.2±5.4	88.0±10.4	-4.2	0.036
Ciplukan juice	91.9±5.5	81.1±7.2	-10.8	0.000
p^b	0.852	0.015		

Note: Δ = Mean difference before and after treatment; p^a = Wilcoxon statistic result; p^b = Mann-Whitneystatistic result

blood pressure through vasodilation or relaxation of vascular smooth muscle (Carlström, 2021).

Magnesium in Ciplukan also contributes to the relaxation of vascular smooth muscle, helping to reduce blood pressure (AlShanableh and Ray, 2024). In this study, the magnesium content in 250 ml of Ciplukan juice was 12 mg. Magnesium functions as a vasodilator in blood pressure regulation. It acts as an inhibitor of vascular smooth muscle contraction. Inadequate magnesium intake can lead to arterial and capillary constrictions, increasing blood pressure (Kostov and Halacheva, 2018). Magnesium also plays a role in producing vasodilatory prostacyclin and nitric oxide by modulating the reactivity and movement of blood vessels (Dominguez et al., 2021).

A study by Munthe and Sembiring (2023) showed that consuming Ciplukan fruit by pregnant women with hypertension significantly reduced blood pressure. In this study, the group that consumed Ciplukan fruit experienced a statistically significant decrease in systolic and diastolic blood pressure (p = 0.000). In contrast, the control group that did not consume Ciplukan fruit showed no significant changes in blood pressure. Another study by Trivadila et al. (2022) demonstrated that 30% ethanol extract of Ciplukan herb exhibited an ACE-inhibitory activity of 18.5%. Since ACE plays a key role in blood pressure regulation, its inhibition can aid in reducing blood pressure. Furthermore, Husna et al. (2019) reported that Ciplukan juice was more effective in lowering blood pressure than cucumber juice.

The analysis shows a decrease in systolic blood pressure in both groups after intervention. The control group decreased from 149.7 to 133.9 mmHg, while the Ciplukan juice group decreased from 151.3 to 130.8 mmHg, indicating a greater reduction in the juice group (Figure 2). Both groups experienced a decrease in diastolic blood pressure after the intervention. The control group showed a modest reduction of 4.2 mmHg (from 92.2 to 88.0 mmHg), likely due to the effect of nutrition education. In contrast, the juice group demonstrated a more substantial reduction of 10.8 mmHg (from 91.9 to 81.1 mmHg) (Figure 3), suggesting that regular consumption of Ciplukan juice may have an additional antihypertensive effect. The greater decline in the intervention group indicates the potential role of bioactive compounds in Ciplukan juice in supporting blood pressure regulation. The control and juice groups showed a decrease in blood pressure, which may also be attributed to structured educational interventions that improved nutritional knowledge, attitudes, and behaviors, ultimately contributing to better blood pressure control (Kafi et al., 2023).

This study tested quercetin in Ciplukan juice using HPLC. From the test results, Ciplukan juice contains a quercetin concentration of 561.047 ppm. This concentration value indicates that Ciplukan juice contains relatively high quercetin compounds. According to Zhang et al. (2021), the intensity and quality of light accumulate phenolic, flavonoid, and quercetin compounds in medicinal plants, where increasing light intensity can increase the production of these compounds.

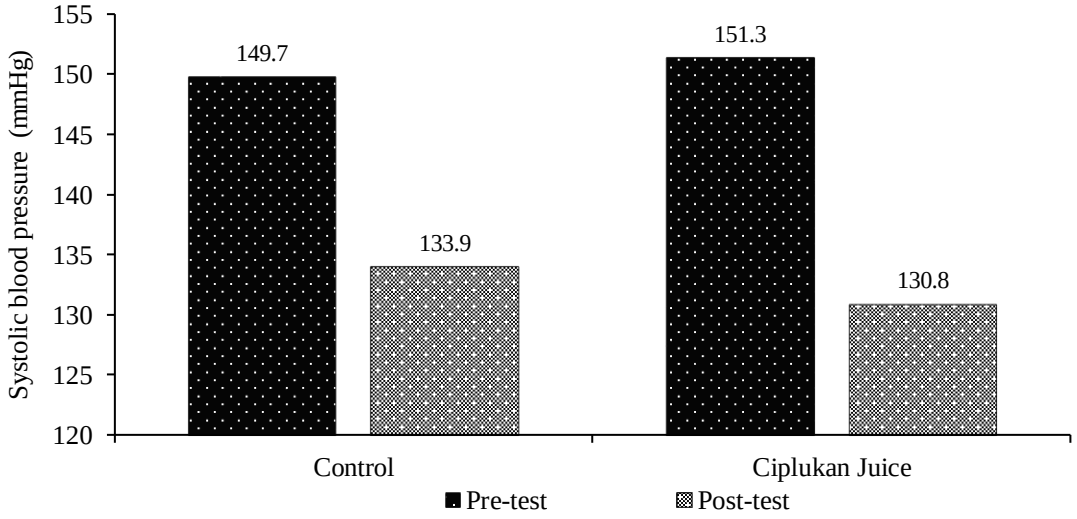


Figure 2. The effect of Ciplukan juice on the systolic blood pressure before and after treatment

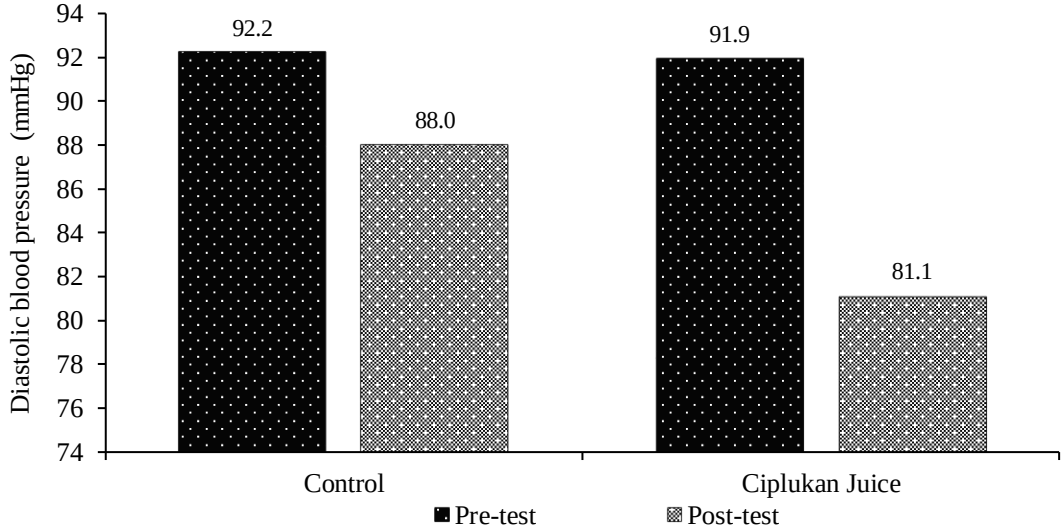


Figure 3. The effect of Ciplukan juice on the diastolic blood pressure before and after treatment

Environment, including water availability and temperature, can affect the chemical composition of medicinal plants, which in turn affects the quality and quantity of active compounds produced (Punetha et al., 2022). In a previous study by Kinasih et al. (2020), ground cherry juice contains 20.775 µg ml^{-1} of juice using HPLC. In comparison, the quercetin content in apples (especially in the skin) only ranges from 100 to 400 ppm, while raw shallots range from 300 to 500 ppm. Therefore, the quercetin content of 561 ppm in Ciplukan juice shows good potential as a source of natural antioxidants. Quercetin in Ciplukan juice contributes to antioxidant activity, anti-inflammatory, and other pharmacological effects that support the use of this fruit as a raw material for functional drinks (Ramakrishna Pillai et al., 2022).

A meta-analysis study by Popiolek-Kalisz and Fornal (2022) involving 10 randomized controlled trials (RCTs) with a total of 841 participants showed that quercetin supplementation significantly reduced systolic blood pressure by 2.38 mmHg and diastolic blood pressure by 3.14 mmHg in individuals with pre-hypertension or hypertension. Proposed mechanisms include increased bioavailability of nitric oxide, which plays a role in vasodilation and inhibition of ACE activity, contributing to lower blood pressure. The effective dose of quercetin to lower blood pressure is ≥ 500 mg day^{-1} (Noshadi et al., 2024). In this study, quercetin content in Ciplukan juice is known to be 561.047 ppm (which means 561.047 mg l^{-1}). Then to find out the quercetin content in 250 ml of juice, researchers calculate: 561.047 mg l^{-1} × 0.25 l = 140.26 mg.

CONCLUSIONS

Consuming Ciplukan juice 250 ml day^{-1} for 30 days was suggested to reduce blood pressure in hypertension effectively. In 250 ml of Ciplukan juice, there is 140.26 mg of quercetin, which can help increase quercetin intake so that blood pressure decreases or is controlled. In further research, variations in the dose of Ciplukan juice can be carried out in each group so that the most effective dose for lowering blood pressure can be determined.

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