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REVIEW

Potential and mechanism of celery as a supportive therapy for hypertension: A review

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Abstract

Background: Celery (Apium graveolens L.) shows promise as a medicinal plant with significant potential for supportive therapy in hypertension. Research indicates that the combination of celery with synthetic antihypertensive drugs lowers blood pressure more effectively than using either component alone. **Objective:** To highlight the potential and mechanisms of celery in managing hypertension and encourage further research on its application in various easy-to-consume dosage forms. **Method:** Both national and international journals were searched on search engines, including Google Scholar, NCBI, PubMed, and several others, using keywords such as celery, content, hypertension, medicinal plants, and Apium graveolens. The data analysis used for evaluation was conducted through descriptive analysis. **Results:** Celery contains bioactive compounds such as Luteolin, Linalool, D-limonene, Apigenin, 3-n-butylphthalide, Kalium, Asparagine, Phthalides, Magnesium and other related compounds. The compounds play vital roles in controlling hypertension through several mechanisms, including the vasodilation of blood vessels. **Conclusion:** Celery has great potential as a supportive therapy for hypertension through various mechanisms of active compounds found in celery. Furthermore, advancements in celery-based medical formulations can enhance the ease of utilising celery as an adjunct therapy.

Introduction

Herbal medicines are medicinal products that contain herbal substances, herbal preparations, or a combination of both as the active components. Herbal medicine has become a popular trend worldwide, with a usage rate reaching 80% of the world's population. Several developed countries in the world have used herbal medicine, with an average percentage reaching 50%. The large percentage comes from several developed countries, namely North America, Europe, and other developed countries such as Australia (48%), France (49%), and Canada (70%). In its utilisation, almost all parts of the medicinal plant can be utilised. Several components of the plant, such as roots, stems, wood, bark, leaves, flowers, fruit, seeds and whole plants, can be utilised because they contain secondary metabolites that can provide pharmacological effects if processed and utilised correctly. These medicinal plants can be processed into various preparations before being used or eaten. These medicinal plants can be utilised in a dry form, either as powder or dried slices. The public often perceives medical plants as a more natural and safer alternative to synthetic pharmaceuticals, offering the advantages of easy accessibility and affordability. This makes them an appealing option for individuals seeking alternative or complementary therapies. Patients with non-chronic diseases who require long-term treatment prefer herbal medicines as an alternative treatment to replace synthetic drugs (EORIB, 2021).

One of the plants that can be used as a medicinal plant is celery, also known as *Apium graveolens*. Celery (*Apium graveolens*) is a vegetable belonging to the Apiaceae family, native to regions across Asia, Europe, and parts of Africa with tropical climates. However, its cultivation has now expanded to various parts of the world. As a biennial herbaceous plant, celery typically

grows to a height of up to one meter. It is characterised by its sturdy, grooved stems and pinnate to bipinnate leaves, consisting of triangular, rhombic, or spear-shaped leaflets, measuring approximately five to 50 mm in length. The edges of the leaves are notched and serrated, with a distinctive celery aroma. Almost all components of the celery plant, including the seeds, foliage, and stems, possess therapeutic properties that can be utilised to treat various ailments. These conditions include gout, rheumatism, urinary tract infections (UTIs), arthritis, and diabetes, as well as offering potential neuroprotective effects. In addition, celery can also be used as a diuretic to stimulate the glands, gallbladder, and kidneys, regulate bowel function, increase appetite, and is especially helpful in treating patients with hypertension. The use of celery as a medicinal plant is based on various secondary metabolite contents such as flavonoids, phenolic acids, furocoumarins, terpenoids, and phthalates (contents that give celery its distinctive aroma). In general, people are still largely unaware that celery is a beneficial herbal plant for human health, particularly in the treatment of various diseases (Khairullah *et al.,* 2021; Yan *et al.,* 2022).

Hypertension is acknowledged as the leading modifiable risk factor for cardiovascular disease (CVD), which includes a variety of serious health issues such as coronary artery conditions, heart failure, cerebrovascular accidents, myocardial infarction, and diseases affecting peripheral arteries. Additionally, hypertension is linked to various chronic diseases and cognitive decline, highlighting its profound implications for public health. The World Health Organisation identifies hypertension as a leading contributor to global mortality and disability, highlighting the urgent need for effective management and intervention strategies. The incremental and continuous association between blood pressure (BP) and cardiovascular disease (CVD) risk begins at values as low as 115/75 mmHg, which remains within the normotensive range. The relationship is exponential, where systolic pressure is more substantial than diastolic pressure.

High blood pressure (>180/110 mmHg) or rapidly increasing, as in untreated eclampsia, can overcome normal microvascular autoregulation. Hypertension is categorised into three distinct stages. The initial stage of hypertension is characterised by a systolic blood pressure between 140 and 159 mmHg or a diastolic blood pressure ranging from 90 to 99 mmHg, signifying the early indications of hypertension. The subsequent stage is defined by a systolic blood pressure of 160 to 179 mmHg or a diastolic blood pressure between 100 and 109 mmHg. The advanced stage, commonly referred to as stage three hypertension, is characterised by a systolic blood pressure of 180 mmHg or greater, or a diastolic blood pressure of 110 mmHg or higher. Therefore, it is hoped that the use of celery medicinal plants as an alternative therapy for treating hypertension patients can help reduce patient risk factors and maintain patient health in the future with minimal side effects (Gabb, 2020). Based on the initial explanation, a literature study was conducted to examine the potential of celery as an alternative treatment for high blood pressure or hypertension.

Methods

This study involved a reference search in both national and international journals using search engines, including Google Scholar, NCBI, PubMed, and several others, assisted by the use of keywords such as celery, content, hypertension, medicinal plants, and Apium graveolens. The collected journal articles comprised six journals, sorted by year of publication, ranging from 2014 to 2024. Additionally, several journal articles were selected based on their completeness and suitability in relation to the criteria and themes of the literature review. The data analysis used for evaluation was conducted using descriptive analysis.

Results

Celery's mechanism in treating hypertension

Based on a thorough literature search, celery (*Apium graveolens* L.) has been shown to contain multiple bioactive compounds which also show antihypertensive mechanisms. Table I summarises the bioactive compounds and their antihypertensive mechanisms.

Table I: Summary of bioactive compounds in celery (*Apium graveolens* L.) and their antihypertensive mechanisms, based on literature

Journal title	Author	Content	Mechanism
"*Antihypertensive Property of Celery: A Narrative Review on Current Knowledge*"	Alobaidi & Saleh, 2024	3-n Butylphthalide	Based on this study, 3-n-butylphthalide has several mechanisms that provide antihypertensive effects in patients, including blocking voltage-operated calcium channels and receptors, reducing oxidative stress and the expression of IL-6, NF-κB, and TNF-α, as well as inducing vasodilation and diuretic effects.
		Apigenin	Apigenin exerts its effects by enhancing the expression of angiotensin-converting enzyme 2 (ACE2) and inhibiting the activity of calcium channels.
		D-limonene	D-limonene, in its role in lowering high blood pressure, acts as a good antioxidant.
		Linalool	Linalool provides a vasodilating effect (widening of blood vessels) in its role in lowering high blood pressure or hypertension.
		Luteolin	Luteolin has a mechanism by inhibiting the proliferation and migration of angiotensin II.
"*The Effectiveness of Celery Boiled Water on Lowering Blood Pressure in the Elderly with Hypertension in the Working Area of The Simalingkar Public Health Centre in 2020*"	Simamora *et al*, 2022	Magnesium and phthalides	The results of this study indicate that magnesium and phthalide play a role in relaxing blood vessels.
		Apigenin	Apigenin prevents abnormal vascular dilation and blood pressure elevation.
		Kalium and asparagine	Potassium and asparagine have diuretic properties, which increase urine production, thereby decreasing blood volume and blood pressure.
"*Tisane Celery as A Non-Medical Therapy in Hypertension Patients*"	Indrawati & Yulianto, 2022	3-n Butylphthalid	According to this research, 3-n-Butylphthalide has a mechanism that reduces hypertension and acts as a vaso-relaxant. The vasorelaxant potential of phthalide can block systolic blood pressure in mice by preventing calcium entry into its receptor channels.
"*The Influence of Celery Juice Against Blood Pressure Reduction in Hypertension*"	Cholifah *et al.,* 2019	Phthalides and magnesium	This study emphasises that phthalides and magnesium play a crucial role in relaxing the smooth muscles surrounding the arteries, thereby aiding in the normalisation of arterial constriction. Additionally, phthalides have been shown to reduce levels of stress hormones, which are known to contribute to elevated blood pressure.
"*Effect of Administration of Combination of Captopril and Celery Extract on Blood Pressure and Electrolyte Levels of Hypertensive Rats*"	Siska *et al.,* 2020	Apigenin, luteolin, and crysoeriol	In this study, apigenin and luteolin enhance nitric oxide (NO) production by regulating the expression of mRNA for endothelial nitric oxide synthase (eNOS), which facilitates vasodilation. Luteolin can also cause vasorelaxation of the aortic blood vessels. This mechanism allows celery to work synergistically with synthetic drugs (such as captopril) to lower blood pressure.
"*Evaluation of mechanism for antihypertensive and vasorelaxant effects of hexanic and hydroalcoholic extracts of celery seed in normotensive and hypertensive rats*"	Sabzevar *et al.,* 2016	Apigenin, linalool, d-limonene, and other related compounds.	Celery seed extract shows significant potential in reducing blood pressure through vasorelaxation mechanisms that involve both endothelial-dependent and endothelial-independent pathways. This effect is due to the production of prostaglandin and d-limonene activity in celery seeds. Additionally, it may offer benefits in improving lipid profile and antioxidant status. These findings highlight the promising role of celery seed extract as a natural agent for managing hypertension and enhancing overall cardiovascular function, offering a comprehensive approach to cardiovascular health.

Celery's potential as an antihypertensive therapy

In the literature search, the bioactive compounds in celery (Apium graveolens L.) and their parts, along with a summary of their involvement in antihypertensive therapy, are presented in Table II. This also includes several innovations in the form of preparations and research results.

Table II: Summary of research on bioactive compounds in celery and their antihypertensive mechanisms, based on literature

Journal title	Author	Parts of the plant used	Result
"*Antihypertensive Property of Celery: A Narrative Review on Current Knowledge*"	Alobaidi & Saleh, 2024	All of the parts	This journal discusses the function of celery in the treatment of hypertensive patients. This celery-based intervention is designed to manage high blood pressure and prevent other complications in patients with the condition. Reported in other scientific literature regarding the mechanisms and potential of the celery plant. Therefore, celery can be utilised as an antihypertensive agent due to its dose-response relationship, where both are significant factors in disease prevention and treatment strategies.
"*The Effectiveness of Celery Boiled Water on Lowering Blood Pressure in the Elderly with Hypertension in the Working Area of the Simalingkar Public Health Centre in 2020*"	Simamora *et al.*, 2022	All of the parts (Boiled water of celery)	A study involving 20 patients with hypertension revealed that those who consumed a celery decoction experienced a significant reduction in average blood pressure. Initially, their average systolic blood pressure was 163 mmHg, and their diastolic blood pressure was 99 mmHg. After one week of treatment, the systolic pressure dropped to 148 mmHg and the diastolic pressure to 89 mmHg, marking decreases of 15 mmHg and 10 mmHg, respectively. Statistical analysis confirmed these reductions were significant, indicating that celery leaf decoction may effectively lower blood pressure in hypertensive individuals.
"*Tisane Celery as a Non-Medical Therapy in Hypertension Patients*"	Indrawati & Yulianto, 2022	Leaves (Tisane Celery)	This study examines the potential of celery leaves as a non-pharmacological treatment option for individuals with hypertension, highlighting their therapeutic properties and the feasibility of incorporating them into dietary regimens for blood pressure management. However, one of the novel innovations in this study is the introduction of celery tisane, an herbal infusion made from celery leaves steeped in warm water, as a therapeutic option for hypertension. This preparation method preserves the plant's natural compounds, potentially offering health benefits such as reduced blood pressure.
"*The Influence of Celery Juice Against Blood Pressure Reduction in Hypertension*"	Cholifah *et al.,* 2019	All parts of the celery plant can be made into celery juice.	The study concludes that celery juice significantly lowers blood pressure in the population of Bakalan Village, Jepara, as evidenced by a p-value of 0.000, with a strong inverse relationship with systolic blood pressure (correlation coefficient of -0.623) and a moderate inverse relationship with diastolic blood pressure (correlation coefficient of -0.525), which shows a strong inverse relationship with systolic and a moderate inverse relationship with diastolic blood pressure. Research on celery juice suggests that it is effective in managing hypertension.
"*Effect of Administration of Combination of Captopril and Celery Extract on Blood Pressure and Electrolyte Levels of Hypertensive Rats*"	Siska *et al.,* 2020	All parts of the celery	This research evaluates the effects of a single dose of captopril alone versus a combination therapy of captopril and celery extract. The results show that the combination significantly reduces blood pressure in hypertensive rats induced by 4% NaCl, with a decrease of 42.34% in systolic and 42.28% in diastolic pressure. This effect is achieved through diuresis, natriuresis, and vasorelaxation, which lower fluid volume and widen blood vessels. Additionally, flavonoids in celery, such as apigenin and luteolin, enhance nitric oxide production, thereby aiding vasodilation. The combination therapy outperforms captopril or celery extract alone, further increasing sodium and potassium excretion to support blood pressure reduction.
"*Evaluation of mechanism for antihypertensive and vasorelaxant effects of hexanic and hydroalcoholic extracts of celery seed in normotensive and hypertensive rats*"	Sabzevar *et al.,* 2016	Seeds (Hexane extract)	A study on celery (Apium graveolens) seed extracts revealed significant antihypertensive properties. The hexane extract exhibited a notable hypotensive effect in an invasive rat model by inhibiting vasoconstriction induced by phenylephrine and potassium chloride (KCl) in isolated rat aortas through both endothelial and non-endothelial mechanisms. This vasodilatory action is linked to n-butylphthalide (NBP) in the seeds. Participants experienced significant reductions in systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial blood pressure (MABP), and heart rate (HR) after receiving the extract. Hexane extract exhibits hypotensive effects through bradycardia and vasodilatory mechanisms. The active compounds in celery seed extract function as calcium channel blockers, impacting both endothelial-dependent and independent pathways. While its vasorelaxant efficacy is weaker than nifedipine, the findings highlight that the extract primarily induces vasodilation by disrupting calcium levels, both extracellularly and intracellularly.

Discussion

Celery is a widely accessible vegetable commonly found in markets. Renowned for its unique aroma and flavour, it is frequently used as a culinary enhancer to elevate the smell and taste of dishes. Additionally, celery contains a variety of bioactive compounds, also known as secondary metabolites. Based on this diverse content, celery may be considered to have pharmacological effects, allowing it to treat several diseases. Some celery contents that can provide pharmacological effects as antihypertensives are apigenin, apin, asparagine, choline, vitamins (A, B and C), 3-n-Butylphthalide, D-limonene, Linalool, Luteolin, nitrate, magnesium, and phytosterol. All of this content can make celery one of the choices of traditional antihypertensive therapy drugs that are strong enough to be consumed. Moreover, each of these contents has a different mechanism in lowering high blood pressure (Simamora *et al.,* 2022; Oktarina & Rahmawaty, 2023; Alobaidi & Saleh, 2024).

In general, celery can lower high blood pressure through several mechanisms, including increasing the excretion of electrolytes (sodium and potassium) through diuresis, as well as vasodilation, chronotropic, and negative inotropic effects (Sabzevar *et al*., 2016; Siska *et al*., 2020).

Conclusion

Celery shows promise as a supportive therapy for hypertension due to active compounds like 3-n-butylphthalide (NBP), apigenin, and luteolin. These compounds can help lower blood pressure by enhancing sodium and potassium excretion, promoting vasodilation, and inhibiting the activity of calcium channels. When combined with synthetic antihypertensive drugs like captopril, celery has shown a more substantial effect in reducing blood pressure in hypertensive rats compared to single therapy. Innovations such as celery juice and tisane offer accessible alternatives for those with hypertension, and further research could lead to more user-friendly celery-based preparations.

Conflict of Interests

The authors declare no conflict of interest.

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