

**RESEARCH PAPER****Exploring the Effects of Celery Stem on Blood Pressure, and Associated Parameters as Social Determinants in Hypertensive Individuals: A Randomized Control Trail****¹Muhammad Umar Zafar*, ² Amna Rasheed and ³ Huda Ismail**

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ABSTRACT

The aim of the current study was to investigate the medicinal effect of celery extract against the parameters of blood pressure, heart rate long with serum electrolyte levels of studied individuals. For this purpose, the celery stem extract was firstly analyses for its chemical and phenolic composition. Thirty Female human subjects chosen randomly from the society based on their history in the fluctuation of hypertension were equally divided into two groups which was G0 as control group contained fifteen subjects and treatment group as G1 contained fifteen subjects. Treatment group-I was given encapsulated celery stem extract in doses of 250mg for the periods of two months. The treatment group showed significant reduction in systolic and diastolic blood pressure and associated parameters. The most potent components of *celery*, *A. graveolens*, have consequently demonstrated hypolipidemic, and hypotensive effects. We outlined the processes behind celery component protection against insulin action, glucose, lipid metabolism, and blood pressure in the article.

Keywords: Antihypertensive, Celery, Diastolic Blood Pressure, Heart Rate, Opium Graveolense, Serum Electrolyte, Systolic Blood Pressure

Introduction

The Elevated systolic, diastolic blood pressure and imbalanced electrolytes are often observed in the general population and those who are living with chronic health disorders including hyperlipidemia and cardiovascular disease (Moradi et al., 2020). Hypertension is usually measured by measuring systolic (120 mmHg) and diastolic blood pressure (80 mmHg). Serum levels of potassium (30-150 mmol) and sodium (50-250 mmol) are measured as an indicator of hypertension. Hypertensive patients usually have higher heart rates >120 beats per minute (Mills et. al., 2020). The term "silent killer" refers to hypertension (HTN), a chronic condition with no symptoms that, if left undiagnosed and untreated, silently harms the blood vessels, heart, brain, and kidneys.² Therefore, patients with hypertension are more likely to experience silent ischemia and an undiagnosed myocardial infarction (MI). Because of this, patients with acute MI frequently have HTN that has been present but undiagnosed or untreated. (Abbasi et al., 2014)

Traditional medicine includes therapeutic and medicinal herbs as a key element. Traditional medicine is not only more affordable than current medical treatments, but it also has fewer negative effects. Numerous of these herbal plants and traditional remedies are being studied for the treatment of other ailments, including hypertension. There is scientific proof that diets based on plants and high in fiber, potassium, magnesium, and calcium can help lower high blood pressure readings. Additionally, the serum sodium and potassium levels, as well as other electrolyte imbalances, were found to be well treated by these medicinal plants (Sk, 2002)

Garlic, hawthorn, and cayenne pepper are just a few examples of the many natural remedies available today for the treatment of HTN. The components of some herbs work together to produce positive outcomes. Celery, also referred to as *Apium graveolens*, is a member of the Apiaceae plant family. Celery has odd-pinnate compound leaves with dentate leaflets on a central stalk that can reach a height of 1 m. (Hedayati et al., 2019). Celery has shown antioxidant, hypolipidemic, and anti-inflammatory properties in recent pharmacological trials. In folk medicine, it was also used as an antihypertensive medication. One of the chemical components in celery oil, 20 n-butylphthalide (NBP) together with sedanolide, is principally accountable for the flavor and aroma of celery. (Kawai et al., 2010).

Among the other worthy properties of celery are antimicrobial, antioxidant, anti-inflammatory and anti-hypertensive properties. Extract of celery has shown strong hypotensive properties, and this characteristic is due to hydrophobic properties of the components found in celery (Hassanpou et al., 2013).

Material and Methods

Preparation of raw materials

Celery was obtained from botanical garden University of Agriculture Faisalabad. Leaves of celery were removed, and stems were stored separately.

Preparation of celery stems extract

Two washes were performed on the celery stalks: one with tap water and the other with distilled water. Celery stems were dried and ground into powder before being used (Chen et al., 2015). 70% ethanol was used to make the celery stem extract. 100g of funnel seed sample was maintained in a water bath at 40 for 48 hours after being dissolved in 500 ml of ethanol. The solution was then evaporated, allowed to cool, and finally allowed to condense. The extract was stored at 4 degrees Celsius in amber-colored vials.

Chemical Characterization of Celery stems extract

Proximate Composition of celery stem extract

By using AOAC Method No. (AOAC) protocols, the moisture, ash, crude fat, fiber, and crude protein of celery stem were assessed (Braun and Jana, 1982).

Antioxidant features of celery stem extract

Activity of -diphenyl-picrylhydrazyl (DPPH) in celery stems extract with certain modifications, the celery extracts' radical scavenging activity was found to be quite like that reported by Katerere and Eloff (2005).

The extracts and BHT were taken at various concentrations (ranging from 50 to 250 g) and placed in several test tubes. Methanol was added to get the amount to 3.0 ml. These tubes were filled with one milliliter of a 0.1 mM DPPH methanol solution, and they were given a vigorous shake. The tubes were left at 37°C for 20 minutes. Methanol was utilized for the baseline correction, and the control was made in the same way as the sample but without any extract. At 517 nm, the samples' variations in absorbance were quantified.

Phytochemical Profile of Celery stem extract

Determination of total phenolic contents

The Folin-Coicalteu (FC) technique was used to determine the total phenolic content (Singleton and Rossi, 1965). A DMSO solution of the test substance (40 l) was combined with distilled water (3.16 ml) from Jung et al. 7023. A 200 l dose of FC reagent was then added. 600 l of a 20% sodium carbonate solution was added after 5 min, and the mixture was again completed. For two hours, the solutions were kept at room temperature. The produced blue color's absorption was then measured at 765 nm with a Macasys Optizen 2120UV plus UV-spectrophotometer (Mecasys, Korea). Using an equation derived from the gallic acid calibration curve, the concentration of the total phenol content was calculated as mg of gallic acid equivalent.

Evaluation of total flavonoid contents

With a few adjustments, the aluminum chloride colorimetric method as reported (Willet, 2002) was used to determine the total flavonoid content of celery leaves. The following ingredients were combined: extracts (0.5 ml), 10% aluminum chloride (0.1 ml), 1 M potassium acetate (0.1 ml), and distilled water (4.3 ml). Using a Macasys Optizen 2120UV plus UV-spectrophotometer (Mecasys, Korea), the absorbance was measured at 415 nm after 30 minutes of incubation at room temperature. To create the calibration curve, quercetin was utilized.

Encapsulation of celery stems extract

After that, 250 mg of extract was encapsulated in gelatin capsules purchased from Halal capsule Pvt. Ltd. found safe for human consumption (Gullapalli et al., 2017).

Investigation of Medical aspects of e effect of celery stems extract as antihypertensive agent.

Selection of studied subjects from general society

30 female subjects of age 18-45 years were randomly selected from the population based on their medical history in the fluctuation of blood pressure, abnormal heartbeat, and electrolytes composition.

Exclusion Criteria

The study excluded female patients with additional comorbidities including coronary heart disease and hyperlipidemia.

Inclusion Criteria

All female subjects were assessed for the systolic and diastolic blood pressure and those with blood pressure greater than 120/80 were recruited for the study after taking informed consent without any pressure to being a part of study.

Study duration and study design

The study was conducted for 60 days, and it was a controlled randomized trial.

Treatment Groups and Treatment Plan

Female subjects were divided into two groups of 15 subjects in each group. The control group was given no treatment. Treatment group-I was given encapsulated celery stem extract in doses of 250 mg (Table 1).

Table 1
Treatments groups and treatments plans

Control Group (G0)	Treatment Group (G1)
No Treatment	250 mg of encapsulated celery stem extract

G0: Control group with 15 hypertensive patients; No treatment.

G1: Treatment group-I with 15 diabetic patients; 250 mg of encapsulated celery stem extract

Evaluation of Blood pressure, Heart rate and Serum electrolytes of patients

Blood pressure of each patient of both groups along with heartbeat was monitored every work along with the biochemical analysis to check the serum electrolytes like sodium and potassium before and after the completion of trail and compare the values with the control group.

Ethical approval

Ethical approval was taken from the ethical review committee of the institution.

Statistical analysis

To determine the level of significance ($p < 0.05$), descriptive statistical analysis using the two-sample t-test in a Completely Randomized Design (CRD) was performed. The results displayed mean S.D. IBM SPSS Statistics 20 is used for all statistical analysis

Results and Discussion

This research study has been designed to determine the therapeutic effect of celery stem extract against elevated systolic and diastolic blood pressure and improvement in their heart rate along with serum electrolytes.

Chemical characterization of celery stem extract

Proximate Composition of celery

The proximate analysis of celery stem powder shows the composition 6.17% ash, 6.05% crude protein, 2.07% crude fat, 6.01% crude fiber with standard deviation value of ash 6.17 ± 0.15 , crude protein $6.05 \pm 0.02c$, crude fat $2.07 \pm 0.13b$, and crude fiber $6.01 \pm 0.11b$ (Table 2 & Figure 1).

Table 2
proximate % Composition of celery stem Powder on Dry Weight Basis

Proximate analysis	Composition (%)
Ash	6.17 ± 0.15
Crude protein	$6.05 \pm 0.02c$
Crude Fat	$2.07 \pm 0.13b$
Crude fiber	$6.01 \pm 0.11b$

TPC and TFC of celery stem extract

The phytochemical composition of barley stem shows the composition 0.31mg GAE/g TPC, 12.58mg GAE/gTFC with standard deviation value of TPC $0.31 \pm 0.07b$ and TFC $12.58 \pm 0.21a$.

Table 3
Phytochemical Composition of celery stem

TPC (mg GAE/g)	TFC (mg GAE/g)
0.31±0.07b	12.58±0.21a

Antioxidant Assay and Antihypertensive Assay of celery stem

The DPPH and FRAP analysis of celery stem shows the composition 39.21 DPPH, 107.17 FRAP, Antihypertensive assay of celery stem extract shows 62.7% ACE inhibition with standard deviation value of DPPH 39.21b ± 2.29, FRAP 107.17a ± 0.76 and ACE inhibition 62.7* ± 6.01.

Table 4
Antioxidant and antihypertensive Assay of celery Stem

DPPH	FRAP
39.21b ± 2.29	107.17a ± 0.76
ACE inhibitions (%)	62.7* ± 6.01

Evaluation of Blood pressure, Heart rate and Serum electrolytes of patients

To check the effects of celery stem extract in the management of blood pressure, the following associated improvements in heart rate, ACE inhibitors along with serum electrolytes were showed in after introducing the celery stem extract in the form capsule in the selected individual who were the part of study.

Table 5
Effect of celery stem extract on the changes in the blood pressure parameters

Parameters	0-DAY T0	60-DAY T0	0-DAY T1	60-DAY T1
Systolic blood pressure (mm Hg)	143.26±11.21	145.21±10.93	142.98±10.86	123.67±12.45*
Diastolic blood pressure (mm Hg)	98.21±7.65	99.34±9.45	100.23±10.32	83.09±9.03*

T0= No Treatment, T1 =250 mg of celery stem extract

Trial study shows the effect of celery stem extract on the changes in blood pressure parameters from day 0 to day 60. Systolic blood pressure (mm Hg) of T0 at 0-day 143.26±11.21 and at 60-day 145.21±10.93 while of T1 at 0-day 142.98±10.86 and at 60-day 123.67±12.45*. Diastolic blood pressure (mm Hg) of T0 at 0-day 98.21±7.65 and at 60-day 99.34±9.45 while of T1 at 0-day 100.23±10.32 and at 60-day 83.09±9.03*.

Table 6
Changes in Heart Beat of Selected Patients

Parameter	0-DAY T0	60-DAY T0	0-DAY T1	60-DAY T1
Heart rate (Beats per min.)	113±1.03	111±1.89	114±2.12	97±1.89*

T0= No Treatment, T1 =250 mg of celery stem extract

Trial study shows the effect of celery stem extract on the changes in heartbeat from day 0 to day 60. Heart rate (Beats per min.) of T0 at 0-day 113±1.03 and at 60-day 111±1.89 while of T1 at 0-day 114±2.12 and at 60-day 97±1.89.

Table: 7
Changes in Serum Electrolytes of patients

Parameter	0-DAY T0	60-DAY T0	0-DAY T1	60-DAY T1
Serum sodium level (mmol)	287±12.89	288±13.09	277±11.10	243±15.02*
Serum potassium level (mmol)	87±7.89	85±6.23	79±5.87	123±2.34*

T0= No Treatment, T1 =250 mg of celery stem extract

Trial study shows the effect of celery stem extract on the changes in Serum Electrolytes of patients from day 0 to day 60. Serum sodium level (mmol) of T0 at 0-day 287±12.89 and at 60-day 288±13.09 while of T1 at 0-day 277±11.10 and at 60-day 243±15.02*. Serum potassium level (mmol) of T0 at 0-day 87±7.89 and at 60-day 85±6.23 while of T1 at 0-day 79±5.87 and at 60-day 123±2.34.

Discussion

Celery, a famous medicinal plant, has a significant place on human health and shows several essential macro-nutrient and micro-nutrient. For proper analysis, an experiment was conducted by taking celery stem powder and extraction. The celery was analyzed for macro-nutrient and micro minerals which include proximate analysis, DPPH, FRAP, TPC, TFC (Singh et al., 2023). The study was also conducted to analyze the effect of celery on blood pressure parameters, heart rate, electrolyte parameters including sodium and potassium and antihypertensive assay between two groups T0 and T1 shows the significant result from 0-day to 60-day (Putra, M.Y et al, 2023). A randomized trial study showed that the celery stem capsule was not only secure to treat hypertension in patient but also showed other significant results including reduction in high BP, FBS, and lipid profile values (Hussain et al., 2023). Rather than hypertension, it had beneficial effects on kidney and liver functions too. According to the favorable results of this randomized clinical trial, celery stem extract can be appraised as a safe supplement to eat for hypertensive patients (Shayani et al., 2022). In this study of randomized clinical trial, it showed the visible reduction in systolic blood pressure and diastolic blood pressure of hypertensive patient after the interval of 60-days consumption of celery stem extract but there was no significant change was observed by placebo group after the interval of 60-days. In place of systolic blood pressure and diastolic blood pressure, there was a notable change observed in the heart rate of patients who had celery stem extract in their diet. According to the promising results of this clinical trial, it is proven that the consumption of celery stems from a famous plant has a great impact on hypertension but also improves heart rate of the patient. This study was limited by small sample size therefore randomized clinical trial based on large sample size is required (Mashhad et al., 2022). The inclusion of celery stems on daily basis would fulfill a notable part of daily mineral requirement also help in lowering high blood pressure levels and heart rate. It opens a new avenue for further enhancement in the field of research (Yang et al., 2023). According to the study on the ingestion of celery stem extract on serum electrolyte including potassium, sodium, and magnesium with respect to hypertension, it came up with the results that showed the consumption of celery stem extract had higher level of potassium (3500mg/day) may help in lowering high blood pressure (Filippini et al., 2017). Celery also contains a good amount of magnesium. After the consumption for specific time period, it was observed that the higher level of magnesium (365-450mg/day) in celery stem can lower blood pressure of hypertensive patient (Dibaba et al., 2017). By seeking this randomized clinical trial, it showed up with the results that by consuming specific amount of celery stem extract had a great impact on lowering serum sodium level with respect to increasing serum potassium level after the interval of 60-days. Results of the study showed significant reduction in the systolic and diastolic blood pressure. The treatment group also showed significant reduction in heart rate, and serum levels of sodium

and potassium. Celery leaves extract was found effective against hypertension in rats with induced hyperlipidemia with the help of fructose. The study reported similar findings that celery leaves extract was effective against elevated systolic and diastolic blood pressure. Use of celery leaves extract was also found effective against parameters of hyperlipidemia. The study concluded that the antihypertensive effect of celery leaves extract was due to the hydrophobic effect of components of celery (Dianat, 2015). Another study showed similar results i.e., reduction in hypertension parameters but investigated the effect of celery juice in hypertensive elderly population. Study concluded that use of celery juice for six months in elderly population decreased the elevated blood pressure and brought it to 118/82 mm Hg from 150/80 mm Hg. However, no weight changes were reported in the subjects (Iles, 2021). Azizah et.al., 2020 also reported the reduction in hypertension in response to celery juice. Another study investigated the effect of celery seed extract against chronic hypertension and reported that it reduced the blood pressure in rats but showed contrast in the results of the heart rate. Celery seed extract increased the heart rate in rats induced with hypertension. This increase in heart rate was contrary to the results of this study and could be due to the use of ethanolic extracts of celery seeds as compared to aqueous extract (Moghadam et al., 2013). Celery extract contained n-butylphthalide and this component was found to be mainly responsible for the vasodilation. The study also reported the mechanism involved in the reduction of hypertension in response to celery extract is due to the calcium ion blocking and vasodilation. Study also reported that celery influenced both intra and extracellular calcium levels and thus influenced the blood pressure parameters including heart rate and serum electrolytes levels (Tashakori-Sabzevar, 2016). There were several pilots, clinical trials, and case-controlled studies that reported the antihypertensive effect of different parts of celery using them in powder form, as extract and in the form of juice (Madhavi, 2013) & (Shayani, 2022).

Conclusion

In the current investigation, it was discovered that the extracts of *A. graveolens* leaves tested using all methods had decreasing antioxidant activity in the following order: methanol > water extract > ethyl acetate extract > butanol extract. This arrangement is comparable to the phenolic contents of the extracts, which demonstrated that an extract's level of antioxidant activity correlated with its phenolic content. Celery is an important plant with vital properties of aroma and taste. It is also an important part of therapeutic medicines due to the antimicrobial, anti-inflammatory, antioxidant, and antihypertensive properties. The study reported significant reduction in blood pressure, heart rate and serum electrolyte levels. Celery stem extract was found effective against hypertension.

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