The Use of Celery (*Apium Graveolens* L.) for Reducing Blood Pressure in Individual with Hypertension in Indonesia: A Review Paper

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Abstract. Celery *(Apium graveolens L.)* contains active compounds that can help lowering blood pressure. The purpose of this study was to present an overview of the effectiveness of celery administration in reducing blood pressure of people with hypertention based on studies performed in Indonesia. Two digital reference databases, Google *Scholar* and *Research Gate* were used for eligible studies. Keywords to obtain the eligible studies were "apium", "hypertension", "celery", and "blood pressure" with the period of publication from 2011–2021. Inclusion criteria included full text articles in Indonesian language or English published in Indonesian indexed journal called Sinta (S1–4) or Scopus indexed journal through the Scimago website (Q1-Q4), and experimental study in subjects with hypertension by celery administration. There were 7 sudies included in this review with the number and age of respondents varied from 5 to 78 participants and 20 years to elderly, respectively. The provision of celery was varied including celery boiled water, celery juice, celery leaves extract, simplicia or dried celery leaves, and celery steeping for the various duration of intervention from 3 to 56 days. Of all the studies, 6 articles reported a decrease in systolic and diastolyc blood pressure from 6.13 mmHg to 30 mmHg and from 2.9 mmHg to 13.67 mmHg, respectively. The studies concluded that the celery administration was effective in the lowering blood pressure for the individual with hypertension, with p-values before and after the intervention varied from 0.000 to 0.005, while for the studies used the positive control groups showed no difference in the decrease in the blood pressure between the 2 groups.

Keywords: Apium · Blood Pressure · Celery · Hypertension

1 Introduction

Hypertension is classified as a non-communicable disease which is still a global health problem including in Indonesia. The 2018 Indonesian basic health research data reported that prevalence of hypertention is 34.1%, which increase approximately 9% compared to the previous health reseach data on 2013 of 25.8% [1]. Individual with hypertension can be treated with *pharmacological* therapy and non-*pharmacologi-cal* therapy by consuming plants that have been proved to have compounds that can lover blood pressure.

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Celery (*Apium graveolens L.*) has been used in Chinese traditional medicine to lower blood pressure [2]. The active compounds in celery that are responsible for lowering the blood pressure are *apigenin,* nitrate, *potassium, asparagine, mannitol, magnesium, pthalides, apiin, 3-n-butylphthalide,* and *phytosterols.* The mechanism action of these bioactive-compounds in lowering the blood pressure through its role as an antidiuretic, blood vessels relaxation [3, 4], prevention of blood vessels constriction [5, 6] and atherosclerosis prevention [7].

The use of celery as a natural treatment for hypertention is quite well known to some people in Indonesia. A number of studies examine the celery administration in the various processing technique, for instance celery juice [8] celery boiled in water [9] or celery leaves stew [10]. Limited study provides an overview of the effectiveness of these celery administration in a review study. The general aim of this study was to provide an overview of the effectiveness of celery in reducing blood pressure in individual with hypertension. The specific objectives were to describe: 1) study and respondent characteristics, 2) study design and celery administration (type, dosage and duration of intervention), and, 3) the effectiveness of the celery administration on blood pressure from the eligible studies.

2 Methods

A l*iterature review* was performed to answer the reserch questions. *Google Scholar* and *Research Gate* reference databases were used to find the eligible studies. The keywords used were "apium", "celery", "celery", and "hypertension". Publication period applied for the last 10 years (2011–2021). Inclusion criteria for this *review* were: 1) full text articles in Indonesian language or English, 2) articles published in Indonesian indexed journal, *Sinta* (S1–4, https://sinta.kemdikbud.go.id/) or by *Scopus* categorized in quartile 1–4 (https://www.scimagojr.com/), and 3) an experimental study with celery administration in individual with hypertension. The exclusion criteria included: 1) review articles and articles in the form of theses or books. According to these criteria, 7 studies were eligible for this review (Fig. 1).

3 Results

3.1 Study and Respondent Characteristics

Based on the selected studies, the number of respondents varied from 5 to 78 participants, as well as for the age, from 20 years to the elderly. Female group was more dominant than the male based on the available sex data (Table 1).

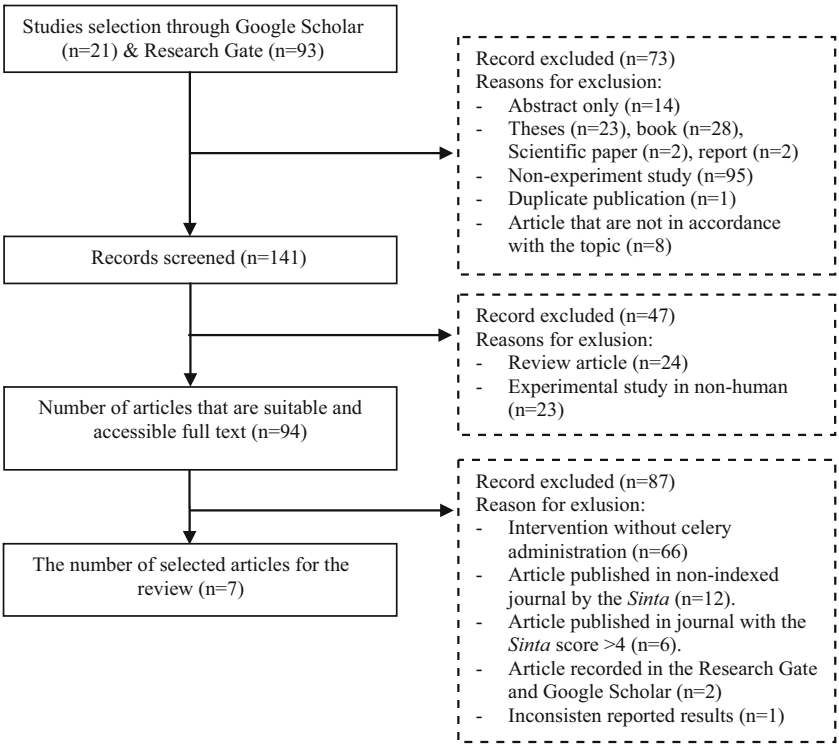

Fig. 1. Selection process of the studies

Table 1. Study and characteristics of respondents

Author	Total (n)	Gender (n,%)		Age (n, %)
		Male	Female	
Muzakar & Nuryanto, 2012 [9]	62	16 (25.8)	46 (74.2)	30–49: 20 (32) 50–64: 32 (51) 65+: 10 (16)
Asmawati *et al.*, 2015 [3]	18	n/a	n/a	60–76 (n/a)
Azizah *et al.*, 2020 [8]	24	16 (66.7)	8 (33.3)	40–45: 10 (41.7) 46–50: 14 (58.3)
Badrujamaludin *et al.*, 2020 [10]	22	n/a	n/a	45–59 (n/a)
Simamora *et al.*, 2021 [11]	10	n/a	n/a	60–64: 6 (60) 65–69: 4 (40)
Triyono *et al.*, 2018 [12]	78	22 (28.2)	56 (71.8)	20–30: 3 (3.85) 31–40: 5 (6.41) 41–50: 15 (19.23) >51: 55 (70.51)
Siantar *et al.*, 2021[a] [13]	5	3 (60)	2 (40)	n/a

n/a = *not available*, [a] on-going study

3.2 Study Design and Celery Administration

The most widely used study design was a quasi-experimental with pre-post test, while only 4 studies used a control group to measure the effect of the celery administration on the blood pressure. The sampling technique used in the eight articles was different, including purposive sampling, random sampling, and multistage random sampling. Most the study was conducted in public health center. In term of the celery administration methods including the type of processing/cooking, dosage, and duration of intervention varied.

Two studies used celery juice [8, 11], celery stew [3, 10] and celery simplicial [12], the rest used celery in the form of celery boiled water plus anti-hypertensive medicine [9] and steeping celery [13]. Of the total studies, 4 articles reported the celery doses given to participants was 100 mL twice a day for celery boiled water and celery leaf, 100 mL for celery juice and 200 cc 3 times a day for simplicial with the duration of intervention from 3 to 56 days (Table 2).

Table 2. Study design and intervention of celery administration on blood pressure of hypertention subjects

Author	Study design	Sampling technique	Research place	Celery administration form	Dosage per day	Duration of administration (days)
Muzakar & Nuryanto, 2012 [9]	Quasi experiment, one group pretest-posttest with control group	Purposive Sampling	Public health center	Celery boiled water + anti-hypertensive medicine	2 x 100 cc	3 consecutive days
Asmawati *et al.*, 2015 [3]	Quasi experiment, one group pretest-posttest	Purposive Sampling	Community Health Service (*Posyandu*) for Elderly	Celery stew	n/a	7
Azizah *et al.*, 2020 [8]	Quasi experiment, pretest-posttest with control group	Random Sampling	Bakalan Wetan Village	Celery juice	n/a	n/a
Badrujamaludin *et al.*, 2020 [10]	Quasi experiment, non equivalent control group	Purposive Sampling	Public health center	Celery leaf stew	2 x 100 mL	7
Simamora *et al.*, 2021 [11]	Experimental pre-post	Purposive Sampling	Public health center	Celery juice	100 mL water, 100 g celery leaf	7

(*continued*)

Table 2. (*continued*)

Author	Study design	Sampling technique	Research place	Celery administration form	Dosage per day	Duration of administration (days)
Triyono *et al*., 2018 [12]	Open label randomized clinical trial	n/a	Clinic, Scientific Herbal Medicine, Research Center and Development of Traditional Medicine	Herbal simplicia	3 x 200 cc	56
Siantar *et al*., 2021 [13]	Comparative causal research, unconventional one group pretest-posttest with control group	n/a	Public health center	Celery steeping	n/a	n/a

Simplicia is a natural medicinal raw material that has been dried and pollinated; n/a, *not available*

3.3 The Effectiveness of the Celery Administration on Blood Pressure

Table 3 presented the effectiveness of the celery administration on the blood pressure from the studies eligible for this review. In general, there was an improvement of systolic and diastolic blood pressure of individual with hypertention in the groups treated with celery, as well as in the control groups. The decrease in systolic and diastolic blood pressure varied from 6.13 mmHg to 30 mmHg and 2.90 mmHg to 13.67 mmHg, respectively, except for the 8^{th} study which was an on-going study with only 5 subjects and showed an increase in diastolic of 0.60 mmHg after the intervention. The significant values (p-values) of the all studies before and after the intervention of each group varied from 0.000 to 0.005, while for the studies used the control groups, the p-values showed $>$ 0.05 or there were no significant differences the decrease in the blood pressure between the 2 groups (Table 3).

Table 3. The effectiveness of celery administration on blood pressure of individual with hypertension

Author	Groups (n)	Celery intervention form	Systolic blood pressure before intervention (mean ± SD)	*p-value*[a]	Systolic blood pressure after intervention (mean ± SD)	*p-valuea*	*p-value*[b]	Diastolic blood pressure before intervention (mean ± SD)	*p-value*[a]	Diastolic blood pressure after intervention (mean ± SD)	*p-valuea*	*p-value*[b]	Statistic test	Decrease in Blood Pressure (mmHg)	
														Systolic (mmHg)	Diastolic (mmHg)
Muzakar & Nuryanto, 2012 [9]	I (31)	Celery boiled water antihyper-tensive medicine	157.42 ± 10.32	> 0.05	137.10 ± 15.53	> 0.05	0.001	89.03 ± 8.31	> 0.05	81.91 ± 8.33	> 0.05	0.001	T-dependent	20.32	7.09
	C (31)	Antihypertensive medicine	151.61 ± 15.01		145.48 ± 18.59		0.001	89.03 ± 7.46		86.131 ± 8.44		0.026	T-dependent	6.13	2.90
Asmawati *et al.*, 2015 [3]	I (18)	Celery stew	166.33 ± 9.47	n/a	146.28 ± 13.67	n/a	0.000	98.17 ± 7.63	n/a	84.50 ± 2.68	n/a	0.000	Analisis bivariat	20.05	13.67
Azizah *et al.*, 2020 [8]	I (12)	Celery juice	151.83	n/a	134.25 ± 2.42	n/a	0.000	96.25	n/a	85.75 ± 0.75	n/a	0.000	Paired sample test	17.58	10.50
	C (12)	Low salt diet	148.33		141.92 ± 5.23		> 0.05	92.83		88.08 ± 3.18		> 0.05	Paired sample test	6.41	4.75
Badrujamaludin *et al.*, 2020 [10]	I_1 (11)	Celery leaf stew	151.18 ± 5.154	n/a	140.36 ± 5.95	0.365	0.001	94.82 ± 4.77	n/a	84.82 ± 5.06	0.574	0.001	T-independent	10.82	10
	I_2 (11)	Bay leaf stew	151.18 ± 7.22		137.27 ± 9.32		0.001	98.18 ± 1.78		86.27 ± 6.77		0.001	T-independent	13.91	11.91
Simamora *et al.*, 2021 [11]	I (10)	Celery juice	171	n/a	101	n/a	0.000	141	n/a	87	n/a	0.000	T-dependent	30	14
Triyono *et al.*, 2018 [12]	I_1 (40)	Herbal simplicia	154.12 ± 11.20	0.037	d28: 130.15 ± 17.59 d56: 134.86 ± 17.67	d28: 0.243 d56: 0.633	0.000	94.12 ± 4.65	0.081	d28: 83.82 ± 9.53 d56:85.91 ± 15.04	d28: 0.885 d56: 0.985	0.000	*Paired t-test*	d28: 19.26 d56: 23.97	d28: 8.21 d56: 10.30
	I_2 (38)	HCT medicne	151.97 ± 9.76		d28: 130.30 ± 1.,65 d56: 132.97 ± 12.88		0.000	93.00 ± 7.19		d28: 83.78 ± 9.45 d56:85.31 ± 14.03		0000	*Paired t-test*	d28: 19.00 d56: 21.67	d28: 7.69 d56: 9.22
Siantar *et al.*, 2021[c] [13]	I (5)	Celery steeping	154.4 ± 19.36	n/a	144.40 ± 22.83	n/a	0.174	84.8 ± 11.52	n/a	85.4 ± 11.63	n/a	0.822	*Paired t-test*	10	+ 0.60

I, intervention; C, control; n/a, *not available*; [a], significance value between the intervention and the control groups; [b], significance value in each group before and after intervention, * no difference significant between the intervention group; d, day; [c]on-going study

4 Discussion

Hypertention is a common health problem in Indonesia especially in adults, starting in their 30s and increasing with age [1]. Our study showed that from the 7 studies, only one study reported the age of respondents under 30 years by 3% [12] and the rest were over 30 years old with most of them were over 50 years old. Changes in the structure of blood vessels with increasing age in the elderly tend to increase the risk of hypertention [14]. Compared to men, elderly women are more susceptible to hypertention due to hormonal factors. Before entering menopause, women begin to lose the hormone estrogen slowly gradually until that time the hormone estrogen must undergo changes starting at the age of 45–55 years.

Interm of research design and administration/ intervention of celery (type, dosage and duration of intervention), a clinical trial using quasi-experimental with pre-post test with control group was the study design that was widely reported in this review. Basically, clinical trials are used to ensure the effectiveness, safety, and description of side effects that often arise in humans due to the administration of an intervention. Interventions can be in the form of drugs, vaccines, traditional medicines, medical devices, and others as test products [15]. A quasi-experiment is an experiment that aims to reveal a causal relationship involving a control group other than the the experimental group, but the selection of the two groups is not performed by random technique. The effectiveness of the celery administration on blood pressure from the eligible studies can be seen from the decreasing of blood pressure after the intervention compared to the baseline data. For this reason, it is important to measure the homogeneity of blood pressure in the intervention and control groups, before intervention. Therefore, the changes that occur are really due to differences between groups or indeed because of the intervention given.

5 Conclusions

Based on our review on the 7 studies that measured the effectiveness of celery administration in hypertention subjects in Indonesia, it is concluded that administration of celery is effective in lowering blood pressure in individual with hypertension. This was reported in 6 studies, with significant values before and after the intervention of 0.000 to 0.005.

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