INTERNATIONAL RESEARCH JOURNAL OF PHARMACY
www.irjponline.com
ISSN 2230 – 8407

Review Article

PLANTS WITH ANTIHYPERTENSIVE ACTIVITIES: A REVIEW

Indah Irma Suryani Lubis, Zikra Azizah *, Rusdi, Ridho Asra
School of Pharmaceutical Science (STIFARM), Padang, Indonesia
*Corresponding Author Email: zikraazizah1990@gmail.com

Article Received on: 16/12/20 Approved for publication: 31/1/21

DOI: 10.7897/2230-8407.1201117

ABSTRACT

Hypertension is one of the most common causes of morbidity and premature death worldwide. Hypertension or high blood pressure is a condition of an increase in systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg. Hypertension is very dangerous because in most cases there are no symptoms in the sufferer (silent killer). Conventional treatment for hypertension often causes various side effects, so that the choice of herbal treatment is being considered more. Medicinal plants such as *Cratoxylum formosum, Adansonia digitata* L., *Vitex pubescens, Cinnamomum zeylanicum, Catharanthus roseus, Crotalaria burhia, Leersia hexandra, Moringa oleifera* L., *Allanblackia floribunda, Holarrhena floribunda, Berberis vulgaris, Morinda citrifolia* L., *Ficus carica, Bidens pilosa, Panax ginseng, Lantana camara, Allium sativum, Apium graveolens, Vitex cienkowskii*, and *Achillea wilhelmsii* have antihypertensive activity which can be used as an alternative in the treatment and prevention of hypertension. This review article used the literature study method of national and international journals published in the last 10 years (2010-2020) that was done through several websites such as ScienceDirect, NCBI, ResearchGate and Google Scholar.

Keywords: hypertension, silent killer, medicinal plants

INTRODUCTION

Hypertension is one of the most common causes of morbidity and premature death worldwide. WHO (World Health Organization) stated that hypertension attacks 22% of the world's population, and 36% of the incidences occurred in Southeast Asia. Hypertension is also a cause of death with 23.7% of the total 1.7 million deaths in Indonesia in 2016[1]. The prevalence of hypertension in Indonesia in 2018 reached 34.1%. This showed an increase where the incidence of hypertension in 2013 was only 25.8%[2].

Hypertension or what is often called as the silent killer is very dangerous because in most cases there are no symptoms in the sufferer and is the most significant risk factor for atherosclerosis and the clinical manifestations of atherosclerosis include: heart failure, coronary artery disease, stroke, kidney disease, and peripheral artery disease[3].

Definition of hypertension or high blood pressure is an increase in systolic blood pressure of more than 140 mmHg and diastolic blood pressure of more than 90 mmHg at two measurements with an interval of five minutes in a state of rest / calm. Increased blood pressure that lasts for a long time (persistent) can cause damage to the kidneys (kidney failure), heart (coronary heart disease) and brain (causing stroke) if not detected early and receive adequate treatment[4].

Treatment for hypertension can be carried out conventionally or herbal. As many as 56% of hypertension sufferers also use herbal remedies in addition to conventional medicines. The cost of using natural medicines that are considered cheaper and with fewer side effects causes herbal treatment for hypertension to have increased in the last decade[5].

Antihypertensive drugs have many side effects such as coughing, dizziness, diarrhea, constipation, feeling tired, headache, nausea and weight loss or gain[6]. Therefore, herbal medicine is an alternative that needs to be considered. Herbal medicines that can reduce the risk of hypertension are mostly sourced from plants that grow in various parts of the world. Based on the large number of herbal medicines that have been researched previously, this study will conduct a review of 20 articles about plants that have antihypertensive activity Thus, one would see the content and the working mechanism of these plants in lowering blood pressure and reducing the risk of hypertension.

DATA COLLECTION

In compiling this review article, the technique used was to use the literature study method in the form of national and international journals published in the last 10 years (2010-2020). The search for data on online media was done with the following keywords: Hypertension; Antihypertensives; Herbal plant; and Hypotensive Effects. The search for the main references in this review was carried out through the web such as through ScienceDirect, NCBI, ResearchGate, Google Scholar, and other relevant journal databases.

Table 1. Plants with antihypertensive activity

Name of Plant	Part of Plant	Solvent	Extraction Method	Chemical Content	Testing Methods	Antihypertensive Mechanism	Reference
Cratoxylum formosum	Leaves	Water	Infusion	Flavonoids	Animal Testing (Rats)	Increase NO bioavailability and inhibit the effects of the Renin-Angiotensin System (RAS)	7
Adansonia digitata L.	Leather Trunk	Water	Maceration	Antioxidants	Animal Testing (Rats)	Prevent cell damage caused by oxidative stress as well as increasing levels of NO	8
Vitex Pubescens	Leaves	Petroleum Ether, chloroform, methanol, water	Maceration	Spathulenol	Animal Testing (Rats)	Vasorelaxation, Anti-inflammatory, Antimicrobials and Antioxidants	9
Cinnamomum zeylanicum	Tree Bark	-	-	Polyphenols, Coumarin, Cinnamic Acid, Eugenol, and Cinnamaldehyde	Human Subjects	Vasorelaxation effects and reduces systemic vascular resistance	10
Catharanthus roseus	Leaves	Water	Infusion	Alkaloid	Animal Testing (Rats)	Increase antioxidants of endogenous enzyme and suppress the formation of free radicals	11
Crotalaria burhia	All parts of the plant	Water-Methanol	Maceration	Glycosides, Alkaloids, Flavonoids, Quercetin, Saponins, Steroids, and B-Sitosterol	Animal Testing (Rabbit)	Depressant effect, vasodilator, cardio-depressant, blocking calcium channel and diuretic action.	12
Leersia hexandra	Leaves and Stems	Water	Infusion	Antioxidant	Animal Testing (Rats)	Prevents cell damage due to oxidative stress and inhibits lipid peroxidation.	13
Moringa oleifera L.	Leaves	Methanol-Ethyl Acetate	Maceration	Glycosides and Flavonoid	Animal Testing (Rats)	Inhibit or to simpatis and decrease oxidative stress	14
Allanblackia floribunda	Stems	Water	Infusion	Antioxidants (flavonoids)	Animal Testing (Rats)	Reducing arterial blood pressure and increase the oxidative balance.	15
Holarrhena floribunda	Skin Stem and Leaf	Water-Ethanol	Infusion and Maceration	Antioxidants	Animal Testing (Rabbit)	Decrease in vascular permeability and increase capillary resistance	16
Berberis vulgaris	Skin Roots	Water	Infusion	Alkaloids	Animal Testing (Rats)	Inhibits resistance of peripheral vascular	17
Morinda citrifolia L.	Leaves and Fruits	Ethanol	Maceration	Flavonoid, Routine, and Scopoletin	Animal Testing (Rats)	Prevents cell damage due to oxidative stress and inhibits lipid peroxidation	18
Ficus carica	Fruit	Water-Methanol	Maceration	(Polyphenols) Quercetin, Gallic Acid, Caffeic, Vanillic Acid, Syringic Acid, Coumaric Acid and Chromotropic Acid.	Animal Testing (Rats)	Antioxidant and vasorelaxant effect of blood vessels	19
Bidens pilosa	Leaves	Ethylene acetate	Maceration	Quercetin 3,3 '-dimethyl ether 7 -0- β - D-glucopyranoside.	Animal Testing (Rats)	Vasodilator, inhibits calcium and free radicals that eliminate insulin sensibility, and increases lipid profile	20
Panax ginseng	Root	Ethanol	Reflux	Saponin and Ginsenoside Rg3	Animal Testing (Rats)	Inhibits ACE	21
Lantana camara	Leaves	Ethanol	Soxhlation	Alkaloids, Glycosides, Polypeptides, Saponins	Animal Testing (Rats)	Maintain ionic levels (increase potassium and decrease sodium levels)	22
Allium sativum	Bulb	-	-	-Glutamyl-S-Allyl-Cysteine (GSAC)	Human Subjects	Inhibit ACE	23
Apium graveolens	Seed	Hexane, Methanol, Water-Ethanol	Maceration	N-Butylphthalide (NBP)	Animal Testing (Rats)	Vascular vasodilation effect	24

Vitex cienkowskii	Skin	Methanol	Maceration	Flavonoid, Penta-Cyclic Triterpenoid, and Ceramide	Animal Testing (Rats)	Provides a cardioprotective effect	25
Achillea wilhelmsii	All Parts of the Plant (Except Roots)	Water-Ethanol	Maceration	Alkaloid	Animal Testing (Rabbit)	Vasorelaxant effect on fur blood h	26

Cratoxylum formosum

Figure 1. ***Cratoxylum formosum***[27]

Cratoxylum formosum is a traditional plant and is widely consumed in Thailand. The fresh young leaves of this plant are widely consumed as a vegetable side dish or as an ingredient in food[28]. *Cratoxylum formosum* extract contains high levels of flavonoids, myricetin, luteolin, as well as phenolic acids, syringic acid, protocatechuic acid and vanillic acid[29]. Extracts of *Cratoxylum formosum* demonstrated antioxidant capacity, hemodynamic improvement and vasorelaxant[30].

Aqueous extract of *Cratoxylum formosum* was proven to have antihypertensive activity tested on L-NAME induced male Sprague-Dawley Rats[7]. Extracts at doses of 100, 300, and 500 mg/kg were significantly able to reduce blood pressure, where the extract at a dose of 300 mg/kg was the effective concentration for lowering blood pressure in hypertensive Rats (117.0 ± 1.9 mmHg). *Cratoxylum formosum* increased contractile response mediated by the nervous system, as well as increasing the concentration of nitric oxide metabolites (NOx).

***Adansonia digitata* L.**

Figure 2. ***Adansonia digitata* L.**[31]

Adansonia digitata L. is a medicinal plant from the Malvalesorder (family of Bombaceae), which is commonly used in traditional African medicine for cardiovascular disorders[32]. This herb is reported to have anti-inflammatory, antioxidant, antimalarial, and antimicrobial properties[33]. Aqueous extract of *Adansonia digitata* L. was shown to have antihypertensive activity tested on hypertensive male Wistar Rats induced by Nω-nitro-L-arginine methyl ester (L-NAME)[8]. The water extract of *Adansonia digitata* L. at a dose of 100 and 200 mg/kg was effective in reducing systolic blood pressure, diastolic blood pressure and average blood pressure. This is because *Adansonia digitata* L. has antioxidant properties by increasing the availability of NO and preventing cell damage due to oxidative stress.

Vitex pubescens

Figure 3. ***Vitex pubescens***[34]

Vitex pubescens (Verbenaceae) is locally called Halban in Peninsular Malaysia. This plant has been used traditionally to treat hypertension and gastrointestinal disorders[35]. Spathulenol is the main compound of *Vitex pubescens* which acts as a smooth muscle vasorelaxant, anti-inflammatory and antioxidant[36]. The leaves of *Vitex pubescens* were shown to have antihypertensive activity tested on Rats[9]. *Vitex pubescens* was extracted with petroleum ether, chloroform, methanol, and water, wherein petroleum ether extract was considered the strongest extract and was selected for fractionation. The Rats given the oral extract every day of 500 mg/kg/day significantly reduced systolic blood pressure and diastolic blood pressure for 14 days of treatment. This is because *Vitex pubescens* has a vasorelaxant effect.

Cinnamomum zeylanicum

Figure 4. ***Cinnamomum zeylanicum***[37]

Cinnamomum, or also known as cinnamon, is a 10-17 m tall tree that grows in South America, Southeast Asia and Australia[38]. Traditionally used in cooking as a flavoring / coloring agent[39]. Generally, the major chemicals reported in cinnamon include coumarin, cinnamic acid, eugenol, and cinnamaldehyde which contribute to its pharmacological properties (as anti-inflammatory, anti-oxidant, anti-diabetes, and anti-obesity)[38]. *Cinnamomum zeylanicum* capsules (containing 500 mg of dry cinnamon powder) have been shown to have antihypertensive activity[10]. Capsules containing 500 mg of cinnamon powder given 3 times a day for 90 days showed a decrease in blood pressure in stage I hypertensive patients. *Cinnamomum zeylanicum* can increase HDL-c, reduce LDL-c and total cholesterol levels temporarily and reduce the average systolic blood pressure of hospitalized patients with moderate clinical course.

Catharanthus roseus

Figure 5. ***Catharanthus roseus***[40]

*Catharanthus roseus*is a native plant of Madagascar belonging to the Apocynaceae family. In traditional medicine, the leaves and roots of this plant are widely used in the treatment of diseases[11]. Certain active compounds such as alkaloids contained in *Catharanthus roseus* have hypotensive activity. The intravenous administration of *Catharanthus roseus* at a dose of 1, 3, and 10mg/kg, was able to reduce the mean arterial blood pressure of Rats respectively; 14.70 ± 1.21, 22.00 ± 2.24 and 36.21 ± 2.65%.

Crotalaria burhia

Figure 6. ***Crotalaria burhia***[41]

Crotalaria burhia Buch.-Ham, belonging to the family Fabaceae, is commonly found in arid parts of Pakistan, Afghanistan and India[41]. This herb contains glycosides, alkaloids, flavonoids such as quercetin, saponins, and steroids such as β-sitosterol[42]. All parts of this plant are reported to be used in the treatment of hypertension[43]. The aqueous extract of *Crotalaria burhia* leaves showed a very significant reduction in blood pressure at doses of 200 to 1000 mg/kg[12]. *Crotalaria burhia* extract isable to stabilize blood sugar, greatly reduce insulinemia, systolic blood pressure, diastolic blood pressure and fructose-induced heart rate in rabbits.

Leersia hexandra

Figure 7. ***Leersia hexandra***[44]

Leersia hexandra belongs to the Poaceae family which is used in traditional medicine to treat many diseases including hypertension. *Leersia hexandra* is widely grown in tropical and subtropical countries and hot regions of Africa. *Leersia hexandra* (Poaceae) water extract was shown to have antihypertensive activity tested on ethanol-induced Wistar Rats[13]. Water extract given intraperitoneally at a dose of 100 and 200 mg/kg was able to reduce the mean arterial pressure (MAP) because *Leersia hexandra* has an antioxidant effect that protects tissue and cell damage due to free radicals from ethanol metabolism.

***Moringa oleifera* L.**

Figure 8. ***Moringa oleifera* L.**[45]

Moringa oleifera L. or also known as moringa is included in the Moringaceae family. This plant is generally used as food and medicine. Methanol and ethyl acetate extracts of *Moringa oleifera* L. have been proven to have antihypertensive activity tested on Rats induced by Nω-nitro-L-arginine methyl ester (L-NAME)[14]. The extract given at doses of 100 and 300 mg/kg, respectively, showed a hypotensive effect. *Moringa oleifera* L. significantly reduced systolic blood pressure (90.97 ± 0.7975 mm Hg) in Rats treated with methanol extract and (87.71 ± 0.9623 mm Hg) in Rats treated with ethyl acetate extract.

Allanblackia floribunda

Figure 9. ***Allanblackia floribunda***[46]

Allanblackia floribunda Oliver (Clusiaceae) is a medicinal plant widely used in Africa to treat hypertension and many other ailments. The water extract of *Allanblackia floribunda* was shown to have antihypertensive activity tested on ethanol-induced male Wistar Rats[15]. The extract at a dose of 200 and 400 mg/kg significantly reduced blood pressure by an average of 14.06% and 23.25% at each dose. This is because *Allanblackia floribunda* is an antioxidant that can suppress the inflammatory process caused by alcohol.

Holarrhena floribunda

Figure 10. ***Holarrhena floribunda***[47]

Holarrhena floribunda (G. Don) T. Durand & Schinz is a tree that can grow up to 25 m with its organs in the form of white sap. Generally, this plant grows in African countries and is traditionally used for the treatment of dysentery, diarrhea, fever, snake bites, infertility, venereal disease, diabetes, hypertension, and malaria. Water-ethanol extract of *Holarrhena floribunda* has

shown to have antihypertensive activity tested in rabbits[16]. The extract was administered intravenously at a dose of 10, 20, 40, 80 mg/kg and was able to reduce systolic blood pressure, diastolic blood pressure and mean arterial pressure. The hydro-ethanol extract of *Holarrhena floribunda* stem bark has antihypertensive and antioxidant properties, of which a dose of 40 mg/kg is considered the most effective.

Berberis vulgaris

Figure 11. ***Berberis vulgaris***[48]

Berberis vulgaris is a plant that is widely used in traditional medicine[17]. Aqueous extract of *Berberis vulgaris* root bark was proven to have antihypertensive activity tested on Rats. The water extract of *Berberis vulgaris* root bark given intravenously at different doses of 1, 10, and 20 mg/kg showed a hypotensive effect, where at doses of 10 and 20 mg/kg had the most effect on lowering mean arterial blood pressure for more than one hour and returned to baseline there after 106±12.36 minutes and 193±13.94 minutes respectively. The active alkaloid content of the root bark of *Berberis vulgaris* is very effective as an antihypertensive by inhibiting peripheral vascular resistance.

***Morinda citrifolia* L.**

Figure 12. ***Morinda citrifolia L.***[49]

Morinda citrifolia L. is a plant that contains antioxidants and is widely used to treat dyslipidemia, inhibits the activity of angiotensin con-verting enzyme (ACE), as an analgesic, and is used for the treatment of hypoglycemia[50]. The ethanol extract of *Morinda citrifolia* L. leaves and fruit was shown to have antihypertensive activity against dexamethasone-induced male Wistar Rats[18]. Leaves ethanol extract (MCLEE) and fruit ethanol extract (MCFEE) can each show a hypotensive effect because they contain flavonoids and antioxidants that can prevent cell damage due to oxidative stress, where the combination of leaves ethanol extract (MCLEE) 500 mg/kg BW and fruit ethanol extract (MCFEE) of 500 mg/kg BW showed the highest hypotensive activity with a combination of MCLEE and MCFEE 1: 1 reducing systolic blood pressure by 16.71 + 3.95%, diastolic blood pressure by 21.49 + 7.90%, and pressure arterial blood on average by 19.58% + 6.35.

Ficus carica

Figure 13. ***Ficus carica***[51]

Ficus carica Linn. (Moraceae*)* has been widely used for the treatment of cardiovascular diseases. The water-methanol extract of *Ficus carica* fruit was shown to be able to show antihypertensive effects tested on glucose-induced Rats[19]. The water-methanol extract given at doses of 250, 500, and 1000 mg/kg, respectively, showed a decrease in blood pressure, where the dose of 1000 mg/kg showed the most effective antihypertensive effect. *Ficus carica* is a plant that is rich in polyphenols, thus it has an antioxidant effect that can prevent cell damage due to oxidative stress.

Bidens Pilosa

Figure 14. ***Bidens pilosa***[52]

Bidens pilosa is a medicinal plant belonging to the Asteracae family which is found mostly in tropical and hot regions of Africa, including Cameroon. This herb is used in traditional medicine for at least 40 disease categories, including hypertension[53]. The ethylene acetate extract of *Bidens pilosa* was proven to have antihypertensive activity which was tested on Rats induced by Nω-nitro-L-arginine methyl ester (L-NAME). The ethylene acetate extract of *Bidens pilosa* at a dose of 75 and 150 mg/kg in vivo can lower blood pressure without affecting heart rate[20].

Panax ginseng

Figure 15. ***Panax ginseng***[54]

Korean red ginseng (*Panax ginseng)* is ginseng originating from Korea which contains saponins, ginsenoside Rg3 which can provide a protective effect against hypertension[55]. The ethanolic extract of Korean Red Ginseng Root was shown to have antihypertensive activity by testing Wistar male rats[21]. The ginsenoside content in this plant can have the effect of decreasing renin activity and inhibiting ACE. Giving ethanol extract orally at a dose of 500 and 1000 mg/kg BW for 8 weeks each can reduce

blood pressure, where at a dose of 1000 mg / kg BW gives the most effective results because it can increase NO levels by 52%.

Lantana camara

Figure 16. ***Lantana camara***[56]

Lantana camara belongs to the Verbenaceae family and is widely used in the treatment of various diseases. The ethanol extract of *Lantana camara* was shown to be able to show antihypertensive effects tested on NaCl-induced wistar albino Rats[22]. Ethanol extract at doses of 200 and 400 mg/kg showed that it could lower the mean arterial blood pressure by balancing ionic levels, reducing sodium and increasing potassium levels in salt-induced hypertensive Rats.

Allium sativum

Figure 17. ***Allium sativum***[57]

Allium sativum, or otherwise known as Garlic, is commonly used throughout the world for both culinary and medicinal purposes[58]. Gamma-glutamylcysteines are compounds present in garlic that can lower blood pressure by inhibiting the conversion of Angiotensin I to Angiotensin II. Garlic at doses of 300 mg, 600 mg, 900 mg, 1200 mg and 1500 mg in divided doses per day for 24 weeks each showed a significant reduction in systolic and diastolic blood pressure in stage I hypertensive outpatients[23].

Apium graveolens

Figure 18. ***Apium graveolens***[59]

Apium graveolens, or commonly known as celery, is a species of plant from the Apiaceae family. Celery grows to a height of 1 m and has odd-pinnate compound leaves[60]. In recent pharmacological studies, celery has demonstrated antioxidant, hypolipidemic and anti-inflammatory activity. Therefore, it can be used as an antihypertensive agent in traditional medicine. *Apium graveolens* celery seed extract has been shown to have antihypertensive activity tested on Rats induced by deoxycortisone acetate[24]. The hexane, methanol, and water-ethanol extracts administered intraperitoneally were able to lower blood pressure respectively, whereas 300 mg/kg hexane extract was significantly more effective in lowering blood pressure than the other extract groups (methanol and water-ethanol groups).

Vitex cienkowskii

Figure 19. ***Vitex cienkowskii***[61]

Vitex cienkowskii (Verbenaceae) is commonly used in traditional Cameroonian medicine to treat cardiovascular disease. *Vitex cienkowskii* contains flavonoids, cyclic penta-triterpenoids (oleanolic acid, maslinic acid, and ceramide). Methanolextract of *Vitexcienkowskii* (Verbebaceae) was shown to have anti-hypertensive activity tested on male Wistar Ratsinduced by Nω-nitro-L-arginine methyl ester (L-NAME)[25]. The methanolic extract administered intravenously at a dose of 40 mg/kg caused mean arterial pressure in the rats. Extracts of *Vitex cienkowskii* have antioxidant activity which can provide protection to blood vessels by increasing NO levels.

Achillea wilhelmsii

Figure 20. ***Achillea wilhelmsii***[62]

Achillea wilhelmsii is the main species grown in Iran which is used in traditional medicine. This plant contains alkaloid chemical compounds (Achilleine), cineol, borneol, α and β pinen, luteolin, apigenin, lignans, camphor, caryophllene, routine and carvacrol[63]. The ethanol aqueous extract of *Achillea wilhelmsii* was shown to have antihypertensive activity in rabbits[26]. Ethanol extract intravenously at a dose of 20, 40, and 80 mg/kg, respectively showed a hypotensive effect where at a dose of 80 mg/kg the most effective at reducing blood pressure significantly (16.7 ± 1.4 mmHg) and does not have a significant effect on heart rate. This is because the aqueous-ethanolic extract has a vasorelaxant effect.

CONCLUSION

Based on the aforementioned description, it can be concluded that each plant has different secondary metabolites, and each plant used different activity testing methods and administration doses, thus each plant showed different antihypertensive activities.

ACKNOWLEDGMENTS

The author would like to thank the lecture of STIFARM Padang who helped in compiling the review of this article.

REFERENCES

1. Anitasari. Indonesian Ministry of Health Web site. [Online]. 2020[cited 2020 Sep 10]. Available from: http://p2ptm. kemkes.go.id/kegiatan-p2ptm/pusat-/hari-hipertensi-dunia-2019-know-your-number-kendalikan-tekanan-darahmu-dengan-cerdik.
2. Riskesdas Team 2018. Indonesian Ministry of Health Web site. [Online]. Jakarta: Publisher Institute for Health Research and Development; 2019 [cited 2020 Sep 11]. Availablefrom:https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas 2018_1274.pdf.
3. Sawicka K, Szczyrek M, Jastrzębska I, Prasał M, Zwolak A, Daniluk J. Hypertension – The Silent Killer. Journal of Pre-Clinical and Clinical Research. 2011; 5(2):43-46.
4. Center for Data and Information of the Ministry of Health of the Republic of Indonesia. Indonesian Ministry of Health Web site. [Online]. Jakarta: Center for Data and Information of the Ministry of Health of the Republic of Indonesia; 2014 [cited 2020 Sep 12]. Available from: https://pusdatin. kemkes.go.id/folder/view/01/ structure-publikasi-pusdatin-info datin.html.
5. Paramita S, Fitriany E, Tiyantara MS, Setyorini A, Cahyasit TE. Comparison of Adherence to the Use of Herbal Medicine with Conventional Medicine in Hypertensive Patients at Lempake Public Health Center, Samarinda City. Health Science Journal of Indonesia. 2018;9(2):82-86.
6. ADAM Health Solutions. MedlinePlus Web site. [Online]. 2020[cited 2020 September 13]. Available from: https://medlineplus.gov/ency/article/007484.htm.
7. Potuea P, Maneesaia P, Kukongviriyapana U, Prachaneyb P, Pakdeechotea P. *Cratoxylum Formosum* extract exhibits antihypertensive effects via suppressing the renin-angiotensin cascade in hypertensive rats. Journal of Functional Foods. 2020; 73:1-10.
8. Ntchapda F, Bonabe C, Atsamo AD, Azambou DRK, Fouda YB, Djibrine SI, et al. Effect of Aqueous Extract of *Adansonia digitata* Stem Bark on the Development of Hypertension in L-NAME-Induced Hypertensive Rat Model. Hindawi. 2020; 2020:1-10.
9. Al-Akwaa AA, Asmawi MZ, Dewa A, Mahmud R. Antihypertensive activity and vascular reactivity mechanisms of *Vitex pubescens* leaf extracts in spontaneously hypertensive rats. Heliyon. 2020;6(7):1-8.
10. Shirzad F, Morovatdar N, Rezaee R, Tsarouhas K, Moghadam AA. Cinnamon effects on blood pressure and metabolic profile: A double-blind, randomized, placebo-controlled trial in patients with stage 1 hypertension. Avicenna J Phytomed. 2020; 2020:1-10.
11. Yoro B, Bahi C, Gouéh G, Yapi JN, Koné SD. Effect of the aqueous extract of *Catharanthus roseus* leaves against hypertension induced by fructose in rats. Journal of Pharmacognosy and Phytochemistry. 2020;9(4):38-44.
12. Raza MA, Imran I. Hypotensive, vaso-relaxant, cardio-depressant and diuretic effect of crude extract of *Crotalaria burhia* (Fabaceae). Tropical Journal of Pharmaceutical Research. 2020; 19(2):323-330.
13. Bilanda D, Tcheutchoua Y, Dzeufiet P, Fokou D, Fouda Bekono Y, Théophile D, et al. Antihypertensive Activity of *Leersia hexandra* Sw. (Poaceae) Aqueous Extract on Ethanol-Induced Hypertension in Wistar Rat. Evidence-Based Complementary and Alternative Medicine. 2019; 6:1-9.
14. Acuram LK, Hernandez CLC. Anti-hypertensive effect of *Moringa oleifera* Lam. Cogent Biology. 2019;5(1):1-10.
15. Bilanda DC, Dzeufiet PDD, Bopda OM, Kamtchouing P, Dimo T. *Allablanckia floribunda* hypotensive activity on ethanol induced hypertension in rats. The Journal of Phytopharmacology. 2018;7(2):146-151.
16. Kpegba K, Kondo ET, Simalou O, Togbenou K, Boyode P, Toundou O, et al. A significant antihypertensive effect of *Holarrhena floribunda* supported by an exploratory phytochemical study. Journal of Herbmed Pharmacology. 2018;7(3):160-167.
17. Ahmed M, Azmat A, Khan S. Acute hypotensive and diuretic activities of *Berberis vulgaris* root bark aqueous extract in normal rats. Brazilian Journal of Pharmaceutical Sciences. 2017;53(4):e17077.
18. Wigati D, Anwar K, Sudarsono , Nugroho AE. Hypotensive Activity of Ethanolic Extracts of *Morinda citrifolia* L. Leaves and Fruit in Dexamethasone-Induced Hypertensive Rat. Journal of Evidence-Based Complementary & Alternative Medicine. 2017;22(1):107-113.
19. Alamgeer, Iman S, Asif H, Saleem M. Evaluation of antihypertensive potential of *Ficus carica* fruit. Pharmaceutical Biology. 2017;55(1):1047-1053.
20. Bilanda D, Dzeufiet PDD, Kouakep L, Aboubakar BFO, Tédong L, Kamtchouing P, et al. *Bidens pilosa* Ethylene acetate extract can protect against L-NAME-induced hypertension on rats. BMC Complementary and Alternative Medicine. 2017;17(479):1-7.
21. Lee KH, Bae IY, Park SI, Park JD, Lee HG. Antihypertensive effect of Korean Red Ginseng by enrichment of ginsenoside Rg3 and arginine-fructose. Journal of Ginseng Research. 2016; 40:237-244.
22. Matta VK, Pasala PK, Netala S, Pandrinki S, Konduri P. Anti Hypertensive Activity of the Ethanolic Extract of *Lantana camara* leaves on high salt loaded wistar albino rats. Pharmacognosy Journal. 2015;7(5):289-295.
23. Ashraf R, Khan RA, Ashraf I, Quresh AA. Effects of *Allium sativum* (Garlic) on systolic and diastolic blood pressure in patients with essential hypertension. Pakistan journal of pharmaceutical sciences. 2013;26(5):859-863.
24. Moghadam MH, Imenshahidi M, Mohajeri SA. Antihypertensive Effect of Celery Seed on Rat Blood Pressure in Chronic Administration. Journal Of Medicinal Food. 2013;16(6):558-563.
25. Metchi FMD, Nguemfo E, Nana P, Temdié JR, Tome ENL, Nkeng-Efouet PA, et al. Cardio protective effects of methanol / methylene chloride extract of *Vitex cienkowskii* (Verbebaceae) in l-NAME induced hypertension in rats. European Journal of Integrative Medicine. 2013; 5:519-526.
26. Niazmand S, Esparham M, Rezaee SA, Harandizadeh F. Hypotensive effect of *Achillea wilhelmsii* aqueous-ethanolic extract in rabbit. Avicenna Journal of Phytomedicine. 2011;1(1):51-56.
27. Issara-Amphorn J, T-Thienprasert NP. Preliminary In vitro pro-apoptotic effects of *Cratoxylum formosum* crude leaf extracts. International Journal of Applied Research in Natural Products. 2014;7(4):26-30.
28. Maisuthisakul P, Pongsawatmanit R, Gordon MH. Characterization of the phytochemicals and antioxidant properties of extracts from Teaw (*Cratoxylum formosum* Dyer). Food Chemistry. 2007;100(4):1620-1629.
29. Senggunprai L, Thammaniwit W, Kukongviriyapan V, Prawan A, Kaewseejan N, Siriamornpun S. *Cratoxylum formosum* Extracts Inhibit Growth and Metastasis of Cholangiocarcinoma Cells by Modulating the NF-κB and STAT3 Pathways. Nutrition and Cancer. 2016;68(2):1-14.
30. Kukongviriyapan U, Luangaram S, Leekhaosoong K, Kukongviriyapan V, Preeprame S. Antioxidant and Vascular Protective Activities of *Cratoxylum formosum*, *Syzygium gratum* and *Limnophila aromatica*. Biological & Pharmaceutical Bulletin. 2007;30(4):661-666.
31. Parkouda C, Ba/Hama F, Ouattara/Songre L, Tano-Debrah K, Diawara B. Biochemical changes associated with the fermentation of baobab seeds in Maari: An alkaline fermented seeds condiment from western Africa. Journal of Ethnic Foods. 2015;2(2):58-63.
32. Kamatou GPP, Viljoen IVAM. An updated review of Adansonia digitata: A commercially important African tree. South African Journal of Botany. 2011;77(4):908-919.
33. Rahul J, Jain MK, Singh SP, Kamal RK, Anuradha, Naz A, et al. *Adansonia digitata* L. (baobab): a review of traditional information and taxonomic description. Asian Pacific Journal of Tropical Biomedicine. 2015;5(1):79-84.
34. Nuraskin CA, Marlina, Idroes R, Soraya C, Djufri. Activities inhibition methanol extract Laban Leaf (*Vitex pinnata*) on growth of bacteria S. mutans Atcc 31987. IOP Conference Series Materials Science and Engineering. 2019; 523:012008.
35. AL-Wajeeh NS, Halabi MF, Hajrezaie M, Dhiyaaldeen SM, Bardi DA, Salama SM, et al. The Gastroprotective Effect of *Vitex pubescens* Leaf Extract against Ethanol-Provoked Gastric Mucosal Damage in Sprague-Dawley Rats. PLOS ONE. 2017;12(5).
36. Moreira F, Santos JA, Kassuya C, Croda J, Cardoso C, Vieira MdC, et al. Antioxidant, anti-inflammatory, antiproliferative and antimycobacterial activities of the essential oil of *Psidium guineense* Sw. and spathulenol. Journal of Ethnopharmacology. 2017;210.
37. Husain I, Ahmad R, Chandra A, Raza ST, Shukla Y, Mahdi F. Phytochemical characterization and biological activity evaluation of ethanolic extract of *Cinnamomum zeylanicum*. Journal of Ethnopharmacology. 2018; 219:110-116.
38. Mousavi SM, Karimi E, Hajishafiee M, Milajerdi A, Amini MR, Esmaillzadeh A. Anti-hypertensive effects of cinnamon supplementation in adults: A systematic review and dose-response Meta-analysis of randomized controlled trials. Critical Reviews in Food Science and Nutrition. 2019;60(18):3144-3154.

39. IM KK, Issac A, Ninan E, Kuttan R, Maliakel B. Enhanced anti-diabetic activity of polyphenol-rich de-coumarinated extracts of *Cinnamomum cassia*. Journal of Functional Foods. 2014; 10:54-64.
40. Tan HTW, Yeo CK. The Potential of Native Woody Plants for Enhancing the Urban Waterways and Water Bodies Environment in Singapore. Raffles Museum of Biodiversity Research. 2009;2019.
41. Saboon , Bibi Y, Arshad M, Ahmad N, Riaz I, Chaudhari SK. An insight into medicinal and ethnopharmacological potential of *Crotalaria burhia*. Asian Pacific Journal of Tropical Disease. 2015; 5(7):511-514.
42. Sandeep K, Birendra S, Khajuria RK, Suri KA, Piush S. Pharmacognostic evaluation of *Crotalaria burhia* Buch.-Ham. Indian journal of traditional knowledge. 2011;10(4):629-635.
43. Ozturk M, Altay V, Latiff A, Shareef S, Shaheen F, Choudhry MI. Potential Medicinal Plants Used in the Hypertension in Turkey, Pakistan, and Malaysia. Plant and Human Health. 2018; 1:595-618.
44. Traiperm P, Norsaengsri M, Gale SW. A taxonomic revision of the tribe Oryzeae (Poaceae) in Thailand. ScienceAsia. 2015;41(6):363.
45. Ali EN, Kemat SZ. Bioethanol produced from *Moringa oleifera* seeds husk. IOP Conference Series Materials Science and Engineering. 2017;206(1):012019.
46. Okonkwo HO, Koyejo OA, Oyediran RI. Pre-Severance and Post-Severance Survival, Growth and Fruiting of Allanblackia floribunda Oliv. Marcots. World Journal of Agricultural Sciences. 2019;15(4):215-219.
47. Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. Agroforestree Database: a tree reference and selection guide version 4.0. 2009[cited 2020 Oct 19]. Available from: http://www.worldagroforestry.org/af/treedb/
48. Zarei A, Changizi-Ashtiyani S, Taheri S, Ramezani M. A quick overview on some aspects of endocrinological and therapeutic effects of Berberis vulgaris L. Avicenna J Phytomed. 2015;5(6):485-497.
49. Macpherson H, Daniells J, Wedding BBC, Davis C. The Potential for a New Value Adding Industry for Noni Tropical Fruit Producers. Rural Industries Research and Development Coorporation. 2007;2007.
50. Yamaguchi S, Ohnishi J, Sogawa M, Maru I, Ohta Y, Tsukada Y. Inhibition of Angiotensin I Converting Enzyme by Noni (*Morinda citrifolia*) Juice. Nippon Shokuhin Kagaku Kogaku Kaishi. 2002; 49(9):624-627.
51. Hafez EE, Abdelkhalek AA, El-Morsi AA. Molecular Characterization of a Potyvirus Associated with a Fig Mosaic Disease in Egypt. Arid Lands Cultivation Research Institute (ALCRI). 2012; 2012:259-274.
52. Mahmoud T, Gairola S, El-Keblawy A. Parthenium hysterophorus and Bidens pilosa, two new records to the invasive weed flora of the United Arab Emirates. Journal on New Biological Reports. 2015; 4(1):26-32.
53. Bartolome A, Villasenor I, Yang WC. Bidens pilosa L. (Asteraceae): Botanical Properties, Traditional Uses, Phytochemistry, and Pharmacology. Evidence-based Complementary and Alternative Medicine. 2013;2013(2):1-51.
54. Yun TK. Brief Introduction of *Panax ginseng* C.A. Meyer. Journal of Korean Medical Science. 2001; 16:3-5.
55. Park D, Bae DK, Jeon JH, Lee J, Oh N, Yang G, et al. Immunopotentiation and antitumor effects of a ginsenoside Rg3-fortified red ginseng preparation in mice bearing H460 lung cancer cells. Environmental Toxicology and Pharmacology. 2011;31(3):397-405.
56. Ray A, Ray R. Rapid divergence of ecotypes of an invasive plant. AoB PLANTS 6. 2014; 2014:1-13.
57. Upadhyay RK. Garlic: A potential source of pharmaceuticals and pesticides: A review. International Journal of Green Pharmacy. 2016;10(1):1-28.
58. Rahman K. Historical perspective on garlic and cardiovascular disease. The Journal of Nutrition. 2001;131(3):977S-979S.
59. Mans DRA, Angela G, Pinas N. Plant-Based Ethnopharmacological Remedies for Hypertension in Suriname. InTech. 2017; 2017:1-40.
60. Sheng JP, Liu C, Shen L. Comparative Study of Minerals and Some Nutrients in Organic Celery and Traditional Celery. Guang pu xue yu guang pu fen xi Guang pu. 2009;29(1):247-9.
61. Dukku U. Identification of plants visited by the honeybee, Apis mellifera L. in the Sudan Savanna zone of northeastern Nigeria. African Journal of Plant Science. 2013;7(7):273-284.
62. Taheri MMH, Hassanpour-Fard M, Ahani A, Hosseini M. Anti-Nociceptive Activity of *Achillea wilhelmsii* Ethanolic Extract in Mice. Journal of Complementary Medicine. 2018; 6(2):001-004.
63. Afsharypuor S, Asgary S, Lockwood GB. Constituents of the Essential Oil of *Achillea wilhelmsii* from Iran. Planta Med. 1996;62(1):77-78.

Cite this article as:

Indah Irma Suryani Lubis *et al*. Plants with antihypertensive activities: A review. Int. Res. J. Pharm. 2021;12(1):46-53.
http://dx.doi.org/10.7897/2230-8407.1201117

Source of support: Nil, Conflict of interest: None Declared