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A SYSTEMATIC REVIEW OF HYPERTENSION AND VARIOUS TREATMENTS USED TO CONTROL HIGH BLOOD PRESSURE

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ABSTRACT

Globally, hypertension is a severe problem. Researchers in both developed and developing nations have identified it as one of the most widespread conditions currently present. Stages 1, 2, and 3 of hypertension are categorized based on the evolution of systolic and diastolic blood pressure. The first stage of treatment is a change in lifestyle, but when it becomes difficult to control, medication is required. Diuretics, beta-blockers, calcium channel blockers, and renin-angiotensin system inhibitors are typically used as pharmacological therapies, either individually or in combination, for both initial and maintenance therapy. The selection of a medicine is based on its good outcomes in a particular therapeutic environment. This review focuses entirely on the causes and remedies for hypertension. The article describes the typical causes of elevated blood pressure in a healthy person. Additionally, it covers review on how various aspects of daily life affect blood pressure. This review is mainly focused on the causes factors and different treatments of hypertension (non-pharmacological, pharmacological, herbal medications).

KEYWORDS: Hypertension, systolic, diastolic, blood pressure, herbal medicines.

1. INTRODUCTION

High blood pressure (Hypertension) in the arteries, which are the vessels that carry blood from the heart to the rest of the body, is defined as hypertension (HTN). A person's normal blood pressure is 120/80 mmHg. The systolic blood pressure (top number) equals the

pressure in the arteries as the heart contracts, while the diastolic blood pressure (bottom number) equals the pressure in the arteries as the heart relaxes. As a result, 120 and 80 are systolic and diastolic measurements, respectively. Blood pressure of 120/80 to 129/80 is considered elevated, and blood pressure of 130/80 or higher is considered as hypertensive.

Primary (essential) hypertension is distinguished from secondary hypertension. Primary hypertension is a condition that has no medical cause and affects 90 to 95% of people. The majority of cases are classified as primary hypertension. The factors that contribute to the development of this disease differ greatly from patient to patient. Although no single cause has been identified, sedentary lifestyle, stress, visceral obesity, potassium deficiency (hypokalemia),[1] obesity,[2] salt (sodium) sensitivity,[3] alcohol consumption[4] and vitamin D deficiency all increase the risk of developing hypertension.[5]

The remaining 5 to 10% of cases are referred to as secondary hypertension. Secondary hypertension is a type of high blood pressure that appears suddenly and causes higher blood pressure than primary hypertension and is caused by an identifiable cause.[6] Some are well-known secondary causes, such as Cushing's syndrome.[7] In addition, secondary hypertension can be caused by a variety of conditions and medications, including hormonal changes such as hyperthyroidism, hypothyroidism, and adrenal gland cancer. Secondary hypertension is also caused by kidney disease, obesity/metabolic disorder, pre-eclampsia during pregnancy, aortic coarctation, and certain prescription and illegal drugs.

Hypertension is a risk factor for strokes, heart attacks, heart failure, and arterial aneurysms, as well as a leading cause of chronic kidney failure.[8] A moderate increase in arterial blood pressure reduces life expectancy. Dietary and lifestyle changes, as well as medications, can improve blood pressure control and reduce the risk of associated health complications.

1. Classification of Hypertension

Hypertension is typically classified based on systolic and diastolic blood pressures.

The BP in vessels during a heartbeat is known as systolic BP. Diastolic blood pressure is the pressure that exists between heartbeats. A systolic or diastolic blood pressure measurement that is higher than the accepted normal values for the individual's age is classified as pre-hypertension.

Hypertension is classified into three stages: Hypertension stage I, Hypertension stage II, and Isolated Systolic Hypertension. Isolated Systolic Hypertension, which is common in the elderly, is defined as elevated systolic pressure with normal diastolic pressure. These classifications are determined by averaging a patient's resting blood pressure readings from two or more office visits. Individuals over the age of 50 are classified as hypertensive if their blood pressure is consistently at or above 140 mmHg systolic or 90 mmHg diastolic. Patients with blood pressures higher than 130/80 mmHg and diabetes or kidney disease require additional treatment. Hypertension is also considered resistant if medications do not reduce blood pressure to normal levels.[9]

Table 1: Threshold values.

Categories of Blood Pressure	Diastolic (mmHg)	Systolic (mmHg)
Normal	<80	<120
Prehypertension	80 - 89	120 - 139
Stage 1 Hypertension	90 - 99	140 - 159
Stage 2 Hypertension	=>100	=>160
Emergency	>110	>180

2. Factors Affecting Blood Pressure

Regardless of developed or developing countries, hypertension has become a global problem.[10] It is to blame for 1 billion deaths worldwide or roughly 7.1 million per year.[11] It is recognized for end-stage renal disease, cerebrovascular disease, and cardiovascular disease (CVD). Numerous studies have found a strong link between high blood pressure and risk factors like age, body mass index, smoking, and inactivity. Physical inactivity is a significant contributing factor to chronic disease conditions like hypertension.[12]

Only 10% of patients know the cause of their hypertension (secondary hypertension), and in nearly 90% of cases, the cause is unknown (referred to as essential or primary hypertension). Although it cannot be cured, essential hypertension can be managed. Although it is frequently stated that essential hypertension has unknown causes, this is only partially true because we know very little about genetic variations, genes that are over- or under-expressed, and the intermediary phenotypes that these genes control to cause high blood pressure.[13] Physical activity, obesity, insulin resistance, high alcohol, and salt intake, getting older, leading a sedentary lifestyle, stress, low calcium, and potassium intake, and obesity are just a few of the factors that raise blood pressure.[14,15]

3. Pathophysiology

When compared to those with essential (primary) HTN, the majority of the mechanisms linked to secondary HTN are typically fully understood. To explain this, the following theories have been put forth:

4.1 Genetics

Mendelian forms of high blood pressure may result from a single gene mutation.[16] Ten genes have been found to be responsible for these monogenic forms of hypertension.[16,17] By changing the way the kidneys handle salt, these mutations affect blood pressure.[18,19] The discovery that the dopamine receptor gene is linked to hypertension is based on the fact that cells use the DRD4 gene to produce the chemical dopamine.[20]

Dopamine regulates sodium excretion through direct interaction with dopamine receptors, which is known to be associated with hypertension.[21] This dopamine receptor is located in the proximal tubule of the kidney, and any defect in this receptor prevents sodium from being reabsorbed in the tubules by inhibiting the activity of the Na, H-exchanger, and Na, K-ATPase.[22] After that, the rise in systolic and diastolic blood pressure results from the increased sodium concentration.

3.2 Sodium/Potassium ratio Hypothesis

The risk of hypertension has long been linked to excessive sodium consumption, and potassium, the primary intracellular cation, has typically been considered a minor contributor to the pathogenesis of hypertension. In hypertensive adult populations, the sodium-to-potassium ratio seems to be more strongly correlated with blood pressure outcomes than sodium or potassium alone.[23]

3.3 Sympathetic Nervous System

Sympathetic stimulation raises blood pressure more in patients with high BP and hypertension than in those with normotension. Changes in baroreflex and chemoreflex pathways at both the peripheral and central levels are involved in the mechanisms of increased sympathetic nervous system activity in hypertension.[24]

3.4 Renin – Angiotensin – Aldosterone system

Renin is a circulating enzyme that keeps arterial vasoconstriction and extracellular volume in check. It works by hydrolyzing angiotensinogen to produce the peptide angiotensin-I. The

most vasoactive peptide, angiotensin-II, is created when angiotensin-I is further cleaved by the enzyme angiotensin-converting enzyme (ACE).[25,26] Angiotensin-II is a strong blood vessel constrictor that increases peripheral resistance and raises blood pressure. Therefore, elevated blood renin levels, which are typically between 1.98 and 2.46 ng/ml when standing up[27], cause hypertension.[28,29]

4. Treatment of Hypertension

5.1 Non-Pharmacological Treatment

The key to reducing the onset of hypertension is lifestyle modification, which is also essential therapy for those who already have the condition.[30] All patients, including those who need drug treatment, should have modifications made when necessary. Lowering blood pressure, managing cardiovascular risk factors, and cutting back on the quantity or dosage of antihypertensive medications are the main objectives.[31]

These changes include a reduction in weight in patients who are overweight or obese, physical activity, controlled consumption of sodium, use of the Dietary Approaches to Diet, controlled alcohol, and the Stop Hypertension (DASH) program reduction in smoking and consumption.

In light of these guidelines, patients whose systolic and diastolic blood pressure (Diastolic BP) ranges from 80 to 130 mmHg and between 80 and respectively, should alter their way of life to control BP, but it's important to monitor the therapy's results. If it is not functioning, the patient should transition to pharmacological therapy.[32]

5.1.1 Increased Potassium intake: A healthy individual with normal kidney function typically consumes 4.7 g of potassium per day; a higher intake is not linked to increased risk due to the ease with which healthy individuals without CKD excrete potassium. In people with low baseline potassium intake as well as high baseline potassium intake, increased potassium intake is associated with reduced BP.[33,34] It should be noted that potassium lowers blood pressure more in blacks than in whites.[35]

5.1.2 Reduced Salt Intake: The amount of salt consumed and lost must balance metabolically. Thus, according to the WHO recommendation (5 g per day)[36], an intake of 5 g of salt per day is thought to be sufficient under normal living circumstances and levels of physical activity.

Contrarily, the average daily intake of salt in most nations is currently estimated to be between 9 and 12 g. The 2013 ESH/ESC guidelines recommend 5-6 g of salt per day 77, while the current recommendations of the American Heart Association[37] and American Society of Hypertension[38] are stricter. They advise lowering salt intake to 3.8 g per day.[39] Reduced sodium intake is consistently linked to lower blood pressure, according to randomized controlled trials done on hypertensive patients.[40]

5.1.3 Physical Activity: Regular exercise lowers blood pressure in people with hypertension. Training for endurance lowers blood pressure more in people with hypertension than in people with normal blood pressure. Regular medium-intensity to high-intensity aerobic activity decreased blood pressure by a mean of 11/5 mmHg[41], according to a narrative review of 27 randomized clinical trials in people with hypertension. The greatest impact on BP was achieved with sessions lasting 40–60 minutes, performed at least three times per week. In three randomized controlled trials of isometric exercise (strength training), people with hypertension experienced a similar reduction in blood pressure to that brought on by aerobic exercise.[42]

5.2 Pharmacological Treatment

The development of various antihypertensive medication classes and extensive outcomes trials demonstrating their benefits on CVD morbidity and mortality have driven the evolution of antihypertensive pharmacotherapy over a number of decades.[43] Clinicians today must choose from a wide range of antihypertensive drugs from various drug classes and fixed-dose combinations. First-line antihypertensive drugs, either in monotherapy or in combination, are frequently used to start antihypertensive pharmacotherapy.[44] In patients with higher pre-treatment blood pressure levels, combination therapy might be preferred. ACE inhibitors, angiotensin II receptor blockers, dihydropyridine calcium channel blockers, and thiazide diuretics are among the first-line antihypertensive drugs.[45]

Table 2: Antihypertensive Agents.

Classes of Drug		**Drug Names**
Diuretics	Thiazide Diuretics	Hydrochlorothiazide, Chlorothiazide, Epitizide, Bendroflumethiazide
	Loop Diuretics	Bumetanide, Torsemide, Furosemide, Ethacrynic acid
	Thiazide like Diuretics	Chlorthalidone, Metolazone, Indapamide
	Potassium Sparing Diuretics	Triamterene, Spironolactone, Amiloride

Adrenergic Receptor Antagonists	Alpha Blockers	Phentolamine, Tolazoline, Phenoxybenzamine, Prazosin, Terazosin, Doxazosin, Indoramin
	Beta Blockers	Oxprenolol, Pindolol, Propranolol, Timolo, Metoprolol, Nadolol, Atenolol
	Mixed Alpha+ Beta Blockers	Carvedilol, Labetalol, Bucindolol
Adrenergic Receptor Agonists	Alpha- 2 agonists	Methyldopa, Guanfacine, Clonidine
Calcium Channel Blockers	Dihydropyridines	Nicardipine, Amlodipine, Nifedipine, Nimodipine, Nitrendipine, Felodipine, Isradipine, Lercanidipine
	Non-Dihydropyridines	Diltiazem, Verapamil
ACE Inhibitors		Lisinopril, Perindopril, Quinapril, Ramipril, Trandolapril, Benazepril, Captopril, Enalapril, Fosinopril
Aldosterone Antagonists		Spironolactone, Eplerenone
Angiotensin II Receptor Antagonists		Eprosartan, Olmesartan, Telmisartan, Valsartan, Candesartan, Irbesartan, Losartan
Centrally Acting Adrenergic Drugs		Methyldopa, Moxonidine, Clonidine, Guanabenz
Vasodilators		Hydralazine, Sodium Nitroprusside

5.3 Naturally Occurring Medicinal Plants having Antihypertensive Potential

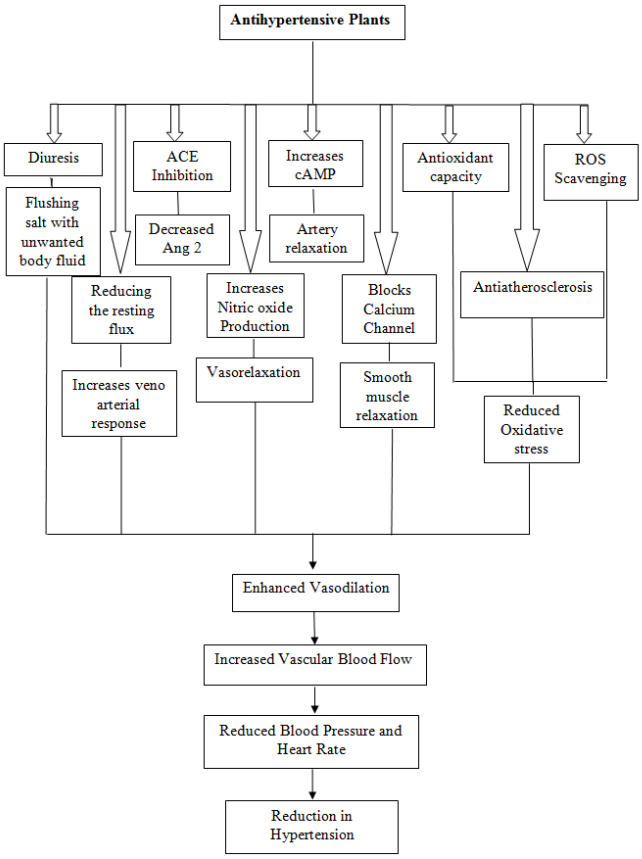

Fig. 1: An illustration showing the beneficial impacts of antihypertensive herbs and plants on the pathogenesis of hypertension.

5.3.1 *Achyranthus aspera*

(Common Name: Charchita; Family: Amaranthaceae) The plant is a common weed throughout the world, growing in Baluchistan, Ceylon, Tropical Asia, Africa, Australia, and America.[46] In India, it grows as a weed on the sides of roads, at the edges of fields, and in waste areas. In traditional medicine, the plant is used as an anti-arthritic, anti-fertility, laxative, abentifacient, anti-helminthic, aphrodisiac, antiviral, anti-plasmodic, antihypertensive, anticoagulant, diuretic, and anti-tumor.[47]

5.3.2 *Agathosma betulina*

(Common name: Buchu; Family: Rutaceae) It is a South African medicinal plant that has been used for ages to heal a variety of diseases by the local aboriginal population. It works well as an anti-inflammatory and diuretic. Using buchu, early Dutch immigrants created a brandy tincture that is still used today to cure a variety of ailments.[48]

5.3.3 *Allium sativum*

(Common name: Garlic; Family: Liliaceae) In particular, hyperlipidemia is one cardiovascular ailment for which garlic has been used for a long time. Additionally, reports of its hypotensive effects exist. It is believed to promote the synthesis of nitric oxide, which relaxes smooth muscles and dilates blood vessels. Allicin is one of the main active components that gives garlic its distinctive smell and many of its therapeutic advantages. Garlic is associated with a reduction in blood pressure in individuals with elevated systolic pressure, but not in people with normal systolic pressure, according to the meta-analysis of literary data that was picked at random.[49] In those with HTN, garlic preparations have been reported to lower BP more effectively than a placebo.[50] After receiving garlic pearls preparation for two months, the antioxidative and antihypertensive effects of garlic were observed in 20 patients with HTN compared to 20 patients with normal blood pressure. The outcomes showed lower blood pressure.[51]

5.3.4 *Apium graveolens*

(Common name: Celery; Family: Apiaceae) According to Chinese belief, celery is beneficial for treating HTN because it affects the liver, which is linked to one kind of HTN. Celery helped 14 out of 16 patients with HTN in Mainland China. Approximately 8 ounces of the juice were taken orally three times each day for up to a week after being combined with an equal amount of honey.[52] Additionally, it is said to lower both systolic and diastolic blood pressure. A. graveolens seeds can be used as a safe and effective treatment for high blood

pressure, as shown by the substantial difference in BP in human subjects before and after treatment (P 0.05).[53]

5.3.5 *Artocarpus altilis*

(Common name: Breadfruit; Family: Moraceae) The plant is indigenous to the western Pacific islands and the Malay Peninsula. According to a study, the plant's leaf extract reduced the tension of isolated guinea pig aorta rings that were activated by phenylephrine by 15% to 35%.[54]

5.3.6 *Avena sativa*

(Common names: Green Oat; Family: Gramineae) Whole oats, which are high in soluble fiber, can dramatically lower the requirement for antihypertensive medication and improve blood pressure control. Increased whole-oat consumption may dramatically lower the risk of cardiovascular disease, especially in light of the improvements in cholesterol and glucose levels.[55] Patients with HTN have been reported to dramatically lower both systolic and diastolic BP by including oat cereals in their regular diets.[56]

5.3.7 *Blond psyllium*

(Common name: Indian plantago; Family: Plantaginaceae) According to preliminary clinical studies, ingesting 15 g of *B. psyllium* (Plantago species) daily will somewhat lower blood pressure, systolic by roughly 8 mmHg and diastolic by 2 mmHg.[57]

5.3.8 *Camellia sinensis*

(Common name: Tea; Family: Theaceae) Tea has a variety of potential health advantages. Researchers are very interested in learning how tea affects cardiovascular disease. There is conflicting research about tea and HTN. Black tea (fermented tea) had no impact on blood pressure in HTN patients, according to research.[58]

5.3.9 *Capparis cartilaginea*

(Common name: Lasaf; Family: Capparaceae) It is a scrambling or prostrate shrub that grows on rocky terrain and occasionally hangs from cliffs. According to reports, sedated rats exposed to a crude extract of *C. cartilaginea* experience a dose-dependent drop in blood pressure and mild bradycardia.[59]

5.3.10 *Cassia occidentalis*

(Common name: Coffee weed; Family: Caesalpiniaceae) It is a little tree with a height range of 5 to 8 meters. This plant's leaf is utilized as an antihypertensive in regional traditional medicine. The leaf extract has been proven to have a relaxing effect on the aortic rings in in vitro experiments. According to the investigations, cassia extract may relax smooth muscle and lower blood pressure by preventing Ca2+ influx through voltage-sensitive and receptor-operated Ca2+ channels, demonstrating its non-selectivity on these Ca2+ channels.[60]

5.3.11 *Castanospermum austral*

(Common name: Black bean; Family: Fabaceae) *C. australe* crude extract has been shown to reduce systolic and diastolic blood pressure in a dose-dependent manner (1–100 mg/kg). The saponin fraction and medicogenic acid glucoside found in the crude extract have been blamed for this drop in blood pressure.[61]

5.3.12 *Commelina virginica*

(Common name: Virginia dayflower; Family: Commelinaceae) It belongs to the dayflower family and is a perennial herbaceous plant. It is indigenous to the southeast and middle east of the United States. The whole plant extract has been shown to reduce the tension of isolated guinea pig aorta rings induced by phenylephrine by 15% to 35%.[62]

5.3.13 *Crinum glaucum*

(Common name: River Lily; Family: Amaryllidaceae) The effects of *C. glaucum* on respiratory and cardiovascular functions were examined because it is traditionally used in Western Nigeria to treat asthma. Increased aqueous extract doses led to higher tidal volumes (higher ventilatory rate and depth) and correspondingly lower systolic and diastolic pressures.[63]

5.3.14 *Daucus carot*

(Common name: Carrot; Family: Umbelliferae) It has been used to treat HTN in conventional medicine. Two coumarin glycosides with the codes DC-2 and DC-3 were isolated during activity-directed fractionation of *D. carota's* aerial parts. In rats under NMT anesthesia, intravenous injection of these substances led to a dose-dependent (1–10 mg/kg) decrease in arterial blood pressure. Both substances inhibited the K+-induced contractions of the rabbit aorta and the spontaneously beating guinea pig atria in the in vitro tests at similar doses (10–200 g/ml). These findings suggest that DC-2 and DC-3 may lower blood pressure by blocking

calcium channels, which may account for the BP-lowering effects of the compounds seen in vivo investigations.[64] Daucuside and daucusol, two novel guaiane-type sesquiterpene terpenoids with an intriguing epoxy unit, have been discovered in *D. carota* fruits.[65]

5.3.15 *Desmodium styracifolium*

(Common name: Osbeck; Family: Leguminosae) Preparations made from the plant's dried leaves and stem that were administered intravenously to dogs under anesthesia enhanced coronary circulation, decreased arterial blood pressure, slowed heart rate, and decreased cardiac oxygen consumption.[66]

5.3.16 *Fuchsia magellanica*

(Common name: Hardy Fuchsia, Chiko; Family: Onagraceae) This plant is indigenous to Chile and Southern Argentina. The leaf extract is infused to lower blood pressure, regulate body temperature, and function as a diuretic.[67] The ethanol/aqueous extracts of this species were studied by Schmeda-Hirschmann et al. in NMT rats, and they discovered a moderate to a significant decrease in the mean arterial pressure.[68]

5.3.17 *Glycine max*

(Common name: Soybean; Family: Fabaceae) It has been discovered that soybean works well to lower blood pressure. One study found a very slight drop in blood pressure, while another found no benefit.[69]

5.3.18 *Gossypium barbadense*

(Common name: Pima cotton; Family: Malvaceae) It is a tropical perennial plant with black seeds and yellow flowers. According to a study, the plant's leaf extract reduced the tension of isolated, phenylephrine-stimulated guinea pig aorta rings by 15% to 35%. The plant's leaves are used to cure HTN and irregular or delayed menstruation in traditional Surinamese medicine.[54]

5.3.19 *Hibiscus sabdariffa*

(Common name: Roselle; Family: Malvaceae) This is one of the herbs whose antihypertensive characteristics have been researched the most. It is customary in many West African nations to consume the leaves, calyx, and corolla of this plant for both culinary and medicinal uses. Studies on this plant extract's antihypertensive properties have varied. Calyx of HS's antihypertensive effects were documented in one study.[70] The BP of experimentally

induced hypertensive rats decreased after receiving an intravenous injection of a water extract of dry HS calyx at a dose of 20 mg/kg. The direct vasorelaxant effects of the HS crude extract's antihypertensive effects have been linked to acetylcholine and histamine-like dependent mechanisms.[71] An earlier study showed that the rat aorta smooth muscle was directly relaxed by the petal crude extract of the same plant.[72]

5.3.20 *Lepidium latifolium*

(Common name: Rompepiedra or Stone breaker; Family: Cruciferae) In the Canary Islands, this herb has been utilized as a traditional remedy for renal lithiasis. Its diuretic impact in rats has been demonstrated to produce hypotensive effects. The aqueous leaf extract demonstrated significant and dose-dependent diuretic and hypotensive effects when administered in doses of 50 and 100 mg/kg intraperitoneally and orally, respectively. The study went further and used the diuretic properties of furosemide in both situations to extrapolate the rat extract's effects on people. The recommended dosage of L. latifolium for men was 3 to 5 g/day in the form of tea or 43 to 71 mg/kg for a patient weighing 70 kg.[73]

5.3.21 *Linum usitatissimum*

(Common name: Linseed, Flaxseed; Family: Linaceae) It is an annual herb that is thought to have come from Egypt. The important fatty acid -linolenic acid, which is abundant in linseed and its oil, looks to be helpful for treating heart disease, inflammatory bowel disease, arthritis, and other health issues. Linolenic acid is a member of the class of compounds known as omega-3 fatty acids.

Numerous studies indicate that diets high in omega-3 fatty acids dramatically reduce blood pressure in those with HTN. By lowering blood cholesterol, platelet aggregation, and inflammatory indicators; enhancing glucose tolerance; and serving as an antioxidant, flaxseed may defend against atherosclerotic cardiovascular disease. Ground flaxseed eating of 15 to 50 g per day can only slightly lower total cholesterol and low-density lipoprotein concentrations.[74]

5.3.22 *Lycopersicon esculentum*

(Common name: Tomato; Family: Solanaceae) Carotenoids included in tomato extract, including lycopene, beta carotene, and vitamin E, are known to be powerful antioxidants that can neutralize free radicals and halt the progression of atherosclerosis. According to a study, tomato extract (Lyc-O-Mato) somewhat lowers blood pressure in those with mild, untreated

HTN.[75] Systolic blood pressure and lycopene concentrations have been found to be significantly correlated. Tomato extract reduced blood pressure by more than 10 mmHg systolic and more than 5 mmHg diastolic pressure in patients receiving low doses of ACE inhibitors, calcium channel blockers, or their combination with low-dose diuretics. There were no negative effects associated with the medication, and compliance with it was very high.[76]

5.3.23 *Moringa oleifera*

(Common name: Murungai; Family: Moringaceae) The crude extract from the leaves of *M. oleifera* reduced systolic, diastolic, and mean blood pressure in a dose-dependent way in rats under anesthesia.

Within two minutes, the antihypertensive effect vanished and blood pressure returned to normal. Except at high doses (3 and 10 mg/kg), where a slight bradycardia was elicited, HR was not appreciably impacted. It was also determined that the crude extract's thiocarbamate and isothiocyanate fractions were what gave rise to the antihypertensive activity.[77]

5.3.24 *Musanga cecropiodes*

(Common name: Umbrella tree, Cork Wood; Family: Cecropiaceae) It is a perennial plant with quick growth that is common to tropical rainforests, especially in West Africa. There have been claims that an ethanol extract from the plant's stem bark has anti-diarrheal properties.[78] Numerous researchers have established the latex and leaf extract's scientific usefulness as a vasorelaxant and, consequently, a hypotensive agent.[79]

It has been documented that the aqueous extract of the stem bark causes a dose-dependent decrease in mean arterial BP, which decreased by 4.51 0.5 mmHg at the dose of 10 mg/kg and 65.23 6.28 mmHg at the dose of 40 mg/kg.[80]

5.3.25 *Ocimum basilicum*

(Common name: Basil; Family: Lamiaceae) A crude extract of O. basilicum has been shown to reduce systolic, diastolic, and mean blood pressure in a dose-dependent manner, with a median effective dose of 30 mg/kg. The transient antihypertensive impact lasts for only two minutes before returning to normal. Eugenol, an ingredient in the extract that works by inhibiting calcium channels, is thought to be responsible for this extract's cardiovascular effects.[81]

5.3.26 *Peganum harmala*

(Common name: Harmal; Family: Nitrariaceae) The crude extract fraction includes all pure chemicals from *P. harmala*, including harmine, harmaline, tetrahydroharmine, harmol, and harmaloi exhibited dose-dependent antihypertensive effects in rats under anesthesia.[82]

5.3.27 *Pinus pinaster*

(Common name: Maritime Pine; Family: Pinaceae) It is best known for being used to treat venous insufficiency and other vascular disorders. But a lengthy list of things are being looked into it for various ailments, such as HTN. Pycnogenol 200 mg/day has been shown in a preliminary clinical study to modestly reduce BP in persons with mild HTN. According to reports, it works by preventing angiotensin-converting enzymes.[83]

5.3.28 *Punica granatum*

(Common name: Pomegranate; Family: Lythraceae) Pomegranate juice is a fruit juice that is gaining popularity. Pomegranate has been found to have a 36% reduction in the activity of ACE, according to research. Clinical studies produce conflicting findings. With one trial, consuming 50 ml of pomegranate juice each day for a year resulted in a slight decrease in systolic blood pressure.[84]

5.3.29 *Rauwolfia serpentina*

(Common name: Rauwolfia; Family: Apocynaceae) It is a woody tropical plant that is native to Asia, South America, and Africa. In Hindu medicine, extracts of rauwolfia and plants that resemble it were used to treat insomnia, insanity, and a variety of other illnesses and complaints. The most potent hypotensive herb is thought to be this one. The first powerful medication that was widely used to treat HTN over the long term was reserpine, a pure alkaloid from *R.serpentina*. To get results and prevent adverse effects, only a tiny amount is needed. The most typical side effect is nasal congestion. Reserpine was first made available under the name in 1952. Reserpine, dihydroergocristine, and a diuretic are still sold together on the market.[85]

5.3.30 *Sesamum indicum*

(Common name: Sesame; Family: Pedaliaceae) In rats under anesthesia, an alcoholic extract of the seeds (1–30 mg/kg) led to hypotension. A dose-dependent decrease in systolic and diastolic blood pressure was seen. When given slightly greater doses (10–30 mg/kg), HR was shown to decline. The cardiovascular reactions were reported to be abolished by atropine (2

mg/kg), indicating the presence of an acetylcholine-like chemical in the seeds. The two main phenolic components of sesame oil are sesamin and sesaminol. According to a study on hypertension patients, eating sesame oil significantly lowered oxidative stress while also boosting the activities of glutathione peroxidase, superoxide dismutase, and catalase. These findings provide credence to the idea that consuming sesame oil may strengthen the body's natural antioxidant defenses.[86]

5.3.31 *Solanum sisymbriifolium*

(Common Name: Sticky Nightshade; Family: Solanaceae) In Paraguay, a perennial herb called S. sisymbriifolium Lam. has been utilised as a traditional medicine with diuretic and antihypertensive characteristics. Both NMT and hypertensive rats were used to study the crude hydroalcoholic root extract's hypotensive effects. When the extract (50 and 100 mg/kg) was administered intravenously to rats with hypertension (adrenal regeneration HTN + deoxycorticosterone acetate), the rats' blood pressure significantly decreased. In conscious hypertensive rats, oral treatment of the extract (10, 50, 100, and 250 mg/kg) similarly had a dose-dependent hypotensive effect. The extract (50 and 100 mg/kg, i.v.) similarly produced dose-dependent hypotension in anaesthetized NMT rats. Finally, the extract had no noticeable impact on blood pressure when given orally to conscious NMT rats (10, 50, 100, 250, 500, and 1000 mg/kg).[87]

5.3.32 *Theobroma cacao*

(Common name: Chocolate, Cocoa Bean; Family: Malvaceae) Cardiovascular disease is prevented by using a cocoa powder that has been fortified with flavonoid components.

Flavonoids, which are present in chocolate, promote vasodilation, boost the production of nitric oxide, and decrease endothelial dysfunction. An increasing amount of clinical research also demonstrates that eating 46 to 105 grams of dark or milk chocolate, which contains 213 to 500 mg of cocoa polyphenols, per day can reduce blood pressure by around 5 mmHg systolically and by about 3 mmHg diastolically.[88]

5.3.33 *Trichosanthes dioica*

(Common name: Parwal; Family: Cucurbitaceae) A perennial herb found in tropical Asia, *Trichosanthes* is a member of the Cucurbitaceae family and is a common vegetable. The herb is widely cultivated, especially in Australia, Bangladesh, India, and Nepal as well as other tropical Asian regions.[89] The herb *T. dioica* contains the following phytochemicals: The

herb includes tetra and pentacyclic triterpenes, tannins, saponins, vitamin A, vitamin C, and tannins. Cucurbitacins (toxic bitter principles), lectin, polysaccharides, phenols, and sterols (such as 24α ethylcholest-7-enol and 24β ethylcholest-7-enol), fats and synthetic oils, as well as proteins and amino acids.[90] *T. dioica* aqueous, ethanol, petroleum ether, and chloroform fruit extracts significantly reduced blood pressure in dexamethasone-induced hypertensive Wistar albino rats after 5 days of oral treatment.[91]

5.3.34 *Vitex doniana*

(Common name: Black plum; Family: Verbenaceae) Ladeji et al. looked at how this plant's extract administered orally to rats affected their blood pressure. It was discovered that the extract has hypotensive effects. Within 45 minutes of the extract's oral administration, both the systolic and diastolic BPs were dramatically decreased. After two hours, the BP started to recover to normal.[92]

5.3.35 *Zingiber officinale*

(Common name: Ginger; Family: Zingiberaceae) Ginger root is commonly used in Asian cooking. It acts to improve blood circulation and relaxes muscles surrounding blood vessels. The crude extract of ginger (Zo. Cr) induced a dose-dependent (0.3-3 mg/kg) fall in the arterial BP of anesthetized rats. In guinea pig paired atria, Zo. Cr exhibited a cardio-depressant activity on the rate and force of spontaneous contractions. In rabbit thoracic aorta preparation, Zo. Cr relaxed the phenyl ephedrine-induced vascular contraction at a dose ten times higher than that required against K+ (80 mM)-induced contraction. Ca2+ channel-blocking activity was confirmed when Zo. Cr shifted the Ca2+ dose-response curves to the right, similar to the effect of verapamil. These data indicate that the BP-lowering effect of ginger is mediated through the blockade of voltage-dependent calcium channels.[93] There have been few human studies looking at the hypotensive effects of ginger, and they often utilised low doses with ambiguous outcomes.[94]

CONCLUSION

According to a survey of the literature, hypertension is one of the largest problems facing society today. Regardless of where the disease is in its development, it is present in every single country in the world. In all types of populations, the sickness is widespread.

Now, it's important to educate people about the disease's seriousness and prevention measures. Prior to administering any medications to the patient, if necessary, they should

subsequently move on to non-pharmacological treatment. The biggest contributing factor to hypertension is a person's lifestyle, which needs to be altered. A number of conventional herbal remedies and dietary supplements have been identified as promising therapeutic agents to treat hypertension and its side effects. Although they have been used for a long time to treat and lower hypertension and to create efficient, natural medications to control high blood pressure, their effectiveness has to be proven by pharmacological research and clinical studies. Since everything in the world is progressing and moving forward, we must also advance our health in that direction.

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