Medicinal Plants Used for Management of Hypertension in Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author OAO designed the study, wrote the protocol and wrote the manuscript. Author KIE corrected the final draft and arrangement of manuscript. Author ABS gathered the initial data and edited the initial manuscript. All authors read and approved the final manuscript

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ABSTRACT

Hypertension is a medical condition characterized by chronic elevation of arterial blood pressure. Management of this chronic disease is essential to reduce cardiovascular risk factors and prevent other end-organ damage leading to stroke, retinopathies, chronic renal disease amongst others. Conventional management involves use of beta-adrenergic blockers, angiotensin receptor blockers, angiotensin-converting enzyme inhibitors, calcium channel blockers, or diuretics. Alongside these orthodox treatment regimens, traditional medicine systems in different parts of the world have means of treatment and management of hypertension which involves the use of herbs in the nature around man. However, these traditional practices are not standardized and there are no empirical bases for the use of many of these medicinal plants. This dearth of information prompted researchers to investigate the antihypertensive properties of claimed medicinal plants and probably determine the mechanism of action and bioactive principle(s) in these plants. Medicinal plants used for treatment and management of hypertension in African Traditional Medicine practiced in Nigeria, West Africa are the focus of this review article. Studies on most of the plants are still at the rudimentary stage but results observed from these studies are noteworthy. Existing information on verification of traditional use and toxicity profile of these plants are

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documented here. Ethnomedical practices of different regions of Nigeria and some of the important plants used for treatment and management of hypertension are also discussed.

**Keywords:** Hypertension; medicinal plants; Nigeria.

1. INTRODUCTION

African Traditional Medicine in Nigeria has survived through the worst catastrophe of human history, the slave trade era [1]. This is evident in the level of dependence of Nigerian locals in the twenty-first century on this medicinal system which has outlived several other systems and also in thriving African communities of Nigerian roots in diaspora, particularly South American countries such as Brazil, Peru which have strong, thriving ethno-medicinal practices till date [2, 3]. During the slavery period, slaves from West Africa particularly Nigeria, usually predominate and emerge as the traditional healer of the African settlements [4].

In contrast to the European Medicine system which included invasive treatment of venesection, cupping, blistering, purging and leeching practiced by Europeans during the plantation slavery era [5,6] the African Traditional Medicine system employed the use of plants and plant materials for treatment of diseases and ailments [4]. The knowledge of use of whole plants, plant parts such as roots, leaves, stem bark by Africans can be traced to pre-colonial centuries. Several vital aspects of this knowledge have been lost due to the oral mode of transfer of knowledge employed. A very few of the surviving information has formed the basis of the ethno-medicinal practice in Africa in the 20th and 21st centuries. This medicinal system requires extensive research into the untapped natural resources of plants in Africa, especially West Africa.

According to the World Health Organization (WHO) [7], 80% of the population in many African countries depend almost entirely on traditional medicines, herbal medicines in particular, for their primary health care needs [8,9]. This is attributed to the perceived effectiveness of the plant-based therapies as well as the availability of these medicinal plants because the continent accounts for about 25% of the total number of higher plants in the world where more than 5,400 medicinal plants were reported to have over 16,300 medicinal uses [10].

Several medicinal plants have been and are in current use for multiple disease conditions [11,12]. Hypertension and related illnesses feature prominently with some of these herbal preparations [13]. To mention, out of all medicinal plants employed by ethno-traditional healers, over 150 species of plants are prescribed as food, with about 100 gathered in the wild and over 30 species cultivated [14]. Roots, stems and their barks are also prescribed for treatment of diseases and ailments. As will be discussed in the course of this review article, many of these medicinal plants have been shown to lower heart rates, systolic and diastolic blood pressures, amongst other symptoms of cardiovascular diseases. Some medicinal plants have been shown to reverse or improve deranged cardiovascular parameters particularly raised blood pressure and other complications associated with these diseases [15,16,17]. In Nigeria, several plant species have been employed for treatment of these conditions with appreciable patient response. Some scientific studies have verified the claims made by these traditional healers or patients themselves.

This review article is dedicated to documentation of existing knowledge of African Traditional Medicine practiced in Nigeria, West Africa, for treatment and management of hypertension and related illnesses. Most studies on medicinal plants are still at the rudimentary stage of drug development. A few of these plants have the toxicity profile, isolation and structural elucidation of bioactive principle(s) responsible for the pharmacological activity, purification and synthesis of bioactive principle(s) from them documented. Several other studies have been based on comparing the effects of crude extracts to that of pure compounds isolated from the plants. The rationale for these studies was adopted from the belief of the traditional healers that plants have a specific way of producing an effect and this view has been shared by some scholars.

2. ETHNOMEDICINAL PLANTS EMPLOYED FOR TREATMENT OF HYPERTENSION

Hypertension is also known as high blood pressure in the world over, and this disease is one of the most common non-communicable diseases affecting adults of all races, including...
Africans [18]. In the study by Raji et al. [19], the authors reported that the true incidence of hypertension in Nigeria was uncertain but estimated to be about 11.2% of the population. This chronic disease cannot be cured, but can be managed throughout life to prevent development of complications. A study by Osamor [20] reported the disposition of a hypertensive population in a Nigerian community to management options adopted. The study showed that of the 440 respondents, 65.2% were women, with about half being illiterate and half being traders. Remarkably, all respondents used antihypertensive recipes prepared as decoctions, prescribed plants included a combination of orthodox medications and herbal medicine [20].

A study by Gbolahan [21] which covered 66.6% of Edo State, central Southern Nigeria, reported the interview of about 189 traditional medical practitioners using semi-structured questionnaire administered by trained interviewers. The study indicated 70 plants belonging to 67 genera in 43 families are commonly prescribed, with 39 species of these plants being cultivated, while 29 species grew in the wild, and 2 plants both grew in the wild and was cultivated. Herbal antihypertensive recipes prepared as decoctions, infusions, powders and or juice. Plants which were most frequently prescribed included Allium species, Persea americana, Acalypha godseffiana, Zingiber officinale, Sida acuta, Hunteria umbellata, Rauwolfia vomitoria, Viscum album and Aframomum melegueta [21].

Another study carried out in Sokoto North West Nigeria reported the interview of 40 traditional medicine practitioner and herbal sellers (65% males and 35% females) using semi-structured questionnaires and open-ended conversations. The study indicated 34 plants belonging to 30 families with reports of validation of some of these antihypertensive plants. Frequently prescribed plants included Allium sativum, Oleo europaea, Commiphora krestiggi, Moringa oleifera, Acacia linotica and Hibiscus sabdariffa [19]. In the study by Olisa and Oyelola [22], it was reported that 47.5% of the hypertensive respondents from a secondary health care facility in Maiduguri, a town in North East Nigeria, in addition to orthodox medications prescribed, used herbal remedies for hypertension. These patients were oblivious of the possibility of drug-drug interactions and probable complications due to toxicities.

Reports have also been documented on ethnomedies of prevalence of hypertension and traditional treatments employed for management of this condition in Akwa Ibom [23], South Western Nigeria from Ibadan [24] and Ilugun [25]. Below are summaries of the findings of researchers on some of the plants employed for management of hypertension in Nigeria.

### 2.1 Vernonia amygdalina

Aqueous extract of Vernonia amygdalina was investigated for its cardiovascular effects in normotensive Sprague-Dawley rats. Administration of the extract intravenously via the femoral vein at doses of 5.0 and 10.0mg/kg caused a bi-phasic alteration of blood pressure, observed as an initial transient rise in mean arterial pressure with a subsequent decline beyond the basal levels. This pattern of response was particularly observed in rats administered with the dose of 10 mg/kg; initial blood pressure of 73.7 ± 3.4 mmHg increased to 101.9 ± 4.1 mmHg in the first phase (p<0.01) and declined to 60.2 ± 2.5 mmHg in the second phase. However, the prominent biphasic response was not observed with higher doses (50 and 100mg/kg). Contractility study with cumulative addition of the plant extract to isolated rings of aorta precontracted with noradrenaline produced a dose-dependent relaxation of the aortic smooth muscle. Maximum relaxation of 31.3 ± 3.1% was observed with extract concentration of 2.7 mg/ml. The authors suggested a direct vaso-relaxant mechanism of action for the antihypertensive effect of V. amygdalina [17].

### 2.2 Parinari curatellifolia

Parinari curatellifolia is used locally in the South Western Part of Nigeria to treat hypertension. Investigations on the antihypertensive potential of the seed extract revealed that Parinari curatellifolia exhibited negative inotropic and chronotropic effects on isolated rabbit heart. A dose-dependent reduction in systolic and diastolic blood pressure, and mean arterial blood pressure were observed in normotensive and salt-induced hypertensive rats. Percentage change in mean arterial blood pressure was increased compared to the control rats in the normotensive group. Salt loading increased Nitric Oxide Synthase (NOS) activity and production of thiobarbituric acid reactive substances (TBARS) with decrease in the catalase, superoxide dismutase and glutathione peroxidase activities in the liver. The extract reversed these biochemical anomalies and also decreased elevated serum levels of creatinine, urea,
glucose, triglycerides, low density lipoprotein (LDL) and total cholesterol, and increased serum concentration of high density lipoprotein (HDL) [26].

A more recent study investigated the effect of *P. curatellifolia* on doxorubicin-induced cardiovascular diseases in experimental albino rats. Rats administered with Doxorubicin (15 mg/kg) showed significant increase (p<0.05) in plasma concentration of some cardiac markers and lipid profiles except HDL which was significantly (p<0.05) reduced. Also, GSH, GST, catalase, SOD levels in serum were significantly (p<0.05) reduced compared to control rats. On the other hand cardiac malondialdehyde (MDA) increased significantly compared to the control group. However, pretreatment with extract of *P. curatellifolia* at doses of 50-, 100- and 150 mg/kg body weight significantly reversed the biochemical alterations caused by doxorubicin.

The authors suggested that *P. curatellifolia* exhibited cardio-protective effect against doxorubicin-induced cardiotoxicity possibly via positive modulation of the cardiac antioxidant defense system in the rats. The presence of phenolic compounds, particularly the flavonols which were most abundant was suggested to be responsible [27].

### 2.3 *Psidium guajava*

The leaf of *Psidium guajava* Linn. (family, Myrtaceae), commonly known as guava is used traditionally for its hypotensive effect. The study by Ojewole [15] investigated the hypotensive effects of *P. guajava* leaf aqueous extract (50-800 mg/kg) in Dahl salt-induced hypertension model in rats. Acute intravenous administrations of the plant extract (50-800 mg/kg i.v.) produced dose-dependent, significant reductions (p < 0.05-0.001) in systemic arterial blood pressures and heart rates of hypertensive, Dahl salt-sensitive rats. Although the exact mechanisms of action of the plant's extract still remain speculative at present, it is unlikely that the extract causes hypotension in the mammalian experimental animal model used via cholinergic mechanisms, since its cardiodepressant effects are resistant to atropine pretreatment. The numerous tannins, polyphenolic compounds, flavonoids, pentacyclic triterpenoids, guajaverin, quercetin, and other chemical compounds present in the plant are speculated to account for the observed hypoglycemic and hypotensive effects of the plant's leaf extract [15].

### 2.4 *Bryophyllum pinnatum*

Leaf extracts of *Bryophyllum pinnatum* (Lam) Oken [family: Crassulaceae] is a medicinal plant commonly used for traditional management of hypertension by natives of the Yorubaland, Western Nigeria. Aqueous and methanol leaf extracts of the herb were investigated using their effects on arterial blood pressures and heart rates of normotensive and spontaneously hypertensive rats. The effect of the extracts on isolated guinea pig atria was also determined. The extracts at doses of 50-800 mg/kg i.v. or i.p. produced dose-dependent, significant (p< 0.001 – 0.05) reduction in arterial blood pressures and heart rates of anaesthetized normotensive and hypertensive rats. The extract had more profound hypotensive effects on hypertensive rats compared to the normotensive rats [28].

The leaf extracts at concentrations of 0.25 - 5.0 mg/ml also produced dose-dependent significant (p<0.001 – 0.05) negative inotropic and chronotropic effects on isolated guinea-pig atria, and inhibited contractions stimulated by electrical field stimulation (ES)-provoked. Also, the extract inhibited contractions of isolated thoracic aortic strips induced by potassium and receptor-mediated agonist drugs in a non-specific manner. The extract showed remarkable hypotensive effect in this study and the authors reported that further studies are on-going to elucidate the plausible mechanism/s of hypotensive action of the plant. Cardiodepression and vasodilatation were suggested to contribute significantly to the antihypertensive effect of the herb [28].

### 2.5 *Persea americana*

The aqueous seed extract (AE) of *Persea americana* Mill (Lauraceae) has been investigated for its antihypertensive effect using the mean arterial pressure (MAP) and heart rate (HR) of hypertensive and naive rats. *P. americana* extract at doses of 240, 260, 280 mg/kg were administered to the rats with bolus doses of Ach (1, 2, 4 µg/kg). Pretreatment for 10 consecutive days significantly reduced MAP from 125.7±11.2 to 92.1 ±8.5 mmHg and HR from 274.6 ± 39.3 to 161.6 ±11.6 beats /min. Also, acute injections of *P. americana* extract significantly reduced MAP from baseline values in naive rats. The effects of AE on MAP were comparable with those of Ach. Combination of AE with 2 µg/kg of Ach only significantly potentiated the MAP reducing effect of 240mg/kg of AE. It is concluded that the aqueous seed
extract of *P. americana* reduces BP and HR in normotensive rats. This observation lends credence to its use by herbalists for the management of hypertension [29].

### 2.6 Sansevieria senegambica

The study by Ayalogu et al. [30] reported the effects of aqueous extract of the leaves of *Sansevieria senegambica* on plasma marker enzymes, plasma chemistry and the haematological profile of salt-loaded rats. Salt loading was carried out via incorporation into feed of rats for a period of 6 weeks. The extract at doses of 150 mg/kg or 200 mg/kg had no significant effects on markers of liver and kidney functions, but it caused leukocytosis and significantly increased (p < 0.05) plasma levels of calcium and potassium. On the contrary, rats administered with the extract had significantly decreased (p<0.05) plasma sodium and chloride levels compared to the control rats. The extract was suggested to act as a potassium-sparing diuretic with the mechanism of antihypertensive action probably via alteration of plasma sodium and potassium balances, or through calcium-mediated changes in vascular muscle tone [30].

### 2.7 Hibiscus sabdariffa

Calyces of *Hibiscus sabdariffa* Linn (family: Malvaceae) is brewed up as a local brewerage in all parts of Nigeria. It is acclaimed to have several medicinal effects which include antihypertensive effect. The antihypertensive effect of the aqueous extracts of the calyx of *H. sabdariffa* was investigated in anaesthetized rats. A dose-dependent, but relatively vagal-independent decrease in mean arterial pressure was observed in rats administered with the extract. The hypotensive effect of the extract was significantly inhibited by atropine, cimetidine and promethazine. However, the extract did not inhibit the induction of increase in blood pressure by bilateral carotid occlusion (48.05 +/- 6.83 mmHg to 46.53 ±7.49 mmHg). Cumulative doses of the extract in isolated aortic rings precontracted with noradrenaline produced dose-dependent relaxation of the rings. The authors stated that the mechanism of antihypertensive effect of the *H. sadarifia* calyces was not mediated via inhibition of the sympathetic nervous system. However, the involvement of acetylcholine-like and histamine-like mechanisms as well as direct vaso-relaxant effects were suggested [31].

A clinical study has been reported, involving patients with moderate essential hypertension (45% males and 55% females; mean age 52.6±7.9 years), but excluded those with secondary hypertension or using two medications. The observations in the experimental group were compared to a control group of males (30%) and females (70%) with mean age of 51.5±10.1 years. Systolic and diastolic blood pressures were measured on days 0, 12 and 15 of intervention. In the experimental group, the study reported that systolic and diastolic pressure was significantly lowered by 11.2% and 10.7% respectively by day 12 of treatment compared to day 0. By day 15, systolic and diastolic blood pressure was elevated by 7.9% and 5.6% respectively [32].

A further study has been reported in which the efficacy of aqueous extract of calyx *H. sabdariffa* was assessed in salt- and L-NAME-induced hypertension and in normotensive controls. A dose-dependent decrease in the blood pressure and heart rate of hypertensive and normotensive rats was observed post-injection (IV) of *H. sabdariffa* (1-125 mg/kg). This suggested that *H. sabdariffa* possesses anti-hypertensive, hypotensive and negative chronotropic effects, with the most significant (p<0.05) lowering of the mean arterial pressure in the hypertensive rats (salt-induced: 94.4+/-8.6 mm Hg; L-NAME-induced: 136.5+/-10.3 mm Hg) compared to the normotensive controls (50.2+/-5.1 mm Hg) [33].

A similar study evaluated the hypotensive effects of aqueous seed extract of *H. sabdariffa* in normotensive cat. The effects of the aqueous extract were compared with normal basal rhythm and Acetylcholine. The study showed the extract significantly lowered cat blood pressure, even at a minimum concentration of 500 μg/ml. The maximum response shown by the study was at a concentration of 1mg/ml of the extract. However, this concentration of the extract was less potent compared to acetylcholine [34]. The study by Onyenekwe et al. [35] reported that the LD50 of *H. sabdariffa* calyx extract was > 5000 mg/kg. It further corroborated the findings by other researchers on the ability of the extract to significantly (p<0.05) lower systolic and diastolic blood pressure in spontaneously hypertensive and normotensive Wistar-Kyoto rats. The reduction in blood pressure in both groups was positively correlated with weight [35].

Another study investigated the effect of *H. sabdariffa* on renovascular hypertension.
induced in Sprague-Dawley rats by left renal artery clamping using a 0.2 mm silver clip under ether anaesthesia with Sham-operated (Sh-Op) rats serving as controls. A hypertensive group of rats (blood pressure (BP) > 140 mmHg) were administered with \textit{H. sabdariffa} (250 mg/kg/day) six weeks after renal artery clamping. Weekly monitoring of BP using rat-tail plethysmography showed a significant (p<0.001) reduction in systolic BP and heart rate (139.6±1.6 mmHg, 388±3.7 bpm) of rats with the left renal artery clamp but treated with the extract compared to the untreated rats (174±2.4 mmHg, 444±6.8 bpm). In comparison to Sh-Op rats, there was however, no significant difference in BP (132±3.4 mmHg), but heart rate was significantly (p<0.01) increased (416±9.3). Post mortem examination also revealed that the hearts of rats with arterial clamps but treated with the extract (0.66±0.03g) significantly (p<0.05) weighed less than those of untreated rats (0.74±0.03g), but was comparable to those of Sh-Op rats (0.57+/-.04 g) [36].

The mechanism(s) of the anti-hypertensive effect of the crude methanol extract of the calyces of \textit{H. sabdariffa} was investigated on vascular reactivity in isolated aorta from spontaneously hypertensive rats. The extract exerted a concentration-dependent relaxation of KCl (high K⁺, 80 mM) and phenylephrine (PE, 1µM)-pre-contracted aortic rings, with the most significant antagonist at α₁-adrenergic receptor. The relaxant effect was significantly reduced in endothelium-denuded aortic rings, it was thus suggested that the relaxant effect of the extract was partly dependent on the presence of a functional endothelium. Furthermore, the relaxant effect was significantly inhibited in the presence of atropine (1 µM), L-Nitroarginine methyl ester (L-NAME; 10 µM) or methylene blue (10µM), but not indomethacin (10µM). Pretreatment of aortic rings with \textit{H. sabdariffa} significantly enhanced acetylcholine and sodium nitroprusside-induced endothelium-dependent and -independent relaxations respectively compared to those observed in control aortic rings. In summary, the extract of \textit{H. sabdariffa} demonstrated it had a vasodilator effect in the isolated aortic rings of hypertensive rats, thereby lowering blood pressure. The effects observed were suggested to be mediated via the endothelium-derived nitric oxide-cGMP-relaxant pathway and inhibition of calcium (Ca²⁺) influx into vascular smooth muscle cells [37].

Another study attempted to characterize vascular effects of crude extract of dried and powdered calyces of \textit{H. sabdariffa} on isolated thoracic aorta of male Wistar rats. The plant was extracted by solvent-solvent extraction with cyclohexane, dichloromethane, ethyl acetate, butanol and a final residual marc was obtained. These fractions were purified by several chromatography methods and assessed for their vascular effects. The crude extract induced mainly endothelium-dependent relaxation of aorta which was associated with NOS activation, and also endothelium - independent relaxation associated with activation of smooth muscle potassium channels. The result of phytochemical analysis carried out in this study revealed the presence of phenolic acids in the ethyl acetate extract and anthocyanins in the butanol extract. The potency of the vasorelaxant property of the extracts showed that Butanol extract > Crude extract > Residual marc > Ethyl acetate extract. The authors suggested that the strong vasorelaxant activity of butanol extract is essentially due to the presence of anthocyanins [38].

### 2.8 \textit{Loranthus micranthus}

\textit{Loranthus micranthus} (Family: Loranthaceae) is a semiparasitic shrub which is also called African mistletoe. In Nigeria, it has been found growing on several tree crops including \textit{Kola acuminata}, \textit{K. nitida}, \textit{Mangifera indica}, \textit{Azadirachta indica}, \textit{Psidium guajava}, \textit{Jatropha curcas}, and \textit{Persia sp}. Like all parasitic plants, this plant also obtains its nutrients and support from the host trees on which it grows [39]. A previous study by Obatomi et al. [40] investigated the effect of the aqueous extract of \textit{L. micranthus} in normotensive and spontaneous hypertensive rats. The rats were orally administered with the extract at a dose of 1.32 g/kg per day for 8 days. Mean Arterial Pressure (MAP) was significantly reduced in both normotensive and spontaneous hypertensive rats, with a significant (p<0.05) reduction of the serum total cholesterol on days 6, 7, and 8 [40].

Iwalokun et al. [41] reported a study on the mechanism of antihypertensive effect of this plant. The extract was partitioned into n-butanol (BF), chloroform (CF), ethyl acetate (EAF) and water (WF) fractions. The median effective concentrations and maximum relaxation of the fractions were determined in epinephrine or KCl pre-contracted rat aorta ring model. Serum lipid profiles and nitric oxide (NO) levels of mice administered with 250 mg/kg b.w. (p.o.) of each fraction for 21 days were determined using spectrophotometric methods. The fractions elicited a dose-dependent inhibitory effect on rat
aorta precontracted with norepinephrine or KCl with the highest relaxant effect by BF < WF > CF > EAF. A similar order of activity was observed in the ability of these fractions to inhibit elevated atherogenic lipids, raise serum nitric oxide and reduce cardiac arginase in mice. The researchers concluded that the anti-hypertensive activity of L. micranthus involves anti-atherogenic events, vasorelaxation, cardiac arginase reduction and NO elevation [41].

2.9 Acalypha wilkesiana Hoffmannii

Nworgu et al. [42] evaluated the cardiovascular effect of Acalypha wilkesiana Hoffmannii leaves, a medicinal plant used by traditional healers for treatment of hypertension. Graded doses of the aqueous extract of A. wilkesiana leaves were administered to rabbits through the auricular vein and blood pressure was measured using the carotid artery. Also, the effect of the extract on isolated rabbit cardiac tissue, portal vein and aortic rings of rats were investigated. The extract at a dose of 20 mg/kg produced a significant decrease in systolic, diastolic and mean arterial blood pressure. The extract at a dose of 10 mg/ml also reduced the rate and force of contraction of isolated rabbit heart. Cumulative doses of the extract at concentrations of 10 – 80 mg/ml produced no effect on the adrenaline-induced contraction of the portal vein or aortic rings of rats. The authors concluded that the extract of Acalypha wilkesiana Hoffmannii leaves exerted blood pressure lowering effect mainly via inhibition of the force and rate of contraction of the heart [42].

2.10 Allium sativum

A study was carried out on the cardiovascular effect of Allium sativum (Family: Amaryllidaceae), commonly known as garlic on normotensive and two-kidney one-clip (2K1C)-induced hypertensive rats. Mean arterial blood pressure (MAP) and heart rate (HR) of anesthetized rats were measured via the left common carotid artery connected to a recording device. Nwokocha et al. [43] reported that intravenous injection of A. sativum (5-20 mg/kg) caused a significant (p<0.05), dose-dependent decrease in MAP and HR in both the normotensive and 2K1C rats, with more significant effects observed in normotensive rats. No significant difference was observed on the hypotensive and the negative chronotropic activities of the extract when the rats were pre-treated with atropine sulphate (2 mg/kg, i.v.). The authors inferred from the study that A. sativum caused hypotension and bradycardia which did not involve the cholinergic pathway in both normotensive and 2K1C rats. From this result, the mechanism of action of A. sativum was suggested to probably involve a peripheral mechanism for hypotension [43].

A clinical trial involving patients with stage 1 essential hypertension (n=210) reported the effect of A. sativum on blood pressure. Patients were administered with A. sativum tablets at the dose of 300 mg/day, 600 mg/day, 900 mg/day, 1200 mg/day and 1500mg/day in divided doses for 24 weeks, with two additional groups receiving atenolol and placebo tables respectively. Their blood pressure was monitored at weeks 0, 12 and 24. The study reported a dose- and duration-dependent significant (p<0.05) decreases in systolic and diastolic blood pressure of these patients compared to patients that received atenolol or placebo [44].

3. SWEET PROTEINS

The in-silico study has been reported on sweet proteins isolated from six plants; Thaumatococcus danielli, Pentadiplandra brazzeanea, Dioscoreophyllum cumminsii, Capparis masaikai, Curculigo latifolia and Richadella dulcifica. The study was informed by the increasing rate of consumption of low-calorie artificial sweeteners by patients with diseases linked to sugar consumption. The potential of replacement of conventional sugar with these sweet proteins derived majorly from under-utilized plants had thus been proposed. The investigation conducted to verify the ability of sweet proteins to release Angiostensin-Converting Enzyme (ACE)-inhibitory peptides is emphasised in this review article. Elevation of ACE is an important pathogenic mechanism of hypertension because it mediates arterial vasoconstriction. The sweet proteins investigated were Thaumatin from Thaumatococcus danielli, Brazzein from Pentadiplandra brazzeanea, Monellin from Dioscoreophyllum cumminsii, Madinlin from Capparis masaikai, Curculin from Curculigo latifolia and Miraculin from Richadella dulcifica.

These were selected for sequence alignment using Basic Local Alignment Search Tool (BLAST) analysis and biological activity search using BIOPEP. Although BLAST analysis gave no homologous similarity among the proteins, BIOPEP analysis showed that they demonstrated either di- or tri-peptide with a total of 51, 14, 40,
28, 30 and 59 potential ACE inhibitory peptides from Thaumatín, Brazzein, Monellin, Madinlin, Curculin and Miraculin respectively. The combined digestion with pepsin, trypsin and chymotrypsin A, a simulation of human gastrointestinal digestion released 8, 2, 9, 2, 5 and 11 ACE inhibitory peptides from Thaumatín, Brazzein, Monellin, Madinlin, Curculin and Miraculin respectively. These results add value to these proteins by demonstrating their innate nutraceutical potential in their ability to reduce hypertension [45].

4. CONCLUSION

In conclusion, this study has highlighted various medicinal and food plants used in Nigeria for management of hypertension. Most of these plants are readily available and affordable at various regions of the countries. However, more research is warranted to identify the most abundant plant in each region of the country and educate individuals on proper use of the medicinal plants with scientific evidence of efficacy. Further to scientific verification of pharmacological effect of the medicinal plants, research to isolate and chemically characterize the bioactive principle responsible for the antihypertensive effect should also be done as a prerequisite for drug development candidature.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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