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Clinical Reviews and Case Reports

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Review Article

Indigenous Analgesic Medicinal Plants with Stress Relieving Potentials

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Received Date: January 09, 2023 | Accepted Date: January 20, 2023 | Published Date: January 31, 2023

Citation: Adeniyi MJ., Awosika A., Idaguko C., Otoikhila C., (2023), Indigenous Analgesic Medicinal Plants with Stress Relieving Potentials. *Clinical Reviews and Case Reports*, 2(1); **DOI:**10.31579/2835-7957/009

Abstract

Physical stress remains an integral and inevitable phenomenon in human life. As a non-specific response, stress involves secretion of barrage of chemical messengers including catecholamine which orchestrate changes in functional markers causing rise in blood glucose, increase in blood pressure and increased pain perception. Worldwide, the use of herbs for the management of ailments and maintenance of health continues to increase. The study reviewed twelve analgesic medicinal plants locally consumed in West Africa which can also alleviate some non-specific stress markers such as blood pressure and blood glucose. Beyond pain regulation, medicinal plants such as Allium sativum, Citrullus lanatus, Abelmoschus esculentus L, Passiflora species, Tamarindus indica, Persea Americana, Carica papaya, Aloe vera, Tridax Procumbens, Moringa olifera, Cassia alata and Ananias comosus were found to be capable of decreasing blood pressure and blood glucose. The blood pressure-reducing and glucose-lowering tendencies were due to the phytochemical constituent of the respective medicinal plants. The study indicated that the indigenous medicinal plants exhibited potentials of alleviating stress.

Keywords: stress; medicinal plants; blood pressure; anti-hyperglycemia; pain

Introduction

For centuries, physical stress has been described in Physics as force that exerts distress on the physical body. In biomedical space, 'stress' was first coined and used by Hans Selye in 1930s [1] when he reported that some of his rats died due to stress, noting that stress elicits general adaptation syndrome that results in alarm, shock and exhaustion. Physical stress as a phenomenon is as old as the age of human existence on earth. Human body and physical stress are not aliens to each other. Hence, stress exists even under normal circumstances. Physical stress is an integral event that characterizes healthy active humans. For these reasons, there appears to be no consensus defining signature for stress. However, it can be described as a sensation of physical, psychological or physico-mental discomforts [2]. During stress, a number of physical, physiological, psychological and biochemical changes take place as a way of coping with heightening metabolic demands. Stress response is non-specific and involves secretion of chemical messengers including catecholamine which orchestrate changes functional markers including blood pressure, blood glucose and pain threshold. Invariably, changes occur in markers of stress and these include increases in heart rate, cardiac output, respiratory rate, blood pressure and blood glucose. Despite the fact that stress has markers, there is an overlap between some markers of physical stress and symptoms of some medical conditions including Diabetes Mellitus [2,3]. Specifically, hyperglycemia occurs both in stress and Diabetic Mellitus. The need to understand whether solving a symptom of Diabetes Mellitus using local anti-diabetic approach would lead to stress alleviation necessitated this review. Age-long management of Diabetes Mellitus in African sphere has always involved the use of medicinal plants. Scientific studies have revealed that the medicinal plants possess huge tendency to suppress blood glucose. As part of their operational mechanisms, these plants inhibit alpha- glycosidase activity, increase plasma insulin level, act as insulin secretagogue, increase insulin binding on insulin receptor, and stimulate synthesis and release of insulin [4]. Plants such as Carica papaya (pawpaw), Aloe vera, Tridax Procumbens, Moringa olifera, Ananias comosus, Passiflora species, Tamarindus indica, Persea Americana, Allium sativum (Garlic), Citrullus lanatus and Abelmoschus esculentus L (okra) have been implicated in the management of diabetes mellitus in Africa by traditionalists and in Complementary Alternate Medicine. Besides the analgesic effects, Carica papaya (pawpaw), Aloe vera, Tridax Procumbens, Moringa olifera, Ananias comosus, Passiflora species, Tamarindus indica, Persea Americana, Allium sativum (Garlic), Citrullus lanatus and Abelmoschus esculentus L (okra) may mitigate general markers of stress causing reduction in high blood pressure and decrease in blood glucose owing to their phytochemical constituents [5-9].

Stress has always been associated with glucocorticoid response in general popular consensus. However, the Sympatho-Adrenal axis also plays unquestionable roles in body's innate response to homeostatic derangements. Catecholamine released in response to stress causes increase in blood pressure and heart rate, rise in blood glucose and changes in pain tolerance among other effects. Consideration of stress from Sympatho-Adrenal

approach and examination of the likely therapeutic outcomes of using some anti-hyperglycemic medicinal plants indigenous to West Africa are the focus of the review. Herbs are part of African systems and about 80% of people throughout the entire world depend on them for cure, care and maintenance of health [10]. Hence, it is pertinent to examine the potential roles of indigenous analgesic medicinal plants in the alleviation general markers of stress such as hyperglycemia and high blood pressure

Stress Relieving Potentials of Allium sativum

Allium sativum (garlic) is a flowering plant with a flat leaf blade that measures 1.25–2.5 cm in width. It is grown in West Africa. It contains diallyl trisulfide, diallyl sulfide, iallyl thiosulfonate, E/Z-ajoene, S-allyl-cysteine sulfoxide and S-allyl-cysteine. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. As an anti-hyperglycemic plant, oral treatment with 100mg/kg, 250mg/kg and 500mg/kg of Allium sativum extract was shown to depress fasting glucose level in rats that were made diabetic through streptozocin. However, the extract had no effect in normal rats. The reported glucose reducing effect was claimed to be comparable to that of glibenclamide [11]. Experimental diabetes induced though intraperitoneal injection of alloxan monohydrate in rats was treated with aqueous Allium sativum extract at a daily dose of 0.5g/kg and 1g/kg body weight. The extract depressed high fasting blood glucose orchestrated by alloxan monohydrate in a dose-related pattern. However, treatment with 1g/kg of the extract, fasting glucose level was suppressed in normoglycemic rats [12].

In addition to suppressing high blood glucose which characterizes stress response, Allium sativum has been shown to lower high blood pressure and improve pain threshold. A review conducted by Reinhart et al., (2008) [13] on primary studies was carried out in human beings to examine the impacts of garlic on blood pressure. Allium sativa suppressed heightened diastolic and systolic blood pressure by 9.3 and 16.3mmHg respectively in patients with high diastolic and systolic blood pressure. However, the plant exerted no effect on people whose diastolic and systolic blood pressure was not high. A systematic review was conducted by Ried et al., (2008) [14] on studies carried out between 1955 and 2007 on the influence of garlic on blood pressure in human beings in non-hypertensive and hypertensive subjects. A mean reduction of 5mmHg was gotten in human being given garlic. Furthermore, in hypertensive patients, a mean reduction of 7mmHg was reported for diastolic blood pressure and 8mmHg for systolic blood pressure. A study to examine the effect of daily enteral administration of 400mg garlic powder on diastolic and systolic blood pressure for 15 weeks was conducted by Soleimani et al., (2021) [15] in patients with Nonalcoholic Fatty Liver Disease. Mean arterial blood pressure was shown to depress in group administered garlic when compared with placebo. Mean diastolic blood pressure reduced in the patients and likewise the systolic blood pressure. The suppressive effect of garlic on blood pressure can be attributed to its constituent sulfur-containing compounds. Hydrogen sulphide has been shown to block L-type calcium channel [9].

In a study by Roozbahani et al., (2014) [16], 42 experimental rats weighing about 0.25kg were administered 2.5% of formalin to induce hind paw pain and then pre-treated intraperitoneally with doses of aqueous extract of garlic acid; 2.5 ml/kg and 5 ml/kg. Evaluation was conducted 15- and 39-minutes post induction. They showed that the extract exerted the peak pain-relieving effect at a dose of 2.5 ml/kg given 15 minutes prior to formalin. Rajender and Reddy, (1999) [17] showed that treatment of experimental alloxan-induced diabetes with 45mg/kg per day of garlic for a period of 28 days depressed not only glucose level but also pain reaction (conducted through tail flick and hotplate). Specifically, garlic suppressed hindpaw weight, relative thickness, allodyna, tailflick and hotplate response.

Stress Relieving Potentials of Citrullus lanatus

Citrullus lanatus (watermelon) is a flowering plant and an edible fruit measuring 16 inches by 10 inches. It is widely grown in Nigeria. It contains potassium, retinol, pyridoxine, ascorbic acid, magnesium and citrulline. Nutritionally, it is majorly made up of water. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Citrullus lanatus reduces high blood glucose. At doses of 500mg/kg and 1g/kg of watermelon juice, in vitro changes were orchestrated in respect to glucose regulation; alpha-glucosidase and alpha amylase were suppressed by watermelon juice dose dependently. There was suppressed basal glucose level when watermelon juice to rats made diabetic through intraperitoneal injection of 150mg/kg of alloxan. Glucose transporters especially GLUT-4 and GLUT-2 and hexokinase were raised in diabetic rats treated with Citrullus lanatus [18]. Abbaszadeh et al., (2021) [19] reported the effect of L-citrulline administrations on 54 type-2 diabetes mellitus patients who were referred to Tabriz specialized clinics. 3g of L-citrulline was given prior to breakfast once per day. In patients with type 2 diabetes mellitus, L- citrulline was shown to depress fasting blood glucose and glycated hemoglobin relative to placebo group. However, L-citrulline exerted no effect at baseline. Watermelon seed extract at 200mg/kg body weight on daily basis was orally administered to rats that were made diabetic through intraperitoneal injection of 60mg/kg of streptozocin one week after diabetic challenge [20]. There was a reduction in plasma glucose level in diabetic rats treated with watermelon.

Besides its anti-hyperglycemic effects, Citrullus lanatus has been shown to exhibit blood pressure- reducing potentials. Magnesium is known to block calcium channel. Ascorbic acid and retinol are antioxidants and antioxidants are important in the regulation of free radical–induced deterioration and vascular endothelial anomaly. Before, during and after exercise, changes occur in cardiovascular functions; systolic blood pressure and heart rate are raised to meet metabolic demand. As systolic blood pressure is increased, it is important for intrinsic arterial blood pressure (diastolic blood pressure) to reduce in order to facilitate adequate tissue perfusion. A study by Figueroa et al., (2016) [21] examined the effect of water melon active agent (L-citrulline) on hemodynamic responses to hand-gripping exercise or cold. The result of the study demonstrated that consumption of L-citrulline assuaged response of systemic arterial blood pressure to exercise associated metabolites. It also alleviated physical exertion-induced rise in afterload. Figueroa et al., (2010) [22] investigated the influence of 6-week watermelon administrations at a dose of 2.7g/day/1.3g/day of L-citrilline/L arginine) on arterial function and blood pressure in pre-hypertensive people. All measurements including heart rate, brachial systolic blood pressure, brachial pulse pressure, aortic pulse pressure, aortic systolic blood pressure and augmentation index were taken in supine position. Although the administrations showed no significant effect on brachial diastolic blood pressure and brachial systolic blood pressure but depressed the amplitude of reflected wave implying an improvement in aortic blood flow. Watermelon supplementations depressed brachial and ankle blood pressure when administered for six weeks in pre-hypertensive subjects when compared with placebo. Carotid wave reflection was also depressed. The study reveals huge potentials in watermelon as far as enhancement of arterial blood flow is concerned [23].

In a study conducted by Wahid et al., (2020) [24], Citrullus lanatus seed extracts were tested for pain relieving potentials at doses of 50mg/kg, 100mg/kg and 200mg/kg. Hot plate and tail flick techniques were utilized in inducing pain and hind paw edema was used to measure anti-inflammatory effect of the plants. The extract exhibited huge pain-relieving potentials. At 100mg/kg and 200mg/kg, the extract showed anti-inflammatory activity but the effect was stronger at 200mg/kg. The pain-relieving tendency of Citrullus lanatus was examined in mice and rats by Deng et al., (2010) [25]. Ear edema and paw edema in mice and rats induced by xylene by carrageenan were suppressed by Citrullus lanatus extract. There was an increase in pain threshold evidenced by the increase in reaction time in hot plate test when the extract was administered in mice. The frequency of writhing was attenuated by Citrullus lanatus extract in mice.

Stress relieving Potentials of Abelmoschus esculentus L

Albelmoschus esculentus (Okra) is an edible flowering plant and an annual crop cultivated in many countries across the globe including West Africa countries. It is 3-5 ft by height and 90-150 cm in width. It contains flavonoids, vitamin C, protein, folates, unsaturated fatty acids, iron, manganese, zinc and calcium. It is an analgesic plant with stress relieving

ability; capable of reducing high blood pressure and high blood glucose. Abelmoschus esculentus L possesses a suppressive effect on high blood glucose. Daliu et al., (2020) [26] indicated the tendency of the plant to reduce blood glucose owing to abscisic acid quantified as isoprenoid compound. In a review, diabetic subjects treated with Abelmoscus esculentus were shown to exhibit low blood glucose [27]. An elevated glucose and fatty acids were reported to be reduced by administrations of Abelmoschus esculentus subfraction in an experimental type II diabetes mellitus rat model induced using streptozocin. The modulatory effect of okra on glycemic index was demonstrated by Moradi et al., (2020) [28] in type II diabetic patients. Possible mechanisms might include depressed expressions of PPAR-γ and PPAR-α gene in islet of langerhan which have been reported to be raised in stressful situations including experimental diabetes mellitus induced courtesy of high fat diet and streptozocin [29]. However, more studies are needed to clarify the impacts of okra on PPAR-γ and PPAR-α gene in the liver, muscles and adipose tissues, as well as glucose uptake extent in the liver, muscles and adipose tissues.

Besides its hypoglycemic property, Abelmoschus esculentus exhibits tendency to alleviate stress. Da Rocha et al., (2014) [30] indicated that administration of 200miligram/kg of methanolic and aqueous Abelmoschus esculentus extracts for seven days depressed acute restraint stress induced increase in glucocorticoid in mice. Methanolic extract of okra was demonstrated strong analgesic, anti-inflammatory and anti-nociceptive effects in Swiss rats [31]. Mondal et al., (2019) [32] showed that okra exhibited antihypertensive effect reducing blood pressure and heart rate.

Hossen et al., (2013) [33] showed the pain-relieving tendency of Abelmoschus esculentus methanolic extract causing decrease in acetic acid induced abdominal writhing and suppressing inflammation magnitude induced by formalin. Owing to its flavonoids, okra showed an analgesic and high blood pressure suppressing potentials [34].

Stress Relieving Potentials of Passiflora species

Passiflora, a short form of passion flower, is a species of plants in many countries of the world including North American, Asia, South American and Africa countries. Its fruit is about 2 to 3 inches. It contains vitexin, umbelliferone, coumerin and chrysin. Others are flavonoids, maltol, and indole alkaloids. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Gupta et al., (2011) [35] indicated that oral administration of Passiflora incarnate doses at 100mg/kg and 200mg/kg exhibited hypoglycemic potential even in experimental streptozocin-induced diabetic animals. In a Sri Lankan study, Passiflora suberosa L was shown to exert a glucose reducing effects following sucrose-induced hyperglycemia with 100mg/kg of the extract exerting maximum glucose reducing effect [36]. In 43 patients with Type II diabetes mellitus, de Queiroz et al., (2012) [37] showed that administration of the peel flour of yellow passion caused suppression of fasting blood glucose and HOMA insulin resistance. A reduction in insulin resistance signifies an increase in tissue sensitivity and response to insulin. With aqueous extract of Passiflora ligularis, Gong et al., (2014) [38] showed that there was a reductive effect on streptozocin induced diabetes mellitus. One of the major underlying mechanisms was depletion of free radicals evidenced by fall in lipid peroxidation and improvements in antioxidants such as catalase, glutathione peroxidase, vitamins C and E and reduced gluthathione. Salgado et al., (2022) [39] showed that out of the three doses of Passiflora fruits used in treating diabetes mellitus in rats; namely 5 and 10%, the peak fall in glycemic index in these rats occurred with 5% of passiflora fruit. The reduction in glycemic index was mediated through improvement in the conversion of glucose to glycogen.

Passiflora species, specifically, Passiflora edulis, were demonstrated in a study by Guerrero-Ospina et al., (2018) [40] to suppress systolic and diastolic blood pressure in hypertensive patients. The increased antioxidant levels also implied that the medicinal plant may exert its reductive effects on blood pressure through enhancement of antioxidant capacity. Passiflora quadrangularis L has been utilized in Columbia by Lesly et al., (2017) [41] for the management of L-NAME induced hypertension in experimental rats. At daily dose of 75mg/kg, 150mg/kg and 300mg/kg, there was an increase in acetylcholine induced arterial wall relaxation in isolated aorta walls.

Passiflora cincinnata Mast has been reported to possess pain-relieving property [42]. In their study, mice that were subjected to nociceptive stimulation were treated with oral doses of the plants at 100mg/kg, 200mg/kg and 400mg/kg of body weight. It was shown that the plant extract was able to suppress experimental nociception, causing decreased in the frequency of paw licking and abdominal cramping and orchestrating an increase in reaction time. The pain suppressing effect of the extract was mediated by cholinergic and opioid receptors through nitric oxide and potassium channel. The pain-suppressing potentials of the plants may be attributed to the constituent flavonoids. Flavonoids have been widely reported for its anti-inflammatory potentials being able to mitigate migration of macromolecules from microcirculation. It has also been known to exhibit antioxidant activities [43]. Sasikala et al., (2011) [44] reported that administration of 200mg/kg of P. foetida caused pain alleviation; increased reaction time and reduced the severity of swelling orchestrated by carrageenan in rats.

Stress Relieving Potentials of Tamarindus indica

Tamarindus indica is majorly found in tropical Africa as leguminous plants. It is about 30 meters in height. It contains flavonoids, acetic acid, tartaric acid, pectin, succinic acid, tannins, gum, sugar, alkaloid, sesquiterpenes and glycosides. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Tamarrindus indica seed coat hydroethanol extract, when administered for fourteen days, was showed to suppress blood glucose status in experimental diabetes mellitus induced through administration of alloxan and this is owing to flavonoids, a polyphenol, it contains. The flavonoid constituent of the plant may have exerted hypoglycemic effect through enhanced uptake of glucose by diaphragm [45]. Treatment with 300mg/kg and 500mg/kg of body weight of Tamarindus indica for a period of fourteen days have been shown to cause modulation of blood glucose in experimental diabetes mellitus orchestrated by 150mg/kg administration of alloxan [46]. Krishna et al., (2020) [47] indicated that Tamarindus indica Linn possessed glucose reducing effect in-vitro through strong suppression of alpha glucosidase. Glucosidase are enzymes that hydrolyze glucosidic bonds, causing uproar in blood glucose level. Administration of 5000mg/kg of stem bark extract of Tamarindus indica Linn caused suppression in blood glucose level in rats made diabetic by 150mg/kg intraperitoneal injection of alloxan. The extract was also reported to be virtually non-toxic when administred through oral route [48].

Iftekhar et al., (2006) [49] reported that Tamarindus indica suppress diastolic blood pressure but not systolic blood pressure in human beings who were used as experimental subjects. Diastolic blood pressure is the intrinsic pressure existing within the arterial vasculature and it is dependent on peripheral resistance, a reduction in vascular diameter of arterial walls. Hence, reduction in diastolic blood pressure represents changes in the patency of blood vessels, occasioned by stimulation of beta-2 receptors, reduction in alpha-1 stimulation or decrease in blood cholesterol levels [50].

There are many ways through which Tamarindus indica can improve pain threshold. One of them is inhibition of inducible cyclooxygenase (cyclooxygenase-2). Suppression of inducible nitric oxide aynthase (iNOS) and stimulation of opioid receptor are possibly mechanisms involved in the pain alleviation action of Ramarindus indica [51]. A formulation containing Tamarindus indica extracts was reported to suppress knee pain and enhanced knee joint function in 27 human subjects. Urinary collagen degradation and inflammatory level were altered. Inflammation-related chondrocyte degradation was lowered following utilization of extracts [52]. Suppression of abdominal writhing and rise in reaction time evidenced by increased latency time were produced when Tamarindus indica was administered. The authors attributed the rise in pain threshold to stimukation of opioid pathway involving the duo of central and peripheral levels [53].

Stress Potentials of Persea americana

Persea Americana is a flowering plant cultivated in many counties of the world including Nigeria. While its leaves are about 4-8'', the plant typically grows to about 30 to 60' in height. It contains vitexin, C oritentin, isoorientin

and isovitexin which are all glycosyl flavones. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. The ethanolic extract of Persea Americana showed a dose-related glucose-reducing effect in streptozocin-induced diabetes in rats following 42 days of treatment. Furthermore, a rise in liver glucogen was recorded following the administration of the extract subchronically [54]. Daily doses of 150mg/kg and 300mg/kg of hydroalcoholic leaf extract of Persea Americana were investigated for anti-diabetic potential in experimental rats. A reduction in blood glucose status was recorded when the doses of the extract were administered to rats that were made diabetic through streptozocin intraperitoneal injection. Hepatic protein kinase B activation was reported. In the skeletal muscles, protein kinase B was also induced [55]. Ojo et al., (2019) [56] showed in an in-vitro study that aqueous seed extract of Persea Americana orchestrated a suppressive effect on blood glucose status in rats that were made diabetic using alloxan injection. Underlying mechanisms included depression in Nuclear Factor kappa B (NF-kB), interlukin-6, malondialdehyde and tumor necrosis factor (TNF-alpha) and increase in hepatic glycogen, high density lipoprotein and hexokinase. The glucose suppressing effect of Persea Americana was linked by Marshi et al., (2019) [57] to its flavonoids and phenolic contents. In addition, the hypoglycemic effect was influence by mode of extraction. For instance, ethyl acetate extract was shown to exhibit the peak glucose reducing effect, followed by chloroform, hexane and butanol extract accordingly.

A study by Ojewole et al., (2007) [58] indicated that the use of Persea americana aqueous extract caused relaxation of arterial vasculature, low blood pressure and reduction in heart rate in the experimental animals. In-vitro study was conducted on myocardial contractility and thoracic aortic rings and portal veins of healthy rats to demonstrate effect of the plant extract on heart rate and vascular diameter respectively. On the other hand, normotensive and hypertensive Dahl salt-sensitive rats were utilized for in-vivo study of the effect of plant extract on blood pressure. These effects were reported to be mediated by endothelium-related increase in nitric oxide perhaps through the release of endothelium nitric oxide synthase. Administration of Persea amaericana seed extract at 200mg/kg, 500mg/kg and 700mg/kg body weight caused suppression in high blood pressure orchestrated by chronic sodium chloride administration in experimental hypertension study using rats. The extract was shown to reduce determinants of diastolic blood pressure such as low-density lipoprotein, total cholesterol and triglyceride [59]. In the study by Sousa et al., (2020) [60], heart rate variability, heart rate and cutaneous conductance were evaluated prior and during submaximal exercise. It was discovered that consumption of Persea americana prior the treadmill work-out led to acceleration of cardiovascular recovery after the exercise. The use of Persea Americana was reported by a Nigerian study to ameliorate experimental hypertension [61]. Specifically, pretreatment with the extract for ten days caused suppression in heart rate and mean arterial blood pressure. In naïve rate, acute administration of the extract was also shown to depress mean arterial blood pressure.

Using Persea Americana aqueous extract, there was an increase in pain threshold evidenced by a dose-related suppression of pain perception in mice. Reduction in swelling caused by injection of carrageenan was also documented [62]. In an experimental model of burn in mice, Deuschle et al., (2019) [63] revealed the assuaging roles of Persea Americana. In the study, while ultraviolet rays were used to orchestrate burn. It was reported that there was prevention of allodyna caused by ultraviolet rays with Persea americana following second and third of exposure. The authors attributed the preventive effect to the presence of catechin, chlorogenic acid and rutin in the plant extract. Persea Americana at 100mg/kg, 200mg/kg and 400mg/kg elicited dose-unrelated decreased frequency of writhings caused by acetic acid administration and lengthened reaction time following pain receptor stimulation through tail immersion and hot plate. Suppression of prostaglandin production probably due to interference with cyclooxygenase activity may be responsible for the pain alleviating prowess of the plant [64].

Stress Relieving Potentials of Carica papaya

Carica papaya is a widely grown perennial crop worldwide most especially tropical and subtropical areas including Nigeria. Its fruit is about 3-20 inches. Biochemical analyses have revealed that the plant contains saponins, fibers, tocopherol, polyphenols, isothiocyanate, vitamin C, oleic, linoleic, stearic and palmitic acids, myricetin, caffeic acid, papain, kaempferol among others. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Miranda-Osorio et al., (2016) [65] showed that administrations of Carica papaya leaf extract at 3mg/kg -125 mg/kg mitigated abnormal insulin physiology associated with experimental diabetes mellitus induced using 6mg of streptozocin for twenty days. Reduction in high blood glucose was also observed. In a similar vein, management using aqueous extract at 750mg/kg, 1500mg/kg and 3000mg/kg for four weeks alleviated high blood glucose characterizing diabetes mellitus in rats. However, the extract was also reported to preserve pancreatic histology and averted liver disruption in the experimental diabetic rats [66]. Oral instillation of Carica papaya ethanolic extract for 2 weeks at doses of 200mg/kg, 400mg/kg and 600mg/kg of body weight suppressed elevated blood glucose in thirty experimental male diabetic rats. The effect of the extract was comparable to anti-diabetic drug glibenclamide [67]. In a study to determine whether unripe pulp of Carica papaya exhibited glucose lowering effect especially in hyperglycemic situation such as diabetes mellitus, rats were challenged metabolically using streptozocin and treated with the extract for fourteen days. Low blood glucose profile was thereafter observed [68].

The use of unripe fruit of Carica papaya in the treatment of elevated blood pressure has been highlighted by Eno et al., (2000) [69]. In their study, rats made hypertensive through deoxycorticosterone acetate/salt exhibited suppression in their mean arterial blood pressure when treated with 200mg/0.1kg intravenous injection of the extract comparable to the effect produced by hydralazine. A follow up in-vitro study conducted by the authors also showed that administration of the extract at 10mg/ml caused dilation of isolated aorta, vertebral and renal arteries and this effect was mediated by alpha adrenoceptor. Phytochemical analysis reveals clitorin, manghaslin and nicotiflorin. Following 30 days of treatment with 100mg/kg methanolic extract of Carica papaya in spontaneous hypertensive rats. Depressed blood angiotensin converting enzyme that was similar to enalapril was observed. There was also attenuation of cardiac hypertrophy and baroreflex sensitivity in the treated rats was reported to be similar to that of the rats that were given enalapril [70]. Processed Carica papaya (Nori) was administered at doses of 5%, 10% and 20% through diet to experimental hypertensive rats. It was reported that rats that were administered 10% dietary formulation containing the processed extract exhibited normal diastolic blood pressure and systolic blood pressure relative to rats that received captopril administration. Stiffness of arterial vasculature was also reported to be suppressed when the hypertensive rats were administered the processed extract through diet [71].

Papain, an active component of Carica papaya was investigated for anti-inflammatory and analgesic potential through experimental sciatic nerve ligation induced neuropathic path in rats. Oral administration of palpain at 50 and 100mg/kg body weight for two weeks assuaged the neuropathic pain. The underlying mechanism was amelioration of oxidative stress [72]. Hasimun et al., (2014) [73] examined the pain-relieving potential of ethyl acetate and n-hexane fractions of Carica papaya leaf extract. It was reported that administrations of 0.175mg/kg, 0.35mg/kg and 0.7mg/kg of body weight resulted in pain suppression with the peak effect noticed with 0.7mg/kg of body weight. Moreover, the pain suppressing activity of the extract was claimed to be similar to aspirin. Unripe Carica papaya was investigated for anti-inflammatory effects in oxidative damage induced using methylglyoxal. Pretreatment with the extract was shown to lead to declined endothelium-dependent nitric oxide synthase, modulation of janus kinase/P38 mechanism, inhibition of inflammatory pathway and mitigation of carbonyl stress [74].

Stress Relieving Potentials of Aloe vera

The plant can grow up to 30-61cm in height and it is cultivated in Nigeria. It contains beta-carotene, ascorbic acid, tocopherol, cyanocobalamin, folic acid, choline, sugars, enzymes (alkaline phosphatase, aliiase, amylase, brady kinase, carboxypeptidase, cellulase and peroxidase) (alkaline phosphatase, aliiase, amylase, brady kinase, carboxypeptidase, cellulase and peroxidase), minerals (calcium, copper, chromium, selenium, magnesium, potassium,

manganese, sodium and zinc), lignin, amino acids, saponins and salicylic acids. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Supplementation of Aloe vera has been shown to exert beneficial effects as therapeutic target for diabetes mellitus. The use of the plant for the treatment of diabetes mellitus has been shown to cause a huge decline in fasting blood glucose. There was also depression in the level glycosylated hemoglobin in diabetic patients who utilized Aloe vera [75]. Suk Somboon et al., (2016) [76] in a systematic review highlighted the implications of using Aloe vera as a therapeutic measure for combating diabetes mellitus and regulating blood glucose profile in people who are prediabetics. Aloe vera was found to reduce a high blood glucose level associated with type II diabetes mellitus and those who are prediabetic. However, Hemoglobin AIc was unaffected by the plant. A placebo-controlled study conducted by Devaraj et al., (2013) [77] investigated the role of Aloe vera based products UP780 and AC92 in the management of people suffering from impaired glucose uptake and prediabetes. Fasting blood glucose and frucosamine were assayed. It was observed that treatment with AC92 caused decline in fructosamine and fasting blood glucose. Rajasekaran et al., (2005) [78] investigated the effect of oral administration of ethanolic extract of Aloe vera at 300mg/kg body weight on experimental diabetes mellitus in rats. The rats were treated with the extract for 21 days. Depression in high fasting blood glucose was observed. The glucose reducing tendency of the plants may be due to reduction in hydroperoxides and malondialdehyde and elevation of antioxidant enzymes such as superoxide dismutase, catalase and luahione peroxidase.

Osteoarthritis is a debilitating medical condition affecting the bones and joints. It is characterized by pain. Management of the condition involves among other things alleviation of pain. Work by Cowan, (2010) [79] based on documented primary studies recommended the prescription of Aloe vera for the management of osteoarthritis. A number of conditions including burns, wounds psoriasis and ulcers are characterized by pain. Hekmatpou et al., (2019) [80] highlighted in their review the use of Aloe vera in the management of pain-related medical conditions. They noted specifically that Aloe vera has been successfully devised in the alleviation of postoperative wounds, skin ulcers, chronic wounds among others.

In cadmium induced experimental hypertension, the use of oral pre-administration of a gel extract of Aloe vera at 300 and 600m/kg of body weight was reported to orchestrate normalcy, causing reductive effect. At 600mg/kg of body weight of the extract, it was observed that there was a decline in high blood pressure associated with chronic cadmium use after four weeks of treatment with the extract. At both doses, the therapeutic effects of the extract were similar to that of captopril [81]. Shah et al., (2010) [82] administered 1200mg of Aloe vera orally on 18-year-old healthy subjects on day one and eight day of investigation. Pre- and post-treatment blood pressure and electrocardiogram indicated that Aloe vera had no significant effect. QRS complex, PR interval and QTc interval were not significantly altered.

Stress Relieving Potentials of Tridax procumbens

Tridax procumbens is found in many countries of the world including Nigeria. Its leave measures 2.5-5 cm long. It contains catechins, centaurein and bergenins which are all flavonoids, tannins, alkaloids, steroids, carotenoids, phytosterols, tannins, alkaloids and saponins fatty acids and minerals (calcium, magnesium, sodium and selenium). It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. An Indian study was aimed at determining the effect of methanolic extract of Tridax procumbens in experimental diabetes mellitus orchestrated using alloxan. Decline was observed in high blood glucose characterizing diabetes mellitus. Although the therapeutic effect of the extract was similar to glibenclamide, the glucose reducing effect was not dose dependent. The extract failed to cause reduction in fasting blood glucose in healthy rats [83]. Investigation was conducted on the therapeutic effect of the entire Tridax procumbens on animal model of diabetes mellitus using streptozocin. Oral ethanolic extract of Tridax procumbens at 250 and 500mg/kg body weight was given for twenty-one days to experimental rats. High fasting blood glucose characterizing diabetes mellitus was reduced. Phytochemical analysis indicates the presence of flavonoids, alkaloids, tannins, phenolic and saponins [84]. In-vitro study on the glucose reducing tendency of methanol, chloroform and petroleum ether extracts of Tridax procumbens indicated a huge therapeutic potential of the plants as far as management of hyperglycemia-related conditions such as diabetes mellitus was concerned. The glucose suppressing activity of the plant was connected with its tendency to inhibit alpha amylase [85].

An aqueous extract of Tridax procumbens leaf was administered intravenously at 3mg/kg, 6mg/kg and 9mg/kg on rats that were subjected to anesthesia. There was a decline in mean arterial blood pressure and the decrease was dose-dependent. The authors reported that muscarinic receptor activation was responsible for the blood pressure suppression [86]. Salahdeen and Murtala, (2012) [87] highlighted the mode of actions of Tridax procumbens in isolated arterial smooth muscles. The results indicated the dilatory effect of the extract on aortic blood vessel. In the same study, the extract was reported to suppress the contractile reaction to serotonin. A study was conducted to evaluate the contribution of calcium in the dilatory action of aqueous extract of Tridax procumbens leaf in aortic vascular ring. Calcium antagonism was reported to be involved in vasodilation [88]. In another mechanistic study, Salahdeen et al., (2012) [89] indicated that the vasodilatory activity of Tridax procumbens appears to be endothelium mediated and endothelium independent. The endothelium is known to release nitric oxide in a reaction that is catalyzed by nitric oxide synthase in response to acetylcholine.

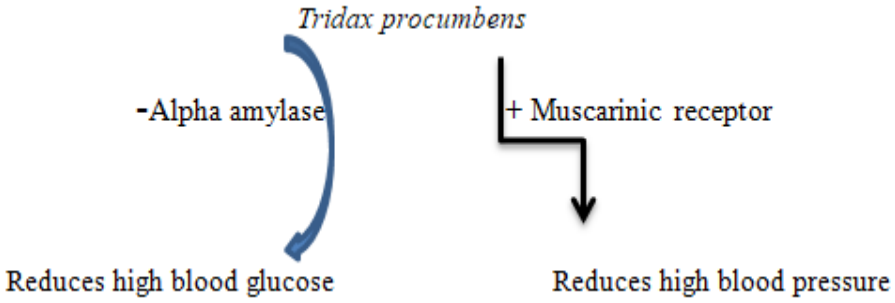

Figure 1: Stress alleviating potentials of Tridax procumbens and the underlying mechanisms. The plant suppresses a high blood glucose level by inhibiting (-) alpha amylase level. It reduces high blood pressure by activating (+) muscarinic receptor.

Vinoth et al., (2011) [90] investigated the pain-relieving tendency of Tridax procumbens ehanolic extract in male C57BL6/J mice weighing between 25g and 30g. In the study pain was induced through formalin and acetic acid instillations. The extract was shown to improve pain threshold. There was decline in the number of abdominal writhings dose dependently. The pain-relieving action of the extract was attributable to flavonoid and sterol constituents. Arthritis is a condition characterized by pain. Experimental arthritis was induced through Freund's complete adjuvant and Tridax procumbens ethanolic extract was administered at 250mg/kg and 500mg.kg of body weight. A dose related anti-arthritic effect was observed with a result

relatively similar to that of indomethacin [91]. The extract was phytochemically shown to comprise of tannins, flavonoids, alkaloids and saponins.

Stress Relieving Potentials of Moringa oleifera

Moringa oleifera is a deciduous tree found in many countries in the world including Nigeria. It measures about 12 m in height. Phytochemically, Moringa oleifera contains quercein, N, α-L-rhamnopyranosyl vincosamide, isoquercetin and isothiocyanate. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. A review by Owens et al., (2020) [92] covering ten-year studies, highlighted the roles of Moringa olifera in the management of diabetes mellitus. Out of the primary studies examined, over 70% documented that Moringa oleifera administered in powdered form depressed blood glucose profile in human beings in diabetes mellitus patients. In animal studies, 90% of publications reported that ethanol and aqueous extracts of the plants suppressed high blood glucose associated with diabetes mellitus. Using a quasi-experimental design, Siska et al., (2021) [93] showed that extract of Moringa olifera administered once per day for a period of seven days caused decline in high blood glucose associated with type II diabetes mellitus in patients. In the study, the leave of Moringa olifera was utilized. Diminution in elevated blood glucose associated with type II diabetes mellitus was observed after seven days of intervention with Moringa oleifera decoction. A review of 44 primary studies which examined the effect of Moringa oleifera on high blood glucose associated with diabetes mellitus was conducted by Watanabe et al., (2021) [94]. It was very significant that Moringa oleifera reduced hyperglycemia in experimental type II diabetes mellitus in animals.

55-year-old Patients who have been confirmed to be suffering from type II diabetes mellitus were exposed to 8000mg of Moringa oleifera once per day. Preliminary baseline blood glucose status was determined and weekly blood glucose profile was conducted. The treatment was found to suppress systolic blood pressure [95]. Aekthammarat et al., (2018) [96] showed that Moringa oleifera leave extract that was administered for three weeks at 30mg/kg and 60mg/kg daily oral doses caused reduction in induced tachycardia and high blood pressure in male rats. The reductive effect of the plant on high heart rate and blood pressure was shown to be dependent on dose. The extract exerted its suppressive effects on high heart rate and blood pressure by enhancing endothelium-related vasodilation. In human subjects, ingestion of 0.12kg of boiled leaves of Moringa oleifera was heighted to lead to decline in blood pressure. In the study, a week before the study, the participants ingested high dose of sodium chloride at 7000mg per day and high systolic and diastolic blood pressure was confirmed. Systolic and diastolic blood pressure was recorded two hours after meal. Administration of the plant caused fall in systolic and diastolic blood pressure [97]. Attakpa et al., (2017) [98] showed that Moringa oleifera administration was to exhibit antihypertensive effect in spontaneously hypertensive rats when compared to wistar Kyoto rats. The hypertensive effect was mediated by alteration in T cell calcium transduction and interletukin-2 inhibition.

10mg/kg, 30mg/kg and 100mg/kg extract of Moringa oleifera was studied for pain relieving and anti-inflammatory activities using experimental animals. An aqueous extract of the plants was prepared and pain induction was conducted through hot-plate, formalin, carrageenan. It was reported that the extract showed dose-related pain-relieving activity. Also, it possessed ability to reduce inflammation and the anti-inflammatory function was dose-related. The extract acted through activation of opioid mechanisms [99]. Moringa oleifera is comprised phytochemically of glycosides, flavonoids, terpenoids, saponins and tannins. Methanolic extract of the plant at 50mg/kg, 100mg/kg and 200mg/kg was tested for pain relieving and anti-inflammatory effects in experimental pain models. Pain and inflammation were induced through acetic acid, formalin, carrageenan and histamine. At 100mg/kg and 200mg/kg, the extract was shown to suppress nociception depressing number of writhes and diminishing extent of swelling. The anti-inflammatory effect may be connected with the scavenging prowess of the plant [100]. Investigation designed to determine the pain-relieving effect of 200mg/kg, 300mg/kg and 400mg/kg leaf and root extract of Moringa oleifera gotten through methanol was conducted. Arthritis was induced through the use of Complete Freund's Adjuvant and the doses were administered following three and six days of Complete Freund's Adjuvant's instillation Pain perception was also assessed before, three and six days after administrations of Complete Freund's Adjuvant and doses of the plant. There was reduction in pain perception and the pain-relieving activity of the 300mg/kg and 400mg/kg was relative to that of indomethacin [101]. Mahdi et al., (2017) [102] reported that administration of ethanolic extract of Moringa oleifera leaf caused pain suppression dose-dependently in experimental arthritis orchestrated through Complete Freund's Adjuvant. In addition, administration of ethanolic extract of the plant was also found to reduce pain perception in non-arthritic normal rats' dose-dependently.

Stress Relieving Potentials of Cassia alata

Cassia alata is a medicinal plant that measures about 2.5-3 m in height. It contains a number of phytochemicals including glycosides, alatinon, alanonal, beta- sitosterol-beta-D-glucoside, flavonoids, flavonols, and flavones. Alkaloids, β-caryophyllene, tannins, α-selinene, caryophyllene, anthraquinone, terpenes, saponins, methaqualone, cannabinoid, 1,8-cineole, limonene, germacrene D, cinnamic acid, volatile oils, pyrazol-5-ol, isoquinoline, steroids, and sugars are also present in Cassia alata. It is an analgesic plant with stress relieving ability; capable of reducing high blood pressure and high blood glucose. Kazeem et al., (2015) [103] investigated the effect of leaf of Senna alata on mechanisms underlying hyperglycemia in an in-vitro study. At doses ranging from 0.63 and 10mg/ml, the extract was shown to suppress alpha-glucosidase and alpha amylase. Alpha-glucosidase and alpha amylase both increase glucose level by splitting glycosidic bond and production of maltose and glucose from carbohydrate. The leaf extract of Cassia alata was tested for its possible glucose reducing potentials. Rats made hyperglycemic through streptozocin were treated with the extract. While the extract did not affect glucose profile in normal rats but depressed high glucose associated diabetes mellitus in rats [104].

In a study that was conducted by Bilanda, (2015) [105] in Cameroon, hydroethanolic extract of Cassia alata administered intravenously at daily doses of 100mg/kg and 200mg/kg orally for a month was reported to depress experimentally induced hypertension using L-NAME. The extract was shown not to derange renal and hepatic functions and neither did it increase oxidative stress. The use of Cassia's extract for the alleviation of experimental blood pressure was demonstrated in a study conducted by Parry et al., (1992) [106]. A dose-related depression in mean arterial blood pressure was reported. The reduction was found to be independent of adrenergic receptor antagonists or muscarinic agonists.

The plants have been implicated in the mitigation of infections especially bacterial and fungal infections [107]. It also possesses anti-inflammatory potentials. In a study by Lewis and Levy, (2011) [108], experimental arthritis using complete freund's adjuvant was managed using hexane extract of the leaves of Cassia alata for twenty-eight days. Inflammation was evaluated by measuring the circumference the knee joint both prior to the induction of arthritis and after. The extract exerted reductive effect on the circumference of knee joints after treatment with the extract. Cassia alata at 125mg/kg, 250mg/kg and 500mg/kg caused dose-related depression in nociception of chemically (acetic acid) induced pain in rats and prolonged the time taken for withdrawal response in thermally (tail flick) induced in a dose-related pattern. The result highlighted the potentials of the extract in increasing pain threshold [109].

Stress Relieving Potentials of Ananias comosus

Ananias comosus (Pineapple) is a perennial and edible plant that measures about 1.0 to 1.5 m in height. It is cultivated in Nigeria. It contains bromelain, phytosterol, phenols, tannins, alkaloids, flavonoids and glycosides. It also demonstrates tendencies of relieving stress. Xie et al., (2005) [110] showed that Ananias comosus ethanolic leaf extract caused decline in glucose prolife in experimental diabetic mellitus rats induced through alloxan. At 0.4g/kg, there was suppression of high blood glucose in rats made diabetic through alloxan. However, the extract had no effect on glucose level in normal rats. Xie et al., (2006) [111] indicated that ethanolic extracts of Ananias comosus caused increase in insulin sensitivity in rats that were made diabetic through streptozocin. The use of oral dose of 0.4g/kg was specifically shown to

increase tissue response to insulin. In HepG2 cells, the extract also increases insulin sensitivity. The leaf extract of Ananias comosus was reported to reduce high blood glucose by Adeel et al., (2020) [112]. In the study, treatment was conducted for thirty days. Moreover, the extract was also shown to suppress the level of glycated hemoglobin, alanine transaminase, aspartate transaminase and alkaline phosphatase. With administration of leaf extract of Ananias comosus at a dose of 0.3g/kg body weight, there was restoration of glycogen, glucose store house [113] and reducing serum alanine transaminase and alkaline phosphatase by reducing lipid peroxide. In a study by Arun et al., (2012) [114], at 200mg/kg, 400mg/kg and 600mg/kg of hydroalcoholic extract of Ananias comosus was administered for three weeks to experimental rats made diabetic using streptozocin. At 600mg/kg, the peak glucose reducing effect was reported and the glucose reducing potency of the extract was comparable to that of glibenclamide.

Bromelain is one of the active ingredients in Ananias comosus. In a randomized trial study conducted by Pekas et al., (2021) [115] indicated that the active agent depressed systolic blood pressure and improved blood flow in health adult subjects when compared with those that received placebo. Although the underlying mechanisms of action of bromelain have not been elucidated, it improves blood flow in healthy individuals. Increasing potassium intake has long been identified as a way of reducing blood pressure Safriani et al., (2018) [116] on the comparative analysis of potassium contents in flesh, peel and core of pineapple (Ananias comosus). They reported that the peel of pineapple contains more potassium content than core and flesh of pineapple.

In a study by Golezar et al., (2016) [117] to determine the effect of bromelain on perineal pain, episiotomy pain assessed using visual analogue scale before and after bromelain dose. The treatment lasted for six days. The result of the study indicated that bromelain improved pain threshold. Hong et al., (2021) [118] indicated the use of bromelain in the amelioration of pain. They noted that bromelain at 2.5microgram/ml, 5 microgram/ml and 10 microgram/ml suppressed interleukin-6, interlukin-1β, interleukin-8 and other inflammatory markers in liposaccharide induced human dental pulp cells.

Discussion

Allium sativum, Citrullus lanatus, Albelmoschus esculentus, Passiflora, Tamarindus indica, Persea Americana, Carica papaya, Aloe vera, Tridax procumbens, Cassia alata and Ananias comosus are potential herbal candidates for stress alleviation owing to their individual tendency to suppress high glucose, depress high blood pressure and modulate pain perception due to their respective phytochemical constituents (Table 1). Virtually, all of them contain phenolic compounds such as flavonoids or flavones, which are in popular consensus recognized as anti-inflammatory, anti-oxidant and analgesic. The sulfur-containing compounds present in Allium sativum such as diallyl trisulfide, diallyl sulfide, iallyl thiosulfonate, E/Z-ajoene, S-allyl-cysteine sulfoxide and S-allyl-cysteine can induce smooth muscle relaxation and decrease diastolic blood pressure due to the ability of sulphuric compounds to block L-type channel [9]. Citrulline contained in Citrullus lanatus is converted in the body into L- arginine and L-arginine is an important precursor for nitric oxide synthesis. Like citrulline, magnesium from Citrullus lanatus causes decrease in blood pressure but by blocking calcium channel. Other compounds most especially vitamin A and vitamin C play important role in free radical scavenging, inhibition and prevention of tissue deterioration.

The modulatory effect of Albelmoschus esculentus on hyperglycemia might include depressed expressions of PPAR-γ and PPAR-α gene in islet of langerhan which are raised in stressful situations including experimental diabetes mellitus [28,29]. However, more studies are needed to clarify the impacts of okra on PPAR-γ and PPAR-α gene in the liver, muscles and adipose tissues, as well as glucose uptake extent in the liver, muscles and adipose tissues. Increased extracellular calcium is necessary for regulation of contraction and relaxation cycle. The calcium acquired from consumption of Albelmoschus esculentus may potentiate smooth muscle relaxation and low blood pressure. Other compounds such as flavonoids, vitamin C and folic acid may protect against tissue deterioration. As previously mentioned, Passiflora are rich in flavonoids, maltol, and indole alkaloids. These substances are crucial for prevention of tissue deterioration and glycemic control [39]. The pain suppressing effect of the passiflora extract was mediated by cholinergic and opioid receptors through nitric oxide and potassium channel. Tamarindus indica also contains flavonoids. The glucose reducing effect of Tamarindus indica Linn occurred through strong suppression of alpha glucosidase [47]. Suppression of inducible nitric oxide synthase (iNOS) and stimulation of opioid receptor are possibly mechanisms involved in the pain alleviation action of Ramarindus indica [51].

The anti-hyperglycemic effect of Persea Americana occurred through hepatic protein kinase B activation [55]. The glycosyl flavones contained in Persea Americana decreased expression of Nuclear Factor kappa B (NF-kB), interlukin-6, malondialdehyde and tumor necrosis factor (TNF-alpha) and increase in hepatic glycogen and hexokinase [56]. The glucose suppressing effect of Persea Americana was also linked by Marshi et al., (2019) [57] to its flavonoids and phenolic contents. Suppression of prostaglandin production probably due to interference with cyclooxygenase activity may be responsible for the pain alleviating prowess of the Persea Americana [64]. The anti-hypertensive effect of Carica papaya was attributable to depression of blood angiotensin converting enzyme that was similar to enalapril was observed. There was also attenuation of cardiac hypertrophy and baroreflex sensitivity in the treated rats was reported to be similar to that of the rats that were given enalapril [70]. The analgesic effect of the extract was shown to be related to decline endothelium-dependent nitric oxide synthase, modulation of janus kinase/P38 mechanism, inhibition of inflammatory pathway and mitigation of carbonyl stress [74].

Oxidative stress plays a crucial role in the pathophysiology of many medical conditions [119-123] and stress. The glucose reducing tendency of the Aloe vera may be due to reduction in hydroperoxides and malondialdehyde and elevation of antioxidant enzymes such as superoxide dismutase, catalase and glutathione peroxidase [77]. Activation of muscarinic receptor (Figure 1) and calcium antagonism are mechanisms involved in vasodilation of Tridax procumbens [87]. The pain-relieving action of the extract was attributable to flavonoid and sterol constituents. The suppressive effects of Moringa oleifera on high heart rate and blood pressure may be connected with enhancement of endothelium-related vasodilation. The anti-hyperglycemic effect of Cassia alata suppressed alpha-glucosidase and alpha amylase [102]. Ananias comosus, on the other hands, caused increase in insulin sensitivity in rats that were made diabetic through streptozocin.

Conclusion

The thirst for herbal remedy for maintenance of health is unquenchable. The review highlighted the potentials of some indigenous analgesic medicinal plants in stress alleviation and indicated that indigenous medicinal plants exhibited blood pressure-lowering and analgesic tendencies besides anti-hyperglycemic effect. Beyond pain regulation, medicinal plants such as Allium sativum, Citrullus lanatus, Abelmoschus esculentus L, Passiflora species, Tamarindus indica, Persea Americana, Carica papaya, Aloe vera, Tridax Procumbens, Moringa olifera, Cassia alata and Ananias comosus are capable of decreasing blood pressure and suppressing blood glucose. The blood pressure-lowering and blood glucose-suppressing tendencies of the plants were due to their respective phytochemical constituent.

Acknowledgement

The authors are grateful to the entire staff of Physiology Department for support.

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