

A Brief Review on Plants Having Ace Inhibitory Activity

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Abstract:

Plants are an important part of the planet and human wellbeing. Years after, the research on plants was gaining more recognition in the world, and several different pharmaceuticals from these plants are being investigated for treatment of different diseases. Hypertension is the most important risk factor that causally affects wellbeing and is the most common single health issue in the world today. By looking at the various plants present in certain dietary supplements, we acquired a general understanding of their capacity to modify levels of the ACE enzyme (a vasopressor medication) and their protection in acquiring a general awareness of what they are like.

INTRODUCTION

Plants are the essential fundament on planet earth and are key to human resources. Few years back, the attention towards plants has increased throughout the world and a lot of conformations show extreme potential in the treatment of various diseases. (1) Natural resources play essential role in prevention of diseases such as coronary heart disease, heart failure, diabetic nephropathy, stroke, hypertension and atherosclerosis (2) Hypertension is developing undesired symptoms that harms health and is most common health problem worldwide.(3) Many natural ACE inhibitory activities have been taken from natural resources

i.e plants, animals and marine. Now a days around 67-70% of modern medicines are produced from natural products because of less side effects on human beings these natural medicinal

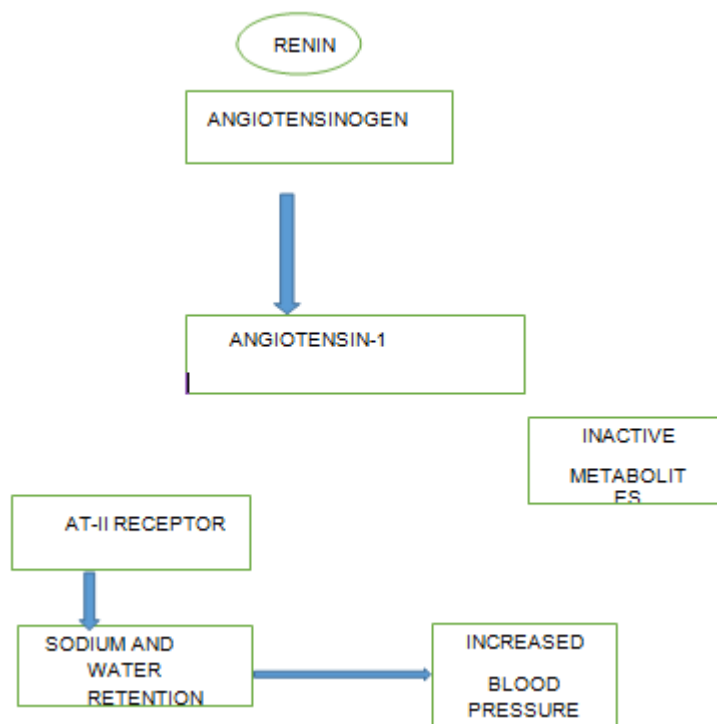
plants have acquired a great importance (4) Various types of plants have been utilized to obtain ACE inhibitory peptides such as soyabean, walnut, spinach, date seed flour, wheat and bitter melon seeds. Among them soyabean based peptides have been most frequently used. (5) Plant based peptides have been examined for ACE inhibitory activity by using in vivo and in vitro assays. (6). Extract from plants acquired ACE inhibitory peptides which is used as a substitute over synthetic drugs and are treated as top known bioactive peptides. (7) Few bioactive compounds extracted from plants which were having ACE inhibitory activity such fatty acids, xanthenes, flavonoids, alkaloids, oligosaccharides, peptide amino acids, phenylpropanes and terpenoids.(8)

ACE inhibition peptides are of two types: Non-competitive and Competitive enzyme inhibition. The molecule of inhibitor had binding affinity for both the enzyme substrate complex and free

enzyme is known as Non-competitive enzyme. Competitive enzyme is defined as the interaction of the inhibitor with active enzyme sites in order to prevent binding of substrate. (9) The Peptide from peanut bound competitively with substrate of ACE at the active site indicated a competitive enzyme inhibition. Whereas, the mushroom *Pleurotus cornucopiae* from purified ACE inhibitor is non-competitive enzyme (10)

Role of ACE and its mechanism

Angiotensin converting enzyme (ACE) plays very important role in the control of blood pressure (BP) by participation of renin-angiotensin-aldosterone system. Body produces an enzyme called renin from kidney to reduce the blood pressure. Renin catalyzes conversion of angiotensinogen to inactive peptide known as angiotensin I. Then angiotensin I is converted to angiotensin II, known as potent vasoconstrictor which acts on vascular smooth muscles and further causes contraction of blood vessels and thereby increasing the pressure of blood (11) Angiotensin II interacts with the SNS both centrally and peripherally in order to increase the vascular tone. (12). Angiotensin II causes sodium retention by stimulating the release of aldosterone from adrenal cortex, which rises the blood pressure (13) The expansion of volume arises due to aldosterone via sodium retention and renal constriction as also because of fluid retention by secretion of antidiuretic hormone (14) Apart from raising BP, angiotensin II also provides hypertrophy, migration and proliferation (15,16)



Plants having ACE inhibitory activity:

A) **Allivumsativum**- its common name is garlic and its family is Alliaceae. The parts seeds, bulbs, flowers, leaves and stalks are used for the study. It is cultivated all over the world and its origin is southern and central Asia. (15) Allivumsativum contains chemical constituents as organosulphur compounds such as alliin, allicin, ajoenein, S- allyl cysteine, several enzymes and amino acids. (16)

Allivumsativum has been used as herbal medicines and species (17) And for treatment of tumors, heart disorder, headache, insect bite, chronic cough, constipation, toothache. (16,18) The experiment of animals, showed that by the administration of captopril and S-allyl cysteine it decreases the blood pressure due to inhibition of ACE. Estimation of bound and free phenolic inhibitory effect on ACE showed that bound phenolic have more effect as compared to free phenolic in lowering of ACE activity. (19)

B) Averrhoa bilimbi – its common name is cucumber tree and it belongs to family Oxalidaceae. Various parts are used such as flowers, fruits, roots and seeds or the whole plant is used for the medicinal purpose. *Averrhoa bilimbi* is found in tropical Southeast Asia and is cultivated in African region, Indonesia, and grows widely in Srilanka and Malaysia. *Averrhoa bilimbi* leaves contain phytol, feluric acid, myristic acid and extract of fruit contain citric acid, flavonoids, triterpenoids and saponins. (20) *Averrhoa bilimbi* is used in the treatment of bowel disease, ulcers and arthritis. Extract of leaves has the ability to decrease blood pressure, antioxidant, antidiabetic, antimicrobial and anti-inflammatory. (21)

The result of phytochemical screening found that the compound has tannins, flavonoids, saponins, phenols, steroids and quinones. This is compatible with many studies that contain flavonoid compound, xanton, sapogenin and hydrolysed tannin have ACE inhibitory activity. Therefore, the ethanolic extract of *Averrhoa bilimbi* has high ACE inhibitory activity. (22)

c) Cinnamomum zeylanicum - its common name is cinnamon tree and belongs to family Lauraceae. The parts used are leaves, roots, flowers, bark and fruits. The *Cinnamomum* has around 250 species, 20 of which develop in India. (23) It contains chemical constituents eugenol and p-cymene as main components that were obtained from leaves of *C. zeylanicum*. Whereas, copaene, calamenene, amorphene, O-methoxycinnamaldehyde, lomonen, β -cadinene, α -pinene, δ -cadinene were found in essential oil of *C. zeylanicum*. Furthermore, cinnzeylanol and cinnzeylanine were obtained from dried bark. (24) *C. zeylanicum* is used by patients of blood pressure with diabetes, it improves oxidative stress and cognitive impairment and avoids tetrachloride-induced damage to reproductive system of males. (25) Bark extract has antihypertensive activity. Methanol extract of *C. zeylanicum* decreases the total cholesterol level and plasma level of triglycerides up to 32.1% and 38.1% respectively. (26)

In the presence of the methanolic extract of *C. zeylanicum* on ACE activity in tissues of sheep, it decreases the ACE activity and its effects were more critical in kidney as compared to lung tissues and testis. (27)

D) Eleusine indica - its common name is Indian goosegrass and it belongs to Poaceae family. (28) It is distributed almost all over the tropical world and in subtropics particularly in Europe, Africa, Philippines and North America. The plant contains steroids, flavonoids, saponins, carotenoids and alkaloids. (29)

Eleusine indica is used as anticancer, antioxidant, antifungal, anti-inflammatory and antibacterial. Decoction from leaves used for treatment of muscle pain, dysentery, asthma, diarrhea and febrifuge. Each part of the plant is used as a laxative, diuretic and depurative which makes it useful for the treatment of hypertension. In Nigeria, this plant is used for the treatment of malaria and diabetes. (30)

The initial approach of fraction and extract of *Eleusine indica* demonstrated that the plant is potential source of bioactive compounds that leads to inhibition of ACE. Extract of ethyl acetate have a high ACE inhibitory activity. (31)

E) *Gynuraprocbens*- its common name is longevity spinach and it belongs to family Asteraceae. The leaves of *G.procumbens* are found in Indonesia, Malaysia, China, Vietnam and Thailand. Extract of leaves contains flavonoids, terpenoids, saponin, sterol glycoside, rutin and tannins. (32) It is used to treat diabetes hyperlipidemia, hypertension, fever. (33) Ethanolic extract of leaves decreases cholesterol in diabetes-induced streptozotocin and serum triglyceride and water extract of *G.procumbens* decrease creatinine phosphatase and blood pressure. (34)

The study showed that the leaves of *G.procumbens* possess ACE inhibitory activity with IC₅₀ values 432 µg/ml in petroleum ether extract, 453 µg/ml in methanolic extract and 227 µg/ml in ethyl ether acetate extract. (35)

F) *Jasminum grandiflorum*- its common name is jasmine and belongs to the Oleaceae family. (36) Different parts of plants are used for medicinal purposes such as flowers, bark, stem, roots and leaves. (37) *J.grandiflorum* is found in tropical areas such as Kashmir, Sri Lanka, Myanmar, Asia and the Philippines and is distributed over the west coast of India. It is distributed over the west coast of India and is also cultivated in China, France, Egypt, Morocco and India. (38) Many studies detected flavonoids, terpenoids, saponins, avonoids and tannins. Various compounds including triterpene, phenolics and oleanolic acid from methanolic extract as chemical constituents. (36,37)

Jasminum grandiflorum is used as anticancer, antioxidant, antiulcer, anti-inflammatory and as anticonvulsant. (39)

In vitro enzymatic assay detected high ACE inhibitory activity from extracts obtained from aerial parts of *J.grandiflorum*. The ACE inhibitory activity of acetone, aqueous and ethanol was 78%, 46% and 60% respectively. (38,40)

G) *Landophiaowariensis*- its common name is vine rubber or white rubber. It belongs to Apocynaceae family. It contains chemical constituents such as essential oil and volatile oil. The components of essential oil were B-ionone, tetradecanol, squalene and hexadecatrienal. *Landophiaowariensis* is cultivated in Tanzania in East Africa, Nigeria. (41) *Landophiaowariensis* is used as an analgesic, anti-inflammatory and antioxidant. Stems of plant is used for treatment in intestinal worms. (42)

ACE activity of single phenolic compounds present in the extract was analyzed by using a standard phenolic compounds. It was found that the extract at highest tested dose was able to inhibit ACE by 87.77% which is compared to standard drug 90.07% (43)

H) *Meliaazedarach*—its common name is chinaberry tree. It is a member of the Meliaceae family. The part used for medicinal purposes are flowers, bark, leaves and fruits. It is distributed in India, China and Japan to Indonesia, North America, Northern Australia, Southern Europe and Africa. It contains active compounds such as saponins, flavonoids, tannins, steroids,

potassium, sodium, calcium, ferulic acid and compound of phenolic acid.

Melia azedarach has been used for the treatment of scabies, fungus on scalp, hypertension, Taeniasis and oxyuriasis. (44)

The test result demonstrated that leaves of *Melia azedarach* have ACE inhibitory activity with IC₅₀ value 588 µg/ml in ethyl acetate extract 483 µg/ml in methanolic extract and 536 µg/ml in petroleum ethyl ether extract (45)

M) *Oxalis corniculata*- its common name is woodsorrel. It belongs to the family Oxalidaceae. The part used are flowers and leaves. The species are distributed in Southeast Asia. It contains chemical constituents such as saponins, alkaloids, flavonoids, terpenoids, steroids phlobatanin and glycosides. (46)

Oxalis corniculata is used for the treatment of uterine relaxant, CNS stimulant and used as antipsychotics, antihypertension. (47)

The test result demonstrated that leaves of *oxalis corniculata* have ACE inhibitory activity with IC₅₀ value of 336 µg/ml in the methanolic extract 439 µg/ml in petroleum ethyl ether and 324 µg/ml in ethyl acetate extract. (48)

N) *Tribulus terrestris*- its common name is caltrop. It is member of a Zygophyllaceae family (49). It is distributed in mild temperate and tropical areas such as Mexico, Africa, Asia and Australia. It contains saponins, alkaloids and ligninamides. The leaves of *tribulus terrestris* contain gitogenin, chlorogenin and gitogenin. The root and fruit contains glycosides, alkaloids, phytosteroids and flavonoids. (49,50)

Tribulus terrestris used for the treatment of urinary stone, polyuria, cough, bladder disorder and used as veterinary medicine to improve fertilization and reproductive activity. Some part of plants such as root, leaves and stem are used as appetite, cathartic and as astringent. (51) Aqueous extract of *T. terrestris* recommended that BP reducing the effect of extract developed from its ACE inhibitory activity. ACE inhibitory activities for ethanol, acetone and aqueous extract shows that the highest ACE activity was found in aqueous extract. (38)

M) *Vitis vinifera*- its common name is grapevine. It is a member of Vitaceae family. It is found in Central Europe, North America and Southwestern Asia. The seeds of *Vitis vinifera* contain high value fatty oil, viniferone A, B and C, oxidative derivative of epicatechin and catechin. The leaves contain ellagic acid, gallic acid, organic acid, flavonoids, tartaric acid, succinic acid, myricetin and fumaric. (52)

Vitis vinifera is used treatment of hemorrhage, diarrhea and in urinary problems.

The study suggests that the antihypertensive effect of *Vitis vinifera* occur possibly through inhibition of ACE. (53)

Botanical name of plant	Family	Part used
Adinandra nitida	Pentaphylacaceae	Leaves
Allium cepa	Amaryllidaceae	Rhizomes

Allium sativum	Amaryllidaceae	Bulb
Allium schoenoprasum	Amaryllidaceae	Leaves
Andrographispaniculata	Acanthaceae	Herbs
Annovamuricata	Annonaceae	Leaves
Apium graveolens	Apiaceae	Leaves
Averrhoa bilimbi	Oxalidaceae	Leaves
Catharanthus roseus	Apocynaceae	Leaves
Cinnamomumzeylanicum	Lauraceae	Barks
Curcuma domestica	Zingiberaceae	Rhizomes
Curcuma xanthorrhiza	Zingiberaceae	Rhizomes
Cycleabarabata	Menispermaceae	Leaves
Eleutherinepalmifolia	Iridaceae	Rhizomes
Eleusine indica	Poaceae	Leaves
Ginkgo biloba	Ginkgoaceae	Seeds
Grewiaesomischa	Malvaceae	Root, bark
Gynuraprocumbens	Asteraceae	Leaves
Hibiscus rosasinensis	Malvaceae	Leaves
Ipomeareniformis	Convolvulaceae	Leaves, root
Jasminum grandiflorum	Oleaceae	Aerial
Landopniaowariensis	Apocynaceae	Leaves
Leucaenaleucocephala	Fabaceae	Seeds
Limnocharisflava	Alismataceae	Leaves
Luffa cylindrica	Cucurbitaceae	Fruits
Melia azedarach	Meliaceae	Leaves
Memecylonpauciflorum	Melastomatoceae	Leaves
Millettiapinnata	Fabaceae	Inner bark
Morindacitrifolia	Rubiaceae	Leaves
Moringa oleifera	Moringaceae	Leaves
Morus alba	Moraceae	Leaves
Muntingiacalabura	Muntingaceae	Leaves
Nasturtium officinale	Brassicaceae	Herbs
Orthosiphonstamineus	Lamiaceae	Leaves
Oxalis corniculata	Oxalidaceae	Leaves

<i>Persea americana</i>	Lauraceae	Leaves, seeds
<i>Petalostigma pubescens</i>	Euphorbiaceae	Leaves
<i>Phalleria macrocarpa</i>	Thymelaeaceae	Leaves
<i>Phyllanthus niruri</i>	Phyllanthaceae	Herbs
<i>Piper nigrum</i>	Piperaceae	Seeds
<i>Scurulla aartopurpurea</i>	Loranthaceae	Herbs
<i>Seasmum indicum</i>	Pedaliaceae	Seeds
<i>Solanum indicum</i>	Solanaceae	Fruits
<i>Solanum nigrum</i>	Solanaceae	Fruits
<i>Syzigium polyanthum</i>	Myrtaceae	Leaves
<i>Swietenia mahogany</i>	Meliaceae	Seeds
<i>Thymus vulgaris</i>	Lamiaceae	Leaves
<i>Tribulus terrestris</i>	Zygophyllaceae	Aerial
<i>Vaccinium myrtillus</i>	Ericaceae	Leaves
<i>Vitis vinifera</i>	Vitaceae	Fruits
<i>Wrightia tinctoria</i>	Apocynaceae	Leaves

CONCLUSION

This study indicates that ACE inhibitory activities of various plants are used that is helpful for the advancement of modern medicines. The above mentioned plants have the ability as sources of ACE inhibitor activity and are considered safe which is useful for the treatment of hypertension and other cardiovascular diseases.

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