# MEDICINAL PLANTS AND BIOACTIVE COMPOUNDS FOR TREATMENT OF CARDIOVASCULAR DISEASES IN AFRICA

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#### Contents

- 1. Introduction
- 2. Medicinal Plants Used to Treat Cardiovascular Diseases in Africa
- 3. Bioactive Compounds in Medicinal Plants used for Treating Cardiovascular Diseases

in Africa

- 4. Phenolic Compounds in Medicinal Plants used for Treating Cardiovascular Diseases in Africa
- 4.1. Flavonols
- 4.2. Isoflavones
- 4.3. Procyanidins
- 4.4. Curcumin
- 4.5. Wine Polyphenols
- 4.6. Stilbenes
- 4.7. Anthocyanins
- 4.8. Catechins
- 4.9. Flavanols (Flavan-3-ols)
- 5. Medicinal Plants Interactions with Drugs in Cardiovascular Diseases Treatment:
- Cytochrome P450 (CYPs)

6. Medicinal Plants in Africa used in Treating Cardiovascular Diseases and Their Drug Interactions

- 7. Plant-Based Nutrients against Cardiovascular Diseases
- 7.1. Plant Oil, Sterol, and Stanol Esters against Cardiovascular Diseases
- 7.2. Fiber (Soluble Fiber and Insoluble Fiber)
- 7.3. Plant Proteins (Soy Protein)
- 8. Challenges and Future Prospects
- 9. Conclusion
- Glossary

Bibliography

**Biographic Sketches** 

#### Summary

In this chapter, the medicinal and aromatic plants and their phytoconstituents used in the treatment of cardiovascular diseases are widely covered. Medicinal and aromatic plants

in Africa and their bioactive components have been used to manage or treat conditions such as CVDs. Medicinal and aromatic plants such as *Elettaria cardamom*, *Crataegus* monogyna, Citrus medica, Curcuma longa, Salvia miltiorrhiza, Fucus vesiculosus, Allium sativum, Terminalia bellerica, Piper longum, Zingiber officinale, Moringa oleifera, Ginkgo biloba, Nigella sativa, etc. are used to treat various cardiovascular diseases, including coronary artery diseases, myocardial infarction (heart attack), angina, venous thrombosis, thromboembolic disease, peripheral artery disease, aortic aneurysms, carditis, valvular heart disease, congenital heart disease, abnormal heart rhythms, cardiomyopathy, rheumatic heart disease, hypertensive heart disease, stroke, and heart failure. The bioactive compounds in these plants responsible for their medicinal activities include chebulagic acid. corilagin. digalloylhexahydroxydiphenonyl-hexoside, zingerone, gingerols, paradols, galloyl punicalagin, gallic acid, kaempferol, ethyl gallate, phyllemblin, galloyl glucose, ellagic acid, lignan, steroid, alkaloids, thymoguinones, resveratrol, catechin, volatile oils, flavonoids, curcumin, quercetin galloyl-glucoside, quercetin rutinoside, epigallocatechin-3-gallate (EGCG), piperine, salvianolic acid, miltirone, tanshinone IIA, daucosterol, ursolic acid,  $\beta$ -sitosterol, etc. These plants and their phytochemical have properties that are beneficial to the cardiovascular system, including blood pressure lowering, improving lipid profile, antioxidant, antidiabetic, anti-obesity, anti-inflammatory, antithrombotic, free radical scavenging, anti-glycemic, antihypertensive, and antilipidemic properties. Plant oil (e.g., essential fatty acids, such as docosahexaenoic acid, eicosapentaenoic acid, omega-3 fatty acid, linolenic acid, linoleic acid, oleic acid), sterol, stanol esters, lignans, fiber, and plant protein (e.g., soy protein) have properties against cardiovascular diseases.

## 1. Introduction

Cardiovascular diseases (CVDs) are a group of diseases involving the blood vessels or heart. CVDs include coronary artery diseases (CAD), e.g., myocardial infarction (heart attack) and angina. Other cardiovascular diseases include venous thrombosis, thromboembolic disease, peripheral artery disease, aortic aneurysms, carditis, valvular heart disease, congenital heart disease, abnormal heart rhythms, cardiomyopathy, rheumatic heart disease, hypertensive heart disease, stroke, and heart failure. The basic action mechanisms differ according to the diseases. Stroke, peripheral artery disease, and coronary artery disease usually involve atherosclerosis (arteriosclerotic vascular disease). This can result from poor sleep, excessive alcohol consumption, poor diet, high blood cholesterol, obesity, lack of exercise, diabetes mellitus, smoking, high blood pressure, etc. CVDs can be generally categorized into vascular and heart diseases as shown in Figure 1.

Medicinal and aromatic plants in Africa and their bioactive components have been used to manage or treat conditions such as CVDs. The therapeutic potentials and efficacies of medicinal plants for the treatment of CVDs is popular not only in Africa but worldwide, whether for treating the diseases or helping the body system cope with them. Although traditional medicines in Africa are generally considered safe since they are obtained from natural sources, however, several adverse effects can manifest due to the use of herbal medicines in treating diseases such as CVDs. Excessive use and overdose of herbal medicines have notable side effects that may complicate the occurrence of other diseases. Care should be taken when using medicinal plants and their extracts for the treatment of diseases such as CVDs. Seeking the advice of an expert is strongly recommended. For CVDs treatment in Africa, many people traditionally use complementary and alternative medicine (CAM) and natural bio-based therapies, including medicinal plants (herbs). Herbal medicine includes aromatic plants, herbal extracts and materials, herbal extracts and preparations, and herbal-based products. There are hundreds to thousands of medicinal and aromatic plants in Africa used in the treatment of many diseases such as CVDs, and are also valuable sources of novel drugs for the modern medicines.



Figure 1. Types of cardiovascular diseases

It is estimated that high blood pressure, tobacco, diabetes mellitus, lack of exercise, and obesity are responsible for around 13%, 9%, 6%, 6%, and 5% of deaths linked to CVD, respectively. Rheumatic heart diseases can ensue if strep throat is not treated. In general, cardiovascular diseases have remained the leading cause of deaths globally, with the exception of Africa. Within 2015 to 2019, CVDs resulted in an average of 17.9 million deaths (32.1%) per year, an increase from 25.8% (12.3 million) in 1990. Over <sup>3</sup>/<sub>4</sub> of CVD death occur in low- and middle-income countries. It has been estimated that by 2030, at least 23 million individuals will die per year from cardiovascular diseases. In many countries in Africa and other continents, a significant population still die from CVDs and related diseases. Stroke and coronary artery disease are responsible for 80% and 75% of deaths due to CVDs in males and in females respectively, and mostly affect the older populations. While the average age of coronary artery disease death in the developed countries is about 80, it is approximately 68 in the developing countries such as countries in Sub-Saharan Africa.

Medicinal plants and their parts, including their leaves, stem, bark, root, etc., are used to return health abnormalities back to normal, allay symptoms, and/or prevent illnesses, including CVDs. These plants and their parts/materials contain bioactive compounds and nutrients, including polyphenolic compounds, terpenes, glycosides, alkaloids,

essential oils, etc., which are typical responsible for their healing, medicinal, and therapeutic properties. A bioactive compound is any compound with detectable effect on a living organism, cell, or tissue. This chapter presents the medicinal and aromatic plants and their bioactive compounds used in the treatment of cardiovascular diseases in Africa. Their therapeutic efficacy, clinical significance, interactions with other drugs, medicinal properties, and challenges are sufficiently provided. Recent scientific and empirical evidence have shown that some bioactive compounds obtained from medicinal and aromatic plants in Africa play important roles in the prevention and treatment of cardiovascular diseases. Oral administration of formulations of bioactive compounds together with normal healthy diet can make available the nutrients and substances known to have therapeutic and clinical benefits for treating CVDs. In addition, these bioactive compounds also occur in the normal foods we eat. Bioactive compounds and their plant sources form the basis of the development of many novel drugs for the treatment of CVDs and other diseases, including nervous system diseases such as central nervous system disorders.

## 2. Medicinal Plants Used to Treat Cardiovascular Diseases in Africa

Many medicinal and aromatic plants are used in many parts of Africa, including West, East, and Central Africa, to treat many conditions related to CVDs. Herbs such as Elettaria cardamom, Crataegus monogyna, Citrus medica, etc. have been used due to their medicinal potentials to treat some heart diseases. Citrus medica belong to the family Rutaceae. Many evidences support the use medicinal plants in treating CVDs mostly due to their cardioprotective potentials related to their medicinal properties, antioxidant activities, free radical scavenging activities, therapeutic effects, etc. The species of some plants such as *Crataegus* are effective, safe, and nontoxic in treating CVDs, including ischemic heart disease. The action mechanism of Crataegus species include direct reactive oxygen species (ROS) scavenging, as well as improved superoxide dismutase, antioxidant activity, catalase activities, caspase 3 gene downregulation, etc. Another plant, Crataegus monogyna, is a rich source of polyphenolic compounds; its parts such as fruit, flowers, and leaves have medicinal properties for treating diseases such as CVDs. Many of the medicinal plants in Africa, including C. monogyna, help to regulate high blood pressure and hypotension (low blood pressure), as well as for slow breakdown excessive fat deposits and cholesterol in humans. They also increase rates of low-density lipoprotein (LDL) (also called bad cholesterol) conversion into high density lipoprotein (HDL) (also called good cholesterol) in human liver, in addition to improving oxygen and blood supply to the muscles of the heart. For circulatory disorders and congestive heart failure, Hawthorns is commonly used for treatment, partly due to its role in alleviating swelling and irritation of blood vessels. *Elettaria cardamom*, small cardamom, can effectively boosts antioxidant status, increase fibrinolysis, and lower blood pressure in hypertensive patients under striglycerides e 1 with no effect on fibrinogen levels and blood lipids. A study done on rat showed that cardamom oil has lipid homeostasis restoration ability in hypercholesterolemia presence. A decrease in atherogenicity index can be achieved with cardamom oil/powder; cardamom has cardioprotective potentials. Terminalia arjuna bark has cardioprotective effects against cardiotoxicity induced by doxorubicin through increasing coronary artery flow and myocardium protection from ischemic damage. The pericarp of *Terminalia chebula* has also shown cardioprotective potentials.

Many modern medicines for treating CVDs are developed from medicinal and aromatic plants, including the ones in Africa, and are used in many African countries including Nigeria, Ghana, Uganda, South Sudan, Eritrea, Egypt, Algeria, Ethiopia, Central African Republic, DR Congo, Djibouti, Burundi, Cameroun, Senegal, Niger, Cape Verde, South Africa, Eswatini, Zambia, Sudan, etc., and all over the world. Many medicinal plants in Africa have medicinal, therapeutic, and preventive potentials against several cardiovascular diseases (see Tables 1a,b,c). The use these medicinal plants in treating CVDs, including arrhythmia, cerebral insufficiency, atherosclerosis, angina pectoris, systolic hypertension, congestive heart failure, etc., has in practice for centuries. Herbs (medicinal plants) are unending major source for novel drug development used for treating diseases such as CVDs; e.g., reserpine obtained from *Rauwolfia serpentina*; digitoxin extracted from *Digitalis purpurea*; paclitaxel (antineoplastic drug) obtained from *Taxus brevifolia*; among others. These medicinal plants have been widely applied directly or indirectly for cardiovascular diseases treatment.

Common name	Botanical name	Parts commonly used
Aam	Magnifera indica linn.	Fruit
Agarwood	Aquilaria agallocha	Stem Wood
Ajmoda	Apium graveolens	Fruits
Ajwain	Trachyspermum ammi	Fruits
Alfalfa leaves	Medicago sativa	Leaves
Aloe vera	Aloe vera	Leaves
Alpine strawberry	Fragaria vesca L.	Leaves, rhizome, fruit
Amla	Phyllanthus emblica	Leaves, barks, fruits, branches
Amlavettas	Garcinia pedunculata	Fruits
Amsul	Garcina indica choisy	Fruit, Peel
Anardana	Punica granatum	Flowers, Fruits, Seeds
Anchusa	Anchusa italica	Flowers
Arjuna	Terminalia arjuna	Fruit, Seeds, Bark, Stem
Ashwagandha	Withania somnifera	Roots, Whole Plant
Autumn crocus	Crocus haussknechtii	whole plants
Avon Bulbs	Nectaroscordum	Flowers
Badhar	Gmelina asiatica	Bark, Roots
Bans	Bambusa arundinacea	Leaves
Barberv	Berberis darwinii	Rhizomes
Basil	Ocimum bacilicum	Leaves, Roots, Fruit, Whole Plant, Seeds
Behen	Centaurea behen	Root
Bhringraj	Eclipta prostrata	Whole Plant
Black cardamom	Amomum subulatum	Leaves, Seeds, Fruit
Black cohosh	Actaea racemose	Leaves, stem
Black pepper	Piper nigrum	Stem, Fruit
Black-caraway	Nigella sativa	Fruit, Seeds
Breckland thyme	Thymus serpyllum	Aerial parts

Butcher's broom	Ruscus aculeatus	Whole plant
Calamints	Calamintha acinos.	Aerial parts
Calamus	Acorus calamus	Roots, Rhizome
Camphor tree	Cinnamomum camphora	Camphor
Capsicum	Capsicum annuum	Fruit
Cardamom	Elettaria cardamom	Seeds, Fruit
Cardus marianus	Silybum marianum	Fruit, Seeds
Chicory	Cichorium intybus	Fruit, Seeds, Flower, Leaves,
		Roots
Chinese cinnamon	Cinnamomum cassia	Bark
Christ's thorn jujube	Paliurus spina-christi	Fruit
Cinnamon	Cinnamomum verum	Bark, Leaves, Stem
Citrin	Garcinia cambogia	Leaves, fruits
Citron	Citrus medica	Fruit
Common barberry	Berberis vulgaris	Fruit

Table 1a. Medicinal and aromatic plants used in the general treatment of cardiovascular diseases (heart diseases) (Page 1/3)

Common name	Botanical name	Parts commonly used
Common juniper	Juniperus communis	Fruit
Common mallow	Malva neglecta	Leaves, Stem
Common peony	Paeonia officinalis	Roots
Common polypody	Polypodium vulgare	Roots
Common purslane	Portulaca oleracea	Whole Plant, Fruit, Seeds
Common Yarrow	Achillea millefolium	Seeds, Fruit
Coriander	Coriandrum sativum	Fruit, Leaves
Curlv dock	Rumex crispus	Fruit. leaves
Damask rose	Rosa damascena	Flowers
Dandelion	Taraxacum officinale	Roots, Rhizome
Date	Ziziphus jujuba	Fruit
Dill	Anethum graveolens	Seeds, Fruit
Dog rose	Rosa canina	Flowers
Elecampane	Inula helenium	Whole plant
English marigold	Calendula officinalis	Flowers
European dewberry	Rubus caesius	Fruit, Leaves
European pear	Pyrus communis	Leaves, bark, fruit
Fenugreek	Trigonella foenum-	Fruit, Seeds
	graecum	
French lavender	Lavandula stoechas	Aerial parts, flowers
Garden lettuce	Lactuca sativa	Leaves
Garlic	Allium sativum	Roots
Ginger	Zingiber officinale roscoe	Roots, Whole Plant

MEDICINAL AND AROMATIC PLANTS OF THE WORLD - Medicinal Plants and Bioactive Compounds for Treatment of Cardiovascular Diseases in Africa - Chinaza Godswill Awuchi

Ginkgo	Ginkgo biloba	Leaves
Ginseng	Genus panax	Roots
Gotu kola	Centella asiatica	Leaves, Whole Plant
Grape vine	Vitis vinifera	Fruit
Gugglul	Commiphora wightii	Oleo-Gum Resin, Roots, Stem
Gundelia	Gundelia tournefortii	Leaves
Hawberry	Crataegus pontica	Fruit
Hawthorn	Crataegus monogyna	Flower, Leaves
Indian sandalwood	Santalum album L.	Bark, wood
Jatamamsi	Nardostachys jatamansi	Roots, Rhizome
Jhar ber	Ziziphus nummularia	Flower, leaves, Fruit
Karanda	Carissa carandas	Fruit
Katuka	Picrorrhiza kurroa	Roots
Lemon Balm	Melissa officinalis	Aerial parts, leaves
Lempoyang	Zingiber zerumbet	Pseudo-stem
Lesser burdock	Arctium minus hill.	Roots
Long pepper	Piper longum	Roots, Fruit
Mayweed	Anthemis gayana	Leaves, flower
Motherwort	Leonurus cardiac	Whole plant

Table 1b. Medicinal and aromatic plants used in the general treatment of cardiovascular diseases (heart diseases) (Page 2/3)

Common name	Botanical name	Parts commonly used
Myrobalan	Terminalia chebula	Fruits
Myrrh	Commiphora myrrha	Oleo-Gum Resin
Nerium	Nerium oleander	Leaves, flower
Nettle	Urtica dioica	Leaves, branches
Nutmeg	Myristica fragrans	Fruit
Olibanum-tree	Boswellia sacra	Gum resin
Olive	Olea europaea	Seeds
Peppermint	Mentha × piperita	Leaves
Pistachio	Pistacia vera	Seeds
Puarnava	Boerhavia diffusa	Roots, Whole Plant
Red sandalwood	Pterocarpus santalinus	Bark, wood
Rhubarb of babilonia	Rheum ribes	Stem
Safflower	Carthamus tinctorius	Fruit, Seeds
Saffron	Crocus sativus	Flowers
Scotch elm	Ulmus glabra	Leaves
Senna	Senna alexandrina	Leaves, Fruit, Seeds
Sesame	Sesamun indicum	Leaves, Wood
Sicilian sumac	Rhus coriaria	Leaves, Fruit
Sickleweed	Falcaria vulgaris	Leaves, flower, Stem

Skullcap	Scutellaria pekinensis	Roots
Smyrnium	Smyrnium cordifolium	Seeds
Sondh	Zingiber officinale	Roots, Whole Plant
Spearmint	Mentha spicata	Leaves
Squirting cucumber	Ecbalium elaterium	Fruit
Suaeda	Suaeda aegyptiaca	Leaves
Sweet clover	Melilotus indicus	Leaves
Symplocos	Symplocos racemosa	Bark
Table apple	Malus domestica Baumg.	Peels, fruits
Tamarind	Tamarindus indica	Leaves, fruit
Tea	Camellia sinensis	Leaves
Terminalia	Terminalia horrida	Fruits
Thorn jujube	Ziziphus spina-christi	Leaves, Stem
Turmeric	Curcuma longa	Tuber, Roots, Rhizome
Usnea barbata	Usnea barbata	Filaments
Valerian	Valeriana officinalis	Fruit
Vishatinaduka	Strychnos nux-vomica	Seeds, Stem, Fruit, Bark
White nenuphar	Nymphaea alba	Flowers
Wild almond	Prunus scoparia	Seeds
Yellow salsify	Tragopogon porrifolius	Roots
Yew	Taxus baccata	Leaves
Zedoary	Curcuma zedoaria	Rhizome
Zerešk	Berberis integerrima	Fruit

Table 1c. Medicinal and aromatic plants used in the general treatment of cardiovascular diseases (heart diseases) (Page 3/3)

# **3.** Bioactive Compounds in Medicinal Plants used for Treating Cardiovascular Diseases in Africa

As earlier said, the bioactive compounds, nutrients, and other natural substances in medicinal and aromatic plants in Africa usually form the basis of their pharmacological and medicinal properties. The therapeutic and medicinal effects of medicinal plants, including anti-atherogenic, antithrombotic, antioxidant, anti-glycemic, antihypertensive, and antilipidemic effects have been linked bioactive compounds in these plants. Epigallocatechin-3-gallate (EGCG), tannins, resveratrol, cinnamic acid. epigallocatechin (EGC), catechin, anthocyanins, etc. have been reported to ameliorate and prevent cardiovascular diseases; both vascular and heart related CVDs. Tables 2a,b shows common phytochemicals and bioactive compounds effective against cardiovascular diseases and their associated risk factors.

Phenolic acids, flavonoids, volatile oils, glycosides, alkaloids, etc., have been studied for their cardioprotective properties, with positive outcomes. Several bioactive compounds have shown to enhance endothelial injuries via various mechanisms of actions, including anti-apoptosis, anti-inflammatory, and antioxidant stress mechanisms, among others. Phenolic compounds, including stilbenes such as 3,5,4'- trihydroxystilbene (resveratrol), are principally found in the skin of groundnut and grapes. Resveratrol is richly found in red wine and has been suggested to be responsible for the cardioprotective properties linked with moderate wine consumption. Under catechols, curcuminoids are naturally found in medicinal plants in Africa, and has shown promising anti-inflammatory and cardioprotective properties and naturally occur in parts of plants in Africa such as dried rhizomes of turmeric (*Curcuma longa*). These bioactive compounds have shown effectiveness in managing many CVD related conditions such high blood pressure, carbohydrate metabolism (insulin resistance, insulin, glucose regulation), lipid profile [HDL, LDL, cholesterol, triacylglycerol], endothelial function, inflammation, oxidative stress, etc.

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#### **Biographic Sketches**

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