BOTANICALS FOR MANAGING CARDIOVASCULAR DISORDERS: A REVIEW OF MEDICINAL WEEDS ON KNUST CAMPUS

Christopher Larbie¹*, Daniel Ankamah Mensah²

¹²Department of Biochemistry and Biotechnology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
*Corresponding author: ekowlarbie@gmail.com

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ABSTRACT

Cardiovascular diseases (CVD) are the major cause of mortality and morbidity throughout the world, claiming more than 17.1 million lives each year. These diseases are caused by dyslipidemia, lack of physical activities, smoking, high levels of low-density lipoprotein (LDL) cholesterol, oxidative stress and excessive alcohol consumption. Natural products have played a significant role in drug discovery and development especially for agents against cancer and infectious disease. Natural compounds possess highly diverse and complex molecular structures and often provide highly specific biological activities. Ethnopharmacological use of plant-derived natural products has been a major source for discovery of potential medicinal agents. A wide variety of extracts from these plants have been used for about a century as alternative source of medical care for most of the population of the developing world. The extracts of some medicinal plants treat cardiovascular diseases without affecting coronary blood flow. Phytochemicals such as carotenoids, flavonoids, cinnamic acids, phenolics and proanthocyanidins possess antioxidant properties which enable them to play a significant role in the adsorption and neutralization of free radicals mainly due to their redox properties. This review focuses on the medicinal weeds grown on the main campus of the Kwame Nkrumah University of Science and Technology, Kumasi-Ghana with documented evidence of use in the management of cardiovascular disease.

KEYWORDS: Cardiovascular diseases, Medicinal plants, Phytochemicals, Antioxidants, flavonoids.

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INTRODUCTION

The World Health Organization (2007) reported that cardiovascular diseases (CVD) are the major cause of mortality and morbidity throughout the world. The World Heart Federation (WHF, 2011) estimated that 17.1 million lives are claimed by the cardiovascular diseases each year and stated that these diseases are among the most widespread and costly health problems facing many nations today. According to the Centre for Disease Control (CDC, 2009), about one third of all deaths recorded in the United States were caused by CVDs. A 5-year retrospective study in a major teaching hospital in Ghana has indicated that about 22.5% of all deaths within the period were cardiovascular in nature (Sanuade et al., 2013). Walden and Tomlinson (2011), suggested the major causes of these diseases to be insufficient consumption of fruits and vegetables, dyslipidemia, lack of physical activities, smoking, high levels of low-density lipoprotein (LDL) cholesterol, oxidative stress and excessive alcohol consumption. Drug treatment of conventional risk factors has been very effective in reducing cardiovascular events such as lowering LDL and treatment of hypertension (Anderson et al., 2007; Turnbull et al., 2008).

Recent studies have revealed that there is growing awareness of the use of medicinal plants in the prevention and treatment of CVD (Walden and Tomlinson, 2011). Kumar et al. (2011) reported that about 80% of the world’s population rely on traditional medicines for their primary health care which is predominantly based on plant materials. They have been effectively used worldwide to control heart diseases and other conditions (Walden and Tomlinson, 2011; Mwitari et al., 2013; Ghulam et al., 2013). A wide variety of extracts from these plants have been used for about a century as alternative source of medical care for most of the population of the developing world (Ghulam et al., 2013). Walden and Tomlinson, (2011) reported that the extracts of some medicinal plants have cardioprotective effects and treats cardiovascular diseases without affecting coronary blood flow. According to Lokhande et al. (2005), in Ayurvedic preparations, medicinal plants are used extensively for the treatment of many cardiac disorders such as angina, hypertension, myocardial infarction, cardiomyopathes, congenital heart diseases and other cardiovascular diseases.

Doughari et al. (2009) reported that the medicinal values of these plant extracts are due to the presence of phytochemicals. These include antioxidant compounds that play a major role in the adsorption and neutralization of free radicals mainly due to their redox properties. The antioxidant compounds act as reducing agents and singlet oxygen quenchers (Walden and Tomlinson, 2011). Plant based antioxidant compounds include carotenoids, flavonoids, cinnamic acids, phenolics and proanthocyanidins used for cardiovascular disease (Olayinka and Okoh, 2009).

Recent investigations have been undertaken that suggest a correlation between phytochemicals intake and reduced risk of cardiovascular disease (Ullah and Khan, 2008). Epidemiological studies suggest that flavonoids are effective in the prevention of diseases associated with oxidative damage of biomolecules, thus can help lower the risk of coronary heart diseases (Olayinka and Okoh, 2009). Flavonoids’ ability to scavenge oxidants enable them to lower peroxidative tendencies and retard coronary artery disease, myocardial infarction, atherogenesis and thrombosis (Ullah and Khan, 2008). Proanthocyanidins are antioxidants that inhibit lipid peroxidation and have anti-inflammatory and antiallergenic properties (Walden and Tomlinson, 2011). Thus the identification of medicinal weeds, which hitherto are controlled and/or destroyed by both chemical and physical means, and characterization of phytochemicals present in them will provide evidential usage for managing human ailments including CVDs. This review paper mainly focuses on the medicinal weeds identified on the main campus of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi-Ghana that
could be used to manage and control cardiac disorders. The KNUST is the main public science and technology university in Ghana and the environment serves as habitat for both flora and fauna. Biomedical scientists in the university are engaged in pharmacological evaluation including cardiotonic effects of extracts from these plants and animals. The summary of some identified plants are as shown in Table 1. All plants were certified by Dr. George H. Sam of the Department of Herbal Medicine (KNUST, Kumasi) and a specimen was deposited at the department’s herbarium.

Table 1. Summary of medicinal weed used for managing cardiac disorders

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Family Name</th>
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<th>Cardiotonic Agents</th>
<th>Studies Carried</th>
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<td>Asteraceae</td>
<td>Whole plant</td>
<td>Flavonoids</td>
<td>Ethnomedical studies</td>
<td>(Evani et al., 2008)</td>
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<td>Nyctaginaceae</td>
<td>Root</td>
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</table>

ACANTHOSPERMUM HISPIDUM DC

Description: A. hispidum DC is an erect annual herb that belongs to the family Asteraceae, originated from tropical America and commonly known as the Bristly starbur, Goat’s head, Hispidstarburr and Starbur (Anup et al., 2012). The plant has a characteristic light, slightly sweet aroma and found in a wide range of habitats. It is commonly found in cultivated upland crops, roadsides, pastures, waste areas, around corrals, and along railroads and cattle trails and is particularly adapted to light textured soils but also grows well in heavy textured soils (Evani et al., 2008; Anup et al., 2012;). It also grows in cultivated areas of KNUST.

Parts used: Whole plant (Anup et al., 2012)

Investigational uses: Evani et al. (2008) reported that the plant has been used traditionally for the treatment of hypertension.

Phytochemical studies: Harekrishna et al. (2010) reported that the petroleum ether extracts of A. hispidum contained only terpenoids but chloroform and ethanol extracts exhibited the presence of carbohydrates, alkaloids, glycosides, flavonoids, tannins and saponins. According to Evani et al. (2008), the leaves of A. hispidum contain caffeic acid and phenylpropanos, sesquiterpene hydrocarbons, β-caryophyllene, α-humulene, bicyclogermacrene, germacrene D, α-bisabolol, nonanal, carvacrol and methyl carvacrol.

Most active phytochemicals: Flavonoids

The presence of flavonoids in the plant makes it beneficial in managing hypertension. Schaeffer (2012) stated that several studies have demonstrated that flavonoids can significantly lower systolic blood pressure. Plants high in flavonoids appear to lower systolic blood pressure remarkably as well as LDL cholesterol-lowering and HDL-raising.
without the risk of weight gain. Epidemiologic studies also suggest that higher polyphenol intake from plants are associated with decreased risk for cardiovascular disease (Schaeffer, 2012; Walden and Tomlinson, 2011). In addition, phytochemicals have been shown to have roles in the reduction of platelet aggregation, modulation of cholesterol synthesis and absorption, and reduction of blood pressure (Walden and Tomlinson, 2011).

Other medicinal uses: *A. hispidum* has reportedly been used traditionally in the form of a paste to treat skin ailments, jaundice, malaria, vomiting, cephalgia, head-ache, abdominal pain, convulsions, stomachache, constipation, eruptive fever, snake bite, epilepsy, blemnorrhoea, hepato-biliary disorders, malaria, microbial infection and viral infections (Anup et al., 2012; Tijani et al., 2013).

Pharmacological activities: The plant has been suggested to possess abortifacient and teratogenic, antiviral, antidiarrheal, antitumour, anthelmintic, antimicrobial, antiplasmodial, antifeedant, antipyretic, sudorific, depurative, astringent, abortive, and diuretic activities (Evani et al., 2008; Anup et al., 2012).

Toxicology: Both seeds and leaves contain phenolic acids that are allelopathic to other plants (Anup et al., 2012). Studies in mice showed that ingested seeds were toxic and resulted in liver damage, glomerular atrophy, congestion and hemorrhaging in the spleen, the lungs and the heart and catarrhal enteritis (Evani et al., 2008).

**BOERHAVIA REPENS L.**

Description: *Boerhavia repens* is a terrestrial annual to perennial herb that belongs to the family Nyctaginaceae (Avijit et al., 2013). It is commonly called spreading hogweed, creeping spiderling, red hogweed in English and has a pantropical distribution. It is distributed throughout regions with a distinct dry season in Africa. It can also be found in India (Avijit et al., 2013). *B. repens* occurs in disturbed sandy and rocky localities, often in occasionally inundated areas, such as ditches along roadsides, dry river beds, flood plains and irrigated fields.

Parts used: Root, leaves and seeds (Mahesh et al., 2012).

Investigational uses: Used as cardiotonic (Santhosha et al., 2011).

Phytochemical studies: Phytochemical screening of *B. repens* revealed the presence of liriodendrin, punarnavoside, boerhavine and potassium nitrate, rotenoid, flavonoid glycosides, the alkaloid punarnavine, flavonoids, steroids, triterpenoids, lipids, lignins, carbohydrates, hypoxanthine 9-larabinofuranoside, ursolic acid, punarnavoside, lirodendrin and glycoproteins (Santhosha et al., 2011; Mahesh et al., 2012).

Most active phytochemicals: Flavonoids and terpenes.

For a drug or chemical to be called a cardiotonic, it should contain cardiotonic agents that strengthen the heart output and serve as a stimulant to the heart. According to Olayinka and Okoh (2009), many studies have revealed that flavonoids have antioxidant properties and hence prevent low density lipoprotein oxidation in vitro and so may play a role in the prevention of coronary heart disease (CHD). The intake of flavonoids has been found to be inversely correlated with the plasma total cholesterol and low-density lipoprotein (LDL) cholesterol concentrations thereby revealing the potential of flavonoids in the reduction of risk for coronary artery disease (Walden and Tomlinson, 2011). Triterpenes are very important phytochemicals which have the potential to treatment of cardiovascular diseases. The triterpene glycosides are believed to be the primary active components used for recovery from heart attacks. The triterpenes lower blood lipids and enhance oxygen utilization and may have cardiac protective effects (Siddique and Sallem, 2011).
Other medicinal uses: The plant has been reported by Mahesh et al. (2012), to have numerous medicinal uses. It aids in the treatment of liver disorders such as jaundice, hepatitis, cirrhosis, anaemia, detoxification and treats chemical injury, kidney urinary tract disorders and obesity (Mitra and Mukherjee, 2010).


**Pharmacological activities:** It has been demonstrated that the plant exhibits various pharmacological and biological activities such as aphrodisiac, antimalarial, hepatoprotective, anti-convulsant, anthelmintic, anti-inflammatory, anti-flatulent, appetite stimulant, abortifacient, anti-fibrinolytic, anti-metastatic and aphrodisiac activities (Santhosha et al., 2011). The chloroform and methanol extracts of the roots and aerial parts of *B. repens* exhibited hepatoprotective activity against carbon tetrachloride intoxication in experimental rats. Hepatoprotective activity of 50% aqueous alcohol extract of the whole plant against experimentally induced carbon tetrachloride hepatotoxicity in rats and mice was also observed (Santhosha et al., 2011).

**CLEOME VISCOSA LINN.**

**Description:** *Cleome viscosa* Linn., commonly known as thick weed or spider plant belongs to the family Capparaceae. It is an annual sticky herb found in India and throughout the tropics of the world. According to Saradha and Subba (2010), it occurs mostly in woodland and grassland, and is a weed of fallow land, fields, roadsides and wasteland, often occurring on sandy soils.

**Investigational use:** Cardiac stimulant and management of cardiac disorders (Ahmed et al., 2011).

**Phytochemical studies:** Koche et al. (2010) and Jane and Patil (2012) reported the presence of alkaloids, tanninoids, flavonoids, saponins and terpenoids in the leaves of *Cleome viscosa*.

**Most active phytochemicals:** Flavonoids

**Other medicinal uses:** The leaves and seeds are used as a rubefacient and vesicant and to treat infections, rheumatism, diarrhoea, fever, inflammation and mental disorders (Jane and Patil, 2012).

**Pharmacological activities:** The seeds and oils of the weed have anthelmintic properties but they are ineffective in treating roundworm infections, analgesic activity in mice and local anaesthetic activity in guinea pigs. In tests with rats, the anti-diarrheal and antipyretic activities of the extracts have been confirmed. It has also been reported to possess hepatoprotective, immunomodulatory, carminative, antiseptic, sudorific, irritant, acrid, rubefacient and vesicant activities (Mali, 2010; Ahmed et al., 2011).

**CELOSIA TRIGYNA L.**

**Description:** *Celosia trigyna* L. is an annual erect herb which belongs to the family Amaranthaceae. It is commonly called silver spinach, wool flower, and cock’s comb in English. *C. trigyna* occurs almost throughout tropical Africa, South Africa and southern Arabia and is regarded as a weed but is used as a leafy vegetable in Benin and southern Nigeria. It is found in forest clearings and grassland, along roadsides and rivers, and as a weed in fields. It grows on a wide range of soils, but prefers fertile well-drained loamy soils (Denton, 2004).

**Parts used:** Whole plant, leaves and flowers (Denton, 2004).

**Investigational uses:** Treatment of heart complains (Denton, 2004).

**Phytochemical studies:** Flavones, glycosides, saponins, steroids, tannins and alkaloids.

**Most active phytochemicals:** Flavonoids.
Other medicinal uses: It is used traditionally for the treatment of kidney disorders, liver diseases, menstrual cycle problems, pulmonary troubles, stomach troubles and venereal diseases. In Ghana it is applied to sores and boils to heal (Denton, 2004).

Pharmacological activities: Pharmacological investigation of the plant showed that the plant serves as vermifuge and diuretic and has anthelmintic properties (Denton, 2004).

**DISSOTIS ROTUNDIFOLIA (SM) TRIANA**

Description: *Dissotis rotundifolia* Triana, is a perennial herb commonly called Pinklady. It belongs to the family Melastomataceae and is a native of tropical West Africa (Mann et al., 2009).

Parts used: Whole plant and leaves (Abere et al., 2010)

Investigational uses: Managing circulatory problems (Abere et al., 2010).

Phytochemical studies: Phytochemical evaluation revealed the presence of alkaloids, cardiac glycosides, saponins and tannins (Mann et al., 2009).

Most active phytochemicals: Cardiac glycosides

The cardiotonic agents are agents that have a strengthening effect on the heart or that can increase cardiac output. These agents include cardiac glycosides and are used after myocardial infarction, cardiac surgical procedures, in shock and in congestive heart failure. The presence of cardiac glycosides therefore makes *D. rotundifolia* very vital medicinal source for the treatment of heart problems. Cardenolides, for example, inhibit the Na⁺/K⁺ -ATPase pump in mammals. Several plants with cardiac glycosides or cardenolides are used medicinally and often used to treat heart problems (Piacente et al., 2009).

Other medicinal uses: In Nigeria, *D. rotundifolia* is used mainly for the treatment of rheumatism and painful swellings. The leaf decoction is used to relieve stomach ache, diarrhoea, dysentery, cough, stop abortion, conjunctivitis, circulatory problems and venereal diseases (Abere et al., 2010). In East Africa the plant is used for the treatment of bilharzias (Abere et al., 2007).

**GONGRONEMA LATIFOLIUM BENTH**

Description: *Gongronema latifolium* is a shrub that belongs to the family Apocynaceae. It is widespread in tropical Africa.

Parts used: Whole plant and Stem bark

Investigational uses: Antihypertensive (Oguwike et al., 2013).

Phytochemical studies: The plant contains phytochemicals such as polyphenols, alkaloids, glycosides, flavonoids, terpenes, tannins, saponins, alkaloids, β-sitosterol, lupenyl esters, pregnane ester and essential oils (Nnodim et al., 2012).

Most active phytochemicals: Polyphenolic acids and flavonoids

Quiñones et al. (2013) reported in their study that in recent years, numerous studies have demonstrated the health benefits of polyphenols against cardiovascular diseases. These polyphenols present vasodilator effects and are able to improve lipid profiles, attenuate the oxidation of low density lipoproteins and can modulate apoptotic processes in the vascular endothelium due to their antioxidant properties.

Other medicinal uses: It is used to treat malaria, stomach disorders, diabetes, muscular pains, arthritis and inflammation, cough and loss of appetite. It has also been reported that the plant is used for the treatment of sore gums, colic, dyspepsia, worm infections and for maintaining healthy blood glucose level (Akuodro et al., 2010).
Pharmacological activities: *G. latifolium* is reported to have anthelmintic, anti-inflammatory, antibacterial, antioxidant, anti-asthmatic and antiplasmodial activities. The leaf extracts have analgesic effects, antipyretic, antisickling activities. The stem bark extracts have anti-ulcerative property (Oguwike *et al*., 2013).

**LAUNAEA TARAXIFOLIA (WILLD.) AMIN EX C. JEFFREY**

Description: *Launaea taraxifolia* is a perennial herb usually called dandelion. It belongs to the family Asteraceae and occurs mostly in the Tropical West Africa, Mexico, West Indies, Central and South America, Europe, North Africa, Atlantic Islands, South, West and Central Asia. It grows in an open habitat and is considered as weed.

Part used: Whole plant and leaves

Investigational uses: Heartburns and lower blood pressure (Adinortey *et al*., 2012).

Phytochemical studies: Phytochemical screening by Dickson *et al.* (2012), revealed the presence of alkaloids, glycosides, terpenes, flavonoids and phytosterols. The leaves also contain cardiac glycosides, terpenoids, tannins, saponins and steroids (Adinortey *et al*., 2012).

Most active phytochemicals: Flavonoids and terpenes.

Some of these metabolites act as natural antioxidants to neutralize the harmful effect of oxygen radicals in the body. One of the major classes of natural antioxidants found in plants that remove such free radicals is polyphenols.

The phenolic compounds (flavonoids and tannins) are able to neutralize reactive oxygen and nitrogen species and also break down peroxides. The presence of these phenolic metabolites in the *L. taraxifolia* are notably helpful as their utilization would protect the individual from some of the free radical mediated diseases such as Alzheimer’s, cardiovascular diseases and cancer (Cartea *et al*., 2011).

Other medicinal uses: The plant has been traditionally used as remedy for abdominal disorders, liver diseases, skin, conjunctivitis, measles and diabetes (Gbadamosi *et al*., 2012; Adinortey *et al*., 2012).

Pharmacological activities: From indigenous knowledge, Dansi *et al.* (2012) noted that through simple and regular consumption as leafy vegetable, the plant has lactogenic, antibiotic, antimalarial, antioxidant, anti-hyperglycemic, anti-inflammatory, hypercholesterolemic, anti-cancer, antimicrobial and anti-diabetic activity. The leaf extract of the plant has been observed to have antiviral potentials and has cholesterol lowering effect (Obi, 2011; Dickson *et al*., 2012).

**CONCLUSION**

To avert cardiovascular diseases as the world’s leading killer among non-infectious diseases, it becomes more important to identify plants materials that are very relevant to the managements of cardiac metabolic disorders and further investigated to extract some important secondary metabolites that can serve as the source of therapeutic agents for managing cardiac disorders.

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