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Phenetic and Medicinal Properties of *Senna didymobotrya (Fresen.)* H. S. Irwin & Barneby in Kenya. A review paper

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Abstract: While industrialized nations are increasingly embracing complementary and alternative medicine, underdeveloped nations have long utilized herbal medicine. The East African plant, *S. didymobotrya* is promising due to its distinct phenotypic traits and potential medical uses. Therefore, this work reviews the phenetic and therapeutic characteristics of S. didymobotrya. This shrub is indigenous to East Africa and is a member of the Fabaceae family. *Phenotypically, S. didymobotrya stands out with its clusters of vivid yellow flowers, complex leaves, and thin stems. The leaves have a unique scent due to their high concentration of essential oils, especially 2,6-dimethyl-7-octen-2-ol.* The smell of popcorn permeates the plant, which is immediately recognisable even from a distance and is caused by this volatile chemical. African traditional healers have long used different components of the plant to cure a wide range of illnesses, from skin issues to gastrointestinal diseases. Common preparations for the leaves and roots include infusions or decoctions, which work well as cures for indigestion, constipation, and stomach discomfort. The plant's laxative effects come from sennosides A and B, which have a lot of anthraquinone and help you go to the bathroom by moving your intestines around and making more fluids. *S. didymobotrya* exhibits encouraging pharmacological potential in addition to its customary applications. Recent studies have emphasised its antioxidant, antibacterial, and anti-inflammatory properties, suggesting potential wider medicinal uses. The results have proven the plant's extracts to have inhibitory effects against a variety of harmful bacteria and fungi, suggesting the development of natural antibacterial drugs. Additionally, its antioxidant activity may aid in the fight against oxidative stress and related disorders, and its anti-inflammatory qualities may prove beneficial in the treatment of ailments including dermatitis and arthritis.

Keywords: *Senna, Pharmacology, Phenetic, medicinal, Kenya*.

INTRODUCTION

Most regions of the world, particularly developing nations, have long used herbal remedies [29]. The World Health Organisation [74] has promoted traditional medicines as a foundational element of primary healthcare, notwithstanding significant advancements in conventional medicine [59].

Notably, several traditional medications have not shown promise in treating novel diseases like HIV and AIDS or have dangerous side effects [46; 6]. Studies on therapeutic plants have garnered significant attention worldwide in recent years. A study on medicinal plants in Uganda revealed that 262 species—among which *S. didymobotrya* was identified—are used to cure 78 different ailments [71].

In Kenya, Senna didymobotrya is used as a medicinal plant.

An ethnobotanical study of the medicinal plants used by the Nandi people revealed the use of nine plant species as cures for gastrointestinal issues in humans. The Nandi people employed forty plant species in therapeutic situations. According to [24], people used several species to treat colds and coughs, and five species to treat skin conditions. Rural Luo moms in Bondo, Siaya County, utilised *S. didymobotrya* to treat their children's congested noses, false teeth, mouth infections, labour pains, constipation, edoema, and worms [20]. [47] looked at the different types and uses of ethnobotanical treatments for malaria among the Kikuyus in central Kenya. They found that the traditional practices in the area were always changing and included both native and introduced species. *The investigation cited S. didymobotrya six times, out of the 58 identified species [47].*

According to conventional therapy for disorders of the ears, nose, and throat [48], 67 species from 36 families were used; a decoction made from *S. didymobotrya* leaves was given orally to treat tonsillitis. A study in Central Province on the ethnotherapeutic management of STDs and related illnesses utilised 49 plant species from 30 families to treat a variety of STDs and related conditions.

A study on weed species used in traditional medicine in central Kenya found 75 species to be significant [50]. Observations show that people used S. didymobotrya to treat typhoid, tonsillitis in men, back discomfort, anaplasmosis, malaria, acne, skin rashes, pneumonia in cattle, and STDs [45].

In Muranga, Nyandarua, and Kiambu Counties, the leaves of *S. didymobotrya* were cooked and a patient bathed in them to treat pimples, scabies, warts, and measles, according to an ethnobotanical assessment of traditional medicines for controlling skin disorders. *An ethnobotanical survey on herbal medicine in the urban slums of Thika, specifically in Kiandutu and Kiang'ombe, discovered S. didymobotrya as one of the 41 species used for diarrhoea treatment.* They used the seeds, bark, leaves, and sap [49].

Documentation on ethnobotanical information and traditional medicines investigated in Embu County and Mbeere sub-county in Kenya showed 40 commonly used herbal plants, of which 25 were used as multi-ppurpose medicinal plants and 15 were used to treat one disease [30]. The authors reported that they ranked S. didymobotrya leaves as one of the most commonly used for managing fungal infections and ringworms.

Phyllogenetic diversity of the genus *Senna*

The phyllogenetic variety, phytoconstituents, and biological activity of the genus Senna, formerly known as Cassia, have been the subject of numerous studies. Only 46 of the 580 species found worldwide in this genus have undergone phytochemical studies. There is still a critical need to investigate active compounds, and the phytochemical studies on this genus appear to be far from complete [19]. Emodin, chrysophanol, and rhein may be used as chemotaxonomic markers for the Senna genus because they are found in large amounts in this species [19].

Current climate change has prompted numerous studies to forecast future changes in ecosystems, species distributions, impacts on rare species, and impacts on invasive species [12]. The significance of population genetic studies lies in their ability to ascertain the distribution of variation within and between populations, as well as the degree of diversity. Most of these studies have focused on individual diversity, or accessions, while a smaller number have studied populations [15].

Senna became a naturalized citizen of Australia and some parts of America, among other countries. Originally introduced to tropical Asia and America as a cover crop, green manure, and fodder, people today grow S. didymobotrya as an ornamental all over the world [69]. Tropical Africa is the native habitat of *S. didymobotrya* [5]. It is indigenous to Sudan, Ethiopia, Mozambique, and Angola. Numerous tropical nations, including the Comoros, Madagascar, Mauritius, and South Africa, have received it as an ornamental plant [69].

It has spread throughout grasslands, forests, wastelands, coastal scrubs, roadside areas, and riverbanks in South Africa [52]. It imported, naturalized, and eventually became an invasive species in some areas of Kenya, Uganda, and Tanzania [69]. Notably, it is rarely damaged by disease or pests [43].

Research has also demonstrated differences in bioactive chemicals within a single plant. It is possible to harvest some plant parts in a more sustainable way than others [22]. Thus, it is critical to evaluate the phytochemicals' levels of expression in various plant sections. The acquired knowledge will enable the ability to target species utilisation, conservation, and harvesting tactics.

By looking at the variety of S. didymobotrya populations using morphometric analysis, we can find out which of the known S. didymobotrya populations are morphologically different from each other and if this variation is related to where the populations are found. This information is used to determine the taxonomy of the species. S. didymobotrya has many medical uses, so it is important to learn more about it so that it can be used as a medical resource in Kenya. This can be done by studying its phenetic diversity, phytochemicals, and antibacterial activity against different types of pathogenic bacteria and fungi.

Taxonomic information for the genus *Senna*

The genus *Senna,* formerly *Cassia* (*Senna* Mill.), belongs to the kingdom plantae, sub-kingdom vividiplantae, infrakindom streptophyta (land plants), super-division embryophyta, division tracheophyta (vascular plants), subdivision spermatophytina (seed plants/phanerogames), class magnoliopsida, superorder rosanae, order fabales, family Leguminosae (alt. Fabaceae), with three sub-ffamilies (Leguminosae, Caesalpinioideae, and Cassiinae) [66].

With only a few species found in temperate climates, this genus is native to and widely distributed across the tropics. Known for its diverse biological and pharmacological properties, this genus encompasses between 580 and 600 species, widely distributed globally [11]. Of these, it is known to cultivate fifty (50) species, and tropical regions are home to 250 species [66]. At some point, scientists assigned almost all species to the close relative Cassia, which, until a few decades ago, acted as a "wastebin taxon" to include all Cassiinae.

A unique floral morphology and the presence of extra floral nectaries (EFNs) in many species define the genus *Senna*. It has effectively colonised a wide range of habitats in diverse temperatures and latitudes and has demonstrated a remarkable diversity of behaviours, including herbs, shrubs, treelets, tall trees, and lianas [38]. The problematic taxonomic interpretation of *Senna's* morphological variety best explains the genus *Senna's* fluctuating taxonomic limits, which have marked the history of traditional systematics. For instance, the great degree of specialisation typical of buzz-pollinated Senna flowers makes it difficult to clearly identify features for taxonomic purposes [38].

Scientific classification

Kingdom: Plantae
Divisions: Spermatophyta and Angiospermae
Class: Magniolopsida
Order: Magniolopsidales or Fabales
Family: *Caesalpiniaceae/FFabaceae (*alt. *Leguminosae*)
Sub-ffamily: *Caesalpiniodeae*
Tribe: *Cassieae*
Sub-tribe: *Cassiinae*
Genus: *Senna*
Species: *Senna didymobotrya* (Fresen.) H. S. Irwin & Barneby
Synonyms: Cassia didymobotrya Fresen. (1839); *Cassia nairob(i)ensis* L. H. Bailey (1941); *Cassia verdickii* De Wild.; *Chamaesenna didymobotrya* Small [69].

Common and local names

This plant is known by several names, including peanut butter cassia [10], popcorn cassia, popcorn senna, wild senna, African senna, and African wild sensitive plant. It is also known as the Séné *africain* (French) and candelabra tree in English [62]. The leaves emit a scent reminiscent of freshly cooked buttered popcorn, hence the name Popcorn Senna [10].

In Mozambique, it is referred to as mudlayanhoka or nyocanyokani [35], whereas in South Africa, among the Vha-VVendas, it is called Tshiduwana. Different ethnic communities in Kenya use different vernacular names to describe the species. For instance, Meru [18], Nandi [Senetwet], and Kipsigis [24] refer to the plant as Murao or Kirao. Senetwo in Pokot [52] Mwino/MMwinu in Kikuyu [47], Owinu/OOvino/OObino-LLuo, Ithaa/MMuthaa in Kamba [73], Osenetoi in Maasai, Lubino/LLuvino-LLuhya, Esletoi in Maasai, Mbinu/MMshua in Taita, and Atupa in Swahili [32].

Botanical description

Senna plants produce bright, nectar-free flowers that entice pollinators—typically big female bees from the *Xylocopa* genera—with pollen in exchange for their services [38]. *Senna*'s heteroantherous blooms normally have ten stamens; three of them are staminodial, while the remaining seven or less are fertile. Bees divide the poricidal fertile stamens into two sets: one set consists of four middle stamens, situated between the adaxial staminodes and abaxial stamens, from which they buzz to collect food pollen; the other set consists of two or three (often longer) abaxial stamens, from which they transfer pollen to the stigma of other flowers while they buzz [38].

Moreover, many Senna species have asymmetric blooms, which redirect the gynoecium either to the left or to the right within the same inflorescence. The term "enantiostyly" refers to this kind of floral assymmetry. Monographic works have studied the taxonomic value of extra floral nectaries in Senna, but their genus-specific distribution, morphology, and evolutionary importance remain unknown [38].

Temperate climates host a few species of S. didymobotrya, a shrub native to the tropics. It is indigenous to Eastern and Central Africa, where it opens from brown buds to produce golden, yellowish blooms with a pronounced peanut butter aroma [57]. Usually, it's a little tree or shrub with multiple stems. Its height ranges from 0.5 to 5 (-9) metres [52]. According to [57], its branches are pubescent to villous, terete, striate, and infrequently subglabrous.

The evergreen leaves emerge from dark buds. They have more than 30 leaflets and range in length from 14 to 50 cm [69]. The leaves are simply paripinnate, narrowly oblong to elliptical in outline, and measure between 10 and 50 cm in length. The stipules are broadly ovate-cordate, measuring 6 to 17 mm x 8 to 10 mm, acuminate, palmately veined, reflexed, and tardily caducous. The petiole is terete, measuring between 1 and 8 cm in length, and the rachis can reach 40 cm in length, both pubescent and glandular; the petiolules are up to 3 mm long. Eight to eighteen pairs of chartaceous, elliptical-ooblong leaflets, measuring 2 to 6.5 cm x 0.5 to 2.5 cm, twice as long as wide, feature an oblique base, a rounded but mucronate apex, pubescent to glabrescent, and distinct marginal veins [25].

There are ten to twenty inflorescent flowers in each group. Each group contains inflorescences of bright yellow flowers with long flower stalks [25]. The tall, axillary, spike-like raceme with 20–30 flowers is known as an inflorescence. The peduncle is terete, 5–8 cm long, and glabrous. The broad, ovate, black-green bracts (8–27 mm x 5–15 mm) initially imbricate and enclose the flower buds. Bracteoles are missing; 5 subequal, oblong-obovate, 9–14 mm long, puberulous, green sepals; pedicel slender, 3–10 mm length, thickly hairy.

The flower has five petals that are slightly uneven and ovate to obovate, measuring 17–27 mm x 10–16 mm, with a thin, hairless, bright yellow claw with finely spaced veins. There are ten stamens, with filaments shorter than the anthers. The anthers of two lower stamens are 9–11 mm long, three upper stamens staminodial, and five median stamens measuring about 5 mm long. The ovary and stipe are velvety pubescent, and the style is slender, hairless, recurved, and about 1 cm long.[57] said that the fruit was flat, linear–oblong, 7–12 cm x 1.5–2.5 cm, glabrescent, short-beaked, dehiscent or not dehiscent when dry, depressed between the seeds, with raised sutures that were blackish–brown. Seed flattened, oblongoid, apiculate, 8–9 mm x 4–5 mm x 2.5 mm, smooth, pale brown; areole elliptical, 3–4 mm x 0.7–1.5 mm.

Ecology and geographic distribution of *S. didymobotrya*

Because least a few *Senna* species are suited for any environment warmer than cool-temperate due to their large range of species and ecological adaptations [69]. According to [52], *S. didymobotrya* is widespread in grassland and woodland, along lakeshores, streams, rivers, and other moist areas, as well as deciduous bushland. It may be found from sea level to 2500 metres above sea level. Sometimes, people discover it in hedgerows near buildings and in abandoned plantations [52].

1. *didymobotrya* is typically ruderal in riparian montane woodland grasslands or evergreen bushlands, which are its natural habitats. Their biological limit in altitude is between 900 to 2400 m, and they can withstand light frost [52, 69]. It has been discovered that the plant is exotic in Malaysia, Sri Lanka, Indonesia, and India. Australia and some regions of America have seen *S. didymobotrya* naturalization [69]. The plant is grown in well-drained soils either inside or in a climate free of frost. It is widespread in tropical and subtropical locations, grows quickly, and is frequent in undisturbed areas [39].

Ethnobotany of *S. didymobotrya*

The science of ethnobotany investigates the historical and contemporary uses of plants [63]. Studies on ethnobotany show how humans use plants for a wide range of basic survival and decorative needs. It aids in identifying locally significant plant species for the discovery of unprocessed pharmaceuticals. Additionally, these surveys have shown how human selection has led to the evolution of distinct plant forms through the process of domestication, which is a major evolutionary force. Moreover, they can provide valuable information on beneficial plants that should be domesticated in order to increase revenue and make the products more accessible to healers and other resource users [63].

For thousands of years, herbal and traditional medicine have extensively used Sennas. Growing traditionally around the middle Nile but more widely in several areas across the north-western Indian Ocean, *Alexandrian Senna* (*S. alexandrina*) is and continues to be an important item of transnational trade by the Ababdah peoples in Egypt. According to [64], the Vha - Vendas in South Africa utilized the roots of this plant to treat STDs.

S. didymobotrya (Fresen.) Irwin & Barneby and S. occidentalis L. [49] treat ringworm, worm infestations, and eruptive skin disorders. Laxative and antibacterial properties are possessed by *S. fistula* L., *S. spectabilis* DC., and *S. podocarpa* (Guill. Et Perr.) [1]. While the leaves of *S. nigricans* are used to cure skin conditions like ringworms, *S. occidentalis* is used to treat mycosis, a skin infection [1]. Antibacterial and antifungal properties are present in the stems, roots, and flowers [39]. [23] also discovered that *S. didymobotrya* and *S. occidentalis* extracts exhibit antifungal action through the reduction of aflatoxin production and mycelial proliferation.

Most of the beneficial compounds produced by *S. didymobotrya* have been utilised since ancient times. It is an extensively used medicinal plant, particularly in East Africa, where large amounts of it are eaten as an emetic and a decoction or infusion from the leaves, stems, and roots is consumed as a laxative and purgative for the treatment of gastrointestinal symptoms [69]. It is also used to cure ringworms and remove intestinal worms in Burundi, Rwanda, and Uganda. In the event that the mixture causes the patient to become weak, milk should be consumed. Young leaves are fried in banana leaves and administered orally to heal children. An infusion produced from the roots is consumed to cure diarrhea in Kenya and Uganda [10].

A root decoction of *S. didymobotrya* is used in the Democratic Republic of the Congo, Rwanda, Burundi, Kenya, Uganda, and Tanzania to cure jaundice, various fevers, and malaria [52] Venerereal infections and skeletal muscle abscesses are treated with a decoction of fresh plant parts or a powder of the root or leaf diluted with water [52]. According to [35], the roots of the plant are traditionally used in Mozambique to treat infections such as fevers, diarrhoea, skeletal muscle abscesses, and venereal illness.

Ugandans have long utilised *S. didymobotrya* as a herbal remedy [71]. *S. didymobotrya* has been utilized to cure poultry illnesses in Eastern Uganda [9]. Cattle ailments like helminthiasis and bacterial infections are treated using macerated leaves [28]. The stem of *S. didymobotrya* is highly valued in western Ugandan culture and society, where it is linked to beneficial travel, weeding, and protection from witchcraft [26]. In western Uganda, sixty-seven species were identified in a survey on medicinal plants used to treat bacterial and fungal diseases; *S. didymobotrya* leaves and roots were also employed [27]. Similarly, [71] mentioned using it to treat malaria.

In Kenya, people treat skin disorders with pounded leaves and young stems. On the skin, the pulp is placed [16]. The leaf sap is administered orally, diluted with water, to cure dysentery and diarrhea. In addition, it is used as an emetic, laxative, and diuretic. A decoction prepared from the roots is used to treat livestock for East Coast fever and blackleg, as well as to counteract poisoning and remove a placenta that has been stuck. In Kenya's Central Province, the herb has been used to treat malaria, fungal infections, and STDs [14; 50].

In Kenya's Central Province, a decoction made from the leaves is consumed orally to treat tonsils [47]. Traditional healers among the Embu and Mbeere frequently employ *S. didymobotrya* to cure ringworm and other skin conditions [3]. Their research in Kenya's Central Province revealed candidiasis and ringworm as the most common fungus infections. *S. didymobotrya* was one of the plant species most frequently used in the same survey to treat a variety of skin disorders.

1. *Didymobotrya* has been used as a malaria treatment in the Kenyan counties of Makueni and Samburu [42]. Malaria and gastrointestinal issues are treated using extracts from its fruits and seeds. According to [40], its leaves are also consumed as a vegetable in homes. In the Makueni and Kitui regions, *S. didymobotrya* leaves are used to treat typhoid [73]. *Senna* leaves are used by the Embu and Mbeere people of Kenya to treat ringworms, fungal infections, malaria, and worms in both humans and animals [30].

Additionally, people frequently use S. didymobotrya to treat livestock illnesses. To treat external parasites such as ticks, a decoction produced from the leaves is applied either alone or in combination [46; 18]. The Ameru community has been using leaf and root decoctions to treat cattle for helminthiasis and anaplasmosis [18]. Additionally, it is used in Central Kenyan traditional medicine to treat ear, nose, and throat (ENT) disorders in people. For tonsillitis, a decoction made from the leaves is administered orally [48].

Since *S. didymobotrya* is utilised in many communities for the treatment and preservation of milk, it is known as the "milk tree" [41; 43]. It is believed that applying ash from burned twigs to the inside of gourds intended for milk storage can enhance their palatability and ease of digestion. They can store milk for more than a year [71]. [52] stated that in order to preserve and flavor milk, West Pokot pastoralists peel the bark, dry the stem, and burn it into charcoal.

The leaves of *S. didymobotrya* are utilised as mulch or green manure, and the wood can be used for firewood and handicrafts [69]. In some tea plantations, it is occasionally planted as a shade tree. Fibers can be colored with a variety of plant materials, including flowers, bark, leaves, and pods (yellow, orange, red). Bark is used for tanning and dehairing leather [69]. By encircling the bunch, the leaves are employed to ripen the bananas. Beer mugs are cleaned with the hot ashes.

The Nandi community has utilised *S. didymobotrya* as a purgative to eliminate excess bile and as a cure for skin conditions, gonorrhea, cancer, ringworms, malaria, and emetic ailments. According to [24; 10], it is used as an infusion from the leaves and roots. It is used in the Kipsigis community to treat opportunistic fungal infections, malaria, diarrhea, and skin diseases in humans [7; 33]. [46] have also reported that it is also frequently used to treat cattle infections in Kenya.

The Kisii use a root infusion to treat intestinal worms, jaundice, malaria, and various fevers [37]. Venereal and skeletal muscle disorders are treated with infusions of roots or leaves. In addition, fungal, bacterial, and parasite infections, hypertension, hemorrhoids, sickle cell anemia, inflammation of the fallopian tubes, fibroids, and backaches can all be treated using the plant's stem, leaves, and roots. *S. didymobotrya* is used by women to promote lactation, cause uterine contractions, and cause abortions [37; 71].

According to W. Obambo's personal communication from September 20, 2011, the Luo community in Siaya County believes that the plant is used in witchcraft. According to [57], Africans use S. didymobotrya as an attractive plant due to its vivid yellow blooms and black-green bracts, in addition to its medicinal benefits. Because *S. didymobotrya* grows above ground biomass as ground cover, it has been exploited as a soil improver in nitrogen fixation. It was discovered to have 0.7 g N per 100 g of fresh material in Sri Lanka. It was brought to Peninsular Malaysia, Java, India, and Sri Lanka as a cover crop and green manure [57].

A study conducted by [75] on the root bark of *S. didymobotrya* provided evidence for a potential scientific justification for using it as a biopesticide to protect grains from bean weevils. It is used to preserve milk [41] and control diarrhea in multicultural cities [49]. [61] found in their earlier research that *S. didymobotrya* can induce germination in *Striga* seeds in a manner akin to that of the vulnerable host crops. According to reports, it can reduce Striga infections in fields of maize [61].

Due to its ability to trigger the germination of Striga seeds, it can serve as a trap crop in a rotation with grains [17]. The potential of *Senna* as a crop for green manure and ground cover was emphasized by [69]. In areas where *Erythrina* is not growing, it is utilized as a substitute plant, and its potential as an attractive pot plant is also being investigated [69].

Pharmacognosy and phytochemistry of *Senna didymobotrya*

Senna species are widely used across the globe to treat a variety of illnesses; the plants' therapeutic effects are likely due to the synergistic action of their metabolites. Alkaloids, sterols, glycosides, anthraquinones, tannins, and terpenoids are found in these plants [39]. According to [54], phytochemicals for plants belonging to the Lamiaceae family, which includes *Vitex* species, may be employed as chemotaxonomic markers.

Traditional medicine has demonstrated the usefulness of a variety of pharmacological characteristics found in Senna species. Numerous *Senna* species exhibit significant medical qualities, and some of them yield tannic materials that are highly valuable economically due to their nutritional or medicinal value, toxins, and other pertinent chemical components [19]. It has been observed that anthracene derivatives, either as glycosides or in their free form, are present in about 26 species of *Senna*. Within the genus *Senna*, anthraquinone molecules are found in large quantities as aglycones, glycosides, or dianthrone glycosides. These compounds possess unique biological characteristics.

The genus *Senna* is thought to have hepatoprotective, anti-inflammatory, wound-healing, and purgative qualities. The leaves and pods of S. angustifolia

(Vahl) Batka and S. acutifolia (Del.) yield the anthraquinones known as contact purgatives. They promote peristalsis, which causes soft, bulky feces, and they prevent the colon from absorbing salt and water. According to available studies, rhein has strong purgative properties, but chrysophanic acid-9-anthrone showed strong fungicidal properties. Sennosides come in calcium salt form and are useful when taken orally. The flavonoid compounds found in *Senna* may be responsible for its anti-inflammatory properties [19].

Researchers have discovered that S. didymobotrya leaves and pods contain derivatives of anthraquinones. These included 10 hydroxyl – 10 - (physcion -7'-yl) – 1, 4 – anthraquinone, didyronic acid, chrysophanol, physcion, β-sitosterol, isorhamnetin, rhein, pauentinic acid, torosachrysone, emodin, and knipholone [19]. Aloe emodin, rhein, and trace amounts of dianthrone emodin, dianthrone aloe - emodin, sennoside B, C, and D, catechinic tannins, flavonoids, and aloe emodin B glucoside are among the other chemicals that have been identified from the leaves. It has been discovered that the seeds comprise 6% ash, 24% protein, and 4% oil. [69] reported that *S. didymobotrya* leaves contained the trisaccharide raffinose and choline.

According to [69], anthraquinone derivatives are not well absorbed in the small intestine. However, once in the colon, the bacterial flora hydrolyzes them, reducing them to anthrones, which have the laxative effect of inducing peristalsis. In addition to exhibiting or enhancing ion transport between colon cells, atheroquinones such as emodin also contribute to the laxative effect. In addition, they display additional biological effects such as dieresis, antioxidant qualities, antibacterial and antifungal activity, vasorelaxation, and activation of muscle contractions.

Emodin inhibits the appetite of a variety of creatures, including bees and herbivores [6]. Researchers have reported the presence of flavonoids, anthraquinones, saponins, tannins, and cardiac glycosides [37] and [43]. Additionally, it has been reported that the water extracts from the leaves of *S. didymobotrya* from Kenya included phenols, a steroidal ring (aglycone sections of the glycoside), and a steroidal nucleus (aglycone portion of the glycoside). It was discovered that *S. didymobotrya* leaves lacked anthraquinones, terpenoids, and alkaloids [43]. According to [31], *S. didymobotrya* contains saponins.

We refer to triterpenes and sterols with cardiac depressive and hypertensive qualities as saponins [14]. According to [31], their pharmacological actions were linked to cytotoxicity, anti-tumor, anti-mutagenic, anti-inflammatory, anti-viral, anthelminthic, and cardiac properties. Because of their similarities to substances known as sex hormones, saponins are significant and interesting to pharmacists. It's possible that this is why *S. didymobotrya* is used in abortions [13]. Precursors of saponins have also been discovered in medicinal medications such as cortisone and estrogens used in contraception.

According to [4], saponins prevented sodium ions (Na+) from leaving the cell by blocking their entry, which increased the amount of calcium ions and strengthened the contractions of the cardiac muscles. Alkaloids have been employed as potent pain relievers, anti puretic effects, central nervous system (CNS) stimulants, and topical anesthetics in ophthalmology. According to [14], alkaloids impede cell division, which is why they are used as a cancer treatment.

According to reports, *S. didymobotrya's* leaves and roots contain choline, trisaccharide raffinose, and several anthraquinones. People have used these substances as laxatives because they have stimulant-like sennosides and anthraquinone derivatives, which are used to treat conditions like anxiety attacks, high blood pressure, and heart disease that happened in the past, but stimulants shouldn't be used for those conditions. Research has shown that senna contains fungitoxic qualities [56].

Flavonoids are critical for protecting plants from outside infections, heat, and ultraviolet light, according to studies conducted. They also help with pollination by drawing pollinators, such as insects [53]. It is also in charge of giving fruits and flower petals their color. Because of its limited incidence, it serves as a valuable taxonomic marker.

Flavonoids, according to [55], are potent antioxidants that shield various biological systems from the damaging effects of free radicals. Flavonoids, due to their polyphenolic chemical content, have been associated with a range of pathological conditions such as liver diseases, arthritis, cancer, and cardiovascular disorders [34]. According to Donald and Cristobal's epidemiological study documented by [4], the incidence of heart attacks and coronary heart disease mortality are inversely correlated with the consumption of flavonoids and carotenoids.

Researchers have observed flavonoids, anthraquinones, phenolics, and alkaloids in S. didymobotrya stem bark methanol extracts. Terpenoids, alkaloids, flavonoids, phenols, and anthraquinones were found in dichloromethane extracts of the same [33]. The antibacterial action of *S. didymobotrya* has been attributed to the presence of flavonoids, phenolics, and terpenoids [51].

Plant products generated from flavonoids have been shown to exhibit antimicrobial defense properties [33]. [52] discovered flavonoids and alkaloids in the methanol extracts of stem charcoal that had undergone peeling without the presence of bark. According to [52], the methanol, chloroform, and water extracts contained saponins, sterols, and steroids, while the chloroform and methanol extracts contained condensed and hydrolyzable tannins.

Pharmacology of *S. didymobotrya*

Scientific studies by many different groups of researchers have shown that S. didymobotrya has important biological properties, such as antimicrobial, antibiofilm, antifungal, and antioxidant properties. Plant extracts possess antibacterial activity that can be ascribed to multiple bioactive principles as well as the collective action of other chemicals [70].

Researchers have investigated numerous phytochemicals, such as terpenoids and alkaloids, for their potential antibacterial properties against infectious illnesses. It is also evident that the antimicrobial agents' chemical makeup falls under the most widely occurring classes of secondary metabolites found in higher plants, including phenolic acids, flavonoids, and terpenoids [58].

It may be advantageous to add herbs to a person's diet that are particularly abundant in compounds that can neutralise free radicals [21]. Three categories include the screening techniques now in use for determining if natural compounds have antimicrobial activity: diffusion, dilution, and bioautography [65].

Dilution methods are regarded as quantitative assays once they determine the minimal inhibitory concentration, whereas bioautographic and diffusion methods are referred to as qualitative techniques because they only provide an idea of the presence or absence of substances with antimicrobial activity [72].

In vitro pharmacology

According to reports, S. didymobotrya leaf in vitro cultures can transform chemical compounds into low-energy sweets and pesticides [36]. The authors found that while the root and stem bark extracts did not prove fatal, they did limit the growth of Giardia lamblia in *in vitro* testing. Although it suppresses fever, there has been little observed bioactivity against malaria [71]. [33] examined the antibacterial properties of the stem bark of two medicinal plants—*S. didymobotrya*—that were utilised in Bomet County, Kenya. According to these authors, hexane extracts from the stem bark had no action against Cryptococcus neoformans, *Candida albicans*, *Candida parapsilosis*, *Candida krusei*, or *Trichophyton mentagrophyte*, but were active against *Microsporum gypseum* with 16 mm inhibitory zone widths.

They discovered that *S. didymobotrya* extracts exhibited a wide range of action against isolates of fungi as well as gram positive and grammeme-negative bacteria. In general, extracts performed better on bacterial isolates than on isolates of fungus [33]. Additionally, they stated that when compared to extracts made of water and hexane, those made of *S. didymobotyra* in dichloromethane and methanol had the highest activity.

The water extract had a 10 mm zone of inhibition against Pseudomonas aeruginosa and an 11 mm zone of inhibition against K. pneumoniae. The hexane extracts, on the other hand, had no effect on S. aureus, E. coli, or Klebsiella pneumoniae. It was discovered that the minimal inhibitory concentration of methanol extracts was comparatively moderate to low [33].

A study by [35] in Mozambique on the in vitro antibacterial activity of S. didymobotrya revealed that the methanol extracts exhibited the highest activity. *Enterococcus faecalis*, *P. aeruginosa*, *Mycobacterium smegmatis*, and *S. aureus* were all successfully combated by the extracts. According to [73] while screening of eleven Kenyan medicinal plants from Machakos and Kitui regions, *S. didymobotrya* shown possible antibacterial action against four types of bacterial pathogens: *Bacillus cereus*, *Escherichia coli, Micrococcus lutea*, and *P. aeruginosa*. Gram-positive bacteria were more susceptible to the effects of methanol extracts than Gram-negative bacteria. [52] used the cork and bore diffusion method to measure the antimicrobial activity of *S. didymobotrya* stem charcoal. They found that, with the exception of *Bacillus subtilis*, chloroform extracts did not clearly establish a zone of inhibition against *S. aureus, P. aeruginosa, E. coli*, or *C. albicans*. With the exception of *B. subtillis*, all test microorganisms exhibited a zone of inhibition when exposed to methanol extracts. With a distinct zone of inhibition of 15.3 ± 0.6 mm, *E. Coli* showed the highest level of inhibition, followed by *P. aeruginosa* and *C. albicans*. Either tannins or alkaloids were present to support this action.

In vivo pharmacology of *S. didymobotrya*

1. *didymobotrya* possesses fungicidal, anti-dermatophyte, and anti-fungi static properties. Alkaloids, anthraquinone, diterpenes, and tannin are said to be present [39]. In isolated guinea pig trachea rings, methanol extracts of *S. didymobotrya* have been shown to diminish contractions generated by acetylcholine by half of the relaxation induced by theophylline, a common medication used in respiratory illness therapy [69].

As a result, this characteristic has been critical for bronchodilatation during asthma treatment. At 250 mg/l concentration of leaf extracts, *S. didymobotrya* leaves have been shown to exhibit 100% mortality on young mosquitoes 37; 43].

Dosage, mode of usage, toxicological assessment and precaution / safety for usage of *Senna didymobotrya*

You can make decoctions from all plant parts to use as herbal remedies. Numerous writers have discussed *S. didymobotrya's* toxicity. For example, [33] found that hexane extracts from the bark at high concentrations and high dosages likely to be hazardous relative to lower concentrations and doses in both mouse cells and acute toxicity.

We advise taking herbs at lower doses and concentrations as a precaution due to the poisonous nature of S. didymobotrya dichloromethane (DCM) extract, which killed 80% of mice. The LD50 of the extract was between 1000 and 5000 mg kg-1. They also suggested using margarine, hot water, and milk as antidotes to counteract the toxicity of plants.

Phenetic studies on the genus *Senna*

Numerous studies have been conducted on the genus Senna Mill. For example, a phenetic study conducted in Thailand on *Cassia sensu* lato using 32 vegetative and reproductive floral morphology revealed that *Cassia* s. l. was divided into four groups (*Chamaecrista, Senna alata, Senna* and *Cassia s* / str.) and *Chamaecrista* in cluster analysis. It was discovered that the lengths of the ovary stalk, filament, and fruit distinguished *Senna* and *Cassia* s/ str. as independent taxa. Among the three, *Senna* was said to be a heterogeneous taxon [8].

Thirteen quantitative characteristics of the leaves, fruits, seeds, and flowers were used in a morphometric study of *Senna* in south-western Nigeria. The results showed that the species shared a considerable deal of similarity, which led to their classification under the same genus. Additionally, it demonstrated a closer relationship between *S. sophera* and *S. hirsuta*. There were similarities among *Senna occidentalis, Senna siamea,* and *Senna spectabilis*. *S. sophera* and *Senna occidentalis* were distantly linked [66; 67].

A different study conducted in Bangladesh using 32 vegetative and floral features revealed that *S. obtusifolia* and *S. tora* had the greatest similarities, whereas *S. alata* and *S. hirsuta* showed the greatest diversity [60]. Cluster analysis showed that the UPGMA tree was divided into three main groups. The first group was made up of two species, S. alata and S. auriculata. The second group was made up of four species, S. hirsuta, S. obtusifolia, S. tora, and S. occidentalis. The third group was made up of five species, S. multiglandulosa, S. sophera, S. siamea, and S. surattensis [60].

CONCLUSION

Senna didymobotrya is a botanical treasure that possesses both phenotypic allure and medicinal prowess. Its distinctive aroma and visual appeal make it a prized ornamental plant, while its therapeutic benefits have earned it a revered status in traditional African medicine and garnered scientific interest in modern pharmacology. As research continues to unveil the depth of its pharmacological potential, *Senna didymobotrya* remains a compelling subject for further exploration and utilization in healthcare and beyond.

REFERENCES

[1] Abo KA., Adeyemi AA., and Jadege IA. (2000). Spectrophotometric estimation of anthraquinone content and antimicrobial potential of some extracts of *Senna* species used in herbal medicine in Ibadan. *Science Forum*, *3* (2): 57 - 63.

[2] Abondo A., Mbenkum F., Thomas D. (2000). *Ethnobotany and the Medicinal Plants of the Kerup Rainforest, Cameroon*: Traditional Medicinal Plants. Dar – es - sallam University Press. Ministry of Health - Tanzania.

[3] Adongo S. O., Murungi J. Wanjala R., and Ndegwa F. (2012). Analysis of selected essential elements of medicinal plants used by Chuka community, Tharaka Nithi County, Kenya. *The Scientific Journal of Science and Technology*, Special issue: 87 - 94.

[4] Aja PM., Okaka PN., Onu PN., Ibaim U., Urako AJ (2010). The study focused on the phytochemical composition of Talinum triangure (water leaf) leaves. *Pakistan Journal of Nutrition*, *9* (6): 527 - 530.

[5] Bett S. (2010). Mursik: Indigenous milk preservation technology among Kenya's Kalenjins. Ng'arua Maarifa Center. Article released on 3rd November 2010. Internet: http:// ngaruamain.blogspot.Com / 2010 / 11 / mursik – indigenous – milk - preservation. Html downloaded on 27th September 2013.

[6] Bhadauria S., Kumar P. (2011). Some medicinal plants have demonstrated in vitro antimycotic activity against human pathogenic dermatophytes. *Indian Journal of Fundamental and Applied Life Sciences*, *1* (2): 1 - 10.

[7] Bii C., Ouko TT., and Kumon K. (2003). The medicinal plants used among the Kipsigis community of Kenya and their potential use for management of opportunistic fungal infections. 24th African Health Sciences Congress. Challenges and strategies in combating health problems in Africa, towards development efforts. EHNRI / AU / AFHES / W. H. O, Addis Ababa, Ethiopia. Sept 28 - Oct 2, Abstract 96, p 56.

[8] Boonkerd T., Pechsri S., Baum BR. (2005). A phenetic study of *Cassia* sensu lato (Leguminosae - Caesalpinioideae, Cassieae: Cassiinae) in Thailand. *Plant Systematics and Evolution*, *252*: 153 - 165.

[9] Bukenya-Ziraba R., Kamoga D. (2007). An inventory of medicinal plants used in treating poultry diseases in Jinja district, Eastern Uganda. *African Journal of Ecology*, *45* (Suppl. 3): 31 - 38.

[10] Cherono S., Akoo A. (2011). Kenya: Mursik is not too sweet for plant. Daily Nation, p. 11

[11] Cláudio VJ., Marcos P., Amanda de R., Lidilhone H., Dulce HSS., Vanderlan da S B. (2013). (-) – 7 - Hydroxycassine: a New 2, 6 – Dialkylpiperidin – 3 - ol alkaloid and other constituents isolated from flowers and

fruits of *Senna spectabilis* (*Fabaceae*). *Journal of Brazil Chemical Society*, *24* (2): 230 - 235.

[12] Deduke C., Timsina B., and Piercey - Normore MD. (2012). Effects of environmental change on secondary metabolite production in Lichen - forming fungi. *International perspectives on global environmental change*. Dr. Stephen Young (Ed.), ISBN: 978 – 953 – 307 – 815 - 1, In Tech, Available from: http: // www. Intechopen. Com / books / international – perspectives – on – global – environmental – change / effect – of – environmental – change – on – secondary – metabolite – production – in – lichen – forming - fungi. Downloaded on 28 / 4 / 2014.

[13] Edeoga, HO., Okwu, DE. (2005). Phytochemical constituents of some Nigerian medicinal plants: *African Journal of Biotechnology*, *4* (7): 685 - 688.

[14] Elekwa I., Okereke SC., and Ekpo BO. (2009). Preliminary phytochemical and antimicrobial investigations of the stem bark and leaves of *Psidium guajava* L. *Journal of Medicinal Plants Research*, *3* (1): 045 - 048.

[15] Essilfie MK., Oteng-YYeboah AA. (2013). Morphometric studies of *Clausena anisata* (Willd.) Hook. F. ex. Benth. in Coastal Savanna zone of Ghana. *West African Journal of Applied Ecology*, *21* (1): 1 - 13.

[16] Gachathi F. (1989). *Gachathi F. (1989) published a Kikuyu botanical dictionary of plant names and uses.* Nairobi; Kenya: AMREF.

[17] Gacheru E., Rao M. R. (2005). The potential of planted shrub fallows to combact *Striga* infestation on maize. *International Journal of Pest Management*, *51* (21): 91 - 100.

[18] Gakuubi MM., Wanzala W. (2012). The study conducted a survey on the traditional use of plants and plant products in livestock health management in Buuri district, Meru County, Kenya. *Journal of Ethnobiology and Ethnomedicine*, *8*: 39.

[19] Ganapaty S., Thomas, PS., Ramana KV., Vidyadhar K., Chakradhar, V. (2002). A review of phytochemical studies of *Cassia* species. *Journal of Natural Remedies*, *2* (2): 102 – 120.

[20] Gessler M. C., Harris S A., Prince R J., Olsen A., Odhiambo R., Oketch - Rabah H., Madiega PA., Andersen A., Molgaard, P. (2002). Medicinal plants used by Luo mothers and children in Bondo District, Kenya. *Journal of Ethnopharmacology*, *83*: 39 - 54.

[21] Hakkim L. F., Arivazhagan G., Boopathy F. (2008). Antioxidant property of selected *Ocimum* species and their secondary metabolites content. *Journal of Medicinal Plants Research, 2* (9): 250 - 257.

[22] Harbone JB. (1984). *Phytochemical methods: A guide to modern techniques of plant analysis*, Chapman and Hall Ltd., London.

[23] Humphries JM., Hughes SJ. (2006). Pharmaceutical, nutraceutical, and industrial potential of temperate legumes. *CRC Salinity Bulletin.* No.1.

[24] Jeruto P., Lukhoba C., Ouma G., Mutai C., and Otieno D. (2008). An Ethnobotanical study of medicinal plants used by the Nandi people in Kenya. *Journal of Ethnopharmacology*, *116*: 370 - 376.

[25] Jeruto P. (2009)**.** Ethnobotanical survey, phytochemical analysis, bioassay, and propagation of some endangered medicinal plants from Aldai division, South Nandi district of Kenya. Msc Thesis submitted to Maseno University (Unpublished).

[26] Kakudidi, EK. (2004). Cultural and social uses of plants from and around Kibale National Park, Western Uganda. *African Journal of Ecology*, *42* (Suppl. 1): 114 - 118.

[27] Kamatenesi, Mugisha M., Oryem-Origa H., Olwa-Odyek. (2008). A survey of medicinal plants used in the treatment of fungal and bacterial infections in western Uganda. *Journal of Ethnopharmacology, 115*(1), 124-130.

[28] Kamoga, D. (2010). Some pharmacological activities of selected medicinal plant species used for treating cattle diseases in Kabira sub - county, Rakai District. A dissertation submitted to the School of Graduate Studies for the award of a degree of Master of Science (Botany) of Makerere University.

[29] Kareru PG., Kenji GM., Gachanja AN., Keriko JM., and Mungai G. (2007a). Traditional medicines and healing methods among Embu and Mbeere peoples of Kenya: *African Journal of Traditional, Complementary and Alternative Medicine*, *4* (1): 75 - 86.

[30] Kareru PG., Kenji GM., Gachanja AN., Keriko JM., and Mungai G. (2007b). Traditional medicines among the Embu and Mbeere peoples of Kenya. *African Journal of Traditional, Complementary and Alternative Medicines*, *1*: 75 – 86.

[31] Kareru PG., Keriko JM., Gachanja AN., and Kenji GM. (2008). Direct detection of triterpenoid saponins in medicinal plants. *African Journal of Traditional, Complementary and Alternative Medicines*, *5* (1): 56 - 60.

[32] Kokwaro JO (2009). *Medicinal plants of East Africa*. 3rd Edition. Nairobi, Kenya: University of Nairobi Press; 2009. ISBN 9966 – 846 – 84 - 0.

[33] Korir RK., Mutai C., Kiiyukia C., and Bii C. (2012). Antimicrobial activity and safety of two medicinal plants traditionally used in Bomet district of Kenya. *Research Journal of Medicinal Plant*, 1 - 13. ISSBN 1819 – 3455 / DOI: 10.3923 / rjmp.2012.

[34] Kumar B., Sandhar HK., Prasher S., Tiwari P., Salhan M., Sharma P. (2011). A review of the phytochemistry and pharmacology of flavonoids. *International Pharmaceutica Scientia*, *1* (2): 25 - 41.

[35] Madureira AM., Ratmalhete C., Mulhovo S., Duarte A., and Ferreira M. (2012). Antibacterial activity of some African medicinal plants used traditionally against infectious disesases. *Pharmaceutical Biology*, *50* (4): 484 - 489. ISSN 1388 - 0209 print / ISSN 1744 - 5116 0nline. DOI:10.3109/13880209.2011.615841.

[36] Manda H., Gouagna LC., Foster WA., Jackso RR., Beie JC., Githur, J.I., and Hassanali A. (2007). Effect of discriminative plant-sugar feeding on the survival and fecundity of *Anopheles gambiae*. *Malaria Journal*, *6*: 113.

[37] Maobe MA., Gatebe E., Gitu L., and Rotich H. (2013). Preliminary phytochemical screening of eight selected medicinal herbs used for the treatment of diabetes, malaria and pneumonia in Kisii region, Southwest Kenya. *European Journal of Applied Sciences*, *5* (10): 1 - 6.

[38] Marazzi B., Endress KP., de Queiroz LP., Conti E. (2006). Phylogenetic relationships within *Senna* (Leguminosae, Cassiinae) are based on three chloroplast DNA regions: patterns in the evolution of floral symmetry and extrafloral nectaries. *American Journal of Botany*, *93* (20): 288 - 303.

[39] Mazumnder PM., Percha V., Farswan M., and Upaganlawer A. (2008). *Senna*: A wonderful gift of medical sciences. *International Journal of Community Pharmacy*, *1* (2): 17 - 38.

[40] Mbuvi D., Boon E. (2009). The livelihood potential of non-wwood forest products: The case of Mbooni division in Makueni district, Kenya. *Environment Development Sustainability*, *11*: 989 - 1004. DOI 10. 1007 / s10668 - 008 - 9163 - 2. Springer.

[41] Mureithi W., Biggelaar-DDen C., Wesakania EW., Kamau K., Gatundu C. (2000). Management of trees used in *mursik* (fermented milk) production in Trans - Nzoia District, Kenya. *Journal of Ethnobiology*, *20* (1): 75 - 91.

[42] Nanyingi O., Mbaria M., Lanyasuya L., Wagate G., Koros B., Kaburia F., Munenge W., and Ogara O. (2008). Ethnopharmacological survey of Samburu district, Kenya. *Journal of Ethnobiology and Ethnomedicine*, *4*: 14.

[43] Ngule CM., Swamy TA., and Obey JK. (2013). Phytochemical and bioactivity evaluation of *Senna didymobotrya* Fresen Irwin used by the Nandi community in Kenya. *International Journal of Bioassays*, *2* (7): 1037 - 1043.

[44] Njoroge GN., Bussmann RW. (2007). Ethnotherapeutic management of skin diseases among the Kikuyus of the Central Province of Kenya. *Journal of Ethnopharmacology*, *11*: 303 - 307.

[45] Njoroge GN., Bussmann RW., Gemmill B., Newton EL., Ngumi W. (2004). Utilisation of weed species as sources of traditional medicines in Central Kenya. *Lyonia a Journal of Ecology and Application*, *7* (2): 71 - 87.

[46] Njoroge GN., Bussmann RW. (2006a). The study focused on the use of herbs and the consensus among informants in the ethnoveterinary management of cattle diseases among the Kikuyus in Central Kenya. *Journal of Ethnopharmacology*, *108* (3): 332 - 339.

[47] Njoroge GN., Bussmann RW. (2006b). Diversity and utilisation of antimalarial ethnophytotherapeutic remedies among the Kikuyus (Central Kenya). *Journal of Ethnobiology and Ethnomedicine*, *2*: 8.

[48] Njoroge GN., Bussmann RW. (2006 c). Traditional management of ear, nose, and throat (ENT) diseases in Central Kenya. *Journal of Ethnobiology and Ethnomedicine*, *2*: 54 - 62.

[49] Njoroge GN., Kibunga JW. (2007). Herbal medicine acceptance, sources, and utilization for diarrhoea management in a cosmopolitan urban area (Thika, Kenya). *African Journal of Ecology*, *45* (suppl.1): 65 - 70.

[50] Njoroge GN., Bussmann RW. (2009). Ethnotherapeutic management of sexually transmitted diseases (STDs) and reproductive health conditions in Central Province of Kenya. *Indian Journal of Traditional knowledge*, *8* (2): 255 - 261.

[51] Nostro A., Germano MP., D'Angelo V., Marino A., Cannatelli MA. (2000). Extraction methods and bioautography for the evaluation of medicinal plant antimicrobial activity. *Letter Applied Microbial*, *30*: 379 - 384.

[52] Nyaberi MO., Onyango CA., Mathoko FM. Maina JM., Makobe M., and Mwaura F. (2013). Bioactive fractions in the stem charcoal of *Senna didymobotrya* Freasen Irwin and Barney used by pastoral communities in West Pokot to preserve milk. *Natural Resource Management*: 16: 980 - 985.

[53] Nyananyo BL., Mensah SI., and Achama C. (2010). Phytochemical investigations of some tropical plants from the Niger Delta area of Nigeria. *Scientia Africana*, *9* (1): 173 - 177.

[54] Ochieng CO., Ishola IO., Opiyo SA., Manguro LAO., and Owuor PO. (2012). Phytoecdysteroids from the stem bark of *Vitex doniana* and their anti - inflammatory effects. *Planta Medica*, *79*: 52 - 59.

[55] Ochieng CO., Nandwa BO. (2010). Proximate composition, phenolic content, and antioxidant activities of three black plum (*Vitex* sp.) fruits: Preliminary Results. *Journal of Food Technology 8* (3): 118 - 125.

[56] Ogberbor N., Adekunle AT. (2005). The study focused on the inhibition of conidial germination and mycelia growth of Corynespora cassiicola (Berk and Curt) in rubber (Hevea brasiliensis Muel. Arg.) using extracts from various plants. *African Journal of Biotechnology*, *4* (9): 996 - 1000.

[57] Orwa C., Mutua A, Kindt R., Jamnadass R., Simons A. (2009). Agroforestree Database: a tree reference and selection guide version 4.0 (http: // www. worldagroforestry. org / sites / treedbs / treedatabases. asp) downloaded on 7 / 10/10.

[58] Osamu T. (1990): Ginseng saponins from *Panax* species*. Pure and Appllied Chemistry*, *62* (7): 1281 - 1284.

[59] Patil SM., Saini R. (2012). The study examined the antimicrobial activity of flower extracts derived from Calotropis gigantean. *International Journal of Pharmaceutical and Phytopharmacological Research*, *1* (4): 142 - 145.

[60] Rahman MO., Zahidur R., Begum A. (2013). The study focuses on the numerical taxonomy of the genus Senna Mill., specifically in Bangladesh. *Bangladesh Journal Plant Taxonomy*, *20* (1): 77 – 83.

[61] Rao, M. R., and Gacheru, E. (1998). Prospects of agroforestry for *Striga* management. *Agroforestry Forum*, *9* (2): 22 - 27.
[62] Rehm S. (1994). A multilingual *dictionary of agronomic plants*. Kluwer Academic Publishers, Netherlands.

[63] Reyes-GGarcía V., Marti N., McDade TW., Tanner S., Vadez V. (2007). Concepts and methods in studies measuring individual ethnobotanical knowledge. *Journal of Ethnobiology 27*: 108 - 203.

[64] Samie A., Tambani T., Harshfield E., Green E., Ramalivhana JN., and Bessong PO. (2010). Antifungal activities of selected Venda medicinal plants against *Candida albicans*, *Candida krusei* and *Cryptococcus neoformans* isolated from South African AIDS patients. *African Journal of Biotechnology*, *9* (20): 2965 - 2976.

[65] Smania-Jr. A., Valgas C., Machado de Souza S., Smania EFA. (2007). methods to determine antibacterial activity of natural products. *Brazilian Journal of Microbiology, 38*: 369 - 380.

[66] Soladoye MO., Onakoya MA., Chukwuma EM., Sonibare MA. (2010 a) Morphometric study of the genus *Senna* Mill. in south-western Nigeria. *African Journal of Plant Science*, *4* (3): 044 - 052. ISSN 1996 - 0824. Http: // www. academicjournals. org / ajps. *Academic Journals*.

[67] Soladoye MO., Sonibare MA., Chukwuma EC. (2010 b). Morphometric study of the genus *Indigofera* Linn. (Leguminosae, Papilionoideae) in South - Western Nigeria. *International Journal of Botany*, *6* (3): 343 - 350.

[68] Soladoye MO., Onakoya MA., Chukwuma EM., Sonibare MA. (2010 a) Morphometric study of the genus *Senna* Mill. in south-western Nigeria. *African Journal of Plant Science*, *4* (3): 044 - 052. ISSN 1996 - 0824. Http: // www. academicjournals. org / ajps. *Academic Journals*.

Sunarno B. (1997) [69] *Senna didymobotrya* (Fresenianus) Irwin & Barneby. In Faridah Hanum, I. and van derMaesen, L. J. G. (Eds.): *Plant Resources of South - East Asia*. No. 11. Auxillary Plants. Prosea Foundation, Bogor, Indonesia: 229 – 231.

[70] Sunayana V., Vadivukkarasi P., Rajendran A., Xavier T.F., Natarajan E. (2003). The study examined the antibacterial potential of Plectranthus amboinicus (Lour) Spreng. A study *in vitro. Journal of Swamy Botanical Club*, *20*: 55 - 58.

[71] Tabuti JRS., Kukunda CB., Kaweesi D., Kasilo OMJ. (2012). The study examined the use of herbal medicine in the districts of Nakapiripirit, Pallisa, Kanungu, and Mukono in Uganda. *Journal of Ethnobiology and Ethnomedicine*, *8*: 35.

[72] Vanden Berghe DA., Vlietinck AJ. (1991). The study focused on screening methods for antibacterial and antiviral agents from higher plants. In: Dey, P.M., Harbone, J.D. (eds), Methods in Plant Biochemistry, Academic Press, London, p. 47-69.

[73] Wagate CG., Mbaria MJ., Gakuya DW., Nanyingi MO., Kareru PG., Njuguna A., Gitau N., Macharia JK., Njonge F. (2012). The study involved screening some Kenyan medicinal plants for antibacterial activity. *Phytotherapy Research*, *24*: 150 - 153. Wiley InterScience.

[74] World Health Organisation (WHO). (2002). WHO *Traditional Medicine Strategy 2002 - 2005*.World Health Organization, Geneva, WHO/EDM/TRM/2002.1.

[75] Mining, JK. (2008). Bioactive metabolites of selected Kenyan plants used as biopesticides against *Acanthoscelides obtectus* in Bungoma district Kenya. Unpublished MSc Thesis submitted to Jomo Kenyatta University of Agriculture and Technology library; SB 951.145M56.