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Review Article

Ethnopharmacology, phytochemistry and biological activities of selected African species of the genus *Ficus*

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ABSTRACT

The genus *Ficus* is one of the largest genera of the mulberry family (Moraceae) consisting of about 800 species of woody trees, shrubs, vines and climbers collectively known as 'figs' occurring in most tropical and subtropical forests worldwide. Fig plants are known for their ethnopharmacological, therapeutic and commercial importance and have been used in traditional medicines as a cure against malaria, diabetes, cancer, diarrhea, pyretic, ulcer, as well as gastrointestinal and urinary tract infections. Therefore, the present review aims to offer an updated compendium of documents sourced from recent publications regarding ethnopharmacology, phytochemistry and biological activities of nine selected African *Ficus* species with the aim to open new prospects and strategies for further pharmacological research as a remedy for various ailments and for drug development.

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1. Introduction

Medicinal plants play a significant role in the discovery of new medications and expansion of existing plant drug sources (Bindu et al., 2016). In the food, fragrance, and cosmetics industries, they have also been proven effective and beneficial (Mohammadhosseini et al., 2019; Frezza et al., 2020). About seventy-four percent of the 121 therapeutically active plant-derived phytochemicals currently in use around the world were established after more research has been done to substantiate their ethnomedicinal usage. However, medicine systems are poorly documented even up till now. Unfortunately, due to the rapid loss of natural habitats of some of these plants as a result of anthropogenic activity, recording of therapeutic importance of African species is becoming increasingly important (Gurib-Fakim 2006). Research papers from scientific literatures have revealed the efficacy of medicinal plants from Africa, which are thought to play an essential role in the preservation of health and the introduction of new treatments (Mahomoodally, 2013). In spite of this, there is a paucity of updated comprehensive compilations of promising medicinal plants from Africa.

The angiosperm genus *Ficus* L. (commonly known as the figs) belongs to the Moraceae (Mulberry or Fig) family and is native throughout the tropics and the subtropics with a few species extending into the semi-warm temperate zone (Somashekhar and Mahesh 2013). It is a large genus with about 800 species spread globally (Berg and Corner, 2005) including trees, shrubs, vines, climbers, epiphytes, and hemi-epiphytic stranglers, of which 120 species are found in the Americas, 105 species in Africa (Arabian Peninsula, Indian Ocean Islands including Madagascar), and 367 species occurring through the Asian-Australasian region (Berg

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and Corner, 2005) making it the world's most diverse woody plant genus (Corner, 1988). Approximately 755 species have been estimated, with about 511 species in Asia, Malaysia, Pacific Island and Australia, 132 species in Central and South America and 112 in Africa, South of Sahara and Madagascar (Van Noort and Rasplus, 2004-2012).

Species of this genus are known for their large quantities of latex in the bark, leaves and branches. Hood-like stipules covering new buds at the twig tips, ring scars on their twigs left by the stipules that have fallen off, and a specialized reproductive structure known as the Syconium are common features in them (Burrows and Burrows, 2003). These latex-like materials within their vasculatures are responsible for protection and self-healing potential of plant species in this genus (Berg and Hijman, 1989).

Plants of the genus *Ficus* comprise many varieties, notable generic diversity, and exceptional pharmacological activities (Woodland, 1997) which have been used traditionally against an array of human and animal diseases related to digestive, respiratory, endocrine, reproductive systems and also a cure for gastrointestinal and urinary tract infections (Badgujar et al., 2014).

This review article provides an appraisal in a concise manner regarding the ethnopharmacology, phytochemistry and biological activities of nine selected African species from the genus *Ficus*. These nine species are found in Africa (Table 1) and have been extensively reported in literature when this review was prepared.

2. Methodology

Literature used in this review article was sourced from several electronic databases including Google, Google Scholar, PubMed, Medline and Research Gate using the search terms: *Ficus* genus, figs, fig trees, species of *Ficus*, classification and distribution of the *Ficus*, ethnopharmacology, ethnomedicinal uses, phytochemistry and bioactivity. The search terms yielded more than 300 publications accessible online.

3. Botanical description of the selected African *Ficus*

3.1. *F. carica*

F. carica plant is a bush or small tree, from 1 to 12 m (3-39 ft.) high, with broad, rough, deciduous leaves that are deeply lobed or sometimes nearly entire. The leaves and stems exude white latex when broken. Its fruits, known as syconia, are borne singly or in pairs above the scars of fallen leaves. Flowers are staminate (male) or pistillate (female) and enclosed within the inflorescence structure. *F. carica* is generally a shallow, fibrous-rooted species; however, depending upon the soil conditions, the roots may spread laterally and vertically. The lenticels become corky, rough and darker with increasing age. The length of the internode increases towards the median part of the shoot. The young twigs are commonly glabrous and brownish to green, but quickly change to grey as the branches age (Condit, 1947; Ferguson et al., 1990; Datiles, 2015; Britannica, 2021).

3.2. *F. elastica*

F. elastica is commonly known as rubber fig or rubber tree. *F. elastica* is an epiphyte plant which grows on the branches of various tropical tree species and develops aerial blastogenic roots that penetrate the soil. The aerial part of these roots becomes trunkish 'strangling' the host tree. In cultivation, it often develops an extensive surface root system. It has many trunks and smooth bark of dark pale grayish color. They are usually droop or rarely upright, slightly exfoliated having an initial greenish brown color which when mature becomes greenish gray. The leaves are large, simple and leathery, green in color, relatively thick, acuminate at apex and have a round base with their shape elongated, ovoid or elliptic, mainly arranged alternately, their length being between 8 and 30 cm (3.1-12 in) and their width between 5 and 15 cm (2-6 in). Their petioles are leathery, yellowish-brown to black and have a length of 2.5 to 5 cm (1-2 in). The flowers are produced in the interior of an axillary inflorescence and they have a creamy white color while fruits of *F. elastica* are within the fleshy stem (Kunkel, 1978; Hamilton, 1991; Burrows and Burrows, 2003; Bajaj, 2010).

3.3. *F. exasperata*

F. exasperata, commonly called sandpaper fig tree or white fig tree, is a terrestrial afro-tropical shrub or small tree with scabrous, with ovate leaves that grows up to about 20 m and prefers evergreen and secondary forest habitats. Leaves (3-20 × 2-12 cm) are distichous, alternate, ovate to elliptic, subcoriaceous to coriaceous, apex shortly acuminate. Leaves base are acute to obtuse, upper surface scabrous having a very rough surface, making them look like sand paper. Veins are lateral with 3-5 pairs and has basal pair branched reaching margin at or above middle of the lamina. Petiole and stipules are 0.5-4 cm and 0.2-0.5 m long respectively. Flowers are unisexual and pink, purplish or yellow, that becomes orange or red at maturity (Berg, 1989; Berg and Wiebes, 1992; Ahmed et al., 2012).

3.4. *F. glumosa*

F. glumosa known as hairy rock fig, or mountain rock fig, is a shrub or tree that grow to about 12 m with a trunk of about 2 m of girth. The leaves are ovate, sometimes almost round 2-14 × 2-9 cm, its base are cordate and hairy (especially on lower leaf surface) to glabrous. The Figs are in pairs in leaf axils or just below the leafy part, sessile or on tiny stalks. The branches are mostly horizontal and widely spread, which are often supported by stilt roots (Beentje and Mbago, 2007; Benjamin, 2016).

3.5. *F. ingens*

F. ingens known as red-leaved fig or red-leaved rock

Table 1
Distribution of nine selected African *Ficus* species.

Plant species	Distribution
F. carica L.	**Native:** Afghanistan, Cyprus, Greece, Iran, Iraq, Kriti, Lebanon-Syria, Palestine, Tadzhikistan, Transcaucasus, Turkey, and Turkmenistan. **Introduced in:** Alabama, Albania, Algeria, Andaman Is., Arkansas, Austria, Azores, Baleares, Bangladesh, Bermuda, Bulgaria, California, Canary Is., Cape Verde, Chad, China North-Central, China South-Central, China Southeast, Corse, Czechoslovakia, East Aegean Is., Easter Is., Ecuador, Egypt, El Salvador, Eritrea, Florida, France, Great Britain, Gulf of Guinea Is., Gulf States, Hungary, India, Italy, Juan Fernández Is., Korea, Krym, Libya, Madeira, Masachusettes, Mauritius, Mexico Central, Mexico Southwest, Morocco, New Mexico, New York, New Zealand North, New Zealand South, Nicobar Is., Niger, Norfolk Is., North Carolina, Oman, Peru, Portugal, Réunion, Sardegna, Saudi Arabia, Sicilia, Sinai, Somalia, South Carolina, Spain, Switzerland, Tokelau-Manihiki, Tristan da Cunha, Tunisia, Turkey-in-Europe, Uzbekistan, Western Sahara, Xinjiang, Yemen, and Yugoslavia.
F. elastica Roxb. ex. Hornem	**Native:** Assam, Bangladesh, China South-Central, East Himalaya, Jawa, Laos, Malaya, Myanmar, Nepal, Sumatera, Thailand, and Vietnam. Introduced in: Andaman Is., Bahamas, Cameroon, Cuba, Dominican Republic, Ecuador, El Salvador, Florida, Gambia, Gulf of Guinea Is., Haiti, Jamaica, Juan Fernández Is., Leeward Is., Mauritius, Mexico Southwest, New Caledonia, New Guinea, Nicobar Is., Peru, Puerto Rico, Réunion, Sicilia, Spain, Sri Lanka, Trinidad-Tobago, Venezuela, Venezuelan Antilles, and Windward Islands.
F. exasperata Vahl	**Native:** Angola, Benin, Burkina, Burundi, Cameroon, Central African Repu, Congo, Djibouti, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf of Guinea Is., India, Ivory Coast, Kenya, Liberia, Malawi, Mali, Mozambique, Nicobar Is., Nigeria, Rwanda, Senegal, Sierra Leone, Sri Lanka, Sudan, Tanzania, Togo, Uganda, Yemen, Zambia, Zaïre, and Zimbabwe.
F. glumosa (Miquel) Delile.	**Native:** Angola, Benin, Botswana, Burkina, Burundi, Cameroon, Central African Republic, Chad, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, KwaZulu-Natal, Malawi, Mali, Mozambique, Namibia, Nigeria, Northern Provinces, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zaïre, and Zimbabwe.
F. ingens (Miquel) Miquel	**Native:** Algeria, Benin, Botswana, Burkina, Burundi, Cameroon, Cape Provinces, Central African Republic, Chad, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Kenya, KwaZulu-Natal, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Northern Provinces, Oman, Rwanda, Saudi Arabia, Senegal, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zaïre, and Zimbabwe.
F. lutea Vahl	**Native:** Aldabra, Angola, Benin, Burkina, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf of Guinea Is., Ivory Coast, Kenya, KwaZulu-Natal, Liberia, Madagascar, Malawi, Mali, Mozambique, Nigeria, Oman, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, Swaziland, Tanzania, Togo, Uganda, Zambia, Zaïre, Zimbabwe. **Introduced in:** Chagos Archipelago, El Salvador, Puerto Rico, and Trinidad-Tobago.
F. sur Forssk	**Native:** Angola, Benin, Botswana, Burkina, Burundi, Cameroon, Cape Provinces, Cape Verde, Caprivi Strip, Central African Republic, Chad, Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf of Guinea Islands., Ivory Coast, Kenya, KwaZulu-Natal, Liberia, Malawi, Mali, Mozambique, Namibia, Nigeria, Northern Provinces, Rwanda, Senegal, Sierra Leone, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zaïre, and Zimbabwe.
F. sycomorus L.	**Native:** Angola, Benin, Botswana, Burkina, Burundi, Cameroon, Cape Provinces, Cape Verde, Caprivi Strip, Central African Republic, Chad, Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf of Guinea Is., Ivory Coast, Kenya, KwaZulu-Natal, Liberia, Malawi, Mali, Mozambique, Namibia, Nigeria, Northern Provinces, Rwanda, Senegal, Sierra Leone, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zaïre and Zimbabwe.
F. thonningii Thume	**Native:** Angola, Benin, Botswana, Burkina, Burundi, Cameroon, Cape Provinces, Cape Verde, Caprivi Strip, Central African Republic, Chad, Congo, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf of Guinea Islands., Ivory Coast, Kenya, KwaZulu-Natal, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Northern Provinces, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zaïre, and Zimbabwe.

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fig is a semi-evergreen tree with a briefly deciduous period, up to 10 m, occasionally higher, with a rounded or spreading crown and with a spread of up to 30 m wide. The heart-shaped or lanceolate, dull green leaves are hairless and leathery, with conspicuous yellow veins running parallel from the midrib and loping along the margin with three distinct veins at the base, up to 165 mm long and 85 mm wide. New leaves are coppery or reddish and later turn green. Stalked fruit or small figs are borne in pairs or singly in the leaf axil or on bare stems below the leaves. The smooth bark is pale grey, while younger branches have a yellow tinge. Fruits are white at first, becoming pink, red or purple when mature and are soft and fleshy (Mogg, 1975; Palmer, 1977; Jordaan, 2005).

3.6. *F. lutea*

F. lutea, also called giant leaved fig, is a large briefly-deciduous tree, capable of growing to 25 m. Its large spreading crown can span 30-45 m in width. The bark is relatively smooth-textured and dark grey to brown in color. Branches may be finely hairy when young, becoming smooth with age. The smooth glossy leaves are very large in size and quite distinctive, ranging from 130 to 430 mm in length and up to 200 mm in width. They are held towards the ends of the branches, are ovate to elliptic or obovate and exhibit clear yellow veining. The attractive bronze stipules effectively sheath the terminal buds. The leaf margins are entire and the stout leaf stalks measure from 25 to 150 mm in length. The syconia ('fruits') are crowded towards the ends of the branchlets in the leaf axils or below the leaves. They measure 15 to 30 mm in diameter, are sessile (stalkless) and are densely hairy. Although exhibiting many distinctive characters, *F. lutea* can superficially resemble *F. trichopoda* (swamp fig) with which there is some distribution overlap. The latter is distinguished in having 7 to 11 pairs of lateral veins in the leaves as opposed to the 6 to 8 evident in *F. lutea* (Coates, 2002; Burrows and Burrows 2003; Jan-Hakon, 2004).

3.7. *F. sur*

F. sur, with the common names as broom cluster fig, cape fig and bush fig, is a fast-growing deciduous or evergreen tree with a large and spreading crown that is stabilized on the typically fluted trunks and buttressed roots. It usually grows from 5-12 m (16-39 ft) in height but may attain a height of 35-40 m (115-131 ft). It is characterized by white latex in severed parts of the plant, including in buds, leaves, petioles, fruit stalks, barks, branches and branchlets. Interestingly, the fruits' stalks are particularly rich in the white latex. The trunk is often short (especially where branching begins early in the tree's life cycle) and is firmly buttressed. Bark can be brownish, grayish or whitish externally but the slash is greenish to pink. The spirally-alternate leaves are simple, somewhat grayish-green in color.

F. sur is cauliflorous and its inflorescences are figs. Figs are globular to oblong-ovoid fleshy receptacles which contain the sessile male, female and gall flowers. These flowers are unisexual and are accessed by wasps through an opening called ostioles. The figs occur on stems, branches, and leafless branchlets or in leaf axils. They are densely tomentose and develop as green globular fruits which turn to orange or orange-red as they ripen. Ripe figs are edible, but are full of the wasps (e.g., the Ceratosolen wasps) that pollinated the long female flowers and laid their eggs in the ovules (Palgrave, 1984; Von Breitenbach, 1985; Hankey, 2003; Negash, 2021).

3.8. *F. sycomorus*

F. sycomorus also called sycamore fig or common cluster fig or mulberry fig, is a semi-deciduous tree, up to 35 m tall. The branches start from the lower parts of the stem and make shapes like umbrellas. Bark on young branches is covered with long hairs, greenish yellow, but pale brown to yellowish brown and flaking in papery strips on older branches and stems. The main trunk sometimes grows to more than 2 m in diameter. The leaves are heart-shaped, spirally arranged and about 10 to 14 cm long. The leaves are dark green with yellow veins, base lobed, leaf tip rounded, veins raised on lower surface and leaves are rough to the touch. The 20-30 mm long leaf stalks are hairy on young leaves but become glabrous in older leaves. Figs are in close-packed clusters on many-branched, fruit-bearing branchlets, nearly round, 20-50 mm in diameter and yellowish red to red when ripe, with 25-35 mm long stems. Milky latex is in all parts of the tree. The fruit is round-shaped and has high nutritive value. The fruit is green and is about 2 to 3 cm in diameter. Several hundreds to thousands of seeds are present in the fruit and it is very tasty. Sometimes, the bark is green, but other times it is yellow with white latex. (Singh et al., 2011; Weli et al., 2015; Cathbert, 2019).

3.9. *F. thonningii*

F. thonningii is an evergreen tree of 6-21 m height, with a rounded to spreading and dense crown. Bark on young branches is hairy with a stipular cap covering the growth tip, but smooth and grey on older branches and stems. The whole plant exudes copious, milky latex often turning pinkish. Leaves are simple, glossy, dark green, thin and papery or slightly leathery, margin smooth, elliptic or obovate. Figs in leaf axils, sometimes below the leaves enclosing many small flowers, are mostly hairy and borne in the leaf axils, sessile or on peduncles to 10 mm long (Orwa et al., 2009).

4. Ethnopharmacology of the selected African *Ficus*

Different organs of *Ficus* plants including bark, leaf, twigs and roots possess ethnopharmacological values, and have been used traditionally as a source of food and medicine.

4.1. Stem bark

Ficus carica stem bark is used as a medicine for gastrointestinal (colic, indigestion, loss of appetite, and diarrhea), respiratory (sore throats, cough, and bronchial problems), inflammatory and cardiovascular disorders (Burkill, 1935; Penelope, 1997). *F. exasperata* stem bark decoction is used in the treatment of malaria, worms, hemorrhoids, abnormal enlargement of the spleen, heart problems, cough, dizziness and its sap is used for the treatment of wounds, sores, abscesses, eye ailments and stomach-ache (Neuwinger, 2000). In central Africa and Tanzania, the powdered bark of *F. glumosa* mixed with latex is used to treat dental caries; a decoction of the bark is used as mouth wash against toothache, also applied topically against headache, and bark macerate is applied to the eyes to prevent conjunctivitis in newborn. In Nigeria, the stem bark of *F. glumosa* was also used for rheumatism (Abubakar et al., 2007). A decoction of the bark of *F. lutea* is useful in the treatment of stomach disorders, dysentery, sterility, and colds (Von Maydell, 1990). A decoction of *F. sur* bark has been used as a galactogogue in women and cows and to prevent vomiting in West Africa, by traditional doctors (Kunle et al., 1999). Water extract of powdered stem bark of *F. sycomorus* has been reported as an analgesic or for the treatment of ailments, such as mental illness, wound dressing, and diarrhea (Sandabe and Kwari, 2000). The infusion of pounded stem bark of *F. thonningii* is used for treating influenza, sore throat, colds, arthritis, rheumatism, inflammation, emphysema, diarrhea, cyst, ulcers, infertility, irregular menstrual cycle, constipation, and bowel disorder (Teklehaymanot and Gidday, 2007; Orwa et al., 2009; Prelude medicinal plants database, 2011).

4.2. Fruit

Ficus carica fruits (fresh or dry) are edible and consumed as food, and also for the treatment of inflammations, paralysis, liver diseases, chest pain, piles, leprosy, nose bleeding, and as an antipyretic, aphrodisiac, lithontriptic, hair-nutritive, emollient, demulcent and laxative (Duke et al., 2002; Shukranul *et al*., 2013). The fruits of *F. exasperata* are eaten as a treatment for cough and venereal diseases while powdered dried fruits are added to porridge for the treatment of sterility in women (Neuwinger, 2000). In Senegal and Ivory Coast, the fruits are used in preparations to cure female sterility (Jasen, 2005). Ground *F. sur* fruit is used to treat typhoid fever (Faleyimu et al., 2010) and finally, the fruits of *F. sycomorus* have been reported to treat fungal infections, jaundice, and dysentery (Hassan et al., 2007).

4.3. Latex

Latex from *F. carica* is used as expectorant, diuretic, anthelmintic, anemia and as a curdling agent in the production of extremely well-known milk product like cheese by several indigenous communities (Badgujar et al., 2014). In Zimbabwe, the *F. glumosa* latex is diluted with water and used to treat diarrhea (Hamidu et al., 2017). Also, *F. ingens* latex is used as a substitute disinfectant for iodine and for wound healing (Von Maydell., 1990). Latex of *F. sur* has been used in Zaire, for the treatment of burns (Burkill, 1985). Latex of plants in *Ficus* genus is generally applied externally on wounds to reduce inflammation, pain, edema and enhances its healing (Bhalerao, 2014). Latex from *F. thonningii* has been used for treating fever, tooth decay, ringworm, cataract and as vermifuge and galactogogue (Alawa et al., 2002; Arbonier, 2004; Mali and Mehta, 2007).

4.4. Leaves

Leaves of *F. carica* are used ethnopharmacologically to treat various ailments such as gastrointestinal (colic, indigestion, loss of appetite, and diarrhea), respiratory (sore throats, coughs, and bronchial problems) and cardiovascular disorders. They are also used as anti-inflammatory and antispasmodic agents (Duke *et al*., 2002; Shukranul *et al*., 2013). *F. elastica* leaves extract is used for the treatment of skin allergies, skin infection, anemia, neurodegenerative disorders and as a diuretic agent (Kim, 2012). *F. exasperata* leaves pulp or sap is externally applied for the treatment of rash, wounds, leprous sores, fungal infections, itching, edema, ringworm, rheumatism, gastric ulcer, urinary tract and kidney disease, high blood pressure, cough, colds, flu, asthma, gum inflammation, throat ailments, lumbar and intercostal pain (Neuwinger, 2000). Leaves of *F. glumosa* are used to treat skin diseases and diabetes (Madubunyi et al., 2012). *F. ingens* leaves are used to treat malaria and are taken as a tonic (Achigan-Dako et al., 2010). Leaves of *F. sur* when chewed and swallowed three times per day for approximately six weeks are claimed to act as a remedy for peptic ulcer by people in the middle-belt region of Nigeria (Kunle et al., 1999). Macerations of fresh leaves of *F. thonningii*, taken orally, have been used by traditional healers for treating diarrhea, gonorrhea, diabetes mellitus, stomach pains, gastritis, gastric ulcers, bronchitis, urinary tract infections and other stomach conditions in human and animals (Cousins and Huffman, 2002; Njoronge and Kibunga, 2007).

4.5. Roots

Ficus carica roots have been used to treat colic, indigestion, diarrhea, sore throats, coughs, bronchial problems, inflammatory, cardiovascular disorders, ulcerative diseases and cancers (Rubnov et al., 2001; Gilani et al., 2008). Root decoctions of *F. exasperata* are taken for treatment of urinary tract ailments, gonorrhea, asthma, cough, tuberculosis, and eye problems. In animal, it is used to hasten expulsion of the afterbirth (Neuwinger, 2000). In Senegal and Ivory Coast, the roots are used in preparations to cure female sterility (Jasen, 2005). In northern part of Nigeria, the fresh young aerial root of *F. sur* along with the inner bark is chewed with kolanut to alleviate thirst and to treat sore throat (Kunle et al., 1999). The roots of *F. thonningii* are used for treatment of malaria, fever, hepatitis, miscarriages, nose bleeding, stomach pains, pneumonia, chest pain and dental pain (Njoronge and Kibunga, 2007; Teklehaymanot and Gidday, 2007; Prelude medicinal plants database, 2011).

5. Phytochemistry

The phytochemistry of the genus *Ficus* has been extensively studied revealing the presence of various types of chromones, coumarins, flavonoids, glycosides, pigments, polyphenols, terpenoids, hydrocarbons and other secondary metabolites in different parts of the plants (Table 2). Some of these phytochemicals have been responsible for their medicinal potentials and pharmacological properties and provided evidence in support of ethnopharmacological uses of the genus *Ficus*.

5.1. Anthocyanins

Anthocyanins are most known for their antioxidant activity, by scavenging free radicals or metals that could generate such radicals. The completely conjugated structure of anthocyanins allows electron delocalization, resulting in a very stable radical scavenging product, which is favorable in terms of antioxidative ability (Kahkonen and Heinonen, 2003). Several studies have found a positive link between anthocyanins and health-promoting properties, mostly in *in vitro* and animal studies. Structure-antioxidant activity relationships have been strongly demonstrated by earlier researchers (Rice-Evans et al., 1996; Azuma et al., 2008). Anthocyanins have additionally been associated with antidiabetic by activation of AMP-activated protein kinase (AMPK) (Takikawa et al., 2010), anti-inflammatory by down regulation of cyclooxygenase (COX)-2 (Pereira et al., 2017), and neuroprotective properties by improving the glutamatergic neurotransmission (Shah et al., 2015), as well as the prevention and improvement of cardiovascular disease by increasing the superoxide dismutase antioxidant activity (Wang et al., 2017). Cyanidin **(1)** and pelargonidin **(2)** derivatives have been isolated from the fruits of *F. carica* (collected from Bet-Dagan, Israel and Salamanca, Spain). Cyanidin-3-rhamnoglucoside **(3)** and cyanidin-3-glucoside **(4)** were isolated using hydrochloric acid in methanol (Solomon et al., 2006), while trifluoracetic acid in methanol afforded (*epi*)catechin-(4→8)-cyanidin-3-glucoside **(5),** (*epi*)catechin-(4→8)-cyanidin-3-rutinoside **(6)**, cyanidin-3,5-diglucoside **(7)**, (*epi*)catechin-(4→8)-pelargonidin-3-rutinoside **(8)**, 5-carboxypyranocyanidin-3-rutinoside **(9)**, cyanidin-3-malonylglicosyl-5-glucoside **(10)**, cyanidin-3-glucoside **(4),** cyanidin-3-rutinosyl **(11),** pelargonidin-3-glucoside **(12),** pelargonidin-3-rutinosyl **(13),** peonidin-3-rutinoside **(14)** and cyanidin-3-malonylglucoside **(15)** (Dueñas et al., 2008).

5.2. Ceramide

Ceramides and other sphingolipids have biological activities, including anticancer properties, maintaining nerve function, reducing cholesterol absorption (Wehrmüller, 2007) and antimicrobial properties (Simo et al., 2008; Poumale, 2012). A few ceramides have been reported in the *Ficus* genus. Elasticamide **(16)** was isolated from the methanolic wood extract of *F. elastica* aerial roots and reported for its anti-proliferative activity against human cell lines (glioblastoma, carcinoma, and melanoma) while the chloroform:methanol extract of *F. elastica* aerial roots gave ficusamide **(17)** (collected from Yaounde, Cameroon) (Mbosso et al., 2012). Also, the methanol extract of the stem of *F. exasperata* (collected from Dja, Cameroon) yielded ficusamide **(17)** which showed a weak activity against *Escherichia coli* (Dongfack et al., 2012). The stem bark of *F. glumosa* (collected from Makenene, Cameroon) extracted with dichloromethane:methanol extract gave glumoamide **(18)** and glumoside **(19)** which showed no significant anti-proliferative activity (Nana et al., 2012). Lutamide **(20)**, lutaoside **(21)** and benjaminamide **(22)** were isolated from the methanolic extract of *F. lutea* leaves (collected from Kribi, Cameroon), lutaoside **(21)** and benjaminamide **(22)** inhibited the growth of *Scenedesmus subspicatus, Chlorella sorokiniana, Mucor miehi, Bacillus subtilis, Candida albicans,* with inhibition zone (IZ) diameters ranging from 11 to 17 mm while lutamide inhibited the growth of *Mucor miehe*, *Bacillus subtilis*, *Chlorella vulgaris*, *Scenedesmus subspicatus* and *Candida albicans* with IZ diameters ranging from 10 to 16 mm (Simo et al., 2008; Poumale, 2012).

5.3. Coumarins

Coumarin **(23)** and its derivatives are a class of phenolic compounds found in the *Ficus* genus. Coumarin derivatives are considered to have a wide range of biological activity, such as anti-inflammatory (Witaicenis et al., 2014), anticancer (Bronikowska et al., 2012; Nasr et al., 2014), anti-coagulant, antioxidant, as well as anti-HIV and anti-bacterial (Canning et al., 2013). *F. carica* leaves, stem bark, root heartwood, pulp and pulp peels extracted with methanol or ethanol or hexane:dichloromethane have been reported to contain different coumarin compounds such as umbelliferone **(24)**, 6-(2-methoxyvinyl)-7-methylcoumarin **(25)**, psoralen **(26)**, 8-methyl psoralen **(27)**, 5-(1˝,1″-dimethylallyl)-8-methyl psoralen **(28)**, bergapten **(29)**, xanthotoxin **(30)**, 4′,5′ dihydropsoralen **(31)**, marmesin **(32)** angelicin **(33)** (collected from Yunnan, China) (Liu et al., 2011 and Mawa et al., 2013). Bergapten **(24)** and marmesin **(27)** and were found in *F. glumosa* stembark (collected from KwaZulu-Natal, South Africa) using hexane:dichloromethane (Awolola, 2015).

5.4. Flavonoids

Many flavonoid compounds possesses antioxidative activity, free radical scavenging capacity, cardioprotective, antidiabetic, anti-inflammatory, anti-allergic and antimicrobial activities; more recently as an anti-cancer agents (Cowan, 1999; Cushnie and lamb, 2005; Mishra et al., 2009; Ramchoun et al., 2009; Nagendra et al., 2010; Pan et al., 2010; Karak, 2019). *Ficus carica* aqueous extract afforded quercetin-3-*O*-glucoside **(34)** and rutin **(35)** (Mawa et al., 2013) while the stem bark methanolic extract yielded caricaflavonol diester A **(36)** and caricaflavonol diester B **(37)** (Ahmad et al., 2013). Morin **(38)**, rutin **(35),** quercitrin **(39)**,

Table 2
Phytochemicals from the selected African *Ficus* species.

Plant species	Plant Organ	Compounds	References
F. carica L.	L	Umbelliferone **(24)**, 6-(2-methoxyvinyl)-7-methylcoumarin **(25)**, psoralen **(26)**, bergapten **(29)**, xanthotoxin **(30)**, 4′,5′ dihydropsoralen **(31)**, marmesin **(32)**, rutin **(35)**, caricaflavonol diester A **(36)**, caricaflavonol diester B **(37)**, quercetin **(54)**, β-sitosterol **(86)**, β-sitosterol-3-*O*-β-D-glucoside **(87)**, β-sitosterol acetate **(88)**, β-amyrin **(90)**, β-amyrin acetate **(91)**, stigmasterol **(92)**, lupeol **(93)**, lupeol acetate **(94)**, oleanolic acid **(96)**, bauerenol **(119)**, and methyl maslinate **(121)**	(Saeed and Sabir, 2002; Solomon et al., 2006; Dueñas et al., 2008; Oliveira et al., 2009; Mawa et al., 2013; Ahmad et al., 2013).
	R	Psoralen **(26)**, 8-methyl psoralen **(27)**, 5-(1″,1″dimethylallyl)-8-methyl psoralen **(28)**, bergapten **(29)**, β-sitosterol **(86)**, β-sitosteryl palmitate **(89)**, and neolup-12-en-3β-yl acetate **(97)**	
	P	Psoralen **(26)**, bergapten **(29)**, quercetin-3-*O*-glucoside **(34)** and rutin **(35)**, chlorogenic acid **(74)**, and ferulic acid **(75)**	
	Lx	6-*O*-Palmitoyl-β-D-glucosyl-β-sitosterol **(122)**, 6-*O*-linoleyl-β-D-glucosyl-β-sitosterol **(123)**, *O*-stearyl-β-D-glucosyl-β-sitosterol **(124)**, and 6-*O*-oleyl-β-D-glucosyl-β-sitosterol **(125)**	
	F	Cyanidin-3-*O*-glucoside **(4)**, and angelicin **(33)**	
F. elastica Roxb. ex. Hornem	L	Rutin **(35)**, morin **(38)**, quercitrin **(39)**, myricitrin **(41)**, Icariside F2 **(76)**, syringin **(77)**, oleanolic acid **(96)**, and ursolic acid **(100)**	(Almahyl et al., 2003; Kiem et al., 2012; Mbosso et al., 2012, 2016, 2017).
	ArR-B	Elasticamide **(16)**, ficusamide **(17)**, β-sitosterol (86), sitosterol-3-*O*-β-D-glucoside **(87)**, stigmasterol **(92)**, friedelinol (98), ursolic acid **(100)**, and ficusoside B **(115)**	
F. exasperata Vahl	L	Quercitrin **(39)**, apigenin-C-8 glucoside **(43)**, and isoquercitrin-6-*O*-4-hydroxybenzoate **(44)**	(Bafor et al., 2013; Taiwo and Igbenegbu, 2014).
	SB	Ficusamide **(17)**, bergapten **(29)**, sitosterol-3-*O*-β-D-glucoside **(87)**, stigmasterol **(92)**, (S)-oxypeucedanin hydrate **(116)**, and (R)-oxypeucedanin hydrate **(117)**	
F. glumosa (Miq.) Delile	L	Quercetin-3-*O*-glucoside **(34)**, quercetin-3-*O*-galactoside **(45)**, *p*-hydroxybenzoic acid **(78)**, β-sitosterol **(86)**, 3β-hydroxy-21β-H-hop-22(29)-ene **(102)**, and stigma-4-ene-3-one **(103)**	(Nana et al., 2012; Awolola et al., 2019).
	SB	Glumoamide **(18)**, glumoside **(19)**, bergapten **(29)**, marmesin **(32)**, genistein **(46)**, 6-prenylapigenin **(47)**, wighteone **(48)**, alpinumisoflavone **(49)**, 4′-*O*-methylalpinumisoflavone **(50)**, luteolin **(52)**, catechin **(53)**, 2,4,5-trihydroxybenzoic acid **(80)**, polystachyol **(81)**, vanillic acid **(82)**, β-sitosterol-3-*O*-β-D-glucoside **(87)**, β-amyrin **(90)**, lupeol **(93)**, lanosta-7,24-dien-3-one **(104)**, lanosta-8,24-dien-3-one **(105)**, α-amyrin acetate **(107)**, and dongnoside E **(113)**	
	F	Quercimeritrin **(51)**	
F. ingens (Miq.) Miq.	Ar	Rutin **(35)**, patuletin-3′-*O*-methyl-3-*O*-rutinoside **(55)**, and β-sitosterol **(86)**	(Donia et al., 2013).
F. lutea Vahl	L	Benjaminamide **(22)**, betulinic acid **(99)**, lutamide **(20)**, vitexin **(56)**, stigmasterol **(92)**, and α-amyrin acetate **(107)**	(Poumale et al., 2011; Olaokun et al., 2013, 2014).
	W	Betulinic acid **(99)**, lupeol **(89)**, lutaoside **(21)**, β-amyrin acetate **(91)**, β-amyrin **(90)**, and β-sitosterol-3-*O*-β-D-glucoside **(87)**	
F. sur Forssk	Lx	Catechin **(53)**, 4′,5,7-trihydroxyflavan-3-ol **(57)**, β-amyrin acetate **(91)**, α-amyrin acetate **(107)**, boviquinone 4 **(108)**, salvisyriacolide **(109)**, notoginsenoside R10 (129), lutein (134), 2-cyclohexyl-1-ethyl-β-D-maltoside **(135)**, and 3,5-dipentyl-2-hexyl-pyridine **(142)**	(Feleke and Brehane, 2005; Saloufou et al., 2018).
F. sycomorus L.	L	Rutin **(35)**, quercetin **(54)**, isoquercitrin **(58)**, quercetin 3,7-*O*-α-L dirhamnoside **(59)**, gallic acid **(84)**, and β-sitosterol-3-*O*-β-D-glucoside **(87)**	(El-Sayed et al., 2010).
F. thonningii Thume	L	Vitexin **(56)**, orientin **(60)**, and isovitexin **(61)**	(Daragarembizi, 2013; Fongang et al., 2015; Ango et al., 2016).
	Fig, S, R	Wighteone **(48)**, alpinumisoflavone **(49)**, luteolin **(52)**, thonningiisoflavone **(62)**, luteone **(63)**, conrauiflavonol **(64)**, shuterin **(65)**, hydroxyalpinumisoflavone **(66)**, β-isoluteone **(67)**, thonningiiflavanonol A **(68)**, thonningiiflavanonol B **(69)**, naringenin **(70)**, 5,7,3′,4′,5′-pentahydroxyflavanone **(71)**, 5,7,3′-trihydroxyflavanone **(72)**, thonningiol **(73)**, *p*-hydroxybenzoic acid (78), syringic acid **(85)**, β-sitosterol (86), β-sitosterol-3-*O*-β-D-glucoside **(87)**, β-amyrin acetate **(91)**, lupeol **(93)**, lupeol acetate **(94)**, and taxifolin **(118)**	

Ar = Aerial part, ArR-B = Aerial root Bark B = Bark, F = Fruit, Lx = Latex, L = Leaf, P =Pulp, R = Root; SB = Stem Bark, S = Seed; W= Wood afzelin **(40)**, and myricitrin **(41)** have been isolated from *F. elastica* leaves (Kiem et al., 2012). Apigenin **(42),** apigenin C-8-glucoside **(43)**, isoquercitrin-6-*O*-4-hydroxybenzoate **(44)** and quercitrin **(39)** were isolated from aqueous ethanolic extract of *F. exasperata* leaves (collected from Osun, Nigeria) (Taiwo and Igbeneghu, 2014). Stem bark of *F. glumosa* (collected from Makenene, Cameroon)) extracted with dichloromethane:methanol extract gave quercetin-3-*O*-glucoside **(34)**, quercetin-3-O-galactoside **(45)**, genistein **(46)**, 6-prenylapigenin **(47)**, wighteone **(48)**, alpinumisoflavone **(49)**, 4′-*O*-methylalpinumisoflavone **(50)**, quercimeritrin **(51)**, luteolin **(52)** and catechin **(53)** (Nana et al., 2012). *F. ingens* aerial parts (collected from Tabouk area-KSA) extracted with aqueous ethanol gave rutin **(35)**, quercetin **(54)**, and patuletin-3′-*O*-methyl-3-*O*-rutinoside **(55)** (Donia et al., 2013) and *F. lutea* leaves (collected from Kribi, Cameroon) in methanol, afforded vitexin **(56)** (Poumale, 2012). Catechin **(53)** and 4′,5,7-trihydroxyflavan-3-ol **(57)** were found in *F. sur* ethanol extract of leaves, fruits, stem and roots (collected from Dapaong, Togo) (Saloufou et al., 2018). Methanolic extract of *F. sycomorus* leaves (El-Qualubia, Egypt) gave quercetin **(54)**, rutin **(35)**, isoquercitrin **(58)** and quercetin-3,7-*O*-α-L-dirhamnoside **(59)** (El-Sayed et al., 2010). Genistein **(46)**, wighteone **(48)**, alpinumisoflavone **(49)**, luteolin **(52)**, vitexin **(56)**, isovitexin **(60)**, orientin **(61)**, thonningiisoflavone **(62)**, luteone **(63),** conrauiflavonol **(64)**, shuterin **(65)**, hydroxyalpinumisoflavone **(66)**, β-isoluteone **(67)**, thonningiiflavanonol A **(68)**, thonningiiflavanonol B **(69)**, naringenin **(70)**, 5,7,3′,4′,5′-pentahydroxyflavanone **(71),** 5,7,3′-trihydroxyflavanone **(72)** and thonningiol **(73)** were isolated from the methanolic extract of *F. thonningii* stembark/root/figs (collected from Bamenda, Cameroon) (Fongang et al., 2015).

5.5. Other phenolic compounds

Phenolics are known for their anticancer, anti-inflammatory, antibacterial, antifungal, anti-mutagenic, antidiabetic, antihypertensive activity (Mennen et al., 2005; Veluri et al., 2006; Kang et al., 2008; Yeh et al., 2011; Hsu et al., 2015; Narasimhan et al., 2015; Fahrioğlu et al., 2016; Shahidi and Yeo, 2018). Chlorogenic acid **(74)** and ferulic acid **(75)** were found in *F. carica* leaves (collected from Mirandela, Portugal) aqueous extract (Oliveira et al., 2009), while icariside F_2 **(76)** and syringin **(77)** were isolated from *F. elastica* leaves (Kiem et al., 2012). Stem bark of *F. glumosa* (collected from Makene, Cameroon) macerated in a dichloromethane:methanol afforded *p*-hydroxybenzoic acid **(78)**, protocatechuic acid **(79)**, 2,4,5-trihydroxybenzoic acid **(80)**, polystachyol **(81)** vanillic acid **(82)** and methyl chlorogenate **(83)** (Nana et al., 2012), and gallic acid **(84)** from ethylacetate soluble fraction of methanolic extract of *F. sycomorus* leaves (collected from El-Qualubia, Egypt) (El Sayed et al., 2010). Chloroform and methanol extract of *F. thonningii* stem bark and root (collected from Bamenda and Bagangte, Cameroon) gave syringic acid **(85)** and *p*-hydroxybenzoic acid **(78)** (Fongang et al., 2015; Ango et al., 2016).

5.6. Triterpenoids

Potential biological activities of triterpenoids include antiinflammatory, anticarcinogenic, antidiabetic, hepatoprotective, antimicrobial, antimycotic, analgesic, immunomodulatory, and cardiotonic activity (Ghosh, 2020). β -Sitosterol **(86)**, β-sitosterol-3-*O*-β-D-glucoside **(87)**, β-sitosterol acetate **(88)**, β-sitosteryl palmitate **(89)**, β-amyrin **(90)**, β-amyrin acetate **(91)**, stigmasterol **(92)**, lupeol **(93)**, lupeol acetate **(94)**, methyl maslinate **(95)** and oleanolic acid **(96)**, neolup-12-en-3β-yl acetate **(97)**, were obtained from the methanolic extract of *F. carica* leaves (collected from Punjab, Pakistan) (Saeed and Sabir, 2002; Patil and Patil, 2011). Methanolic extract of the wood of *F. elastica* aerial roots (collected from Yaounde, Cameroon) gave stigmasterol **(92),** friedelinol **(98)**, β-sitosterol **(86)**, betulinic acid **(99)**, ursolic acid **(100)** and β-sitosterol-3-*O*-β-D-glucoside **(87)** (Mbosso et al., 2016) while β-sitosterol **(86)**, stigmasterol **(92)** and 3,7-dioxofriedelane **(101)** were gotten from *F. exasperata* stem (collected from Dja, Cameroon) (Dongfack et al., 2012). Stem bark of *F. glumosa* (collected from Makenene) macerated in a dichloromethane:methanol afforded β-sitosterol **(86)**, β-amyrin **(90)**, lupeol **(93)**, 3β-hydroxy-21β-H-hop-22(29)-ene **(102)**, stigmast-4-ene-3-one **(103)**, lanosta-7,24-dien-3-one **(104)**, lanosta-8,24-dien-3-one **(105)** , α-amyrin **(106)** and α-amyrin acetate **(107)** (Nana et al., 2012). Hexane extract of *F. sur* latex (collected from Shashemene, Ethiopia) gave α-amyrin acetate **(107)** and β-amyrin acetate **(91)** while the leaf, stem roots and fruits (collected from Dapaong, Togo) ethanolic extract yielded boviquinone-4 **(108)** and salvisyriacolide **(109)** (Feleke and Brehane, 2005; Saloufou et al., 2018). *F. lutea* woods (collected from Kribi, Cameroon) extracted with dichloromethane:methanol yielded β-sitosterol **(86)**, β-sitosterol glucoside **(87)**, β-amyrin **(90)**, β-amyrin acetate **(91)**, stigmasterol **(92)**, lupeol **(93)**, lupeol acetate **(94)** (**Fig. 1**), betulinic acid **(99)**, α-amyrin acetate **(107)** (Poumale, 2012) while β-amyrin acetate **(91)** and lupenone **(110)** were found in *F. thonningii* stembark and root (collected from Dja, Cameroon) using chloroform and methanol (Fongang et al., 2015).

5.7. Methods of extraction, isolation and Identification of compounds

Generally, dried and powdered plant samples were extracted either cold or hot extraction methods using non-polar, medium polar and polar solvent. The extracts were concentrated under reduced pressure by rotatory evaporator. Fractionation and isolation were done by subjecting fractions to different chromatographic techniques such as column chromatography. Structures of isolated compounds were characterized based on spectroscopic methods (El-Sayeed et al., 2010: Liu et al., 2011; Dongfack et al., 2012; Fongang et al., 2015).

6. Bioactivity of the selected African *Ficus* species

Many phytochemicals found in the African species of the genus *Ficus* possess antibacterial, anticancer, antifungal, antioxidant and nematicidal properties

(Table 3 and Table 4), and are often implicated to ethnopharmacological applications of these species. The summary of bioactivities of these species is presented below.

6.1. Anticancer activity

A crude methanol extract of the wood of *F. elastica* aerial root exhibited cytotoxic activity against U373n of glioblastoma brain cancer cell lines at IC_{50} values of 5-8 µg/mL. Biochanin A **(111)** and ficusoside B hexaacetate **(112)** from the crude methanol extract showed cytotoxicity against B16F10 of melanoma cell line (IC_{50} = 14 µM) and U373n of glioblastoma brain cancer (IC_{50} = 11 µM), respectively (Teinkela et al., 2017).

Dongnoside E **(113)**, isolated from *F. glumosa* dichloromethane-methanol (1:1) crude extract, showed a significant antiproliferative activity against HT1080 fibrosarcoma cancer cells line with 0.7 µmol L^{-1} as IC_{50} after 48 h. This was more active than reference drug, doxorubicin, with 0.91 µmol L^{-1} as IC_{50} (Nana et al., 2012).

6.2. Antioxidant activity

The ethyl acetate and *n*-butanol extracts of *F. sycomorus* leaves revealed strong DPPH$^{\bullet}$ (2,2′-diphenyl-1-picrylhydrazyl radical) scavenging activity of LC_{50}=13.48 and 8.47 µg/mL respectively (El-Sayed et al., 2010). A methanol extract of *F. thonningii* wood root also had good antioxidant potential at 10, 50 and 100 mg/10mL with 26.10, 37.10 and 74.60 percentage activity, respectively. Methanol stem roots extract showed significant antioxidant property of 68.30, 75.20 and 81.26% at the concentrations of 10, 50 and 100 mg/10 mL, respectively (Fongang et al., 2015). Thonningiisoflavone **(62)** and hydroxyalpinumisoflavone **(66)** from *F. thonningii* showed strong DPPH radical scavenging activity of IC_{50} = 65.50 mM and 68.20 mM respectively compared to the standard BHA of IC_{50} = 44.20 mM (Fongang et al., 2015).

Four compounds isolated from *F. elastica* ethanol extract with the crude ethanol extract displayed antioxidant activity at IC_{50} value of 0.37 ± 0.45 µg/mL (morin **(33)**, 1.39 ± 0.16 µg/mL; quercitrin **(39)**, 11.01 ± 0.15 µg/mL; myricitrin **(41)**, 0.88 ± 0.51 µg/mL; eleutheroside B (syringin) **(77)**, 13.82 ± 0.51 µg/mL (crude extract). Myricitrin **(41)** had the highest activity with value 96.22 ± 1.64% (Ginting et al., 2020). Hydroalcoholic stem bark extract of *F. exasperata* and an isolate, *N*-propyl gallate **(114)**, showed good antioxidant activities at EC_{50} (µg/mL) of 20.0 ± 0.01 and 10.80 ± 0.002, respectively (Amponsah et al., 2013).

6.3. Antimicrobial activity

Methanol extract from the wood of *F. elastica* exhibited antimicrobial activity at minimum inhibitory concentration (MIC) of 39.1 µg/mL. Ficusoside B **(115)**, one of the compounds afforded by this extract, was also active against *Escherichia coli*, *Proteus vulgaris*, *Staphylococcus aureus* and *Candida albicans* at MIC of 4.9 µg/mL (Teinkela et al., 2017). Methanol extract of *F. exasperata* stem bark afforded (*S*)-oxypeucedenin hydrate **(116)** and (R)-oxypeucedenin hydrate **(117)** which showed significant activity (MIC: 9.76 µg/mL) against *Bacillus cereus*, *Candida albicans* and *Microsporum audouinii* (Dongfack et al., 2012). *F. lutea* gave lutaoside **(21)** which exhibited good antimicrobial activity against *Bacillus subtilis* and *Mucor miehei* at inhibition zones of 17 mm and 16 mm respectively. It was more potent against these microbes than the standard drug, nystatin, with inhibition zone of 15 mm and 14 mm respectively (Poumale et al., 2011).

Different extracts of *F. thonningii* exhibited antibacterial activities. Butanol stem bark extract was active against *Escherichia coli* at MIC value of 1.25 mg/mL, aqueous stem bark extract inhibited growth in *Staphylococcus aureus* and *Klebsiella spp* at MIC of 1.25 mg/L and the methanol stem-bark extract displayed potency against *Salmonella typhi* at MIC of 1.25 mg/mL (Dangarembizi, et al., 2013). Methanol extract of *F. thonningii* figs and three compounds from the extract, namely taxifolin **(118)**, conrauiflavonol **(64)** and shuterin **(65)** exhibited moderate antimicrobial activity against *Escherichia coli, Proteus vulgaris, Pseudomonas aeruginosa,* and *Staphylococcus aureus* at MIC below 1.5 mg/mL (Fongang et al., 2015). Lupeol acetate **(94)** from n-butanol extract of the root bark of *F. sycomorus*, was active against *S. aureus* and *S. typhi* at MIC of 12.5 µg/mL (Muktar et al., 2018).

6.4. Anti-inflammatory activity

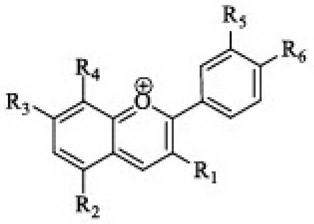
Hydroalcoholic stem bark extract of *F. exasperata* displayed average anti-inflammatory effect on foot pad, oedema induced by carrageenan, at ED_{50} of 50.65 ± 0.012 mg/kg (Amponsah et al., 2013).

6.5. Nematicidal activity

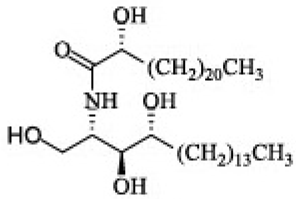
Leaf methanol extract of *F. carica* exhibited strong nematicidal activity against *Bursaphelenchus xylophilus*, *Panagrellus redivivus* and *Caenorhabditis elegans* causing 74.3, 96.2 and 98.4% mortality, respectively, within 72 h. However, psoralen **(26)** isolated from this extract displayed weaker nematicidal activity against *B. xylophilus*, *P. redivivus* and *C. elegans* with median lethal concentrations (LC_{50}) of 258.8, 181.1 and 119.40 mg L^{-1} at 72 h respectively, than the crude extract (Liu et al., 2011).

6.6. Toxicity studies

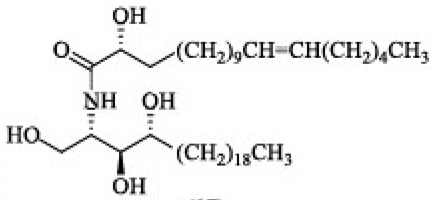
Toxicity assay on *F. carica* leaf aqueous extract showed that it had no adverse effect on the liver or blood constituents of Wistar albino rats at concentrations between 100-400 mg/kg for 6 weeks (Odo et al., 2016). Aqueous leaf extract of *F. exaperata* of 2.5-20 g/kg was found to be relatively safe on short-term for acute toxicity over 24 h and 14-day periods oral administration (Bafor et al., 2009). However, the stem-bark of methanol extract of *F. sycomorus* at higher concentration range of 1600-5000 mg/kg was slightly toxic in rats (Bello et al., 2015).



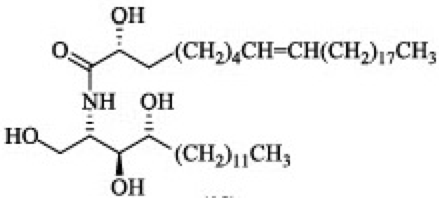
R_1=R_2=R_3=R_5=R_6=OH; R_4=H **(1)**
R_1=R_2=R_3=R_6=OH; R_4=R_5=H **(2)**
R_1=O-rhmanoglucosyl; R_2=R_3=R_5=R_6=OH; R_4=H **(3)**
R_1=O-glucosyl;R_2=R_3=R_5=R_6=OH; R_4=H **(4)**
R_1=R_2=R_3=R_5=R_6=OH; R_4=epicatechin **(5)**
R_1=O-rutinosyl; R_2=R_3=R_5=R_6=OH; R_4=epicatechin **(6)**
R_1=R_2=R_6=OH; R_3=R_5=O-glucosyl; R_4=H **(7)**
R_1=O-rutinosyl; R_2=R_3=R_6=OH; R_4=epicatechin; R_5=H **(8)**
R_1=O-rutinosyl; R_2=5-carboxypyranosyl; R_3=R_5=R_6=OH; R_4=H **(9)**
R_1=O-malonylglicosyl; R_2=R_3=R_6=OH; R_5=O-glucosyl; R_4=H **(10)**
R_1=O-rutinosyl; R_2=R_3=R_5=R_6=OH; R_4=H **(11)**
R_1=O-glucosyl; R_2=R_3=R_6=OH; R_4=R_5=H **(12)**
R_1=O-rutinosyl; R_2=R_3=R_6=OH; R_4=R_5=H **(13)**
R_1=O-rutinosyl; R_2=R_3=R_6=OH; R_4=H; R_5=OCH_3 **(14)**
R_1=O-malonylglucosyl; R_2=R_3=R_5=R_6=OH; R_4=H **(15)**



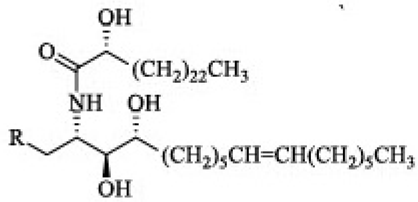
(16)



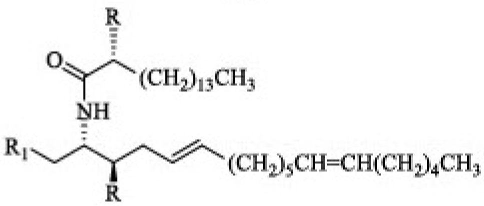
(17)



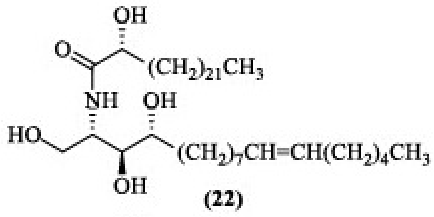
(18)



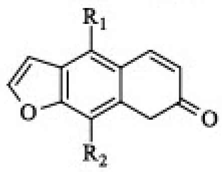
R=O-glucosyl **(19)**



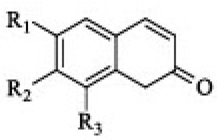
R=R_1=OH **(20)**
R=OH; R_1=O-glucosyl **(21)**



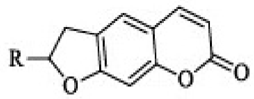
(22)



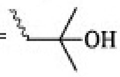
R_1=R_2=H **(26)**
R_1=R_2=CH_3 **(27)**
R_1= $C(CH_3)_2CH{=}CH_2$; R_2=CH_3 **(28)**
R_1=OCH_3; R_2=H, **(29)**
R_1=H; R_2=OCH_3 **(30)**

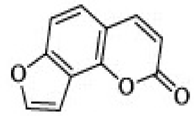


R_1=R_2=R_3=H **(23)**
R_1=R_3=H; R_2=OH **(24)**
R_1=CH=CH(OCH_3); R_2=CH_3; R_3=H **(25)**

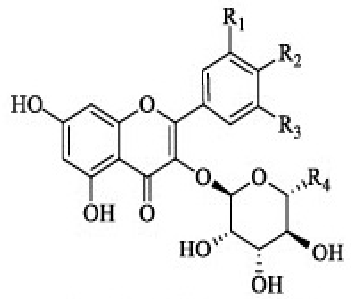


R=H **(31)**

R=  **(32)**



(33)

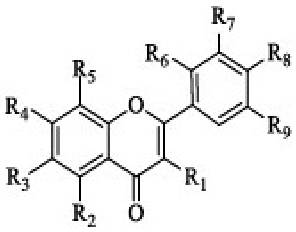


R_1=H; R_2= R_3=OH; R_4=CH_3 **(39)**

R_1=R_3=H; R_2=OH; R_4=CH_3 **(40)**

R_1=R_2=R_3=OH; R_4=CH_3 **(41)**

R_1=R_2=OH; R_3=H; R_4=6-O-4-hydroxybenzoate,**(44)**



R_1=O-glucosyl; R_3=R_5=R_6=R_9=H; R_2=R_4=R_7=R_8=OH **(34)**

R_1=O-rutinosyl; R_3=R_5=R_6=R_7=H; R_2=R_4=R_8=R_9=OH **(35)**

R_1=$OCO(CH_2)_7CH{=}CH(CH_2)_7CH_3$; R_2=$OCO(CH_2)_{14}CH_3$; R_3=R_5=R_6=R_7=R_9=H; R_4=R_8=OCH_3, **(36)**

R_1=$OCO(CH_2)_7CH{=}CH(CH_2)_7CH_3$; R_2=$OCO(CH_2)_{14}CH_3$; R_3=R_5=R_6=R_9=H; R_7=OH; R_4=R_8=OCH_3, **(37)**

R_1=R_2=R_4=R_6=R_8=OH; R_3=R_5=R_7=R_9=H **(38)**

R_1= R_3=R_5=R_6=R_7=R_9=H; R_2=R_4=R_8=OH **(42)**

R_1= R_3=R_6=R_7=R_9=H; R_2=R_4=R_8=OH; R_5=O-glucosyl **(43)**

R_1=O-galactosyl; R_3=R_5=R_6=R_9=H; R_2=R_4=R_7=R_8=OH **(45)**

R_1= R_5=R_6=R_7=R_9=H; R_2=R_4=R_8=OH; R_3=  **(47)**

R_1= R_2=R_8=R_9=OH; R_4=O-glucosyl; R_3=R_5=R_6=R_7=H **(51)**

R_1=R_3=R_5=R_6=R_9=H ; R_2=R_4=R_7=R_8=OH; **(52)**

R_1=R_2=R_4=R_7=R_8=OH ; R_3=R_5=R_6=R_9=H; **(54)**

R_1=O-rutinosyl; R_2=R_4=R_8=OH ; R_5=R_6=R_7=H; R_3=R_9=OCH_3 **(55)**

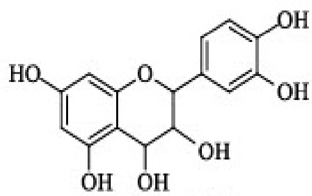
R_1= R_3=R_6=R_7=R_9=H; R_2=R_4=R_8=OH; R_5=O-glucosyl **(56)**

R_1= R_2=R_8=R_9=OH; R_3=R_5=R_6=R_7=H; R_4=O-glucosyl **(58)**

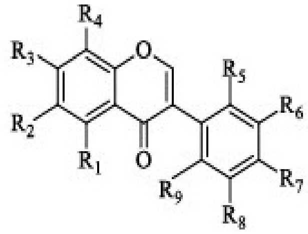
R_1=R_4=O-rhamnosyl; R_3=R_5=R_6=R_9=H; R_2=R_7=R_8=OH **(59)**

R_1= R_5=R_6=R_7=R_9=OH; R_2=R_4=R_8=H; R_3=O-glucosyl **(60)**

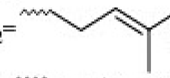
R_1= R_3=R_6=R_9=H; R_2=R_4=R_7=R_8=OH; R_5=O-glucosyl **(61)**



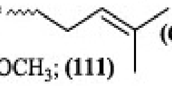
(57)



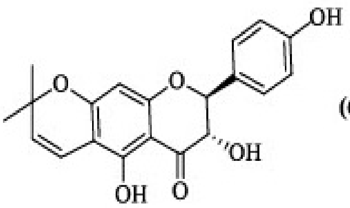
$R_1=R_3=R_7=OH; R_2=R_4=R_5=R_6=R_8=R_9=H$ **(46)**

$R_1= R_3=R_7=OH; R_4= R_5= R_6= R_8= R_9=H; R_2=$  **(48)**

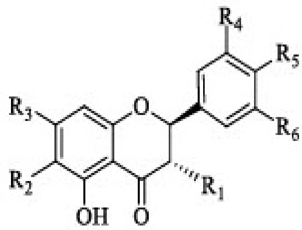
$R_1= R_3=R_7=R_9=OH; R_4=R_4= R_5= R_6=H; R_8=$  **(62)**

$R_1= R_3=R_5=R_7=OH; R_4=R_6=R_8=R_9=H; R_2=$  **(63)**

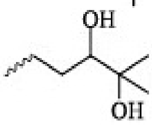
$R_1=R_3=OH; R_2=R_4=R_5=R_6=R_8=R_9=H; R_7=OCH_3$; **(111)**

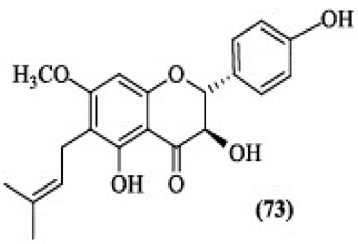


(64)

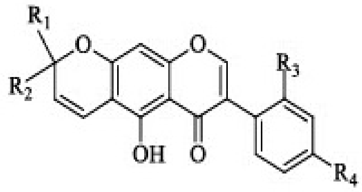


$R_1=R_3=R_5=OH; R_4=R_6=H; R_2=$  **(65)**

$R_1=R_3=R_5=OH; R_4=R_6=H; R_2=$  **(69)**



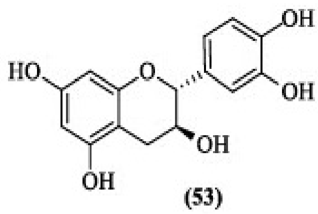
(73)



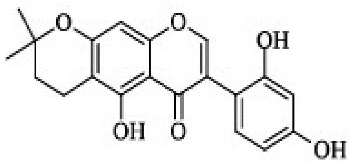
$R_1=R_2=CH_3; R_3=H; R_4=OH$ **(49)**

$R_1=R_2=R_4=CH_3; R_3=H$ **(50)**

$R_1=CH_2OH; R_2=CH_3; R_3=H; R_4=OH$ **(66)**



(53)



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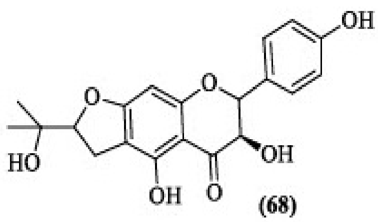
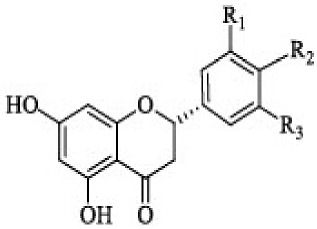


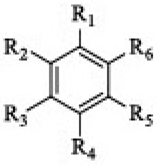
(68)



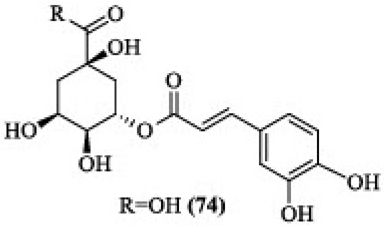
$R_1=R_3=H; R_2=OH$ **(70)**

$R_1=R_2=R_3=OH$ **(71)**

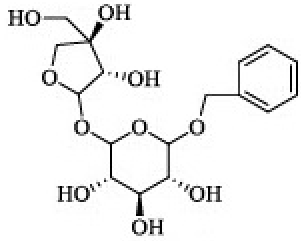
$R_1=OH; R_2=R_3=H$ **(72)**



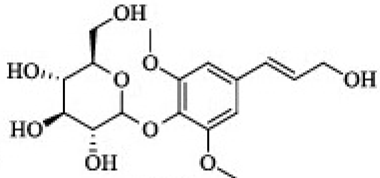
R_1=COOH; R_3=R_4=R_6=OH; R_2=R_5=H **(75)**
R_1=COOH; R_2=R_3=R_5=R_6=H; R_4=OH **(78)**
R_1=COOH; R_2=R_3=R_6=H; R_4=R_5=OH **(79)**
R_1=COOH; R_2=R_4=R_5=OH; R_3=R_6=H **(80)**
R_1=COOH; R_2=R_3=R_6=H; R_4=OH; R_5=CH_3 **(82)**
R_1=COOH; R_3=R_4=R_5=OH; R_2=R_6=H **(84)**
R_1=COOH; R_4=OH; R_3=R_5=R_6=OCH_3; R_2=R_6=H **(85)**



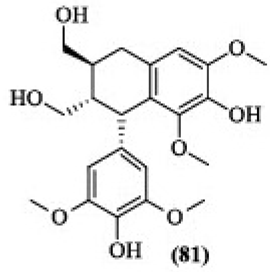
R=OH **(74)**
R=CH_3 **(83)**



(76)



(77)



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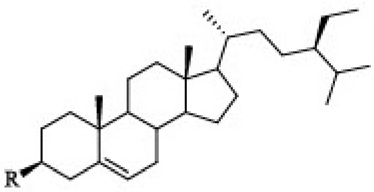
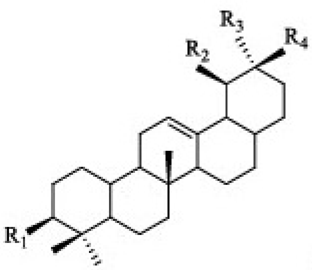
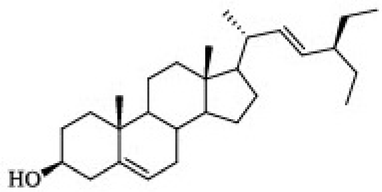


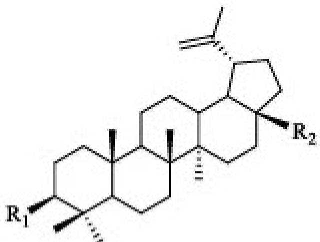
R=OH **(86)**
R=O-glucosyl **(87)**
R=$COOCH_3$ **(88)**
R=$COOC_{15}H_{29}$ **(89)**



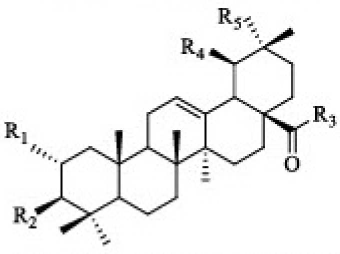
R_1=OH; R_2=H; R_3=R_4=CH_3 **(90)**
R_1=$COOCH_3$; R_2=H; R_3=R_4=CH_3 **(91)**
R_1=OH; R_2=R_3=CH_3; R_4=H **(106)**
R_1=$COOCH_3$; R_2=R_3=CH_3; R_4=H **(107)**



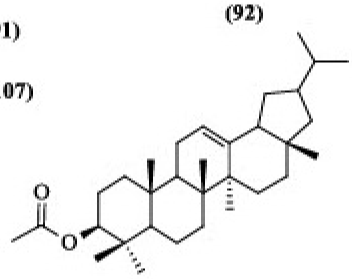
(92)



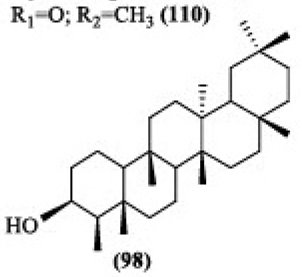
R_1=OH; R_2=CH_3 **(93)**
R_1=$COOCH_3$; R_2=CH_3 **(94)**
R_1=OH; R_2= COOH **(99)**
R_1=O; R_2=CH_3 **(110)**



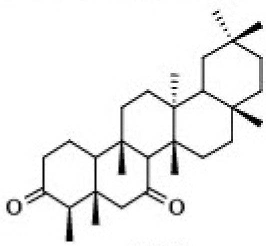
R_1=R_2=OH; R_3=$OCOOCH_3$; R_4=H; R_5=CH_3 **(95)**
R_1=R_4=H; R_2=R_3=COOH; R_5=CH_3 **(96)**
R_1=H; R_2=R_3=OH; R_4=R_5=CH_3 **(100)**



(97)



(98)



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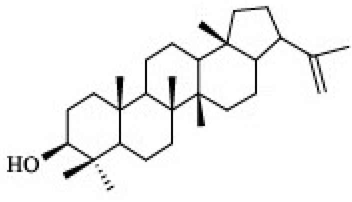

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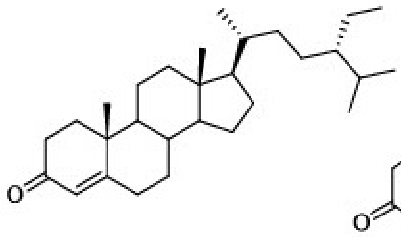

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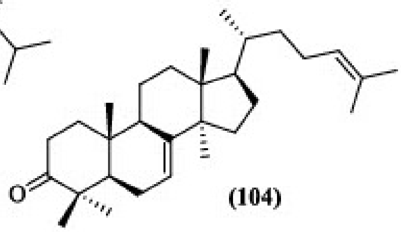

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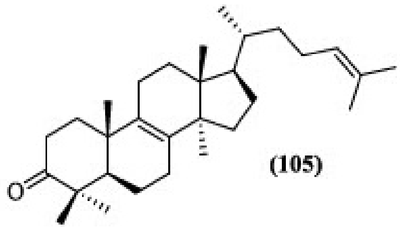

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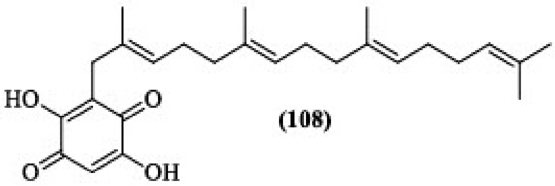

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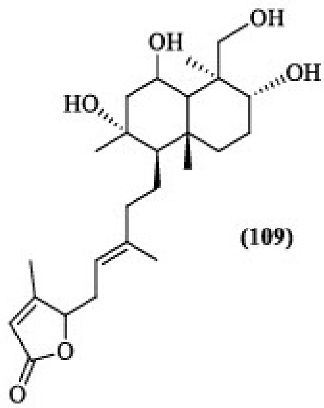

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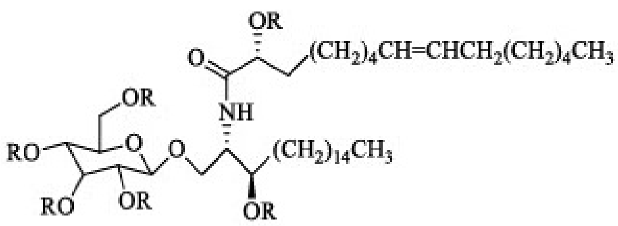
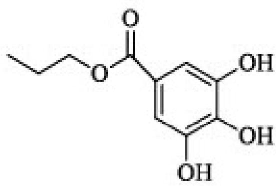


R=$COCH_3$ **(112)**
R=H **(115)**



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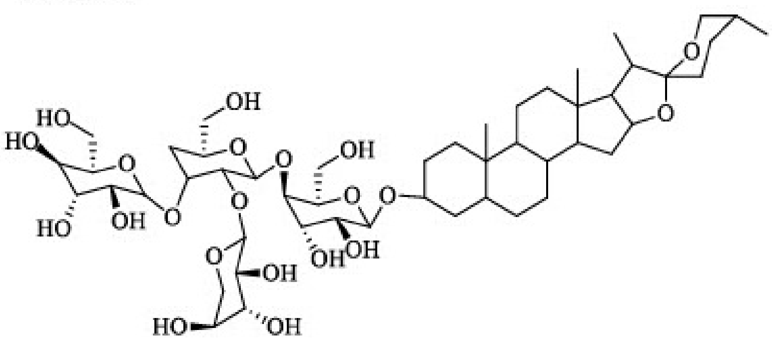
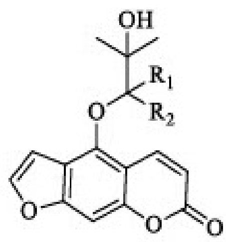
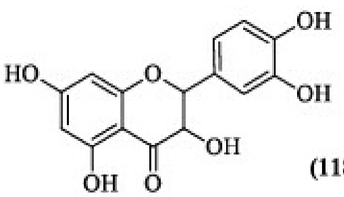


(113)



R_1= H; R_2=OH **(116)**
R_1=OH; R_2=H **(117)**



(118)

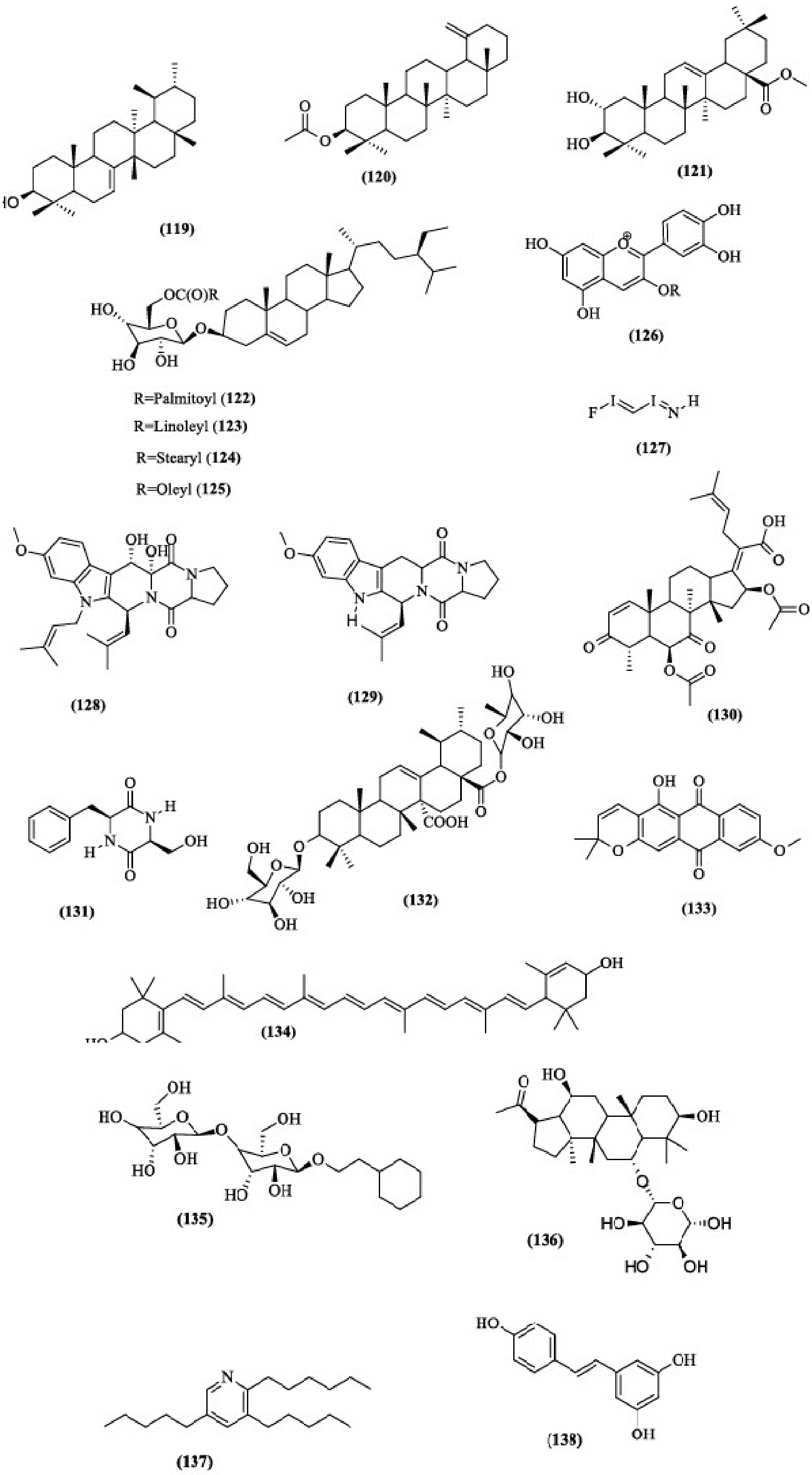


Fig. 1. Chemical structure of compounds **1-138.**

Table 3
Bioactivities of the selected African *Ficus* species.

Plant species	Plant Organ	Bioactivity	References
F. carica L.	F, L, Lx, R	Antiacne, antiangiogenic, antibacterial, anticancer, anticostipation, antifungal, antihelmintic, anti-inflammatory, antimalarial, antimutagenic, antioxidant, antiplatelet, antipyretic, antiseptic, antispasmodic antitumor, antiviral, antiwarts, diuretic, hepatoprotective, hypocholesterolemic, hypoglemic, hypolipdimic, immunostimulant, irritant, lavicidal, and nematicidal activities	(Amol et al., 2010; Joseph and Raj, 2011; Liu et al., 2011; Chawla et al., 2012; Ahmad et al., 2013; Mawa et al., 2013; Badgujar et al., 2014; Bouyahya et al., 2016).
F. elastica Roxb. ex. Hornem	ArR, L, Lx, W	Anticancer, antimicrobial, antioxidant, antischistosomal, antitrypanosomal, and parasiticidal activities	(Kiem et al., 2012; Mbossco et al., 2012; Phan et al., 2012; Seif-el-Din et al., 2014; Mbossco et al., 2016).
F. exasperata Vahl	L, S, SB, R	Anticonvulsant, antidiabetic, antifungi, antimicrobial, antinociceptive, antioxidant, antipyretic activity (mild), antiulcer, antioxlytic, hepatoprotective, hypolipidemic, hypoglycemic, oxytocin inhibiting effect, pesticidal, uterine, and uterotonic stimulating activites	(Ayinde et al., 2007; Odunbanku et al., 2008; Woode et al., 2011; Mbakwem-Aniebo et al., 2012; Bafor et al., 2009, 2010, 2011: 2013; Amponsah et al., 2013; Taiwo and Igbenegbu, 2014; Yakubu et al., 2014; Sabiu et al., 2015).
F. glumosa (Miq.) Delile	Ar	Antiatheroscleotic, antidiabetic, antidiarrheoal, antimicrobial, antioxidant, antitumor diuretic, and hypolipidemic activities	(Nana et al., 2012, Madubunyi et al., 2012; Olaokun et al., 2013, 2014; Ntchapda et al., 2014 ;Onoja et al., 2014).
F. ingens (Miq.) Miq.	B, L, Lx, R	Analgesic, antibacterial, anti-inflammatory, antiinociceptive, antioxidant, antiprotozoal, and hepatpprotective activities	(Aiyelero et al., 2009, Achigan-Dako et al., 2010, Al-Musayeib et al., 2012; Donia et al., 2013).
F. lutea Vahl.	B, F, L, R, W	Antidiabetic, antioxidant, antimicrobial, hepatoprotective, and hypoglycaemic activities	(Poumale et al., 2011; Olaokun et al., 2013, 2014; Awad et al., 2018).
F. sur Forssk	B, F, L, R SB, Tw	Anticonvulsant, anticholinesterase, anti-inflammatory, antimalaria, antimycobacterial, antioxidant, haematinic, lavicidal, sedative, and mutagenic activities	(Ishola et al., 2013; Madikizela et al., 2014; Adebayo et al., 2017; Olayemi et al., 2017; Saloufou et al., 2018).
F. sycomorus L.	B, F, Fw, L Lx, S	Anticonvulsant, antifungal, antioxidant, antiplasmodial, antispermatogenic, and sedative activities	(Ahmadu et al., 2007; Ibrahim et al., 2008; Elsayed et al., 2010; Igbokwe et al., 2010; Abubakar et al., 2017; Sakpa and Wilson, 2019).
F. thonningii Thume	L, Lx, R, SB	Anticancer, antidiarrhoeal, antifungi, antihemintic, antiinflammation, antioxidant, antiprotozoal, hypoglycaemic, reno- and, cardioprotective activities	(Lansky and Paavilanen, 2011; Dangarembizi et al., 2013; Egharevba et al., 2015; Fongang et al., 2015; Ango et al., 2016).

Ar: Aerial part, ArR: Aerial Root; B: Bark; Fw: Flower; F: Fruit; L: Leaf; Lx: Latex, S: Seed; SB: Stem Bark; Tw: Twig; W: Wood.

Table 4
Phytochemicals and pharmacological activity of the selected African Ficus species.

Ficus species	Phytochemicals	Pharmacological activity	References
F. carica L.	Bauerenol **(119)**, calotropenyl acetate **(120)**, lupeol acetate **(94)**, methyl maslinate **(121)**, and oleanolic acid **(96)**	Irritant	(Saeed and Sabir, 2002)
	Psoralen **(26)**	Nematicidal	(Liu et al., 2011).
	6-*O*-Acyl-β-d-glucosyl-β-sitosterols (acyl moiety: palmitoyl **(122)**, linoleyl **(123)**, stearyl **(124)**, and oleyl **(125)**	Anticancer	(Rubnov et al., 2001).
	Cyanidin-3-*O*-rutinoside **(126)**	Antioxidant	(Solomon et al., 2006).
	Ficin **(127)**	Haemostatic effect	(Richter et al., 2002).
	Fumitremorgin B **(128)**, Fumitremorgin C **(129)**, helvolic acid **(130)**, and cyclo-(Phe-Ser) **(131)**	Antifungal, Antiproliferative	(Feng and Ma, 2010).
F. elastica Roxb. ex. Hornem	Biochanin A **(111)**, elasticoside **(127)**, ficusamide **(17)**, ficusoside B **(115)**, β-sitosterol **(86)**, and sitosteryl-3-*O*-β-D-glucopyranoside **(87)**	Antibacterial	(Almahyl et al., 2003; Mbosso et al., 2017).
	Morin **(38)**, quercitrin **(39)** myricitrin **(41)**, and syringin **(77)**	Antioxidant	(Ginting et al., 2020).
	Elastiquinone **(133)**, and elasticamide **(16)**	Antifungal Antiproliferative	(Mbosso et al., 2016; 2017).
F. exasperata Vahl	Bergapten **(29)**	Antidiabetic	(Famobuwa et al., 2019).
	Oxypeucedanin hydrate **(116)**	Antiinflammatory	(Amponsah et al., 2013).
	Apigenin C-8 glucoside **(43)**, isoquercitrin-6-*O*-4-hydroxybenzoate **(44)**, and quercetrin **(39)**	Antibacterial	(Taiwo and Igbenegbu, 2014).
	Ficusamide **(17)**, (S)- oxypeucedanin hydrate **(116)**, and (R)-oxypeucedanin hydrate **(117)**	Antimicrobial	(Dongfack et al., 2012).
F. glumosa (Miq.) Delile	6-Prenylapigenin **(47)**, luteolin **(52)**, β-amyrin **(90)**, lupeol **(94)**, lanosta-7,24-dien-3-one **(104)**, and dongnoside E **(113)**	Antiproliferative	(Nana et al., 2012).
	Isoquercitrin **(58)**, *p*-hydroxybenzoic **(78)**, and quercetin-3-*O*-β-D-galactoside **(45)**	Gastroprotective activity	(Awolola et al., 2019).
F. ingens (Miq.) Miq.		No activity on isolated compounds from literature but only on extracts	(Donia et al., 2013).

Table 4 Continued

Ficus species	Phytochemicals	Pharmacological activity	References
F. lutea Vahl	Benjaminamide **(22)**, and lutaoside **(21)**	Antimicrobial	(Poumale et al., 2011).
	Boviquinine 4 **(108)**, catechin **(53)**, lutein **(134)**, 2-cyclohexyl-1-ethyl-β-D-maltoside **(135)**, notoginsenoside R10 **(136)**, salvisyriacolide **(109)**, 4′,5,7-trihydroxyflavan-3-ol **(57)**, and 3,5-dipentyl-2-hexyl-pyridine **(137)**	Antioxidant	(Saloufou et al., 2018).
F. sycomorus L.	Gallic acid **(84)**, isoquercitrin **(58)**, quercetin-3,7-*O*-α-L-dirhamnoside **(59)**, and rutin **(35)**	Antioxidant	(El-Sayed et al., 2010).
	Lupeol acetate **(94)**	Antibacterial	(Muktar et al., 2018).
F. thonningii Thume	Conrauiflavonol **(64)**, shuterin **(65)**, taxifolin **(118)**	Antimicrobial	(Fongang et al., 2015).
	Ficin **(127)**	Anthelmintic	(Krief et al., 2005).
	Vitexin **(56)**, orientin **(60)**, isovitexin **(61)**, thonningiisoflavone **(62)**, hydroxylalpinumisoflavone **(66)**, thonningiiflavanonol A **(68)**, and thonningiiflavanonol B **(69)**	Antioxidant	(Dangarembizi et al., 2013; Fongang et al., 2015; Ango et al., 2016).
	Resveratrol **(138)**	Cardioprotective	(Baur and Sinclair, 2006).

7. Concluding remarks

The present review shows the ethnomedicinal uses, phytochemistry and bioactivities of some *Ficus* species commonly found in Africa. Various parts of different *Ficus* plants including leaves, roots, twigs, barks, fruits have close characteristics in terms of their chemical constituents and physical features with each part having unique medicinal uses. Species of this genus are rich in flavonoids, triterpenoids, phenolics, coumarins, anthocyanins and glycosides which are responsible for their biological activities known traditionally and scientifically. Some biological activities reported on species of *Ficus* genus include, antimicrobial, nematicidal, antioxidant, antidiabetics, antidiarrhea, anthelmintic, anticancer, anti-inflammatory, antiplasmodial, anti-ulcer, anti-pyretic and gastroprotective activities. However, more *Ficu*s species are yet to be scientifically explored for their bioactivities and phytochemicals. Therefore, further research work, including clinical studies, should be done on more species which could lead to drug development.

Conflict of interest

The authors declare that there is no conflict of interest.

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References

Abubakar, M.S., Musa, A.M., Ahmed, A., Hussaini, I.M., 2007. The perception and practice of traditional medicine in the treatment of cancers and inflammations by the Hausa and Fulani tribes of Northern Nigeria. J. Ethnopharmacol. 111(3), 625-629.

Abubakar, U.S., Danmalam, U.H., Musa, K.Y., Ahmed, A., Jajere, U.M., Abdullahi, S., 2017. Anticonvulsant activity of the methanol root bark extract of *Ficus sycomorus* Linn. (Moraceae). J. Pharm. Pharmacogn. Res. 5(1), 69-77.

Achigan-Dako, E., Pasquini, M., Assogba-Komlan, F., Sognigbe, N., Yedomonhan, H., Dansi, A. Ambrose-Oji, B., 2010. Traditional Vegetables in Benin. Institut National des Recherches Agricoles du Bénin, Imprimeries du CENAP, Cotonou, Bénin.

Adebayo, M.A., Enitan, S.S., Owonikoko, W.M., Igogo, E., Ajeigbe, K.O., 2017. Haematinic properties of methanolic stem bark and fruit extracts of *Ficus sur* in rats pre-exposed to phenylhydrazine-induced haemolytic anaemia. Afr. J. Biomed. Res. 20(1), 85-92.

Ahmad, S., Bhatti, F.R., Khaliq, F.H., Irshad, S., Madni, A., 2013. A review on the prosperous phytochemical and pharmacological effects of *Ficus carica*. Int. J. Bioassays, 2, 843-849.

Ahmadu A.A., Zezi A.U., Yaro, A.H., 2007. Anti-diarrheal activity of the leaf extracts of *Daniella oliveri* Hutch and Dalz (Fabaceae) and *Ficus sycomorus* Miq (Moraceae). Afr. J. Tradit. Complem. Altern. Med. 4(4), 524-528.

Ahmed, F., Ahmed, K.M., Abedin, M. and Karim, A., 2012. Traditional uses and pharmacological potential of *Ficus exasperata* Vahl. Syst. Rev. Pharm. 3(1), 15.

Aiyelero, O.M., Ibrahim, Z.G., Yaro, A.H., 2009. Analgesic and anti-inflammatory properties of the methanol leaf extract of *Ficus ingens* (Moraceae) in rodents. Nigerian J. Pharm. Sci. 8, 79-86.

Alawa, J.P., Jokthan G.E., Akut, K., 2002. Ethnoveterinary medical practice for ruminants in the sub-humid zone of the northern Nigeria. Prev. Vet. Med. 54, 79-90.

Almahyl, H.A., Rahmani, M., SukarP, M.A., Ali, A.A., 2003. Investigation on the chemical constituents of the leaves of *Ficus elastica* Roxb. and their antimicrobial activity. Pertanika J. Sci. Technol. 11, 57-63.

Al-Musayeib, N.M., Mothana, R.A., Matheeussen, A., Cos, P., Maes, L., 2012. *In vitro* antiplasmodial, antileishmanial and antitrypanosomal activities of selected medicinal plants used in the traditional Arabian Peninsular region. BMC complem. Altern. Med. 12(1), 49.

Amol, P.P., Vikas, V.P., Vijay, R.P., Rajesh, Y.C., 2010. Anthelmintic and preliminary phytochemical screening of leaves of *Ficus carica* Linn against intestinal helminthiasis. Int. J. Res. Ayurveda Pharm. 1(2), 601-605.

Amponsah, I.K, Fleischer, T.C, Annan, K., Dickson, R.A, Mensah, A.Y, Sarpong, F.M., 2013. Anti-inflammatory, antioxidant and antimicrobial activity of the stem bark extract and fractions of *Ficus exasperata* Vahl. (Moraceae). J. Pharmacogn. Phytochem. 2(3), 38-44.

Ango, P.Y., Kapche, D.W., Fotso, G.W., Fozing, C.D., Yeboah, E.M., Mapitse, R., Demirtas, I., Ngadjui, B.T., Yeboah, S.O., 2016. Thonningiiflavanonol A and thonningiiflavanonol B, two novel flavonoids, and other constituents of *Ficus thonningii* Blume (Moraceae). Z. Naturforsch. C. 71(3-4), 65-71.

Arbonier, M.A., 2004. Trees, Shrubs and Lianas of West African Dry Zones, second edition, Margraf Publishers, Netherlands 412.

Awad, N.E., Kassem, H.A., Hamed, M.A., Elbatanony, M.M., 2018. Antioxidant and hepatoprotective effects of the lipoidal matters of *Ficus lutea* leaves. J. Herbs Spices Med. Plants 24(4), 368-385.

Awolola, G.V., 2015. Phytochemical Analyses and Biological Activities of Four South African *Ficus* Species (Moraceae). Ph.D. Thesis.

Awolola, G.V., Sofidiya, M.O., Baijnath, H., Noren, S.S., Koorbanally, N.A., 2019. The phytochemistry and gastroprotective activities of the leaves of *Ficus glumosa*. S. Afr. J. Bot. 126, 190-195.

Ayinde, B.A., Omogbai, E.K., Amaechina, F.C., 2007. Pharmacognosy and hypotensive evaluation of *Ficus exasperata* Vahl (Moraceae) leaf. Acta *pol. Pharm*. 64(6), 543-546.

Azuma, K., Ohyama, A., Ippoushi, K., Ichiyanagi, T., Takeuchi, A., Saito, T., Fukuoka, H., 2008. Structures and antioxidant activity of anthocyanins in many accessions of eggplant and its related species. J. Agric. Food Chem. 56, 10154-10159.

Badgujar, S.B., Patel, V.V., Bandivdekar, A.H., Mahajan, R.T., 2014. Traditional uses, phytochemistry and pharmacology of *Ficus carica*: A review. Pharm. Biol. 52(11), 1487-1503.

Bafor, E.E., Igbinuwen, O., 2009. Acute toxicity studies of

the leaf extract of *Ficus exasperata* on haematological parameters, body weight and body temperature. J. Ethnopharmacol. 123(2), 302-307.
Bafor, E.E., Lim, C.V., Rowan, E.G., Edrada-Ebel, R., 2013. The leaves of *Ficus exasperate* Vahl (Moraceae) generates uterine active chemical constituents. J. Ethnopharmacol. 145, 803-812.
Bafor, E.E., Omogbai, E.K., Ozolua, R.I., 2011. Oxytocin inhibiting effect of the aqueous leaf extract of *Ficus exasperata* (Moraceae) on the isolated rat uterus. Acta Pol. Pharm. 68(4), 541-547.
Bafor, E.E., Omogbai, E.K.I., Ozolua, R.I., 2010. *In vitro* determination of the uterine stimulatory effect of the aqueous leaf extract of *Ficus exasperata*. J. Ethnopharmacol. 127(2), 502-507.
Bajaj, Y., 2010. Trees III.Berlin: Springer-Verlag Berlin and Heidelberg GmbH & Co., https://www.kalliergeia.com/en/rubber-plant-ficus-elastica-description-and-uses/ Accessed on 14/03/2022.
Baur, J.A., Sinclair, D.A., 2006. Therapeutic potential of resveratrol: the *in vivo* evidence. Nat. Rev. Drug Discov. 5(6), 493-506.
Beentje, H.J., Mbago, F.M., 2007. A guide to the fig trees of Western Tanzania with special emphasis on Gombe and Mahale National Parks. J. East Afr. Nat. Hist. 96(1), 1-26.
Bello, O.M., Ojediran O.J. Dada, A.O., Olatunya A.M., Awakan, O.J., 2015. *In-vivo* toxicity studies and phytochemical screening of stem bark of *Ficus sycomorus* Linn (Moraceae) J. Environmental Sci. Toxicol. Food Tech. 9(3), 72-74.
Benjamin, F., 2016. *"Ficus glumosa* Delile (= *F. sonderi* Miq.)*"*. PlantZAfrica.com. SANBI, Accessed 30 November 2021.
Berg, C.C., 1989. Classification and distribution of *Ficus*. Experientia 45(7), 605-611.
Berg, C.C., Corner E.J.H., 2005. *Ficus*—Moraceae. Flora Malesiana*,* Series I(17), 1-730.
Berg, C.C., Hijman, M.E.E., 1989. Flora of Tropical East Africa, Moraceae. pp. 1-95.
Berg, C.C., Wiebes, J.T. 1992. African fig trees and fig wasps. Koninklijke Nederlandse Akademie van Wetenschappen. Amsterdam, pp. 1-298.
Bhalerao, S.A., Verma, D.R., Teli, N.C., Didwana, V.S., Thakur, S.S., 2014. *Ficus racemosa* Linn.: A comprehensive review. J. Appl. Chem. 3(4), 1423-1431.
Bhat, M.Z.A., Ali, D.M., Mir, S.R., 2013. Anti-diabetic activity of *Ficus carica* L. stem barks and isolation of two new flavonol esters from the plant by using spectroscopical techniques*.* Asian J. Biomed. Pharm. *Sci*. 3(18), 22-28.
Bindu, C., Bhat, P.R., Prasad, G.K., Girish, B.C., 2016. Relative potency of antidiabetic effect of *Costus speciosus* (Koen. Ex Retz.) Smith plant extract in mouse fibroblast cell line. IJRG 4(3), 99-106.
Bouyahya, A., Bensaid, M., Bakri, Y., Dakka, N., 2016. Phytochemistry and ethnopharmacology of *Ficus carica*. Int. J. Biochem. Res. Rev. 14, 1-12.
Britannica, The Editors of Encyclopaedia. "fig". Encyclopedia Britannica, https://www.britannica.com/plant/fig. Accessed 29 November 2021.
Bronikowska, J., Szliszka, E., Jaworska, D., Czuba, Z.P., Krol, W., 2012. The coumarin psoralidin enhances anticancer effect of tumor necrosis factor-related apoptosis-inducing ligand (TRAIL). Molecules 17(6), 6449-6464.
Burkill, H.M., 1985. Families S-Z Croptograms Addenda. The Useful Plants of West Africa, Royal Botical Garden 5.
Burkill, I.H., 1935. Some Changes in Plant-Names. Bulletin of Miscellaneous Information (Royal Botanic Gardens, Kew), 1935(5), 316-319.
Burrows, J.E, Burrows, S., 2003. Figs of Southern & South-Central Africa. Umdaus Press, Hatfield, South Africa 379.
Canning, C., Sun, S., Ji, X., Gupta, S., Zhou, K., 2013. Antibacterial and cytotoxic activity of isoprenylated coumarin mammea A/AA isolated from *Mammea africana*. J. Ethnopharmacol. 147(1), 259-262.
Cathbert, M., 2019. *Ficus sycomorus L. subsp.* sycomorus. PlantZAfrica.com. SANBI. Retrieved 30 November 2021.
Chawla, A., Kaur, R., Sharma, A.K., 2012. *Ficus carica* Linn, a review on its pharamacognostic, phytochemical and pharmacologica aspects. Int. J. Pharm. Phytopharmacological Res. 1, 215-232.
Coates Palgrave, K., Drummond, R.B., Moll, E.J., 2002. Trees of Southern Africa. Struik Publishers. Cape Town, pp.1212.
Condit, I.J., 1947. The fig. Waltham: Chronica Botanica Co. 222.
Corner, E.J.H., 1988. Wayside Trees of Malaya, Third Ed. Malayan Nature Society, Kuala Lumpur, Malaysia. 2, 861.
Cousins, D., Huffman, M.A., 2002. Medicinal properties in the diets of gorillas: An ethno-pharmacological evaluation. Afr. Study Monogr. 23, 65-89.
Cowan, M.M., 1999. Plant products as antimicrobial agents. Clin. Microbiol. Rev. 12(4), 564-582.
Cushnie, T.T., Lamb, A.J., 2005. Antimicrobial activity of flavonoids. Int. J. Antimicrob. Agents, 26(5), 343-356.
Dangarembizi, R., Erlwanger, K.H., Moyo, D., Chivandi, E., 2013. Phytochemistry, pharmacology and ethnomedicinal uses of *Ficus thonningii* (Blume Moraceae): a review. Afr. J. Tradit. Complem. Altern. Med. 10(2), 203-212.
Datiles, M.J., 2015. *Ficus carica* (common fig). Invasive Species Compendium. Wallingford, UK: CABI. DOI:10.1079/ISC.24078.20203483376.
Dongfack, M.D.J., Lallemand, M.C., Kuete, V., Mbazoa, C.D., Wansi, J.D., Trinh-van-Dufat, H., Michel, S., Wandji, J., 2012. A new sphingolipid and furanocoumarins with antimicrobial activity from *Ficus exasperata*. Chem. Pharm. Bull. 60(8), 1072-1075.
Donia, A.R.M., Soliman, G.A., Zaghloul, A.M., Alqasoumi, S.I., Awaad, A.S., Radwan, A.M., Basodan, O.A., 2013. Chemical constituents and protective effect of *Ficus ingens* (Miq.) Miq. on carbon tetrachloride-induced acute liver damage in male Wistar albino rats. J. Saudi Chem. Soc. 17, 125-133.
Dueñas, M., Pérez-Alonso, J.J., Santos-Buelga, C., Escribano-Bailón, T., 2008. Anthocyanin composition in fig (*Ficus carica* L.). J. Food Compos. Anal. 21(2), 107-115.
Duke, J.A., Bugenschutz-godwin, M.J., Du collier, J., Duke, P.K., 2002. Handbook of Medicinal Herbs, Second edition, CRC Press, Boca Raton, Fla, USA.
Egharevba, H.O., Carew, O., Kunle, O.F., 2015. Phytochemical and pharmacognostic analysis of *Ficus*

thonningii Blume leaves for monograph development. Int. J. Basic Appl. Sci. 4(2), 94-100.

El-Sayed, M.M., Mahmoud, M.A.A., El-Nahas, H.A.K., El-Toumy, S.A.H., El-Wakil, E.A., Ghareeb, M.A., 2010. Bio-guided isolation and structure elucidation of antioxidant compounds from the leaves of *Ficus sycomorus*. Pharmacologyonline 3(3), 317-332.

Fahrioğlu, U., Dodurga, Y., Elmas, L., Seçme, M., 2016. Ferulic acid decreases cell viability and colony formation while inhibiting migration of MIA PaCa-2 human pancreatic cancer cells *in vitro*. Gene 576(1), 476-482.

Faleyimu, O.I., Akinyemi, O., Idris, Y.M., 2010. Survey of forest plants used in traditional treatment of typhoid fever in Chikun Local Government Area of Kaduna State, Nigeria. IJBHS 6(1), 75-81.

Famobuwa, O.E., Agbowuro, A.A., Adekunbi, E.A., Akinwale, M.A., 2019. Isolation andcharacterization of bergapten from the root bark of *Ficus exasperate* (Vahl). Int. J. Biochem. Res. Rev. 25, 1-5.

Feleke, S., Brehane, A., 2005. Triterpene compounds from the latex of *Ficus sur* I. B. Chem. Soc. Ethiopia 19(2), 307-310.

Feng, C., Ma, Y., 2010. Isolation and anti-phytopathogenic activity of secondary metabolites from *Alternaria* sp. FL25, an endophytic fungus in *Ficus carica*. Chin. J. Appl. Environ. Biol. 16, 76-78.

Ferguson, L.., Michailides, T.J. and Shorey, H.H., 1990. The California fig industry. Hortic Rev, 12, 409-490.

Fongang, Y.S.F., Bankeu, J.J.K., Ali, M.S., Awantu, A.F., Zeeshan, A., Assob, C.N., Mehreen, L., Lenta, B.N., Ngouela, S.A., Tsamo, E., 2015. Flavonoids and other bioactive constituents from *Ficus thonningii* Blume (Moraceae). Phytochem. Lett. 11, 139-145.

Frezza, C., Venditti, A., De Vita, D., Toniolo, C., Franceschin, M., Ventrone, A., Tomassini, L., Foddai, S., Guiso, M., Nicoletti, M., Bianco, A., 2020. Phytochemistry, chemotaxonomy, and biological activities of the Araucariaceae family-A review. Plants *9*(7), 888.

Ghosh, S., 2020. Triterpenoids: Structural diversity, biosynthetic pathway, and bioactivity. Stud. Nat. Prod. Chem. 67, 411-461.

Gilani, A.H., Mehmood, M.H., Janbaz, K.H., Khan, A.U., Saeed, S.A., 2008. Ethnopharmacological studies on anti- spasmodic and antiplatelet activities of *Ficus carica*. J. Ethnopharmacol. 119, 1-5.

Ginting, C.N., Lister, I.N.E., Girsang, E., Riastawati, D., Kusuma, H.S.W., Widowati, W., 2020. Antioxidant activities of *Ficus elastica* leaves ethanol extract and its compounds. Mol. Cell. Biomed. Sci. 4(1), 27-33.

Gurib-Fakim, A., 2006. Medicinal plants: traditions of yesterday and drugs of tomorrow. Mol. Asp. Med. 27(1), 1-93.

Hamidu Usman, V.I., Suyi, H.E., Umar, H.A., 2017. Comparative phytochemistry and *in vitro* antimicrobial effectiveness of the leaf extracts of *Clerodendrum capitatum* (Verbenaceae) and *Ficus glumosa* (Moraceae). J. Pharmacogn. Phytochem. 6(6), 945-948.

Hamilton, P., 1991. The ABC's of Indoor Ficus Trees. Pacific Grove, CA: Park Place Publications.

Hankey, A., 2003. *"Ficus sur"*. Plants of SA. PlantZAfrica. com. Retrieved 29 November 2021.

Hassan, S.W., Lawal, M., Muhammad, B.Y., Umar, R.A., Bilbis, L.S., Saidu, Y., 2007. Effects of anthraquinone glycosides and aqueous ethanol extracts of *Ficus sycomorus* L.(Moraceae) on rat liver and kidney functions.

Hsu, W.C., Chang, S.P., Lin, L.C., Li, C.L., Richardson, C.D., Lin, C.C., Lin, L.T., 2015. Limonium sinense and gallic acid suppress hepatitis C virus infection by blocking early viral entry. Antiviral Res. 118, 139-147.

Ibrahim, G., Abdulmumin, S., Musa, K.Y., Yaro, A.H., 2008. Anticonvulsant activities of crude flavonoid fraction of the stem bark of *Ficus sycomorus* (Moraceae). J. Pharmacol. Toxicol. 3(5), 351-356.

Igbokwe, N.A., Igbokwe, I.O., Sandabe, U.K., 2010. Effect of prolonged oral administration of aqueous *Ficus sycomorus* stem-bark extract on testicular size of growing albino rat. Int. J. Morphol. 28(4), 1315-1322.

Ishola, I.O., Olayemi, S.O., Yemitan, O.K., Ekpemandudiri, N.K., 2013. Mechanisms of anticonvulsant and sedative actions of the ethanolic stem-bark extracts of *Ficus sur* Forssk (Moraceae) in rodents. Pak. J. Biol. Sci. 16(21), 1287-1294.

Jan-Hakon, B., 2004. "*Ficus lutea Vahl*". PlantZAfrica. com. SANBI. Accessed on 29 /11/2021.

Jasen, P.C.M., 2005. *Ficus glumosa* Delile. In: Jansen PCM, Cardon, D (Eds.), PROTA 3: Dyes and tannins/ Colorants et tanins. PROTA, Wageningen, Netherlands.

Jordaan, M., 2005. "*Ficus ingens (Miq.) Miq*". PlantZAfrica. com. SANBI. Accessed on 29/11/2021

Joseph, B., Raj, S.J., 2011. Pharmacognostic and phytochemical properties of *Ficus carica* Linn-An overview. Int. J. Pharmtech. Res. 3(1), 8-12.

Kahkonen, P. M., Heinonen, M., 2003. Antioxidant activity of antho-cyanins and their aglycons. J. Agric. Food Chem. 51, 628-633.

Kang, M.S., Oh, J.S., Kang, I.C., Hong, S.J., Choi, C.H., 2008. Inhibitory effect of methyl gallate and gallic acid on oral bacteria. J. Microbiol. 46(6), 744-750.

Karak, P., 2019. Biological activities of flavonoids: An overview. Int. J. Pharm. Sci. Res. 10(4), 1567-1574.

Kiem, P.V., Minh, C.V., Nhiem, N.X., Quang, T.H., Anh, H.T., Cuong, N.X., Kim, Y.H., Jang, H.D., 2012. Chemical constituents of the *Ficus elastica* leaves and their antioxidant activities. Bull. Korean Chem. Soc. 33(10), 3461-3464.

Kim, J., 2012. Chemical constituents of the *Ficus elastica* leaves and their antioxidant activities. Bull. Korean Chem. Soc. 33(10), 3461.

Krief, S., Hladik, C.M., Haxaire, C., 2005. Ethnomedicinal and bioactive properties of plants ingested by wild chimpanzees in Uganda. J. Ethnopharmacol. 101(1-3), 1-15.

Kunkel, G., 1978. Descriptive Part. In: Flowering Trees in Subtropical Gardens. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-9989-3_6.

Kunle, O., Shittu, A., Nasipuri, R., Kunle, O., Wambebe, C., Akah, P., 1999. Gastrointestinal activity of *Ficus sur*. Fitoterapia 70(6), 542-547.

Lansky, E.P., Paavilainen, H.M., 2011. Traditional Herbal Medicines for Modern Times: Figs, The Genus *Ficus*. CRC Press, Taylor and Francis Group LLC. USA, pp. 13-50.

Liu, F.F., Yang, Z.S., Zheng, X., Luo, S.L., Zhang, K.Q., Li, G.H., 2011. Nematicidal coumarin from *Ficus carica L*. J. Asia-Pac. Entomol. 14, 79-81.

Madikizela, B., Ndhlala, A.R., Finnie, J.F., Van Staden, J., 2014. Antimycobacterial, anti-inflammatory and genotoxicity evaluation of plants used for the treatment of tuberculosis and related symptoms in South Africa. J. Ethnopharmacol. 153, 386-391.

Madubunyi, I.I., Onoja, S.O., Asuzu, I.U., 2012. *In vitro* antioxidant and in vivoantidiabetic potential of the methanol extract of *Ficus glumosa* Del (Moraceae) stem bark in alloxan-induced diabetic mice. Comp. Clin. Path. 21, 389-394.

Mahomoodally, M.F., 2013. Traditional medicines in Africa: An appraisal of ten potent African medicinal plants. Special Issue on Recent Advances Towards Validating Efficacy and Safety of African Traditional Medicines. Evid.-based Complement. Alternative Med. 2013, 1-14.

Mali, R.G., Mehta, A.A., 2007. A review on anthemintic plants. Nat. Prod. Rad. 7, 466-475.

Mawa, S., Husain, K., Jantan, I., 2013. *Ficus carica* L. (Moraceae): phytochemistry, traditional uses and biological activities. Evid. Based Complementary Altern Med. 1-8.

Mbakwem-Aniebo, C., Onianwa, O., Okonko, I.O., 2012. Effects of *Ficus exasperata* Vahl on commercial dermatophytes and causative agent of pityriasis versicolor in Rivers State, Nigeria. Am. J. Dermatol. Venereol. 1(1), 1-5.

Mbosso, T.J.E., Assob, N.J.C., Meyer, F., Lenta, N.B., Ngouela, S., Lallemand, B., Mathieu, V., Van Antwerpen, P., Njunda, A.L., Adiogo, D., Tsamo, E., Looze, Y., Kiss, R., Wintjens, R., 2012. Ceramide, cerebroside and triterpenoid saponin from the bark of aerial roots of *Ficus elastica* (Moraceae). Phytochemistry 83, 95-103.

Mbosso, T.J.E., Noundou, X.S., Nguemfo, E.L., Meyer, F., Wintjens, R., Isaacs, M., Mpondo, M.E.A., Hoppe, H.C., Krause, M.R.W., Azebaze, A.G.B., 2017. Biological activities of plant extracts from *Ficus elastica* and *Selaginella vogelli*: an antimalarial, antitrypanosomal and cytotoxity evaluation. Saudi J. Biol. Sci. 25(1), 117-122.

Mbosso, T.J.E., Siwe Noundou, X., Nguemfo, E.L., Meyer, F., Djoukoue, A., Van Antwerpen, P., Ngouela, S., Tsamo, E., Mpondo, M.E.A., Vardamides, J.C., Azebaze, A.G.B., Wintjens, R., 2016. Identification of compounds with anti-proliferative activity from the Wood of *Ficus elastica* Roxb. ex Hornem. aerial roots. Fitoterapia 112, 65-67.

Mennen, L.I., Walker, R., Bennetau-Pelissero, C., Scalbert, A., 2005. Risks and safety of polyphenol consumption. Am. J. Clin. Nutr. 81(1), 326S-329S.

Mishra, A.K., Mishra, A., Kehri, H.K., Sharma, B., Pandey, A.K., 2009. Inhibitory activity of Indian spice plant *Cinnamomum zeylanicum* extracts against *Alternaria solani* and *Curvularia lunata*, the pathogenic dematiaceous moulds. Ann. Clin. Microbiol. Antimicrob. 8(1), 1-7.

Mogg, A.O.D., 1975. Important Plants of Sterkfontein. Johannesburg: University of the Witwatersrand. pp. 78-79. ISBN 0-85494-426-5.

Mohammadhosseini, M., Frezza, C., Venditti, A., Akbarzadeh, A., 2019. Ethnobotany and phytochemistry of the genus *Eremostachys* Bunge. Curr. Org. Chem., 23, 1828-1842.

Muktar, B., Bello, I.A., Sallau, M.S., 2018. Isolation, characterization and antimicrobial study of lupeol acetate from the root bark of Fig-Mulberry Sycamore (*Ficus sycomorus* LINN). JASEM 22(7), 1129-1133.

Nagendra, H. Gopal, D., 2010. Street trees in Bangalore: Density, diversity, composition and distribution. Urban For Urban Green 9(2), 129-137.

Nana, F., Sandjo, L.P., Keumedjio, F., Ambassa, P., Malik, R., Kuete, V., Rincheval, V., Choudhary, M.I., Ngadjui, B.T., 2012. Ceramides and cytotoxic constituents from *Ficus glumosa* Del. (Moraceae). J. Brazil. Chem. Soc. 23(3), 482-487.

Narasimhan, A., Chinnaiyan, M., Karundevi, B., 2015. Ferulic acid regulates hepatic GLUT2 gene expression in high fat and fructose-induced type-2 diabetic adult male rat. Eur. J. Pharmacol. 761, 391-397.

Nasir, E., Ali, S.I., 1972-1994. Flora of Pakistan National Herbarium, NARC. Islamabad. Dept. of Botany, Univ. of Karachi, Karachi. (Fascicles).

Nasr, T., Bondock, S., Youns, M., 2014. Anticancer activity of new coumarin substituted hydrazide-hydrazone derivatives. Eur. J. Med. Chem. 76, 539-548.

Negash, L., 2021. A Selection of African Native Trees: Biology, Uses, Propagation and Restoration Techniques. pp. 621.

Neuwinger, H.D., 2000. African Traditional Medicine: a Dictionary of Plant Use and Applications. With Supplement: Search System For Diseases. Medpharm.

Njoronge, G.N, Kibunga, J.W., 2007. Herbal medicine acceptance, sources and utilisation for diarrhoea management in a cosmopolitan urban area (Thika, Kenya). Afr. J. Ecol. 45, 65-70.

Ntchapda, F., Abakar, D., Kom, B., Nana, P., Bonabe, C., Kakesse, M., Talla, E., Dimo, T., 2014. Diuretic activity of the aqueous extract leaves of *Ficus glumosa* Del. (Moraceae) in rats. Sci. World J. 2014, 1-11.

Odo, G. E., Agwu, J.E., Newze, N., Nwadinigwa, A., Onyeke, C.C., Nzekwe, U., Ajuziogu, G. C., Osayi, E. Ikegbunam, C., 2016. Toxicity and effects of fig (*Ficus carica*) leaf aqueous extract on haematology and some biochemical indices of wistar albino rats (*Rattus norvegicus*). J. Med. Plant Res. 10(22), 298-305.

Odunbaku, O.A., Ilusanya, O.A., Akasoro, K.S., 2008. Antibacterial activity of ethanolic leaf extract of *Ficus exasperata* on *Escherichia coli* and *Staphylococcus albus*. Sci. Res. Essay 3(11), 562-564.

Olaokun, O.O., McGaw, L.J., Awouafack, M.D., Eloff J.N., Naidoo V., 2014. The potential role of GLUT4 transporters and insulin receptors in the hypoglycaemic activity of *Ficus lutea* acetone leaf extract. BMC Complem. Altern. Med. 14(1), 269.

Olaokun, O.O., McGaw, L.J., Eloff, J.N., Naidoo, V., 2013. Evaluation of the inhibition of carbohydrate hydrolysing enzymes, antioxidant activity and polyphenolic content of extracts of ten African *Ficus* species (Moraceae) used traditionally to treat diabetes. BMC Complem. Altern. Med. 13(1), 94.

Olayemi, I.K., Oyiza, M.S., Ukubuiwe, A.C., Ande, A.T., Kamoru, A.A. and Shittu, K.O., 2017. Larvicidal activities of leaf extracts of *Adansonia digitata* L. (Malvales: Malvaceae) and *Ficus sur* Forssk (Rosales: Moraceae) against *Culex quinquefasciatus* Mosquito (Diptera: Culicidae). J. Mosq. Res. 7(15), 115-124.

Oliveira, A.P., Valentão, P., Pereira, J.A., Silva, B.M., Tavares, F., Andrade, P.B., 2009. *Ficus carica* L.: Metabolic and biological screening. Food Chem. Toxicol. 47(11), 2841-2846.

Onoja, S.O., Omeh, Y.N., Ezeja, M.I., Odo, E.C., Elendu, D.S., 2014. Subacute antidiabetic and *in vivo* antioxidant effects of methanolic extract of *Ficus glumosa* stem bark on alloxan-induced hyperglycaemic rats. Comp. Clin. Path. 23(6), 1689-1695.

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., Anthony, S., 2009. Agroforestree Database: A tree reference and selection guide version 4.0. (http://www.worldagrofrestry.org/sites/treedbs/reedatabases.asp).

Palgrave, K.C., 1984. Trees of Southern Africa. Cape Town: Struik. Pp. 105. ISBN 0-86977-081-0.

Palmer, E., 1977. A Field Guide to the Trees of Southern Africa. London, Johannesburg: Collins, pp. 90-91. ISBN 0-620-05468-9.

Pan, M.H., Lai, C.S., Ho, C.T., 2010. Anti-inflammatory activity of natural dietary flavonoids. Food Funct. 1(1), 15-31.

Patil V.V., Patil V. R., 2011. *Ficus benghalensis* Linn, an overview. Int. J. Pharma Bio. Sci. 6(2), 1-11.

Penelope, O., 1997. Great Natural Remedies, Kyle CathicLimited, New York, NY, USA.

Pereira, S.R., Pereira, R., Figueiredo, I., Freitas, V., Dinis, T.C., Almeida, L.M., 2017. Comparison of anti-inflammatory activities of an anthocyanin-rich fraction from *Portuguese blueberries* (*Vaccinium corymbosum* L.) and 5-aminosalicylic acid in a TNBS-induced colitis rat model. PLoS One 12, e0174116.

Phan, V.K., Chau, V.M., Nguyen, X.N., Bui, H.T., Tran, H.Q., Hoang, L.T.A., Nguyen, X.C., Truong, N.H., Seung, H.K., Jin, K.K., Hae-Dong, J., Young, H.K., 2012. Chemical constituents of the *Ficus elastic* leaves and their antioxidant activities. B. Korean Chem. Soc. 33, 3461-3464.

Poumale, H.M., Djoumessi, A.V., Ngameni, B., Sandjo, L.P., Hgadjui, B.T., Shiono, Y., 2011. A new ceramide isolated from *Ficus lutea* Vahl (Moraceae). Acta Chim. Slov. 58(1), 81-86.

Poumale, H.M.P., 2012. Lutamide, a new ceramide isolated from the leaves of *Ficus lutea*. A search for antibacterial agents, 41.

Prelude Medicinal Plants Database, 2011. http://www.metafro.be/prelude/view_plant?pi=06040, Accessed on 14/03/2022.

Ramchoun, M., Harnafi, H., Alem, C., Benlys, M., Elrhaffari, L., Amrani, S., 2009. Study on antioxidant and hypolipidemic effects of polyphenol-rich extract from *Thymus vulgaris* and *Lavendula multifida*. J. Pharm. Pharmacogn. Res. 1, 106-112.

Rice-Evans, C.A., Miller, N.J., Paganga, G., 1996. Structure-antioxidant activity relationships of flavonoids and phenolic acids. Free Radic. Biol.Med. 20, 933-956.

Richter, G., Schwarz, H.P., Dorner, F., Peter, L., 2002. Activation and inactivation of human factor X by proteases derived from *Ficus carica* Linn. Br. J. Haematol. 119, 1042-1051.

Rubnov, S., Kashman, Y., Rabinowitz, R., Schlesinger, M., Mechoulam, R., 2001. Suppressors of cancer cell proliferation from fig (*Ficus carica*) resin: isolation and structure elucidation. J. Nat. Prod. 64, 993-996.

Sabiu, S., Garuba, T., Sunmonu, T., Ajani, E., Sulyman, A., Nurain, I., Balogun, A., 2015. Indomethacin-induced gastric ulceration in rats: protective roles of *Spondias mombin* and *Ficus exasperata*. Toxicol. Rep. 2, 261-267.

Saeed, M.A., Sabir, A.W., 2002. Irritant potential of triterpenoids from *Ficus carica* leaves. Fitoterapia 73(5), 417-420.

Sakpa, C.L., Wilson, O.O., 2019. Anti-spermatogenic effects of *Ficus sycomorus* aqueous leaf extract on testes and epididymis of adult male Wistar Rats. Afr. Sci. 20 (1) 2019.

Saloufou, K.I., Boyode, P., Simalou, O., Eloh, K., Idoh, K., Melila, M., Toundou, O., Kpegba, K., Agbonon, A., 2018. Chemical composition and antioxidant activities of different parts of *Ficus sur*. J. Herbmed Pharmacol. 7(3), 185-192.

Sandabe, U.K., Kwari, H.D., 2000. Some aspects of ethno-veterinary medicine among Kanuri and Bura of Borno state. J. Borno Museum Soc. 44-45.

Sandabe, U.K., Onyeyili, P.A., Chibuzo, G.A., 2003. Sedative and anticonvulsant effects of aqueous extract of *Ficus sycomorus* L. (Moraceae) stembark in rats. Vet. Arch. 73(2), 103-110.

Seifel-Din, S.H., El-Lakkany, N.M., Mohamed, M.A., Hamed, M.M., Sterner, O., Botros, S.S., 2014. Potential effect of the medicinal plants *Calotropis procera*. *Ficus elastica* and *Zingiber officinale* against *Schistosoma mansoni* in mice. Pharm. Biol. 52(2), 144-150.

Shah, S.A., Yoon, G.H., Kim, M.O., 2015. Protection of the developing brain with anthocyanins against ethanol-induced oxidative stress and neurodegeneration. Mol. Neurobiol. 51, 1278-1291.

Shahidi, F., Yeo, J., 2018. Bioactivities of phenolics by focusing on suppression of chronic diseases: a review. Int. J. Mol. Sci. 19(6), 1573.

Shukranul M., Khairana, H., Ibrahim, J., 2013. *Ficus carica* L. (Moraceae): Phytochemistry, traditional uses and biological activities. Evid Based Complement Alternat Med. 2013, 974256.

Simo, C.C., Kouam, S.F., Poumale, H.M., Simo, I.K., Ngadjui, B.T., Green, I.R., Krohn, K., 2008. Benjaminamide: A new ceramide and other compounds from the twigs of *Ficus benjamina* (Moraceae). Biochem. Syst. Ecol. 36(3), 238.

Singh, D., Singh, B., Goel, R.K., 2011. Traditional uses, phytochemistry and pharmacology of *Ficus religiosa*: A review. J. Ethnopharmacol. 134(3), 565-583.

Solomon, A., Golubowicz, S., Yablowicz, Z., Grossman, S., Bergman, M., Gottlieb, H.E., Altman, A., Kerem, Z., Flaishman, M.A., 2006. Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.). J. Agric. Food Chem. 54(20), 7717-7723.

Somashekhar, M.N.N., Mahesh, A.R., 2013. Botanical study of four *Ficus* species of family Moraceae: a review. Int. J. Univ. Pharm. Bio. Sci. 2, 558-570.

Taiwo, B.J., Igbeneghu, O.A., 2014. Antioxidant and antibacterial activities of flavonoid glycosides from *Ficus exasperata* Vahl-Holl (Moraceae) leaves. Afr. J. Tradit. Complem. Altern. Med. 11(3), 97-101.

Takikawa, M., Inoue, S., Horio, F., Tsuda, T., 2010. Dietary anthocyanin-rich bilberry extract ameliorates hyperglycemia and insulin sensitivity via activation of AMP-activated protein kinase in diabetic mice. J. Nutr. 140, 527-533.

Teinkela, J.M., Noundou, X.S., Fannang, S., Meyer, F., Vardamides, J.C., Mpondo, E.M., Krause, R.W.M., Azebaze, A.G.B., Nguedia, J.C.A., 2017. *In vitro* antimicrobial activity of the methanol extract and compounds from the wood of *Ficus elastica* Roxb. ex Hornem. aerial roots. S. Afr. J. Bot. 111, 302-306.

Teklehaymanot, T., Gidday, M., 2007. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, North Western Ethiopia. J. Ethnobiol. Ethnomed. 3(1), 12.

Van Noort, S., Rasplus, J.Y., 2004-2012. *Figweb*. Iziko Museums, South Africa. http://www.figweb.org/Figs_and_fig_wasps/index.htm.

Veluri, R., Singh, R.P., Liu, Z., Thompson, J.A., Agarwal, R., Agarwal, C., 2006. Fractionation of grape seed extract and identification of gallic acid as one of the major active constituents causing growth inhibition and apoptotic death of DU145 human prostate carcinoma cells. Carcinogenesis 27(7), 1445-1453.

Von Breitenbach, F., 1985. Southern Cape Tree Guide. Pretoria: Dept. of Environment Affairs: Forestry. ISBN 0-621-09741-1.

Von Maydell, H., 1990. *Butyrospermum parkii* (G. Don) Kotschy 202-207. Trees and Shrubs of the Sahel: Their Characteristics and Uses. English Text Revised J. Brase. Eschborn: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ).

Wang, Z., Pang, W., He, C., Li, Y., Jiang, Y., Guo, C., 2017. Blueberry anthocyanin-enriched extracts attenuate fine particulate matter (PM2.5)-induced cardiovascular dysfunction. J. Agric. Food Chem. 65, 87-94.

Wehrmüller, K., 2007. Occurrence and biological properties of sphingolipids-A review. Curr. Nutr. Food Sci. 3, 161-173.

Weli, A.M., Al-Blushi, A.A.M. and Hossain, M.A., 2015. Evaluation of antioxidant and antimicrobial potential of different leaves crude extracts of Omani *Ficus carica* against food borne pathogenic bacteria. Asian Pac. J. Trop. Dis. 5(1), 13-16.

Witaicenis, A., Seito, L.N., da Silveira Chagas, A., de Almeida Junior, L.D., Luchini, A.C., Rodrigues-Orsi, P., Cestari, S.H. and Di Stasi, L.C., 2014. Antioxidant and intestinal anti-inflammatory effects of plant-derived coumarin derivatives. Phytomedicine 21(3), 240-246.

Woode, E., Poku, R.A., Abotsi, W.K., 2011. Anticonvulsant effects of leaf extract of *Ficus exasperata* Vahl (Moraceae) in mice. Int. J. Pharmacol. 7, 405-409.

Woodland, D.W., 1997. Contemporary Plant Systematics, Second Edition. Andrews University Press, Berrien Springs, MI 610.

Yakubu, T.M., Salau, A.K., Oloyede, O.B., Akanji, M.A., 2014. Effect of aqueous leaf extract of *Ficus exasperata* in alloxan-induced diabetic Wistar rats. Cameroon J. Exp. Biol. 10(1), 35-43.

Yeh, R.D., Chen, J.C., Lai, T.Y., Yang, J.S., Yu, C.S., Chiang, J.H., Lu, C.C., Yang, S.T., Yu, C.C., Chang, S.J., Lin, H.Y., 2011. Gallic acid induces G0/G1 phase arrest and apoptosis in human leukemia HL-60 cells through inhibiting cyclin D and E, and activating mitochondria-dependent pathway. Anticancer Res. 31(9), 2821-2832.