Chapter 10

# *Olea europaea* subsp. *africana* (Oleaceae)

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Additional information is available at the end of the chapter

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**Abstract**

Background: Medicinal plants have been used as a key source for medication and they remain to provide new therapeutic remedies to date. Extracts of *Olea europaea* subsp. africana *Oleaceae* (leaf, bark and root) are used extensively in Africa to treat various diseases traditionally. Phytochemistry has identified phenols, terpenoids and coumarins in different parts of the plant. However, little pharmacological studies have been done on *Olea europaea* subsp. *africana*. The present review aims to compile available information on the ethnobotany, phytochemistry, pharmacology and toxicology of *Olea africana*.

Materials and methods: Information available pertaining *Olea europaea* subsp. *africana* was collected through electronic search using (Google Scholar, PubMed and Science Direct).

Results: *Olea africana* has been used throughout Africa traditionally for various ailments. Phytochemical studies have led to the isolation of compounds, namely oleuropein, esculin, ursolic acid, scopolin and oleanolic acid. Studies have shown that the leaf extract contains antihypertensive, diuretic, anti-atherosclerotic, antioxidant, antidiarrhoeal and hypoglycaemic activities. Conclusion: *Olea africana* has been used expansively for treating ailments traditionally, but pharmacological studies are seldom published. Further research is required to extend existing therapeutic potential of the African olive.

**Keywords:** *Olea europaea* subsp. *africana*, ethnobotany, phytochemistry, pharmacology, toxicology

## 1. Introduction

Medicinal plants are defined as any plant containing substances which can be used for curative purposes in one or more parts of its organ, which are precursors for the production of useful

drugs [1, 2]. A vast number of these plant species have been used in treating numerous ailments for decades [3, 4]. In Africa, the use of traditional medicine dates back 4000 years ago before the use of orthodox medicine [5]. According to the World Health Organization, traditional medicine still remains the primary healthcare system for an estimated 80% of the population in Africa, because of its affordability and accessibility [2, 6]. South Africa has a profound native knowledge on plants used as traditional remedies [5]. An estimated 30,000 species of higher plants are found in South Africa and 3000 of these species have been used in phytomedicine across the country [7]. It is approximated that 3 million of the South African population uses phytomedicine for primary health purposes [5, 7].

Plant fragments such as leaves, bark, roots, flowers and seeds can be used to derive traditional remedies [8]. These can be prepared not only from a single plant but a combination of plant concoctions [9], aiding in ailments such as influenza, arthritis, heart burn, kidney infections, high blood pressure, etc. [8]. Traditional medicine has also contributed to the management of epidemic diseases such as HIV/AIDS [10], malaria [11] and diabetes [2]. The therapeutic potential of medicinal plants is due to the existence of phytochemicals which comprise of tannins, alkaloids, flavonoids, essential oils and chemical compounds established as subordinate metabolites in plants [4]. It has been reported that at least 25% of commercial drugs are derivatives from plants [2], such as picrotoxin and aspirin [4], and various others are analogues made by chemical synthesis fabricated from isolated compounds from plants [12]. However, biomedical literature data are miniature regarding the safety, quality and efficacy of the plants used in traditional medicine [3]. Therefore, there has been a sudden growth in the interest of studying and using medicinal plants which have led to the isolation of active chemical compounds for therapeutic significance [13]. The plant species from the family *Oleaceae* have been used extensively in traditional medicine in Asia, Southern Africa, European Mediterranean islands, Spain, Italy, etc. [14, 15]; the family *Oleaceae* is a family of dicotyledons [16], containing 600 species in 25 genera, and some genera are wide and arise in several continents [17]. Species of the family are trees, shrubs or woody climbers including the olive tree [16, 17].

## 2. Olea

The genus *Olea* descends from the Greek "elaia" and the Latin "oleum," [16, 18], but it is known in other languages as Olivo (Spanish), Olive (English, French and German), Oliva (Russian, Latin and Italian), Zaitun (Arabic-Persian, Hindi, Urdu and numerous Indian languages) and Zayit (Hebrew) [19]. The genera *Olea* are classified into the subfamily *Oleideae* [20], containing 35 species [21] which extant throughout the Mediterranean, Europe, Africa, Iran and Asia [16]. The olive is thought to have a cultivation history of several 1000 years [19]. It holds historic importance in the context of religion, and it is quoted in the Christian and Hebrew Bibles and the Koran [16, 18].

The olive shrub is rarely consumed as a natural fruit due to its bitter taste but used as oil or table olive [16, 22], and its wild and cultivated forms are considered as a significant botanical research subject [22]. The traditional use of leaves includes treatment for fever, malaria,

bacterial infections, diabetes, inflammatory disorders and hypertension [23]. The decoction of leaves is also used as a mouthwash to treat aphthous, gingivitis and glossitis [23]. The preparation of the bark concoction is taken to treat tapeworm infestation [16]. Olive oil is used externally in the treatment of insect stings and burns [19]. Previous studies established that olive leaves have antioxidant, anti-inflammatory [23], anticancer, antihypertensive and antidiabetic properties [16]. These activities have been shown to be displayed by compounds isolated from the olive tree including iridoids, secoiridoids, lignans, biophenols, flavonoids, flavone glycosides, isochromans and terpenoids [16, 19]. Six species of the olive tree are currently recognized: subsp. *europaea*, subsp. *maroccana*, subsp. *cerasiformis*, subsp. *guanchica*, subsp. *laperrinei* and subsp. *africana* [18].

### 2.1. *Olea europaea* subsp. *africana*

The African species of *Olea europaea*, previously acknowledged as *Olea africana* subsp. *cuspidata*, was defined as *Olea europaea* subsp. *africana* (Mill) in the early 1980s [4, 14]. In Africa, it is commonly known as the wild olive and vernacular names are motholoari (Sotho), olienhout (Afrikaans) and umquma (Xhosa and Zulu) [14, 24].

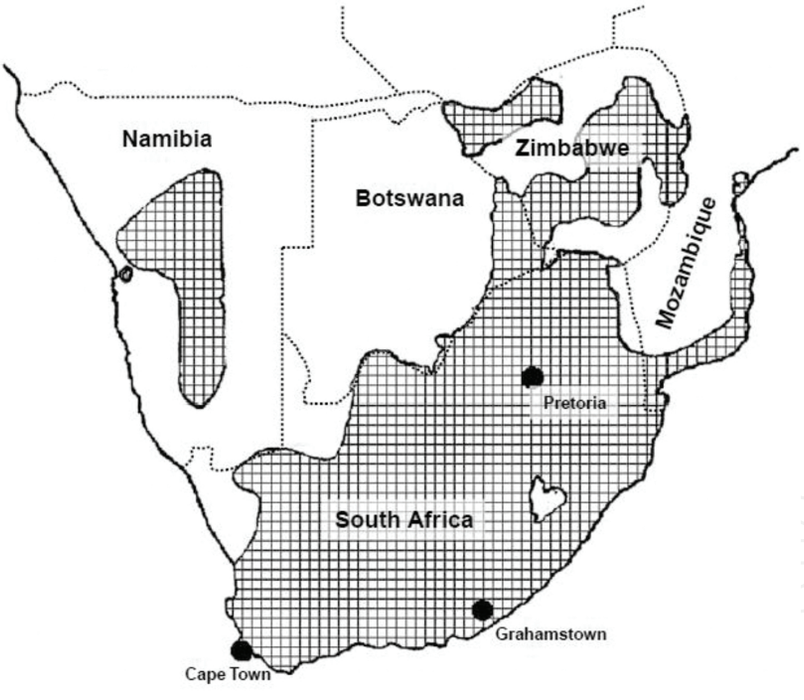


**Figure 1.** Distribution of wild olives in Southern Africa (Mkize et al.) [25].

#### *2.1.1. Geographical distribution*

*Olea africana* is widely distributed in Africa from the southern tip to the north through east Tropical African into Eritrea [14, 15]. The plant is documented in the following countries: South Africa, Tanzania, Sudan, Namibia, Kenya and Ethiopia [15]. In the Asian continent, *O. africana*

is significant in Afghanistan, northern India, Kashmir and Pakistan [15]. The African olive cultivates in a varied range of natural surroundings, from rocky mountain slopes, riverbanks, forest, bush and grassfields [4] (**Figure 1**).

*2.1.2. Botanical description*

The wild olive tree is a shrub which grows to 5–10 m in height, irregularly reaching 18 m [26]. The trees mature into a wild, rounded pattern with a solid upper layer and twisted trunk when exposed to dry conditions [15]. The bark is grey to brownish and flaky once it matures [15]. Flowers are greenish white in colour, 6–10 mm long, with a sweet aroma and held insecurely in axillary or occasionally terminal heads [15, 26]. The ovoid fruit are thinly fleshy, about 7–10 mm in dimension, and upon maturation it turns black or dark brown [15] (**Figures 2–6**; **Table 1**).

**Figure 2.** *Olea africana* shrub (plantzafrica.com).


**Figure 3.** *Olea africana*: Young specimen (a) and mature specimen with twisted trunk (b) (www.KumbulaNursery.co.za).


**Figure 4.** Ovoid fruit of *Olea africana*: Unripe fruit (a), fruits turn red before ripening (b) and ripe fruits (c) (www.KhumbulaNursery.co.za).

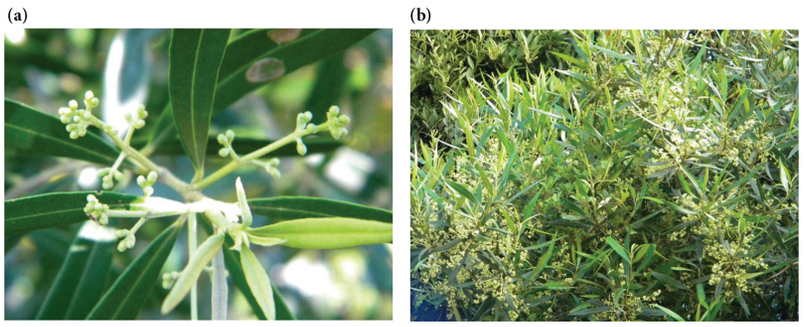


**Figure 5.** Tiny flower buds (a) and blossomed flowers hidden in the foliage (b) (www.KhumbulaNursery.co.za).

**Figure 6.** Wild olive foliage (esc.nsw.gov.au).

| Taxon | Leaf characteristics | Field characteristics/comments |
|---|---|---|
| African wild olive *Olea europaea* subsp. *Africana* | • 6–10 cm in length<br>• 10–25 mm wide<br>• Light green to yellowish brown in the lower part of the leaf<br>• Hooked apex on the tip of the leaf<br>• Yellowish green mid veins | • Fruit are purple black, thinly fleshed drupe about 6–7 mm in diameter<br>• The tree is dense with a twisted trunk, which has dark green glossy leaves. It is weedy in coastal areas |

**Table 1.** Leaf characteristics of the African olive (Cuneo and Leishman, 2006).

### *2.1.3. Photochemistry*

Phytochemicals are various biologically active compounds that occur naturally in plants, which provide potential medicinal benefits for humans [27]. These chemicals assemble in several parts of the plant including the flower, stems, seed, roots and leaves [27]. Phytochemical screening of the African wild olive has led to the separation of phenolic compounds, known as oleuropein, tyrosol and hydroxytyrosol [28] flavonoids [24], triterpenoids (oleanolic acid, ursolic acid) [14] (erythrodiol and uvaol) [29] and coumarin glucosides (esculin and scopolin) [30].

#### *2.1.3.1. Phenols*

Plant phenols are aromatic secondary metabolites, containing antioxidant and antimicrobial properties [31]. The compound oleuropein is a coumarin-like compound, which is profuse in the family *Oleaceae* [32], considered as the main active compound in the olive leaf [27, 33]. It gives olives its bitter principle together with hydroxytyrosol [34], a constituent of oleuropein derived from it through enzymatic hydrolysis [4, 34]. Tyrosol is another structurally related compound that co-occurs with oleuropein [28]. As secoiridoid compounds, they are bound glycosidically, produced from the secondary metabolism of terpenes [32]. In the *Oleaceae* family, it results from the oleoside form of glucoside, which is characterized by an exocyclic 8,9-olefinic functionality [32]. In a previous study, these secoiridoids have been isolated from methanolic and ethyl acetate leaf extracts of the wild olive [28] (**Figure 7**).

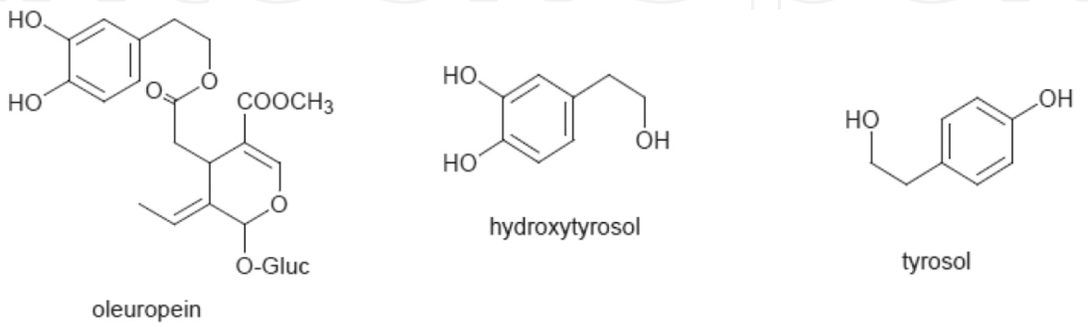


**Figure 7.** Biochemical structures of phenolic compounds found in olives (Ryan and Robards [31]).

*2.1.3.2. Triterpenoids*

Triterpenoids are a vastly varied group of natural products, including steroids, extensively dispersed in plants [35]. These compounds are accumulated by plants in their glycosylated form (saponin) [35]. Oleanolic acid (**Figure 8**) is a biologically active pentacyclic triterpenoid with pharmacologic activities, such as anticancer, hepatoprotective effects, antioxidant and anti-inflammatory [36]. Oleanolic acid is often in existent with its isomer ursolic acid (**Figure 9**) [36]. Ursolic acid is biologically used as an antioxidant, anticancer and anti-inflammatory chemical [37]. Erythrodiol and uvaol are triterpenoids belonging to the oleanane and ursane classes [29]. These compounds have been stated to possess antimalarial, antifungal, antileishmanial, antibacterial and anti-inflammatory activities [29]. Triterpenoids isolated from *O. africana* in previous studies were of dichloromethane [29], ethyl acetate and methanol leaf extracts [14, 28] (**Figure 10**).

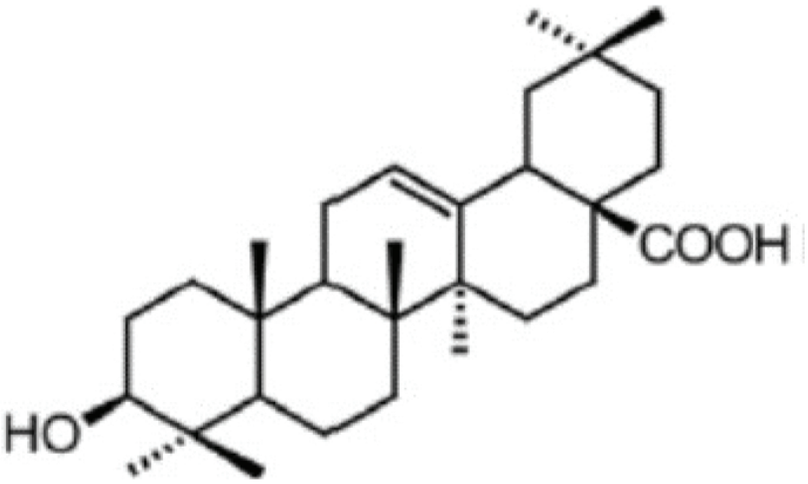


**Figure 8.** Biochemical structure of oleanolic acid (Pollier and Goossens [36]).

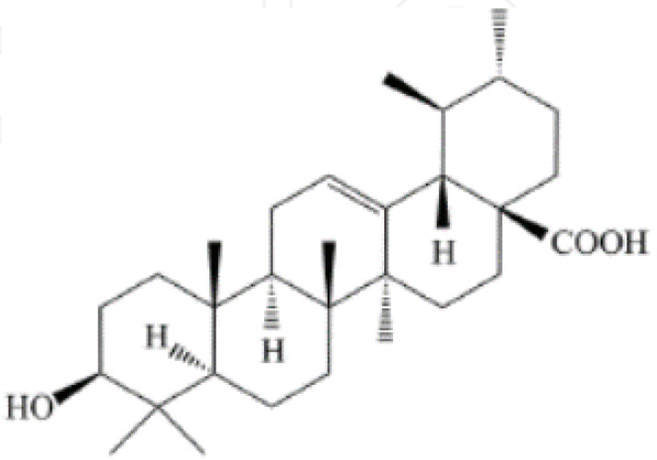


**Figure 9.** Biochemical structure of ursolic acid (Ikeda et al. [37]).

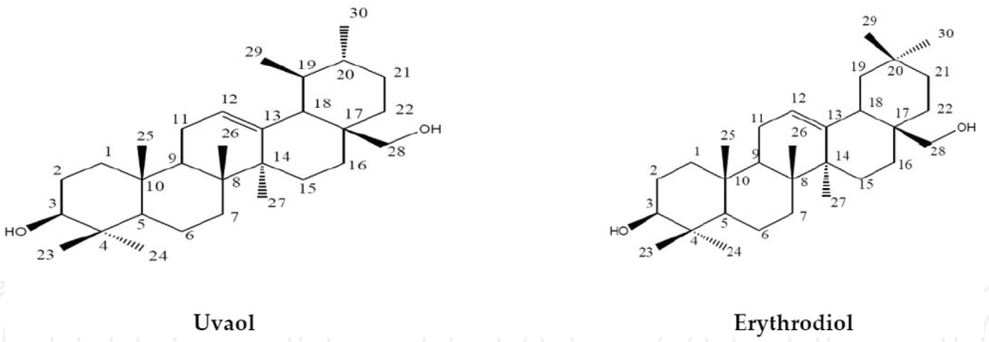


**Figure 10.** Biochemical structures of uvaol and erythrodiol (Douglas et al. [29]).

### *2.1.3.3. Coumarins*

Coumarins are derived from 1,2-benzopyrones, containing of a large class of phenolic elements originating in plants [38, 39] and distributed in the following families: *Guttiferae, Caprifoliaceae, Rutaceae, Umbelliferae, Clusiaceae, Nyctaginaceae, Oleaceae* and *Apiaceae* [39]. Coumarins have received attention in the following therapeutic fields: chemotherapy, multiple sclerosis and organ transplants [38]. The bark of *O. africana* has been reported to contain coumarin glucosides, esculin and scopolin [30] (**Figures 11** and **12**).

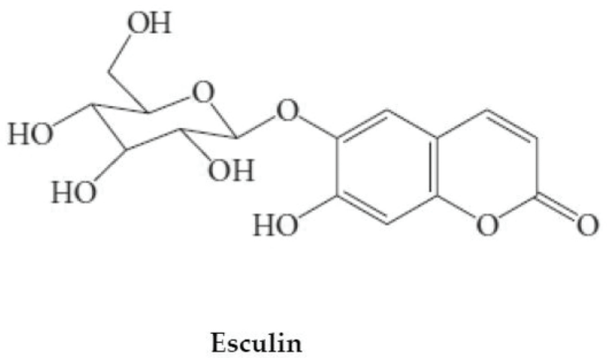


**Figure 11.** Chemical structure of esculin (Venugopala et al. [39]).

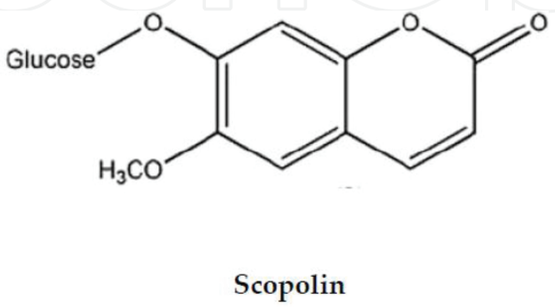


**Figure 12.** Chemical structure of scopolin (Malik et al.) [40].

### *2.1.4. Medicinal uses*

The wild olive tree has been stated to be "the most important plant" from 120 plants being used in traditional medicine [14]. *O. africana* has a number of traditional uses medically that are summarized in **Table 2**. The bark, leaves, roots and fruits are used in different forms, alone or sometimes in combination [28].

| Traditional use | References |
|---|---|
| • Dried and powdered leaf is applied on fresh wounds as a styptic | [28] |
| • Sap from the bark is used for bone-setting (fracture) | [41] |
| • Leaves are used as a treatment for malaria, urinary tract infections, backaches and kidney problems | [4] |
| • Leaf infusions are used as lotion for the treatment of eye infections or to relieve sore throats | [15, 42] |
| • The scraped bark is used to treat headaches and bladder infections. Smoke from a fire made with kindling is believed to clear the head and blood after excessive drinking | [43] |
| • The plant is used traditionally as a hypotensive, febrifuge, diuretic, tonic and emollient, for headaches and bladder and urinary infections | [14] |
| • Powered leaf stops nosebleeds by using it as a snuff. Leaves are used as tea. Sugar and boiled ripe fruits are administered for coughs | [28] |
| • The leaf and stem bark decoctions are treatment for anaplasmosis and also retained afterbirth | [12] |
| • Bark, which is dried, pound and powdered, is applied for eye illnesses. Boiled bark is administered for itchy rashes | [44] |
| • Boiled bark is administered to treat tapeworms | [45] |
| • Decoction of stem bark is used to treat helminthiasis, asthma, rheumatism and lumbago in Samburu district, Kenya | [46] |
| • Bark, root and leaf infusions are taken to relieve colic, leaf infusion taken to treat sore throats and diphtheria | [47] |
| • Fruit infusion treats bloody stool and diarrhoea | [48] |
| • Decoction of the fruits and leaves is used in treating blood pressure in the Transkei region | [49] |

**Table 2.** Traditional uses of *Olea europaea* subsp. *africana* in Africa.

### *2.1.5. Pharmacology*

#### *2.1.5.1. Antidiarrhoeal activity*

A study by Amabeoku and Bamuamba [24] investigated the methanolic leaf extract of *O. africana* for antidiarrhoeal activity in mice. The use of the plant in the Western Cape rural areas in treating diarrhoea is extensive. Albino mice were administered with the methanol leaf extract at doses ranging from 25 to 75 mg/kg, 15 min before the administration of castor oil at a dosage of 0.7 ml (orally (p.o)). It was observed that the methanol leaf extract doses from 50 to 75 mg/kg expressively reduced the occurrence of diarrhoea by notably decreasing the number of mice affected with diarrhoea. The plant extract dose of 25 mg/kg was able to protect 50% of the animals affected with diarrhoea; therefore, signifying it did not have a significant effect on the occurrence of diarrhoea. This study showed that *O. africana* methanolic leaf extract

was able to significantly antagonize diarrhoea, by possibly exerting its activity through reducing intestinal motility [24].

*2.1.5.2. Antihypertensive, antiatherosclerotic, hypoglycaemic and antioxidant activity*

Somova et al. [14] stated that the African wild olive leaf can prevent atherosclerosis and hypertension and improve insulin resistance. The experimental animals were treated at a dosage of 60 mg/kg b.w with ethyl acetate leaf extract, as this fraction is known to contain the active compound oleuafricein. Hemodynamic screening was evaluated for 42 days monitoring the administration of the drug, heart rate, systolic and diastolic blood pressure. The Lipschitz test was conducted to record the excreted urine after 5 h and after 24 h. On completion of the study, the animals were starved overnight and killed. Following killing, blood glucose was estimated, and glutathione peroxidase and superoxide dismutase were assayed. These biochemical parameters showed that treatment with *O. africana* leaf extract after 6 weeks exhibited effective hypoglycaemic, antiatherosclerotic, antihypertensive and antioxidant activity. It was obtained that *O. africana* contains 0.27% combination of ursolic and oleanolic acid accountable for the bioactivities [14].

A study by Abdel-Sattar et al. [50] reported antihypertensive, hypoglycaemic and antioxidant properties of *O. africana* methanol leaf extract. The antioxidant activity was studied by exploring scavenging activity of 1,1-diphenyl-2-picrylhydrazyl free radical. The Olive leaf extract reduced the radical to a yellow-coloured diphenylpicrylhydrazine, confirming its antioxidant property. Experimental animals were treated with the extract for 42 days at a dosage of 200 mg/kg to evaluate hypertension and three dosage levels (100, 300 and 500 mg/kg) for antihyperglycaemic activity. The results obtained were partial reduction of L-N-nitroarginine methyl ester (L-NAME) which triggered hypertension compared to the control group. The Olive leaf revealed blood glucose lowering activity against streptozotocin (STZ) which elicited hyperglycaemia in rats. The highest dose of the extract (500 mg/kg) exhibited a significant decrease in blood glucose level by 69.6% on the fourth week of treatment relative to the control group. *O. africana* was exhibited to have protective activity against diabetes induced by STZ and hypertension induced by L-NAME. The antihyperglycaemic activity was accredited to be caused by an increase in glucose uptake in skeletal muscle, antioxidant activity, inhibition of liver gluconeogenesis and insulinomimetic effect [33].

*2.1.5.3. Antibacterial activity*

A study by Douglas et al. [29] evaluated the antibacterial activity of the leaves of *O. africana*. The bacterial strains *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 87853 and *Bacillus subtilis* BCCM 1735 were used for this study. The crude extracts displayed comparatively elevated action against bacteria in Gram-positive strains with the methanol extract exhibiting the highest antibacterial activity. The triterpenoids (uvaol and erythrodiol) isolated from the plant exhibited adequate antibacterial activity. However, in the *E. coli* strain, the compounds showed no significant activity, as this strain has been stated to have multi-resistance against antibiotics. Erythrodiol presented higher bioactivity compared to uvaol against *S. aureus* [29].

A study by Douglas and Jeruto [51] investigated antibacterial activity of *O. africana* leaf extracts (methanol, ethyl acetate and dichloromethane) against *Pseudomonas aeruginosa, Bacillus subtilis, Escherichia coli* and *Staphylococcus aureus*, by means of micro-broth diffusion method. The bacterium strain *S. aureus* was the most susceptible to dichloromethane extract (15 mg/mL) displaying a zone of inhibition of 19.40 mm. The strains *P. aeruginosa, E. coli* and *B. subtilis* were inhibited effectively with the methanol extract (25 mg/mL) with zones of inhibition 17.40, 17.20 and 19.20 mm, respectively [51]. These studies therefore assume that *O. africana* could be used traditionally in treating symptoms of infection and inflammation by bacteria [29, 51].

*2.1.5.4. Toxicology*

Amabeoku and Bamuamba [24] examined *O. africana* methanolic leaf extract in groups of eight per dose (400, 800, 1200, 1600, 2000, 2400, 2800, 3200, 3600 and 4000 mg/kg). It was observed that the mortality rate increased as the dosage increased from 2800 to 4000 mg/kg. The doses from 2000 to 4000 mg/kg indicated the animals to be hypoactive. The dose at 3475 mg/kg was determined to be the LD50 value for the plant [24]. Somova et al. [14] investigated the effect of the African wild olive leaves on Sprague-Dawley rats using the doses 20, 40, 60 and 80 mg. It was observed using the brine shrimp test that the leaf extract had a toxicity with LC50 of 1.25 at a dosage of 60 mg/kg which was relatively low. The reference substances, ursolic and oleanolic acid, showed low toxicity with LC50 of 0.95 and 0.10 mg/mL, respectively [14]. These studies therefore conclude that the African wild olive is non-toxic and can be used as medical drug.

## 3. Conclusion

*Olea africana* has a varied range of documented medicinal uses such as treatment for eye infections, urinary tract infections, headaches, sore throat, diuretics and hypertension. However, little is known pharmacologically regarding the African olive. The mentioned pharmacological studies found the plant to have hypoglycaemic, antihypertensive, antibacterial, antidiarrhoeal, anti-atherosclerotic and antioxidant activities. These bioactivities are elicited by compounds isolated from the plant including oleuropein, ursolic and oleanolic acid. Further scientific research is required to attain the traditional therapeutic potential, identification of potential mechanism of action and toxicity of the African olive.

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