A review of the chemistry of some species of genus *Aloe*  
(Xanthorrhoeaceae family)

**Japheth Omollo Ombito**, Elsie Nyangweso Salano, Philemon Kipkirui Yegon, Wesley Kipkirui Ngetich, Elizabeth Mathoni Mwangi, Geoffrey K. Kibet Koech*

**Abstract**

In recent years, the focus on plant research has increased all over the world and a large body of evidence has collected to show immense potential of medicinal plants used in various traditional systems. In the traditional systems of medicine, most of the remedies were taken from plants and they were proved to be useful. *Aloe* genus, which belongs to the family Xanthorrhoeaceae, produces a number of metabolites in good yields and some have been shown to possess useful biological activities. Over 130 compounds belonging to different classes, including anthrones, chromones, pyrones, coumarins, alkaloids, glycoproteins, naphthalenes and flavonoids have so far been reported from the genus. This review focuses on ethnopharmacology, phytochemistry and pharmacology of *Aloe* genus to allow an evaluation of the potential for utilization of the largest biomass of *Aloe* genus available.

**Keywords:** *Aloe*, Xanthorrhoeaceae, Phytochemistry, Pharmacology.

**Introduction**

*Aloe* is a genus containing over 500 species of flowering succulent plants. The APG III system (2009) places the genus in the family Xanthorrhoeaceae, subfamily Asphodeloideae. In the past, it has also been assigned to families Aloaceae and Liliaceae or lily family. The genus is native to Africa; species are found in southern Africa, the mountains of tropical Africa, various islands off the coast of Africa including Sardinia, Madagascar, and the Arabian Peninsula. The term aloe is derived from the Arabic word alloeh, which means a shining bitter substance. Medicinally, the gel and dried leaf exudates of *Aloe* species have been used since ancient civilizations of the Egyptians, Greeks and Mediterranean people. *Aloe* species have enjoyed a very wide folkloric usage and are also now used in modern medicine in many parts of the world. The bitter leaf exudates of some *Aloe* species are commercially important sources of the laxative *Aloe* drugs and are also used in the cosmetics industry as additives in shampoos, shaving and skin care creams and in the treatment of skin disorders. The exudates have also been used as a bitters agent in alcoholic beverages. The leaves and roots of *Aloe* species elaborate many interesting secondary metabolites belonging to different classes of compounds including, anthrones, chromones, pyrones, coumarins, alkaloids, glycoproteins, naphthalenes, anthraquinones and flavonoids.

**Medicinal importance and bioactivity of some of the isolated secondary metabolites from *Aloe* species**

a ) *Aloe vera*

*Aloe vera* is known to be an ornamental as well as a medicinal plant. Since Roman times, it has been used therapeutically with its different properties being ascribed to the inner colorless leaf gel and to the exudates from the outer layers.
Several chemical components of the Aloe gel are thought to be responsible for its medicinal properties. As a result of these studies, there have been numerous reports of Aloe having diverse biological activities, including anti-tumor activity, anti-acid activity, tyrosinase inhibiting activity and antioxidant activity. In search of anti-hyperglycemic compounds, Tanaka and co-workers isolated five phytosterols namely cycloartenol, 24-methylene-cycloartenol, lophenol, 24-methyl-lophenol and 24-ethyl-lophenol, and evaluated them for their anti-hyperglycemic effects in type 2 diabetic mice. Ascorbic acid was reisolated from the leaves of Aloe vera to exhibit antimicrobial and antibacterial activities. These compounds were reported to effectively kill or greatly reduce or eliminate the growth of Staphylococcus aureus, Klebsiella pneumoniae, Streptococcus pyogenes, Pseudomonas aeruginosa, Escherichia coli, Propionibacterium acne, Helicobacter pylori and Salmonella typhi.

Aloe hijazensis is a luscious plant with pale green leaves whose edges consist of closely spaced distinct brownish teeth. The plant produces stems that grow up to 1.5 meters long with yellow flowers that grow very close to the stem. The leaves and roots of A. hijazensis possess medicinal properties, which have made them useful in treating a myriad of diseases. The methanol extracts of the leaves and roots of A. hijazensis have been shown to have antibacterial activity against eight different pathogenic bacteria such as Staphylococcus aureus, Streptococcus avium, Corynebacterium pyogenes, Haemophilus paragallinarum, Clostridium perfringens, Salmonella typhimurium, Salmonella pullorum and Escherichia coli. The extracts also portrayed antifungal activity against seven fungal species, including Aspergillus niger, Aspergillus fumigatus, Fusarium moniliforme, Microsorum gypseum, Fusarium oxysporium, Candida albicans and Trichophyton rubrum. However, it was reported that the leaf extracts were more potent than the roots. A later study by Abd-Alla et al revealed that the flower and peduncle extracts of A. hijazensis also possessed antiviral activities against four haemagglutinating viruses, namely, Newcastle disease virus (NDV), avian influenza virus type A (AI-H5N1), egg-drop syndrome virus (EDSV) and avian paramyxovirus type-1 (APMV-1). The active compounds isolated from A. hijazensis include hydroquinones such as emodin, aloemodin, aloesaponarin II, 3-methyl ether, chrysophanol, ziganein, ziganin-5-methyl ether and aloesaponarin I. Other active compounds include feralolid and 4,7-dichloroquinoline, lupeol, aloin and two aloenin derivatives namely ethylidene-aloenin and aloenin. Four flavonoids namely quercetin, kaempferol, cosmosin and isovitexin have also been isolated alongside other compounds such as cinnamic acid, caffeic acid and ferulic acid.
Although little information on the chemical or biological studies of this plant has been published, Minale and co-workers investigated the leaf latex of A. sinana for its antibacterial and antifungal activities. In their study, they isolated and characterized three anthrones, aloin 20, aloinoside 29 and microdontin 30 responsible for the antimicrobial effect of the latex. The three compounds showed broad spectrum antibacterial activity against both Gram-positive and Gram-negative bacteria. Strong activity was observed against the different strains of E. coli, S. typhi Typ 2, Shigella, S. aureus and V. cholerae, which was comparable to ciprofloxacin (Fig 3).

**Figure 3:** Compounds isolated from Aloe sinana

**d) Aloe ferox**

Aloe ferox also known as Cape Aloe is a single stemmed “tree aloe” which grows to 5-6 feet tall. It forms rosettes of canvas green leaves to 2½ feet wide with spines sometimes scattered about the leaves irregularly and sparsely. It is widespread in the Eastern Cape province of South Africa, where it is widely used for the treatment of various diseases including STIs such as gonorrhea and syphilis. In search of compounds with antibacterial activity, Kambizi and co-workers isolated three known compounds, aloemodin 11, chrysohanol 13 and aloin 20 from A. ferox. All the three compounds showed inhibitory activity against Bacillus subtilis, Bacillus cereus, Staphylococcus aureus, Staphylococcus epidermis, Escherichia coli and Shigella sonnei.

Three new naphtho[2,3-c]furan derivatives, 5-hydroxy-3-methylnaphtho[2,3-c]furan-4(9H)-one 31, 5-hydroxy-3-methylnaphtho[2,3-c]furan-4,9-dione 32 and 5-hydroxy-3-methylnaphtho[2,3-c]furan-4(1H)-one 33 were also isolated from this plant. From dichloromethane extract of A. ferox, ten compounds were isolated and tested for their growth inhibiting effect on Ehrlich ascites tumor cells (EATC). Their structures were elucidated as aloemodin 11, p-hydroxybenzaldehyde 34, p-hydroxyacetophenone 35, pyrocatechol 36, 10-oxo-octadecanoic acid 37, 10-hydroxy-octadecanoic acid 38, methyl-10-hydroxy-octadecanoate 39, 7-hydroxy-2,5-dimethylchromene 40, furuoloesone 41and 2-acetyl-8-(2-furoylmethyl)-7-hydroxy-5-methylchromone 42. These compounds exhibited a synergistic growth-inhibiting effect on EATC (Fig 4).

**Figure 4:** Compounds isolated from Aloe ferox

**e) Aloe excelsa**

Aloe excelsa, also known as the Zimbabwe Aloe is an arborescent aloe. The Zimbabwe aloe is named for the large number of specimens found growing around the ruins of Great Zimbabwe, where it has attracted much attention for its size and shape. It is large and reaches tree, dimensions of 5–6 metres, although 3 metres is a common height. It is single-stemmed and all but the lowest part of the trunk is swathed in the remains of dead leaves. A sap from its leaves has been reported to control coccidiosis, a common and fatal disease in poultry. Two compounds 11 and 20 were isolated from the leaves of A. excelsa and tested for antibacterial activities against four Gram negative and five Gram positive bacterial strains. Compound 11 showed inhibitory activity against all test organisms with MIC ranging from 62.5 µg/ml in B. subtilis and E. coli to 250 µg/ml in S. epidermidis and S. sonnei (Fig 2).

**f) Aloe nyeriensis**

Aloe nyeriensis is a succulent species of aloe, endemic to Kenya. The plant grows to an average of 1.5 metres tall and sends up an inflorescence on a flowering stalk from 0.5-0.8 metres tall, densely packed with red flowers. A. nyeriensis grows mostly on rocky soils. From this plant two anthraquinones, Nataloe- emodin 43 and Nataloe-emodin-2-O-Glc 44, an anthrone, Nataloin 45, and three pyrones, Aloein 46, Aloein aglycone 47 and Aloein-2"-p-coumaroyl ester (fig. 5) were isolated (Fig. 5).
A plant traditionally used for treating dreadful diseases have been isolated from the plant kingdom. It is, therefore, very clear that the study of the medicinal plants is important to meet the requirements in effective therapy. Phytochemical studies on the genus Aloe have shown that the plants from this genus are rich sources of different classes of compounds such as anthrones, chromones, pyrones, coumarins, alkaloids, glycoproteins, naphthalenes and flavonoids. These classes of compounds have been shown to possess antiviral, anti-tumor and antibacterial activities. As a result, plants from Aloe genus should be explored further as an alternative source of medicine.

Conclusion

Most of the potent and efficacious medicinal principles used for treating dreadful diseases have been isolated from the plant kingdom. It is, therefore, very clear that the study of the medicinal plants is important to meet the requirements in effective therapy. Phytochemical studies on the genus Aloe have shown that the plants from this genus are rich sources of different classes of compounds such as anthrones, chromones, pyrones, coumarins, alkaloids, glycoproteins, naphthalenes and flavonoids. These classes of compounds have been shown to possess antiviral, anti-tumor and antibacterial activities. As a result, plants from Aloe genus should be explored further as an alternative source of medicine.

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References


