Journal of Scientific and Innovative Research 2015; 4(1): 49-53
Available online at: www.jsirjournal.com


**Review Article**

ISSN 2320-4818
JSIR 2015; 4(1): 49-53

Received: 08-12-2014
Accepted: 27-01-2015

**Japheth Omollo Ombito**
*Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya*

**Elsie Nyangweso Salano**
*Biochemistry Department, Egerton University P.O. Box 536 EgertoSn, Kenya*

**Philemon Kipkirui Yegon**
*Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya*

**Wesley Kipkirui Ngetich**
*Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya*

**Elizabeth Muthoni Mwangi**
*Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya*

**Geoffrey K. Kibet Koech**
*Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya*

**Correspondence:**
**Japheth Omollo Ombito**
Chemistry Department, Egerton University P.O. Box 536 Egerton, Kenya

# 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 Muthoni 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.[1] The APG III system (2009) places the genus in the family Xanthorrhoeaceae, subfamily Asphodeloideae.[2] 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.[3] The term aloe is derived from the Arabic word alloeh, which means a shining bitter substance.[4] Medicinally, the gel and dried leaf exudates of aloe species have been used since ancient civilizations of the Egyptians, Greeks and Mediterranean people.[5] *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[6] and are also used in the cosmetics industry as additives in shampoos, shaving and skin care creams[7] and in the treatment of skin disorders. The exudates have also been used as a bittering agent in alcoholic beverages.[8] 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.[9]

## 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.[10]

Several chemical components of the *Aloe* gel are thought to be responsible for its medicinal properties.[11] As a result of these studies, there have been numerous reports of *Aloe* having diverse biological activities, including anti-tumor activity, anti-acid activity[12] tyrosinase inhibiting activity[13] and antioxidant activity [14]. In search for anti-hyperglycemic compounds, Tanaka and co-workers isolated five phytosterols namely cycloartanol **1**, 24-methylene-cycloartanol **2**, lophenol **3**, 24-methyl-lophenol **4** and 24-ethyl-lophenol **5**, and evaluated them for their anti-hyperglycemic effects in type 2 diabetic mice. Ascorbic acid **6**, p-coumaric acid **7**, cinnamic acid **8** and pyrocatechol **9**, isolated from the leaves of *A. vera* were reported to exhibit antimicrobial and antibacterial activities.[15] 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* (Fig. 1).

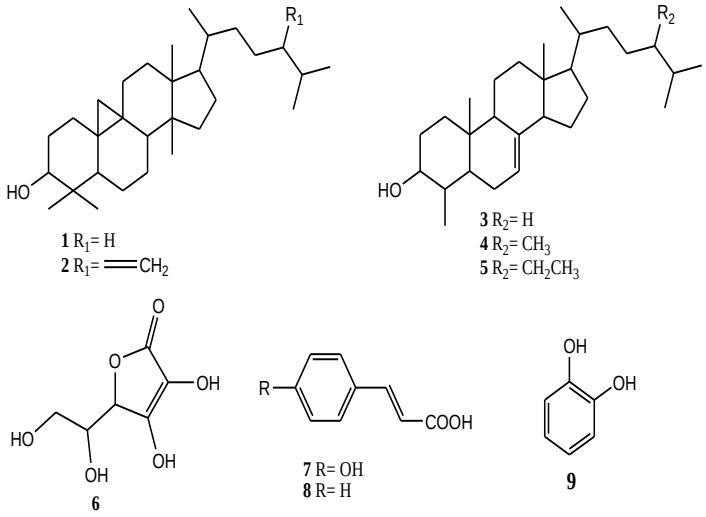


**Figure 1:** Compounds isolated from *Aloe vera*

**b) *Aloe hijazensis***

*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 [16] such as *Staphylococcus aureus, Streptococcus avium, Corynebacerium pyogens, Haemophilus paragallinarum, Clostridium perfringens, Salmonella typhimurium, Salmonella pullurum* and *Escherichia coli.* The extracts also portrayed antifungal activity against seven fungal species, including *Aspergillus niger, Aspergillus fumigates, Fusarium moniliforme, Microsporum 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).[17] The active compounds isolated from *A. hijazensis* include hydroquinones such as emodin **10**, aloe-emodin **11**, aloesaponarin II 3-methyl ether **12**, chrysophanol **13**, ziganein **14**, ziganein-5-methyl ether **15**, and aloesaponarin I **16** [16]. Other active compounds include feralolide **17**, 4,7-dichloro-quinoline **18**, lupeol **19**, aloin **20**, and two aloenin derivatives namely ethylidene-aloenin **21**and aloenin **22**. Four flavonoids namely quercetin **23**, kaempferol **24**, cosmosiin **25** and isovitexin **26** have also been isolated alongside other compounds such as cinnamic acid **8**, caffeic acid **27** and ferulic acid **28.**[16] (Fig. 2).

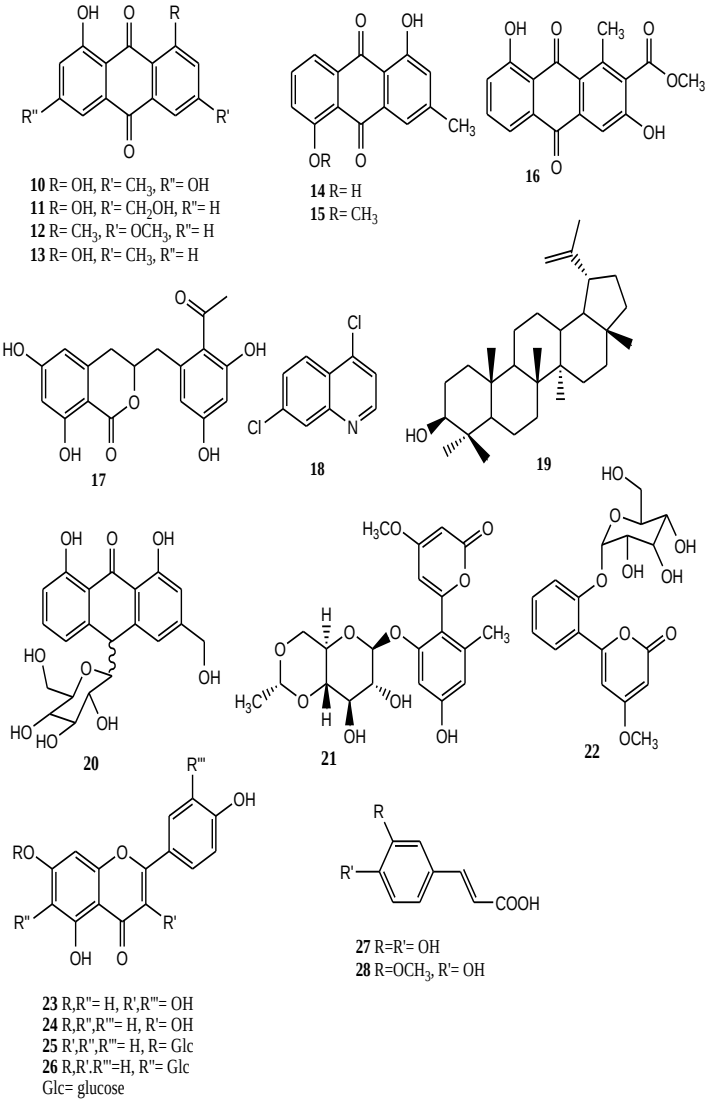


**Figure 2:** Compounds isolated from Aloe hijazensis and *Aloe excels*

**c) *Aloe sinana***

*Aloe sinana* Reynolds is endemic to Ethiopia, where its leaf latex is traditionally used in and around the town of Debre Sina and other central highlands as a wound-healing agent, insecticide and for the treatment of snake bite and malaria by the local people.[18]

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).

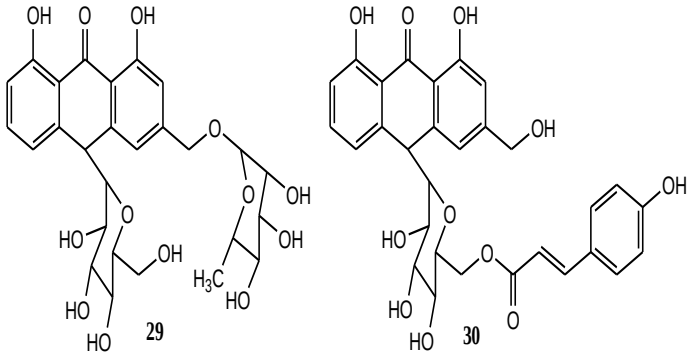

**Figure 3:** Compounds isolated from *Aloe sinana*

**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.[19] In search of compounds with antibacterial activity, Kambizi and co-workers isolated three known compounds, aloe emodin **11**, chrysophanol **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(9*H*)-one **31**, 5-hydroxy-3-methylnaphtho[2,3-c]furan-4,9-dione **32** and 5-hydroxy-3-methylnaphtho[2,3-c]furan-4(1*H*)-one **33** were also isolated from this plant.[20] From dichloromethane extract of *A. ferox*, ten compounds were isolated and tested for their growth inhibiting effect on Ehrlich ascites tumor cells (EATC).[21] Their structures were elucidated as aloe emodin **11**, p-hydroxybenzaldehyde **34**, p-hydroxyacetophenone **35**, pyrocatechol **36**, 10-oxooctadecanoic acid **37**, 10-hydroxyoctadecanoic acid **38**, methyl-10-hydroxyoctadecanoate **39**, 7-hydroxy-2,5-dimethylchromone **40**, furoaloesone **41**and 2-acetonyl-8-(2-furoylmethyl)-7-hydroxy-5-methylchromone **42**. These compounds exhibited a synergistic growth-inhibiting effect on EATC (Fig 4).

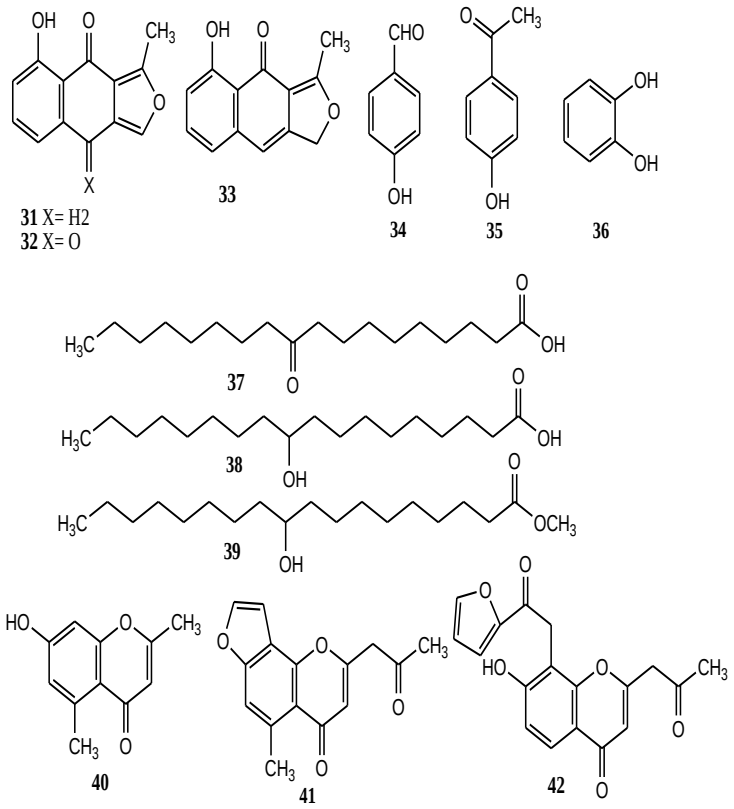

**Figure 4:** Compounds isolated from *Aloe ferox*

**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[22.] 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.[23] 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.[24] *A. nyeriensis* grows mostly on rocky soils. From this plant two anthraquinones, Nataloe-emodin **43** and Nataloe-emodin-2-*O*-Glc **44**, an anthtrone, Nataloin **45**, and three pyrones, Aloenin **46**, Aloenin aglycone **47** and Aloenin-2"-*p*-coumaroyl ester (fig. 5) were isolated (Fig. 5).[25]

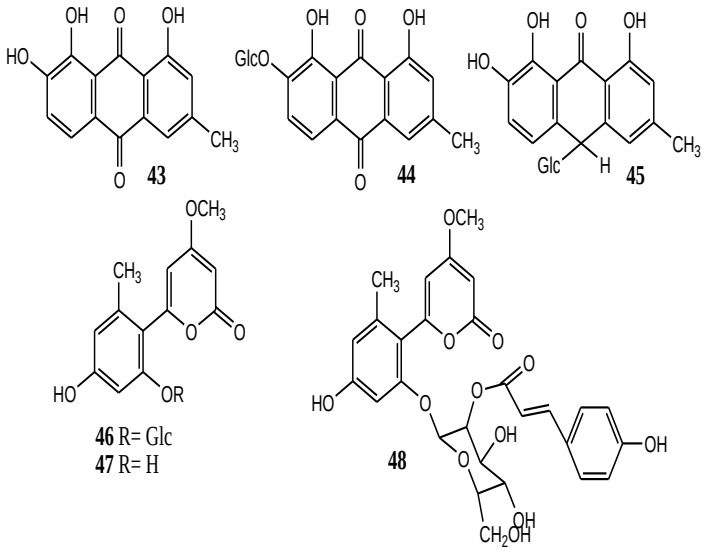


**Figure 5:** Compounds isolated from *Aloe nyeriensis*

**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.

**Acknowledgement**

The authors thank the Department of Chemistry Egerton University, Kenya for providing a conducive research environment.

**References**

1. The Plant List (2010). The Pant List web application Version 1. 12 August 2014. http://www.theplantlist.org.html (12 Aug. 2014).

2. Stevens, P.F. (2001). "Angiosperm Phylogeny Website. Version 12. 7 July 2014. http://www.mobot.org/MOBOT/research/APweb/.html (7 Jul 2014).

3. "Aloe". World Checklist of Selected Plant Families. Royal Botanic Gardens, Kew. 10 August 2014. http://www.app.kew.org/wcsp/home.do.html (10 Aug. 2014).

4. Tyler, V. E., Brady, L. R., Robbers, J. E.. Pharmacognosy. 7th ed. Lee and Febiger: Philadelphia,1976.

5. Trease, G. E., Evans, W. C. Pharmacognosy. 12th ed, Bailliere Tindall, London, 1976, p.404

6. Cheney, R. H.. *Aloe* drug in human therapy. Quart J. Crude Drug Res. 1970; 10: 523-530.

7. Leung, A. Y. *Aloe vera* in cosmetics. Excelsa 1977; 8:65-68.

8. Council of Europe (ed). Flavoring substances and natural resources of flavorings; Maisonneuve, Moulins-les-Metz, 1981.France p 6.

9. Dagne, E. Review of the chemistry of Aloe of Africa. Bull. Chem. Soc. Ethiop. 1996; 10(1): 89-103.

10. Morton, J. F.. Folk uses and commercial exploitation of Aloe leaf pulp. Econ. Bot 1961; 15: 311-319.

11. Tanaka, M., Misawa, E., Ito, Y. Identification of five phytosterols from *Aloe vera* gel as anti-diabetic compounds. Biol. Pharm Bull. 2006;29:1418–1422.

12. Hirata T., Suga T., Z.. Biologically active constituents of leaves and roots of *Aloe arborescens* uar. natalensis. Naturforsc. 1977;32c: 731-734.

13. Piao, L. Z., Park, H. R., Park, Y. K., Lee, S. K., Park, J. H., Park, M. K.. Mushroom tyrosinase inhibition activity of some chromones. Chem. Pharm. Bull 2002; 50: 309—311.

14. Yagi, A., Kabash, A., Mizuno, K., Moustafa, S. M., Khalifa T. I., Tsuji H.. Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from *Aloe vera* gel. Planta Med. 2003; 69: 269—271

15. Rubina, L., Priyanka, T., Ebenezer, J.. Isolation, Purification and evaluation of antibacterial agents from *Aloe vera*. Brazilian Journal of Microbiology 2009;40(4): 906-915.

16. Abd-Alla, H. I., Shaaban, M., Shaaban, K. A., Abu-Gabal, N. S., Shalaby, N. M. M., Laatsch, H.. New bioactive compounds from *Aloe hijazensis*. Natural Product Research: Formerly Natural Product Letters 2008; 23(11): 1035-1049.

17. Abd-Alla, H. I., Abu-Gabal, N. S., Hassan, A. Z., El-Safty, M. M., and Shalaby, N. M. M.. Antiviral activity of *Aloe hijazensis* against some haemagglutinating viruses infection and its phytoconstituents. Archives of Pharmacol Research 2012; 35(8):1347-1354.

18. Minale, G., Bisrat, D., Asres, K., Mazumder, A.. *In vitro* antimicrobial activities of anthrones from the leaf of *Aloe sinana* Reynolds. International Journal of Green Pharmacy 2014; 8(1): 7-12.

19. Kambizi, L., Sultana, N., Afolayan, A. J.. Bioactive compounds isolated from *Aloe ferox*: A plant traditionally used for the treatment of sexually transmitted infections in the Eastern

Cape, South Africa. Pharmaceutical Biology 2004; 42(8): 636-639.

20. Koyama, J., Ogura, T., Tagahara, K.. Naphthol [2,3-c] furan-4,9-dione and its derivatives from *Aloe ferox*. Phytochemistry 1994; 37: 1147-1148.

21. Kametani, S., Kojima, A., Kikuzaki, H., Kennedy, D.O., Honzawa, M., Matsui-Yuasa, I.. Chemical constituents of Cape Aloe and their synergistic growth-inhibition effect on Ehrlich ascites tumor cells. Biosci. Biotech. Biochem 2007;71: 1220-1229.

22. Gundidza, H. (2001) Personal communication, Harare.

23. Coopoosamy, R. M., Magwa, M. L.. Antibacterial activity of aloe emodin and aloin A isolated from *Aloe excelsa*. African Journal of Biotechnology 2006; 5(11): 1092-1094.

24. Aloe nyeriensis. 21 January 2015. http://en.wikipedia.org/wiki/Aloe_nyeriensis.html (21 Jan 2015).

25. Conner, J. M., Gray, A. I., Reynolds, T., Waterman, P. G.. Anthraquinone, anthrone and phenylpyrone components of *Aloe nyeriensis* var. kedongensis leaf exudates. Phytochemistry1987; 26(11): 2995-2997.