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REVIEW OF THE CHEMISTRY OF ALOES OF AFRICA

Ermias Dagne

Addis Ababa University, Department of Chemistry, P.O. Box 1176, Addis Ababa, Ethiopia

1. INTRODUCTION

The bitter leaf exudates of some *Aloe* species are commercially important sources of the laxative aloe drug [1] and are also used in the cosmetics industry as additives in shampoos, shaving and skin care creams [27] and in the treatment of skin disorder and in particular, as topical medication for the treatment of burns [44]. The exudate has also been used as bittering agent in alcoholic beverages [7]. The term *aloe* is derived from the Arabic word *alloeh* which means a shining bitter substance [59]. Medicinally, the gel and dried leaf exudates of *Aloe* species have been used since ancient civilizations of the Egyptians, Greeks and Mediterranean peoples [60]. *Aloe* species have enjoyed a very wide folkloric usage and are also now used in modern medicine in many parts of the world. In commercial circles "Cape aloe" means the dried latex of the leaves of *Aloe ferox* Miller while "Curaçao aloe" is the latex from *Aloe vera* Miller [61].

Except for a few species which have been made cosmopolitan most *Aloe* species are confined to Africa and Arabia. It is therefore important for Africa that these species which have proved to be a store of diverse and interesting natural products be studied from many aspects. This review highlights the major achievements attained so far in the study of the chemistry of *Aloe* species by workers in many parts of the world. There has not been a major review on the chemistry of *Aloe* since the one by Reynolds in 1985 [40].

The two most important analytical methods in the study of leaves and roots of *Aloe* are TLC and HPLC. Reynolds [43] recommended for TLC of leaf components a mixture of di-isopropyl ether/n-propanol and water (7:5:1) followed by use of the lower layer of $CHCl_3/EtOH/H_2O$ (7:3:1) to develop the spots in a direction at right angle to the first. For root constituents we have found [10] petrol/$CHCl_3$ (1:1), $CHCl_3$-EtOAc (7:3) and for analysis of leaf components EtOAc-MeOH-H_2O (77:13:10) to be quite suitable solvent systems. Developed TLC plates may be viewed under UV_{254} and UV_{366}, or sprayed with 0.5% aqueous solution of Fast Blue Salt B followed by spraying with caustic soda solution [24]. 5-Hydroxyaloin gives characteristic violet-brown color when sprayed with 5% aqueous sodium metaperiodate [38].

Reversed phase HPLC of the methanol extract of leaf exudate has proved to be one of the best methods for establishing chemical profile in *Aloe*. Whereas it is very difficult to distinguish between aloin A and B by TLC, these epimers can be easily distinguished by HPLC [43]. The roots of seven species of *Lomatophyllum* were analysed by Van Wyk *et al.* [64] by TLC and HPLC for the presence of nine anthraquinones and pre-anthraquinones which are known to be characteristic constituents of roots of *Aloe*. The results support the inclusion of the genus *Lomatophyllum* in *Aloe*. Furthermore comparative studies of roots of 46 species belonging to the genera *Bulbine*, *Bulbinella* and *Kniphofia* (family Asphodelaceae) [62] revealed the relationships as well as differences of the two families Asphodelaceae and Aloaceae, which until recently were kept together in one family.

2. CONSTITUENTS OF *ALOE* SPECIES

The leaves and roots of *Aloe* species elaborate many interesting secondary metabolites belonging to different classes of compounds including alkaloids, anthraquinones, pre-anthraquinones, anthrones, bianthraquinoids, chromones, coumarins and pyrones. The three most important constituents of commercial aloe drug are the anthrones aloin A and B (**33**), and the chromones aloesin (**68**) and aloeresin A (**63**). We discuss below briefly each of the major classes of *Aloe* compounds followed by a Check List in Table 2 of almost all compounds isolated to date from *Aloe* species.

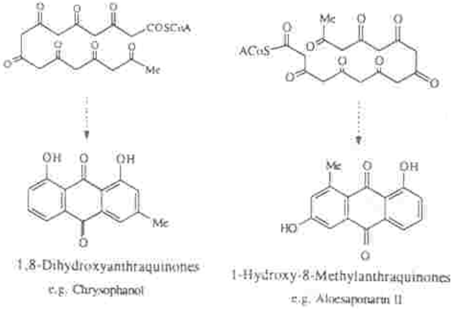


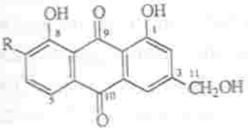
Figure 1. Two folding mechanisms of octaketides leading to 1,8-dihydroxy- and 1-hydroxy-8-methyl-anthraquinones

2.1 Alkaloids

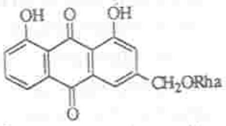
The piperidine alkaloid γ-coniceine and other related hemlock alkaloids were reported to occur in seven *Aloe* species with very restricted distribution [15]. By screening 224 *Aloe* species for alkaloids Nash *et al.*[32] found 21% of the species positive and identified tyramine and its derivatives in 18 species. In view of the potential toxicity of many alkaloids, the authors pointed out the importance of screening for alkaloid prior to the use of *Aloe* plants as medicines.

2.2 Anthraquinones and pre-anthraquinones

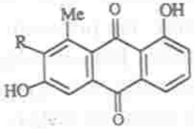
Several free anthraquinones occur in roots and leaves of *Aloe* species. Aloe-emodin (**1**) is a typical leaf constituent and is wide spread in the genus. Chrysophanol (**5**) occurs both in roots [71] and leaves [8] while nataloe-emodin (**13**) has so far been reported only from leaves [3].The anthraquinones in leaves may be present as O-glycosides as is the case in compounds **2** and **14**. The anthraquinones, physcion and emodin which are oxygenated at the 6 position are not found in *Aloe*. Aloesaponarin I (**3**), aloesaponarin II (**4**), desoxyerythrolaccin (**7**), helminthosporin (**9**), isoxanthorin (**11**) and laccaic acid D methyl ester (**12**) were isolated first from roots of *A. saponaria* [70] but have recently been shown to occur in roots of many other *Aloe* species [10].



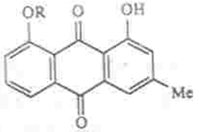
1 R = H (Aloe-emodin)
10 R = OH (7-Hydroxyaloe-emodin)



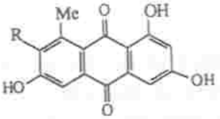
2 Aloe-emodin-11-O-rhamnoside



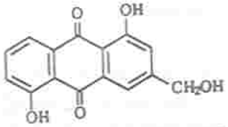
3 R = COOMe (Aloesaponarin I)
4 R = H (Aloesaponarin II)



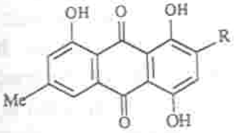
5 R = H (Chrysophanol)
6 R = Me (Chrysophanol-8-methyl ether)



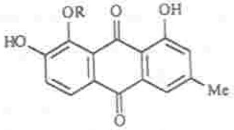
7 R = H (Desoxyerythrolaccin)
12 R = COOMe (Laccaic acid D methyl ester)



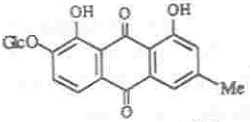
8 1,5-Dihydroxy-3-hydroxymethylanthraquinone



9 R = H (Helminthosporin)
11 R = OMe (Isoxanthorin)

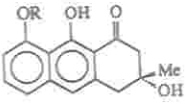


13 R = H (Nataloe-emodin)
15 R = Me (Nataloe-emodin-8-methyl ether)

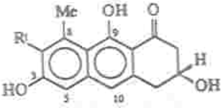


(14) Nataloe-emodin- 2-O-Glc

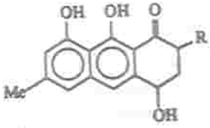
Thus two main types of anthraquinones are present in the roots of *Aloe*, these are 1,8-dihydroxyanthraquinone (e.g. chrysophanol, aloe-emodin) and 1-hydroxy-8-methylanthraquinone (e.g. aloesaponarin I). Whereas anthraquinones of the former type are known to occur both in leaves and roots, those that belong to the latter type are confined only to roots. In a recent study of the roots of 172 species of *Aloe*, van Wyk *et al.* [62] detected 1,8-dihydroxyanthraquinones in almost all and 1-hydroxy-8-methylanthraquinones in 129 *Aloe* species. As shown in Figure 1 these two types of anthraquinones appear to be derived through two parallel biogenetic routes of the polyketide pathway, differing by the way the octaketide chain folds [26].



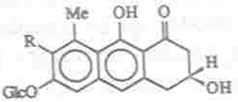
16 R = Me (Aloechrysone)
25 R = H (Prechrysophanol)



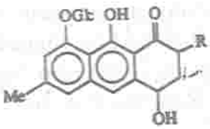
17 R = COOMe (Aloesaponol I)
18 R = H (Aloesaponol II)



19 R = H (Aloesaponol III)
20 R = OMe (Aloesaponol IV)



21 R = COOMe (Aloesaponol I-6-O-Glc)
22 R = H (Aloesaponol II-6-O-Glc)

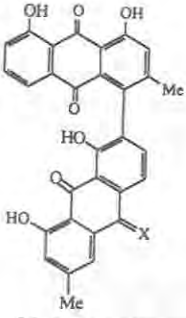


23 R = H (Aloesaponol III-8-O-Glc)
24 R = OMe (Aloesaponol IV-8-O-Glc)

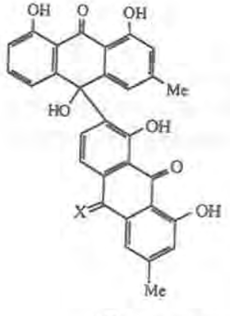
Several pre-anthraquinones, which could be considered as progenitors of the above two types of anthraquinones, have been isolated and characterized mainly from subterranean parts of *Aloe*. However, the pre-anthraquinone aloechrysone was detected both in roots and leaves of four *Aloe* species from Ethiopia [8]. It is interesting to note that the related genus *Gasteria* (Aloaceae), elaborates *Aloe* type preanthraquinones both in the leaves and roots [11]. The pre-anthraquinones could be readily converted to the corresponding anthraquinones by treatment with base [76].

2.3 Anthrones

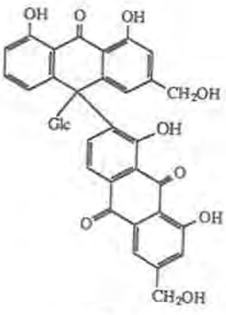
Anthrones are by far the most important of all the classes of compounds present in *Aloe* species. The most outstanding members of this class are aloin A and B (**33**), which are collectively known as barbaloin because they were first isolated from Barbados aloe. Aloin A and B are two diastereomeric C-glucosides that differ in the configuration at C-10 of the aloe-emodin anthrone moiety. These compounds are believed to be mainly responsible for the bitter and purgative properties of the well known commercial aloe drug, which is principally made up of the leaf exudates of *A. ferox* and *A. vera*. The leaf exudate of *A. ferox* may contain up to 10% barbaloin [19]. However not all *Aloe* species are found to contain barbaloin. In a screening of 240 *Aloe* species, barbaloin was found to occur in exudates of 85 of the species examined [42] usually in 10-20% concentration. Although *A. littoralis* Baker is reported to be positive for presence of barbaloin in Reynolds screening [42] and also reported to be present to the extent of 18.2 % by Groom and Reynolds [19], our analysis by TLC and HPLC of the exudate of *A. littoralis* did not show the presence even of a trace of barbaloin [12]. Instead we isolated 10-hydroxyaloin B (**40**) and its two novel nilate ester derivatives littoraloin (**45**) and deacetyllittoraloin (**38**). The chemotaxonomic significance of these compounds in *Aloe* has been recently published [66].



26 X = O (Asphodelin)
28 X = H_2 (Bianthracene III)



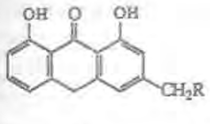
27 X = O (Bianthracene II)
29 X = H_2 (Bianthracene IV)



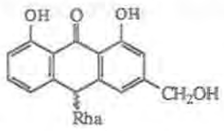
30 Elgonicardine

Interestingly barbaloin and homonataloin seem to be mutually exclusive, with the notable exception of *A. mutabilis* [41]. It should be pointed out that aloin should not be regarded to be confined only to *Aloe* species as it has also been found in the extracts of cascara bark (*Rhamnus purshiana* D.C.) [29]. Rauwald *et al.* have also reported occurrence of 10-hydroxyaloin B (**40**) in *Rhamnus* sp. [37].

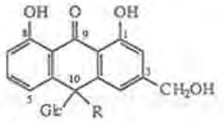
The determination of the absolute configuration of aloin A and B (**33**) has engaged several workers [29, 35]. In the true natural product, i.e., aloin B, the glucose moiety attached to C-10 has the α orientation (i.e., 10*R*,1'*S*) and the β orientation (i.e., 10*S*,1'*S*) follows for aloin A.



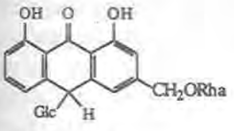
31 R = OH (Aloe-emodinanthrone)
35 R = H (Chrysophanolanthrone)



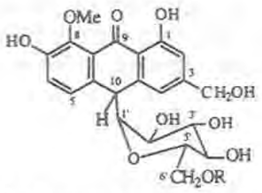
32 Aloe-emodin-10-C-rhamnoside



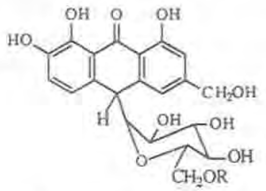
33a R = ····· H (Aloin A)
33b R = ─ H (Aloin B)



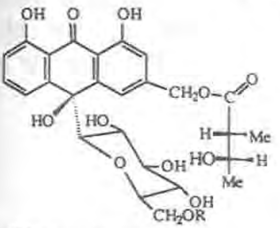
34 Aloinoside



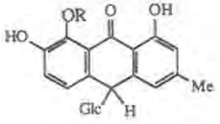
36 R = Cinnamoyl (6'-O-Cinnamoyl-8-O-methyl-7-hydroxyaloin)
46 R = H (8-O-Methyl-7-hydroxyaloin)



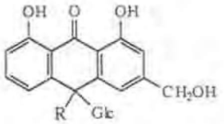
37 R = p-Coumaroyl (6'-O-p-Coumaroyl-7-Hydroxyaloin)
42 R = H (7-Hydroxyaloin)



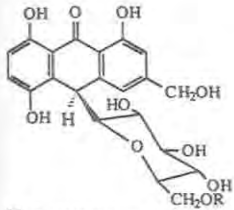
38 R = H (Deacetyllitoraloin)
45 R = Ac (Littoraloin)



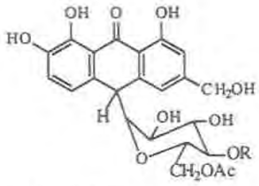
39 R = Me (Homonataloin)
49 R = H (Nataloin)



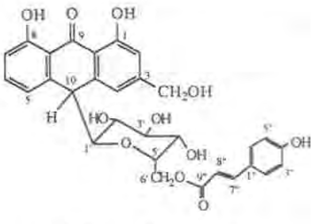
40a R = ····· OH (10-Hydroxyaloin A)
40b R = ─ OH (10-Hydroxyaloin B)



41 R = H (5-Hydroxyaloin)
48 R = Caffeoyl (Microstigmin A)



43 R = H (7-Hydroxyaloin-6'-O-monoacetate)
44 R = Ac (7-Hydroxyaloin-4',6'-O-diacetate)



47a R = ---- H (Microdontin A)
47b R = ─ H (Microdontin B)

Biosynthetic study of Grün and Franz [20] has shown that aloin B is the true natural product but is gradually converted to aloin A. That study also established that aloin B is formed by attachment of glucose to aloe-emodinanthrone (**31**), a compound detected so far in flowers but not in leaves of *Aloe* [45]. In 10-hydroxyaloin B (**40**) and its two novel nilate ester derivatives **38** and **45** [12] obtained from *A. littoralis*, the glucose also has the α configuration indicating that hydroxylation at C-10 occurs prior to epimerization of the natural aloin B. On the other hand, 5-hydroxyaloin A (**41**) is known only in the A form [38] i.e. with the β orientation for the glucose moiety at C-10, an observation which is also the case for its natural derivative microstigmin A (**48**) a novel compound that we recently found in *A. microstigma* [13].

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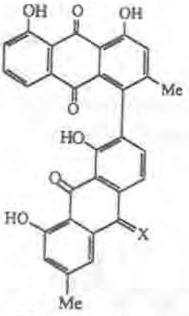

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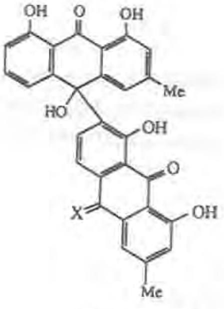

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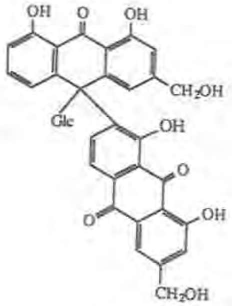

30 Elgonicardine

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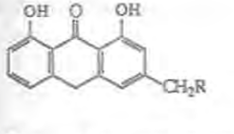
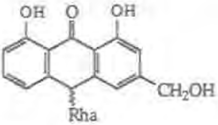


31 R = OH (Aloe-emodinanthrone)
35 R = H (Chrysophanolanthrone)



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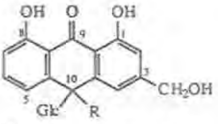
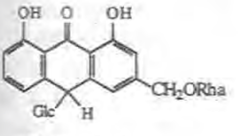
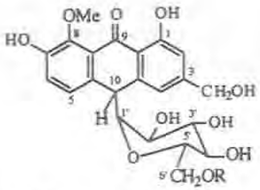


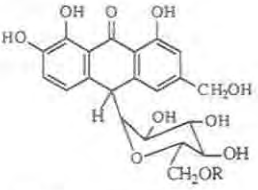
33a R = ····· H (Aloin A)
33b R = ── H (Aloin B)



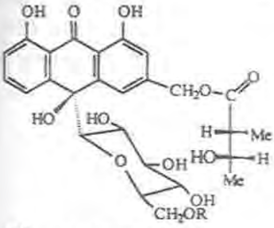
34 Aloinoside



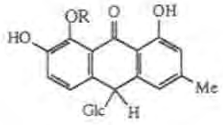
36 R = Cinnamoyl (6'-O-Cinnamoyl-8-O-methyl-7-hydroxyaloin)
46 R = H (8-O-Methyl-7-hydroxyaloin)



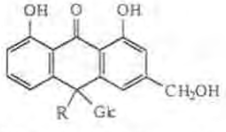
37 R = p-Coumaroyl (6'-O-p-Coumaroyl-7-Hydroxyaloin)
42 R = H (7-Hydroxyaloin)



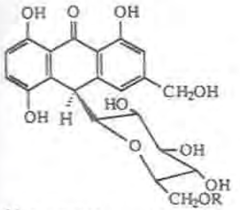
38 R = H (Deacetyllittoraloin)
45 R = Ac (Littoraloin)



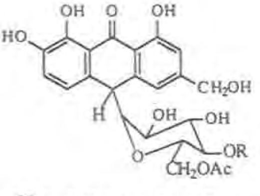
39 R = Me (Homonataloin)
49 R = H (Nataloin)



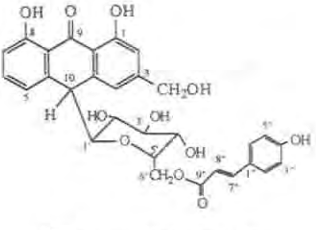
40a R = ····· OH (10-Hydroxyaloin A)
40b R = ── OH (10-Hydroxyaloin B)



41 R = H (5-Hydroxyaloin)
48 R = Caffeoyl (Microstigmin A)



43 R = H (7-Hydroxyaloin-6'-O-monoacetate)
44 R = Ac (7-Hydroxyaloin-4',6'-O-diacetate)



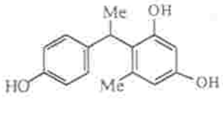
47a R = ---- H (Microdontin A)
47b R = ── H (Microdontin B)

Biosynthetic study of Grün and Franz [20] has shown that aloin B is the true natural product but is gradually converted to aloin A. That study also established that aloin B is formed by attachment of glucose to aloe-emodinanthrone (**31**), a compound detected so far in flowers but not in leaves of *Aloe* [45]. In 10-hydroxyaloin B (**40**) and its two novel nilate ester derivatives **38** and **45** [12] obtained from *A. littoralis*, the glucose also has the α configuration indicating that hydroxylation at C-10 occurs prior to epimerization of the natural aloin B. On the other hand, 5-hydroxyaloin A (**41**) is known only in the A form [38] i.e. with the β orientation for the glucose moiety at C-10, an observation which is also the case for its natural derivative microstigmin A (**48**) a novel compound that we recently found in *A. microstigma* [13].

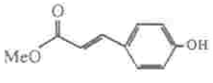
Interestingly, none of the anthrones shown in Table 2 have been detected in the roots of *Aloe* species analyzed so far. Roots of *Aloe* spp. elaborate in the main anthraquinones and pre-anthraquinones. It has recently been shown that inflorescence of *Aloe* also produce anthrones [45].

2.4 Benzene/naphthalene derivatives

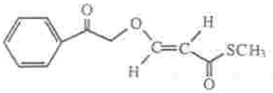
Several naphthalene and benzene based secondary metabolites have been reported from *Aloe* species. One of the first such compounds to be reported is the naphthalene derivative of isoeleutherol-5-*O*-glucoside (**58**) isolated by Yagi *et al.* [72] from the subterranean stems of *Aloe saponaria*. It is interesting to note that such a glycoside is present in the subterranean part of *Aloe*. The aglycone isoeleutherol (**57**) was reported for the first time as a natural product by our group [10] from roots of more than a dozen *Aloe* species belonging to the series Saponariae. Isoeleutherol was conspicuously absent from other series investigated, indicating its chemotaxonomic significance in delineating members of the Saponariae series from other series. The insecticidal compound pluridone (**52**) isolated from roots of the South African *A. pluridens* is the only example of a sulfur containing compound ever isolated from *Aloe*. The recently reported 1,1-diphenylethane (**50**) from Cape aloe [55] and plicataloside (**62**) from *A. plicatilis* [68] have added more variety to benzene- and naphthalene-derived compounds found in *Aloe* species. Furthermore the discovery of the tetrahydronaphthalenes feroxidin (**54**), feroxin A (**55**) and B (**56**) in Cape aloe by Speranza *et al.* [51, 52] is a further testimony of the diversity of the constituents of this *Aloe* of commerce.



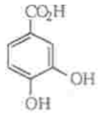
50 CA-12 (1,1-Diphenylethane-derivative)



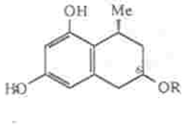
51 Methyl p-coumarate



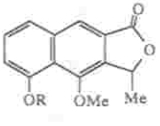
52 Pluridone



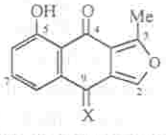
53 Protocatechuic acid



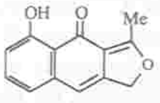
54 R = H (Feroxidin)
55 R = Glc (Feroxin A)
56 R = 4,6-Dicoumaroylglucose (Feroxin B)



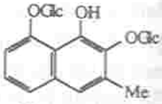
57 R = H (Isoeleutherol)
58 R = Glc (Isoeleutherol-5-O-Glc)



59 X = H₂ (5-OH-3-Methylnaphtho[2,3-c]furan-4(9H)-one)
60 X = O (5-OH-3-Methylnaphtho[2,3-c]furan-4,9-dione)



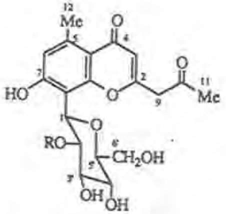
61 5-OH-3-Methylnaphtho-[2,3-c]furan-4(1H)-one



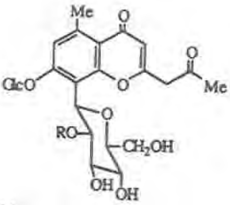
62 Plicataloside

2.5 Chromones

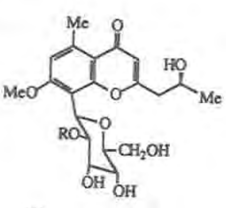
Aloesin (**68**) formerly called aloeresin B, is one of the three most significant constituents of aloe drug, the other two being barbaloin and aloeresin A. Random screening of *Aloe* species indicated its presence in leaves of at least 30% of the species examined [40]. Its structure was established as **68** in 1970 by Haynes *et al.* [21] and subsequently in 1972 its aglycone named as aloesone (**70**) was recognized as an *Aloe* leaf constituent by Holdsworth [23]. The structure of aloeresin A, first proposed incorrectly as a *p*-coumarate ester of aloesin esterified on C_6 of the sugar moiety, was later on revised to structure **63** in which the ester was placed on C_2 of the sugar [18]. Mebe [31] reported the aloeresin derivative (**77**) from *A. excelsa* but incorrectly named it as 2'-*p*-methoxycoumaroylaloeresin when it should have been called either 2'-*p*-*O*-methylcoumaroylaloesin or 2'-*p*-methoxycinnamoylaloesin.



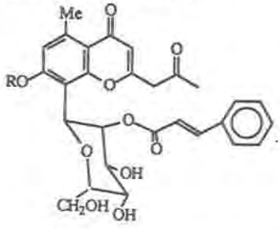
63 R = *p*-Coumaroyl (Aloeresin A) or (2'-O-*p*-Coumaroylaloesin)
68 R = H (Aloesin or Aloeresin B)



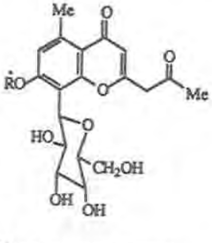
64 R = *p*-Coumaroyl (Aloeresin C)



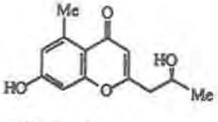
65 R = *p*-Coumaroyl (Aloeresin D)
78 R = Caffeoyl (Rabaichromone)



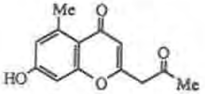
66 R = Glc (Aloeresin E)
67 R = H (Aloeresin F)



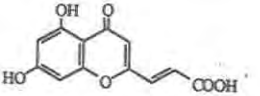
76 R = Me (7-O-Methylaloesin)



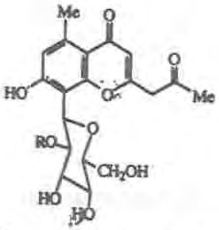
69 Aloesol



70 Aloesone



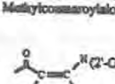
71 2-(Carboxyethenyl)-5,7-dihydroxychromone

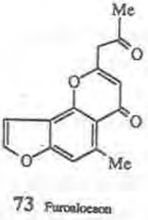


72 R = Feruloyl (2'-O-Feruloylaloesin)

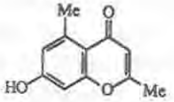
75 R =  (Iso-aloeresin A)

77 R = *p*-O-Methylcoumaroyl (2'-*p*-O-Methylcoumaroylaloesin)

79 R =  (2'-O-Tigloylaloesin)



73 Furoaloesone



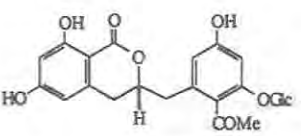
74 7-Hydroxy-2,5-dimethylchromone

TLC and HPLC examination of *Aloe rupestris* Bak. leaf exudate showed the total absence of aloin and homonataloin as well as aloeresin A, C and D but instead revealed the presence of two major and several other minor constituents. Isolation of the major components resulted in their characterization as aloesin (**68**) and the new natural product 7-*O*-methylaloesin (**76**) [14]. The latter compound is of considerable chemotaxonomic value since it is present in most species of *Aloe* series Asperifoliae Berger.

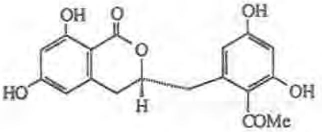
A number of other interesting chromones recently identified in exudates of different African *Aloe* species are listed in Table 2.

2.6 Pyrones

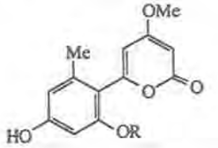
Aloenin (**82**), a phenylpyrone derivative, is a relatively infrequently encountered bitter component of *Aloe* leaf exudate, whose revised structure was reported in 1974 [56]. Aloenin aglycone (**84**) and the coumaroyl ester **86** were reported recently [3]. Aloenin B (**85**) is one of the major (13.5%) constituents of commercial Kenya aloe [49].



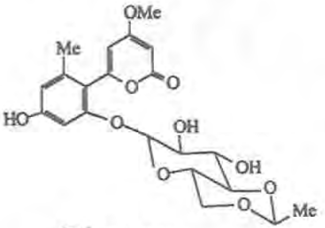
80 Dihydroisocoumarin glucoside



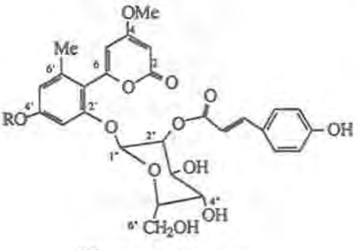
81 Feralolide



82 R = Glc (Aloenin or Aloecarbonoside)
84 R = H (Aloenin aglycone)



83 Aloenin acetal



85 R = Glc (Aloenin B)
86 R = H (Aloenin-2''-*p*-coumaroyl ester)

3. AN OVERVIEW OF THE CHEMISTRY OF ALOES OF NORTH EAST AFRICA

As shown in the previous paper by Demissew in this Journal, there are many unique *Aloe* species in the N.E. African region. We have, over the years, collected many of these, planted them in our botanic garden and conducted chemical study on several species.

The ethanol extract of the leaves of the endemic Ethiopian species *A. berhana* now renamed as *A. debrana* yielded the interesting pre-anthraquinone, aloechrysone (**16**) [8] in addition to chrysophanol, aloe-emodin, barbaloin and β-sitosterol. Aloechrysone fluoresces strongly under 366 nm UV light, a property that helps to identify it during separation using silica gel columns and plates. Aloechrysone was first detected in the roots of *A. berhana* [9] and was later found also in roots of other *Aloe* species [10]. It is the most likely precursor of chrysophanol-8-methyl ether (**6**), an anthraquinone that also occurs in roots of *A. berhana* and other *Aloe* species [10]. The isolation of the simple, biologically important, aromatic acid, 3,4-dihydroxybenzoic acid, also known as protocatechuic acid, from *A. berhana* leaves is noteworthy [8]. Although this acid is known to occur in other plants such as in coffee pulp [8], this was the first report of its occurrence in *Aloe* species. Other constituents of roots of *A. berhana* include: aloesaponol I, laccaic acid D methyl ester, aloesaponol III, aloesaponarin I, chrysophanol-8-methyl ether and chrysophanol [10].

Likewise study of the leaves of *A. megalacantha* yielded, barbaloin, chrysophanol, aloinoside and β-sitosterol [8], while its roots [10] afforded aloechrysone, aloesaponarin I, aloesaponol I, aloesaponarin II, aloesaponol II, aloesaponol III, asphodelin, chrysophanol, chrysophanol-8-methyl ether, helminthosporin and laccaic acid D methyl ester.

Table 1. Distribution of typical aloe compounds in leaf exudates of 11 *Aloe* species of Ethiopia

		A	B	C	D	E	F	G	H
A. debrana	D. Berhan, S-288	+	+	-	++	-	-	-	-
A. calidophila	Negelle, S-213	-	-	-	-	++	-	-	-
A. camperi	Kombolcha, S-208	-	++	-	++	-	++	-	-
A. elegans	Blue Nile G., S-168	-	+	-	++	-	-	-	-
A. gilbertii	Awassa, S-226	-	+	-	++	-	+	-	-
A. megalacantha	Asbeteferi, S-325	-	++	-	++	-	++	-	-
A. pulcherrima	D. Libanos, S-171	-	-	-	-	-	-	++	++
A. pubescens	Negelle, S-316	-	-	+	-	-	-	-	-
A. rivae	Mega, S-321	-	++	-	++	-	++	-	-
A. secundiflora	Moyale, S-219	-	-	-	+	-	+	-	-
A. sp.	Zuquala, S-388	-	++	-	++	-	++	-	-

A Aloenin (82)
B Aloinoside (34)
C Aloesin (68)
D Barbaloin (33)
E Homonataloin (39)
F Microdontin (47)
G Nataloin (49)
H 7-Hydroxyaloin (42)

As indicated in the previous paper by Demissew, the taxon *A. lateritia* is now believed to encompass *A. graminicola* as well. A recent study [76] of the subterranean stem of this species, i.e., *A. lateritia* Engl. var. *graminicola* (formerly *A. graminicola*) resulted in the isolation and characterization of prechrysophanol (**25**), which can be considered as the direct progenitor of chrysophanol. This plant has also been shown [10] to be among the few species of *Aloe* that elaborate in their roots the chemotaxonomicaly important 2-naphtoic acid derivative, isoeleutherol (**57**), which has been indicated as a chemotaxonomic marker for a group of *Aloe* lumped in the series Saponariae. The presence of isoeleutherol in the roots of *A. kefaensis* Gilbert & Sebsebe and *A. macrocarpa* Tod. also confirms their placement in the above mentioned series Saponariae.

A. pulcherrima is one of the most beautiful of the *Aloe* taxa found in Ethiopia. It is known as "Sete-Eret" and is mainly used to accelerate wound healing. Chemical analysis of its leaves revealed the conspicuous absence of barbaloin but showed instead nataloin and 7-hydroxybarbaloin as its major constituents [8] .

The root chemistry of *A. calidophila, A. camperi, A. gilbertii, A. pulcherrima, A. rivae, A. schelpei, A. sinana* is similar to that of *A. megalacantha*. However, *A. secundiflora* differs because it does not contain aloechrysone, a compound also absent from all members of the Saponariae series [10].

Table 2. Check list of *Aloe* compounds (1970-1996) (substances isolated from roots are marked with asterisks all the others are from leaves).

Class/Cpd.	Structure No.	Source	Reference
Alkaloids			
γ-Coniceine	-	*A. gillilandii*	15
Coniine	-	*A. viguieri*	15
N-Methyltyramine	-	*Aloe* spp.	32
O,N-Dimethyltyramine	-	*Aloe* spp.	32
Anthraquinones (1-15), pre-anthraquinones (16-25) and bianthraquinoids (26-30)			
Aloe-emodin	**1**	*Aloe* spp.	6, 40
Aloe-emodin-11-*O*-rhamnoside	**2**	*A. rabaiensis*	4
Aloesaponarin I	**3**	*A. saponaria**	70
Aloesaponarin II	**4**	A. saponaria*	70
Chrysophanol	**5**	*A. saponaria**	71
Chrysophanol-8-methyl ether	**6**	*A. berhana**	10
Desoxyerythrolaccin	**7**	*A. saponaria**	70
1,5-Dihydroxy-3-hydroxymethylanthraquinone	**8**	*A. excelsa*	31
Helminthosporin	**9**	*A. saponaria**	71
7-Hydroxyaloe-emodin	**10**	*A. succotrina*	45
Isoxanthorin	**11**	*A. saponaria**	71
Laccaic acid D methyl ester	**12**	*A. saponaria**	70
Nataloe-emodin	**13**	*A. nyeriensis*	3
Nataloe-emodin-2-*O*-glc	**14**	*A. nyeriensis*	3
Nataloe-emodin-8-methyl ether	**15**	*A. specrosa*	58
Aloechrysone	**16**	*A. berhana**	9
Aloesaponol I	**17**	*A. saponaria**	70
Aloesaponol II	**18**	*A. saponaria**	70
Aloesaponol III	**19**	*A. saponaria**	71, 46
Aloesaponol IV	**20**	*A. saponaria**	71
Aloesaponol I-6-*O*-glc	**21**	*A. saponaria**	72
Aloesaponol II-6-*O*-glc	**22**	*A. saponaria**	72
Aloesaponol III-8-*O*-glc	**23**	*A. saponaria**	72
Aloesaponol IV-8-*O*-glc	**24**	*A. saponaria*	74
Prechrysophanol	**25**	*A. graminicola**	76
Asphodelin	**26**	*A. saponaria**	73
Bianthracene II	**27**	*A. saponaria**	73
Bianthracene III	**28**	*A. saponaria**	73
Bianthracene IV	**29**	*A. saponaria**	73
Elgonicardine	**30**	*A. elgonica*	6
Anthrones (33-49)			
Aloe-emodinanthrone	**31**	*Aloe* spp.	45
Aloe-emodin-10-C-rhamnoside	**32**	*A. rabaiensis*	4
Aloin A & B	**33**	*Aloe* spp.	29, 35, 39
Aloinoside	**34**	*Aloe* spp.	57
Chrysophanolanthrone	**35**	*Aloe* spp.	45
6'-*O*-Cinnamoyl-8-*O*-methyl-7-hydroxylaloin	**36**	*A. barbadensis*	36
6'-*O*-*p*-Coumaroyl-7-hydroxylaloin	**37**	*A. barbadensis*	36
Deacetyllittoaloin	**38**	*A. littoralis*	12, 66
Homonataloin	**39**	*A. jacksonii*	5
10-Hydroxyaloin	**40**	*Aloe* spp.	12, 37, 66
5-Hydroxyaloin A	**41**	*Aloe* spp.	13, 38
7-Hydroxyaloin	**42**	*A. barbadensis*	33

7-Hydroxyaloin-6'-*O*-monoacetate	**43**	*A. succotrina*	34, 45
7-Hydroxyaloin-4',6'-*O*-diacetate	**44**	*A. succotrina*	34, 45
Littoraloin	**45**	*A. littoralis*	12, 66
8-*O*-Methyl-7-hydroxylaloin	**46**	*A. barbadensis*	36
Microdontin	**47**	*A. microdonta*	16
Microstigmin A	**48**	*A. microstigma*	13
Nataloin	**49**	*A. nyeriensis*	3
Benzene (50-53) and naphthalene (54-62) derivatives			
CA-12 (1,1-Diphenylethane derivative)	**50**	Cape aloe	55
Methyl-p-coumarate	**51**	*A. ferox*	17
Pluridone	**52**	*A. pluridens*	2
Protocatechuic acid	**53**	*A. berhana*	8
Feroxidin	**54**	*A. ferox*	51
Feroxin A	**55**	Cape aloe	52
Feroxin B	**56**	Cape aloe	52
Isoeleutherol	**57**	*Aloe* spp.	10
Isoeleutherol-5-*O*-gluc	**58**	*A. saponaria*	72
5-OH-3-Methylnaphto[2,3-c]furan-4(9*H*)-one	**59**	*A. ferox*	25
5-OH-3-Methylnaphto[2,3-c]furan-4,9-dione	**60**	*A. ferox*	25
5-OH-3-Methylnaphto[2,3-c]furan-4(1*H*)-one	**61**	*A. ferox*	25
Plicataloside	**62**	*A. plicatilis*	68
Chromones (63-79)			
Aloeresin A (2'-*O*-*p*-Coumaroylaloesin)	**63**	*Aloe spp.*	18, 28
Aloeresin C	**64**	Cape aloe	47
Aloeresin D	**65**	*Aloe spp.*	4, 48
Aloeresin E	**66**	*A. peglerae*	22
Aloeresin F	**67**	*A. peglerae*	22
Aloesin (Aloeresin B)	**68**	*Aloe spp.*	5, 21, 30
Aloesol	**69**	*Aloe* spp.	23
Aloesone	**70**	*Aloe* spp.	23
2-(Carboxyethenyl)-5,7-dihydroxychromone	**71**	*A. cremnophila*	5
2'-*O*-Feruloylaloesin	**72**	*A. arborescence*	28
Furoaloesone	**73**	Cape aloe	54
7-Hydroxy-2,5-dimethylchromone	**74**	Cape aloe	54
Iso-aloeresin A	**75**	Cape aloe	50
7-*O*-Methylaloesin	**76**	*A. rupestris*	14
2'-*p*-*O*-Methylcoumaroylaloesin	**77**	*A. excelsa*	31
Rabaichromone	**78**	*A. rabaiensis*	4
2'-*O*-Tigloylaloesin	**79**	*Aloe* spp.	5
Coumarins (80-81) and phenyl pyrones (82-86)			
Dihydroisocoumarin glucoside	**80**	*A. hildebrandtii*	65
Feralolide	**81**	Cape aloe	53
Aloenin	**82**	*Aloe nyeriensis*	3, 56
Aloenin acetal	**83**	*A. arborescens*	69
Aloenin aglycone	**84**	*A. nyeriensis*	3
Aloenin B	**85**	Kenya aloe	49
Aloenin-2"-p-*O*-coumaroyl ester	**86**	*A. nyeriensis*	3
Triterpenes			
Campesterol	-	*A. barbadensis*	67
Cholesterol	-	*A. barbadensis*	67
Lupeol	-	*A. barbadensis*	67
ß-Sitosterol	-	*A. arborescens*	75

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