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CRINUM; AN ENDLESS SOURCE OF BIOACTIVE PRINCIPLES: A REVIEW. PART IV: NON-ALKALOIDAL CONSTITUENTS

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ABSTRACT: Crinum is an important and fascinating genus of the large and equally captivating Amaryllidaceae family. Owing to the valuable biological effects and therapeutic potentials of its chemical constituents, many Crinum species have a worldwide folkloric reputation. Additionally, Crinum species have been subjected to extensive chemical, cytological and pharmacological investigations. The present part of our comprehensive review work on the phytochemical and biological studies conducted on Crinum plants reviews the non-alkaloidal principles isolated up till now in addition to their distribution in different Crinum species.

INTRODUCTION: *Crinums* are herbaceous plants with large tunicated bulbs which produce a neck or a pseudostem made up of the sheathing bases of the old leaves [1]. There are about 130 species of *Crinum* worldwide, occurring in America, Africa, southern Asia and Australia. This genus is related to a group of mostly southern African endemic genera, constituting the tribe Amaryllideae and about twenty-two species at present are recognized in southern Africa [2]. Larger in stature than most other Amaryllidaceae species, most *Crinums* are suitable as landscape plants. Furthermore, *Crinum* species have been used traditionally to cure ailments and diseases throughout the world and some of the most noted effects are analgesic, anticholinergic, antitumour and antiviral [3].

Recently, galanthamine has been registered as an acetylcholinesterase inhibitor, which is an important approach in treating Alzheimer's disease [4]. Since about 1950s, *Crinums* have been subjected to extensive chemical and biological investigations due to their richness in pharmacologically active principles, especially alkaloids whereas the non-alkaloidal constituents received much less attention [5]. Therefore, in continuation of our comprehensive review work regarding both the alkaloidal and non-alkaloidal principles of *Crinums* as well as their biological activities, the present part of our work concentrates on the non-alkaloidal constituents (**Table 1 and Figure 1**) isolated so far together with their structural and stereochemical differences. Additionally, their distribution in various species is also completely considered.

Volatile Constituents of *Crinum*: In addition to the non-alkaloidal compounds mentioned in Table 1, the volatile constituents of some *Crinum* plants were analyzed using GC/MS technique and several compounds belonging to different structural types were identified as follows:

The volatiles of *C. latifolium* L. leaves were found to contain *n*-hexadecane, *n*-heptadecane, *n*-octadecane, 2-methyl hexadecane, tetramethyl pentadecane, tetramethyl hexadecane, decylbenzene, phenanthrene, phytol, phenol, cyanophenol, *o*-cresol, *p*-cresol, acetaldehyde, nonanal, benzaldehyde, hexahydro farnesyl acetone, acetic acid, 2,2-dimethyl propanoic acid, nonanoic acid, benzoic acid, formamide, *N*-methyl-*N*-phenyl-formamide, *N*,*N*-diphenyl-formamide and *N*-propyl benzamine [6].

Similarly, the volatile constituents of *C. asiaticum* L. leaves were found to contain 2,2-diethoxy ethyl benzene, glycerin, phytol, 3,7,11,15-tetramethyl-2-hexadecen-1-ol, 3-octyn-1-ol, octahydro-azocine, *n*-hexadecanoic acid, dodecanoic acid, (*Z*, *Z*)-9,12-octadecadienoic acid, (*Z*, *Z*, *Z*)-9,12,15-octadecatrienoic acid, (+)-2-piperidinecaboxylic acid, *n*-hexadecanoic acid ethyl ester, 9,12-octadecadienoic acid ethyl ester, 5-hydroxymethyl-2-furancarboxaldehyde, 4*H*-pyran-4-one-2, 3-dihydro-3, 5-dihydroxy-6-methyl, 1-mono linoleoyl glycerol trimethylsilyl ether, 2-amino-9,10-anthracenedione, 1*H*-azonine octahydr-1-nitroso, 2-methyl-*N*-1-butanamine, *β*-D-glucopyranose and farnesyl-*β*-D-mannofuranoside [7].

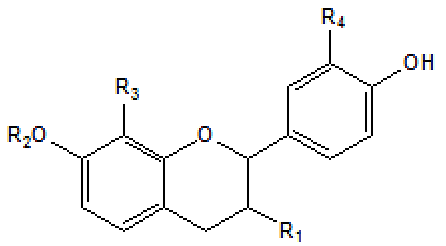
Moreover, the volatile oil of *C. asiaticum* L. flowers were found to contain *n*- pentacosanol, *n*-octacosanol, *n*-nonadecanol, *n*-nonacosanol, butylated hydroxy toluene, eugenol, isoeugenol and 1,2-benzene dicarboxylic acid dibutyl ester [8]. In another study, the volatile oil of *C. ornatum* Ait. bulbs were found to contain 2,4-dimethyl hexane, nonacosane, eicosane, heneicosane, 2, 6, 10, 15-tetramethylheptanedecane, tetratriancontane, tetratetracontane, *Cis*-1,3-dimethyl cyclohexane, methyl benzene, *Cis*-decahydro naphthalene, *trans*-decahydronaphthalene, caryo phyllene, dodecanoic acid, *n*-hexanedecanoic acid, 9, 12-octadecadienoic acid, undecanoic acid ethyl ester, eicosanoic acid ethyl ester and 14-methylpentane decanoic acid methylester [9].

TABLE 1: A LIST OF NON-ALKALOIDAL COMPOUNDS ISOLATED FROM DIFFERENT *CRINUM* SPECIES

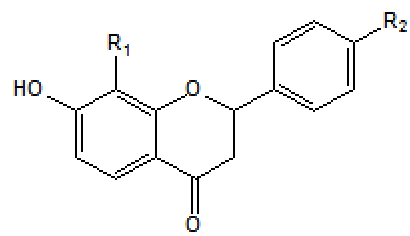
No.	Compound	M. F.	mp (°C)	Plant source	Plant parts	References
A) Flavonoids:						
1	4', 7-dihydroxy-flavan.	$C_{15}H_{14}O_3$		*C. latifolium* Linn.	Whole plant	10
2	(−)- 4'-hydroxy-7-methoxy-flavan.	$C_{16}H_{16}O_3$	142−145°	*C. americanum* L. *C. asiaticum* L. *C. asiaticum var. japonicum* *C. augustum* Rox. *C. bulbispermum* Milne. *C. moorei* Hook F. *C. powellii* Hort.	Bulbs Bulbs Bulbs Bulbs Bulbs Bulbs Bulbs	11 12 13 14 15 16 17
3	4', 7-dihydroxy-3'-methoxy-flavan.	$C_{16}H_{16}O_4$		*C. latifolium* Linn.	Whole plant	10
4	4',7-dihydroxy-3'-vinyloxy-flavan	$C_{17}H_{16}O_4$		*C. latifolium* Linn.	----	18
5	2(*S*), 3', 4'-dihydroxy-7-methoxy-flavan.	$C_{16}H_{17}O_4$		*C. bulbispermum* Milne.	Bulbs	19
6	(-)- 4'-hydroxy-7-methoxy-8-methyl-flavan.	$C_{17}H_{18}O_3$		*C. augustum* Rox.	Bulbs	20
7	4'-hydroxy-7-methoxy-flavan-3-ol.	$C_{16}H_{17}O_4$		*C. bulbispermum* Milne.	Bulbs	19
8	4'-hydroxy-7-methoxy-5'-methyl-flavan-3-ol.	$C_{17}H_{18}O_4$		*C. americanum* L.	Bulbs	11
9	(-)- 7, 4'-dihydroxy-flavanone [(-)-Liquiritigenin]	$C_{16}H_{12}O_4$	205−206°	*C. asiaticum* L. *C. bulbispermum* Milne.	Bulbs Bulbs	12 19
10	7-hydroxy-8-methoxy-flavanone (Isolarrien).	$C_{16}H_{14}O_4$		*C. bulbispermum* Milne.	Bulbs	19
11	4'-hydroxy-7-methoxy-flavone.	$C_{16}H_{12}O_4$		*C. bulbispermum* Milne.	Bulbs	21
12	5, 6, 3'-trihydroxy-7, 8, 4'-trimethoxy-flavone.	$C_{18}H_{14}O_8$		*C. latifolium* Linn.	Whole plant	10
13	5-hydroxy-7, 4'-dimethoxy-6, 8-dimethyl-flavone (Eucalyptin).	$C_{19}H_{18}O_5$	180−182°	*C. asiaticum* L.	Bulbs	12
14	4, 4'-dihydroxy-2-methoxy-chalcone.	$C_{16}H_{14}O_4$	210−212°	*C. bulbispermum* Milne.	Bulbs	21
15	2', 4, 4'-trihydroxy-3'-methyl-chalcone.	$C_{16}H_{14}O_4$		*C. augustum* Rox.	Bulbs	20
16	2', 4, 4'-trihydroxy-chalcone (Isoliquiritigenin).	$C_{15}H_{12}O_4$	194−196°	*C. asiaticum* L. *C. augustum* Rox. *C. bulbispermum* Milne.	Bulbs Bulbs Bulbs	12 20 19
17	2', 4', 7- trihydroxy-dihydrochalcone.	$C_{15}H_{14}O_4$		*C. latifolium* Linn.	Whole plant	10
18	4-hydroxy-2', 4'-dimethoxy-dihydrochalcone.	$C_{17}H_{19}O_4$		*C. bulbispermum* Milne.	Bulbs	19
19	Isorhamnetin-3-O-glucoside (3'-methyl-quercetin-3-O-glucoside).	$C_{22}H_{22}O_{12}$	179−181°	*C. bulbispermum* Milne.	Flowers	22
20	Kaempferol-3-O-glucoside.	$C_{21}H_{20}O_{11}$	188−190°	*C. bulbispermum* Milne.	Flowers	22
21	Kaempferol-3-O-xyloside.	$C_{20}H_{18}O_{10}$		*C. bulbispermum* Milne.	Leaves	23
22	Kaempferol-3-O-β-D-xylopyranosyl (1→3) β-D-glucopyranoside.	$C_{26}H_{28}O_{15}$		*C. bulbispermum* Milne.	Flowers	22

23	Quercetin-3-O-glucoside.	$C_{21}H_{20}O_{12}$	228–230°	*C. bulbispermum* Milne.	Flowers	22
24	Quercetin-3-O-β-D-(6-O-acetylglucopyranosyl) (1→3) β-D-glucopyranoside.	$C_{29}H_{32}O_{19}$		*C. bulbispermum* Milne.	Flowers	22
B) Chromones:						
25	Eugenin (5-hydroxy-7-methoxy-2-methylchromone)	$C_{11}H_{10}O_4$	104–107°	*C. moorei* Hook F.	Bulbs	16
26	Noreugenin (5,7-dihydroxy-2-methyl-chromone).	$C_{10}H_8O_4$	266–269°	*C. moorei* Hook F.	Bulbs	16
27	5,7-dihydroxy-6-methoxy- 2,8-dimethyl-chromone.	$C_{12}H_{12}O_5$	203–206°	*C. moorei* Hook F.	Bulbs	16
C) Coumarins:						
28	4-[(senecioyloxy) methyl]-3,4-dimethoxycoumarin.	$C_{17}H_{20}O_6$		*C. latifolium* Linn.	Whole plant	10
29	4-[(senecioyloxy) methyl]-6,7-dimethoxycoumarin.	$C_{17}H_{20}O_6$		*C. latifolium* Linn.	—	24
D) Megastigmanes (Ionones):						
30	α-Ionone.	$C_{13}H_{20}O$		*C. firmifolium* Baker	—	25
31	Vomifoliol.	$C_{13}H_{20}O_3$		*C. firmifolium* Baker	—	25
E) Sterols:						
32	Dihydrositosterol.	$C_{29}H_{52}O$		*C. bulbispermum* Milne.	Leaves, Bulbs	26
33	β-Sitosterol.	$C_{29}H_{50}O$	137–138°	*C. asiaticum* L. *C. augustum* Rox. *C. moorei* Hook F.	Bulbs Leaves Bulbs Bulbs	12 8, 27 27, 28 16
34	Stigmasterol.	$C_{29}H_{48}O$	160–164°	*C. asiaticum* L. *C. asiaticum var japonicum* *C. augustum* Rox *C. bulbispermum* Milne.	Leaves Bulbs Bulbs Leaves, Bulbs	8, 27 29 27, 28 26
35	Sitosterol-3-O-β-D-glucopyranoside.	$C_{35}H_{60}O_6$	280–285°	*C. augustum* Rox. *C. purpurascens*	Bulbs Leaves	28, 30 31
36	Stigmasterol-3-O-β-D-glucopyranoside.	$C_{35}H_{58}O_6$	232–234°	*C. asiaticum* L. *C. augustum* Rox.	Bulbs Bulbs	12 28
F) Triterpenes:						
37	Cycloart-24-en-3-ol.	$C_{30}H_{50}O$		*C. asiaticum var. japonicum* *C. latifolium* Linn.	Bulbs —	29 24
38	Cyclolaudenol.	$C_{31}H_{52}O$		*C. asiaticum var. japonicum*	Bulbs	29
39	Cycloeucalenol.	$C_{30}H_{50}O$	142–144°	*C. augustum* Rox.	Bulbs	32
40	24-Methylenecycloartanol.	$C_{31}H_{52}O$	124–126°	*C. augustum* Rox.	Bulbs	32
41	31-Norcyclolaudenol.	$C_{30}H_{50}O$		*C. asiaticum var japonicum*	Bulbs	29
42	Ursolic acid.	$C_{30}H_{48}O_3$	276–279°	*C. asiaticum* L.	Bulbs	12
G) Aldehydes, Ketones, Acids and Esters:						
43	Amabiloside (3-hydroxy-4-O-β-D-glucopyranosyl-benzaldehyde).	$C_{13}H_{16}O_8$		*C. amabile* Donn.	Bulbs	33
44	6-hydroxy-2*H*-pyran-3-carbaldehyde.	$C_6H_6O_3$		*C. yemense* Defl.	Whole plant	34
45	4,5-methylenedioxy-4'-hydroxy-2-aldehyde-(1,1'-biphenyl).	$C_{14}H_{11}O_4$		*C. bulbispermum* Milne.	Bulbs	19
46	Vanillin.	$C_8H_8O_3$		----	----	35
47	5-hydroxydotriacontan-9-one.	$C_{32}H_{64}O_2$	80–82°	*C. augustum* Rox.	Bulbs	30
48	23-hydroxyhentriacontan-29-one.	$C_{31}H_{62}O_2$	76–78°	*C. augustum* Rox.	Bulbs	30
49	5-hydroxyhexacosan-9-one.	$C_{20}H_{52}O_2$	70–71°	*C. augustum* Rox.	Bulbs	36
50	5-hydroxyoctacosan-9-one.	$C_{28}H_{56}O_2$	73–74°	*C. augustum* Rox.	Bulbs	36
51	5-hydroxytriacontan-9-one.	$C_{30}H_{60}O_2$	74–75°	*C. augustum* Rox.	Bulbs	36
52	Benzoic acid.	$C_7H_6O_2$		*C. yemense* Defl.	Whole plant	34
53	*p*-hydroxybenzene acetic acid ethyl ester.	$C_{10}H_{12}O_3$		*C. bulbispermum* Milne.	Bulbs	21
54	1-(2-hydroxy-4-hydroxymethyl) phenyl-6-O-caffeoyl-β-D-glucopyranoside.	$C_{22}H_{24}O_{11}$		*C. asiaticum* L. *var. sinicum* Baker.	Bulbs	37
H) Alcohols, Ethers, Amines and Amides:						
55	Calleryanin (3,4-dihydroxy benzyl alcohol- 4-O-β-D-glucopyranoside).	$C_{13}H_{20}O_9$		*C. powellii* Hort.	Bulbs	17
56	β-(3,4-dimethoxyphenyl)-α,β-ethanediol.	$C_{10}H_{14}O_4$		*C. bulbispermum* Milne.	Bulbs	21
57	Triacontanol.	$C_{30}H_{62}O$	83°	*C. augustum* Rox.	Bulbs	30
58	1,1'-bis (1,1'-carboxyethyl) ether.			*C. yemense* Defl.	Whole plant	34
59	Tyramine.	$C_8H_{11}NO$	158–161°	*C. firmifolium* Baker *C. macowanii* Baker	---- Whole plant	25 38
60	Choline.	$C_5H_{15}NO_2$		*C. bulbispermum* Milne.	Bulbs	39
61	9-Octadecenamide.	$C_{18}H_{35}NO$		*C. latifolium* L.	Leaves	40
62	(*E*)-N'-[(*E*)-2-butenoyl]-2-butenoylhydrazide.	$C_8H_{12}N_2O_2$		*C. defixum* Ker.	Bulbs	41

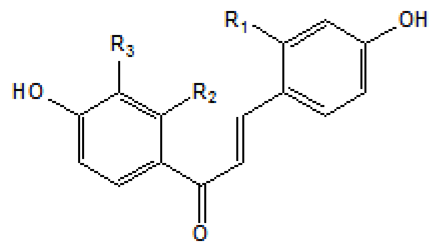
I) Fatty acids and their esters:						
63	Arachidic acid.	$C_{20}H_{40}O_2$		*C. asiaticum* L. *C. augustum* Rox.	Leaves Bulbs, Roots	8, 27 42
64	Behenic acid.	$C_{22}H_{44}O_2$		*C. asiaticum* L.	Leaves	8, 27
65	Capric acid.	$C_{10}H_{20}O_2$		*C. americanum* L.	Leaves, Bulbs, Roots	42
66	Lauric acid.	$C_{12}H_{24}O_2$		*C. augustum* Rox.	Leaves, Bulbs, Roots	42
67	Linoleic acid.	$C_{18}H_{32}O_2$		*C. americanum* L. *C. asiaticum* L. *C. asiaticum var. japonicum* *C. augustum* Rox. *C. bulbispermum* Milne. *C. powellii* Hort.	Leaves, Bulbs, Roots Leaves Bulbs Leaves, Bulbs, Roots Leaves, Bulbs Bulbs	42 8, 27 29 42 26 17
68	Linoleic acid methyl ester	$C_{19}H_{34}O_2$		*C. augustum* Rox. *C. bulbispermum* Milne. *C. americanum* L. *C. asiaticum var. japonicum*	Leaves, Bulbs, Roots Leaves, Bulbs Leaves, Bulbs, Roots Bulbs	42 26 42 29
69	Linoleic acid ethyl ester.	$C_{20}H_{36}O_2$		*C. powellii* Hort.	Bulbs	17
70	Linolenic acid.	$C_{18}H_{30}O_2$		*C. asiaticum* L.	Leaves	8, 27
71	Myristic acid.	$C_{14}H_{28}O_2$		*C. americanum* L. *C. asiaticum* L. *C. augustum* Rox.	Leaves, Bulbs, Roots Leaves Leaves, Bulbs, Roots	42 8, 27 42
72	Myristic acid ethyl ester.	$C_{16}H_{32}O_2$		*C. augustum* Rox.	Bulbs	27, 28
73	Oleic acid.	$C_{18}H_{34}O_2$		*C. americanum* L. *C. asiaticum* L. *C. augustum* Rox. *C. bulbispermum* Milne.	Leaves, Bulbs, Roots Leaves Leaves, Bulbs, Roots Leaves, Bulbs	42 8, 27 42 26
74	Palmitic acid.	$C_{16}H_{32}O_2$	65°	*C. americanum* L. *C. asiaticum* L. *C. augustum* Rox. *C. bulbispermum* Milne.	Leaves, Bulbs, Roots Leaves Leaves, Bulbs, Roots Leaves, Bulbs	42 8, 27 36, 42 26
75	Palmitic acid methyl ester	$C_{17}H_{34}O_2$		*C. augustum* Rox. *C. bulbispermum* Milne.	Bulbs Leaves, Bulbs	36 26
76	Palmitic acid ethyl ester.	$C_{18}H_{36}O_2$		*C. augustum* Rox.	Bulbs	27, 28
77	Palmitoleic acid.	$C_{16}H_{30}O_2$		*C. asiaticum* L.	Leaves	8, 27
78	Pelargonic acid.	$C_9H_{18}O_2$		*C. asiaticum* L.	Leaves	8, 27
79	Pentadecanoic acid.	$C_{15}H_{30}O_2$		*C. asiaticum* L.	Leaves	8, 27
80	Pentadecadienoic acid.	$C_{15}H_{26}O_2$		*C. asiaticum* L.	Leaves	8, 27
81	Stearic acid.	$C_{18}H_{36}O_2$	70°	*C. americanum* L. *C. asiaticum* L. *C. augustum* Rox.	Leaves, Bulbs, Roots Leaves Leaves, Bulbs, Roots	42 8, 27 36, 42
82	Undecanoic acid.	$C_{11}H_{22}O_2$		*C. asiaticum* L.	Leaves	8, 27
I) Hydrocarbons:						
83	n-Pentadecane.	$C_{15}H_{32}$		*C. asiaticum* L.	Leaves	8, 27
84	n-Hexadecane.	$C_{16}H_{34}$		*C. asiaticum* L.	Leaves	8, 27
85	n-Tetracosane.	$C_{24}H_{50}$		*C. asiaticum* L.	Leaves	8, 27
86	n-Pentacosane.	$C_{25}H_{52}$		*C. asiaticum* L. *C. augustum* Rox. *C. bulbispermum* Milne.	Leaves Bulbs Leaves, Bulbs	8, 27 32 26
87	n-Hexacosane.	$C_{26}H_{54}$		*C. augustum* Rox. *C. bulbispermum* Milne.	Bulbs Leaves, Bulbs	32 26
88	n-Heptacosane.	$C_{27}H_{56}$		*C. asiaticum* L.	Leaves	8, 27
				C. augustum Rox. *C. bulbispermum* Milne.	Bulbs Leaves, Bulbs	32 26
89	n-Nonacosane.	$C_{29}H_{60}$		*C. asiaticum* L. *C. augustum* Rox. *C. bulbispermum* Milne.	Leaves Bulbs Leaves, Bulbs	8, 27 32 26
90	n-Monotriacontane.	$C_{31}H_{64}$		*C. asiaticum* L.	Leaves	8, 27
91	β-ocimene.	$C_{10}H_{16}$		*C. asiaticum* L.	----	43
K) Carbohydrates:						
92	Oligosaccharides and polysaccharides.	*C. amabile* Donn. *C. americanum* L. (Its mucilage contains arabinose, xylose, fructose, galactose and galacturonic acid). *C. augustum* Rox. (Its mucilage contains arabinose, xylose, fructose, galactose, glucose and galacturonic acid).			Bulbs Leaves, Bulbs, Roots Leaves, Bulbs, Roots	44 42 42
93	Neoketose.	----			----	45
94	Glucan A.	*C. latifolium* Linn.			Rhizomes	46, 47
95	Glucan B.	*C. latifolium* Linn.			Rhizomes	46
96	Hemicellulose.	*C. amabile* Donn.			Bulbs	44
97	Pectins.	*C. amabile* Donn.			Bulbs	44



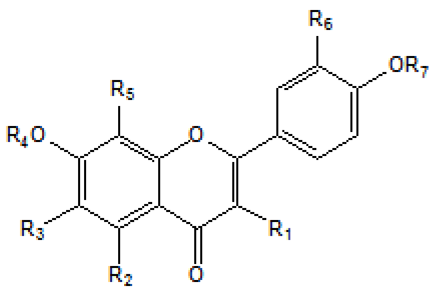
	R_1	R_2	R_3	R_4
(1)	H	H	H	H
(2)	H	Me	H	H
(3)	H	H	H	OMe
(4)	H	H	H	$OCH=CH_2$
(5)	H	Me	H	OH
(6)	H	Me	Me	H
(7)	OH	Me	H	H
(8)	OH	Me	H	Me



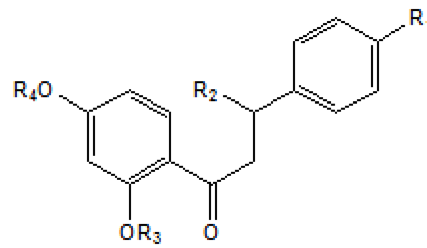
	R_1	R_2
(9)	H	OH
(10)	OMe	H



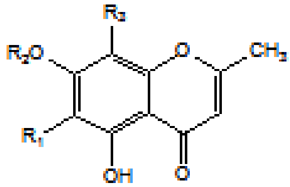
	R_1	R_2	R_3
(14)	OMe	H	H
(15)	H	OH	Me
(16)	H	OH	H



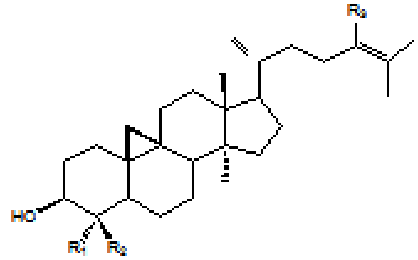
	R_1	R_2	R_3	R_4	R_5	R_6	R_7
(11)	H	H	H	Me	H	H	H
(12)	H	OH	OH	Me	OMe	OH	Me
(13)	H	OH	Me	Me	Me	H	Me
(19)	O-Glc.	OH	H	H	H	H	Me
(20)	O-Glc.	OH	H	H	H	H	H
(21)	O-xyl.	OH	H	H	H	H	H
(22)	O-Glc.-xyl.	OH	H	H	H	OH	H
(23)	O-Glc.	OH	H	H	H	H	H
(24)	6-Ac-Glc-Glc.	OH	H	H	H	H	H



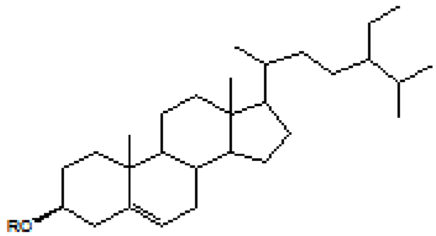
	R_1	R_2	R_3	R_4
(17)	H	OH	H	H
(18)	OH	H	Me	Me



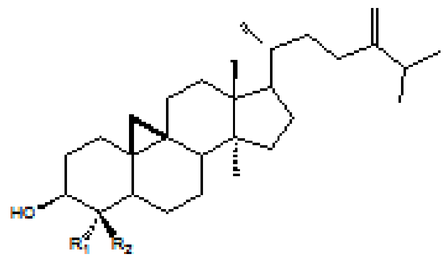
	R1	R2	R3
(25)	H	Me	H
(26)	H	H	H
(27)	OMe	H	Me



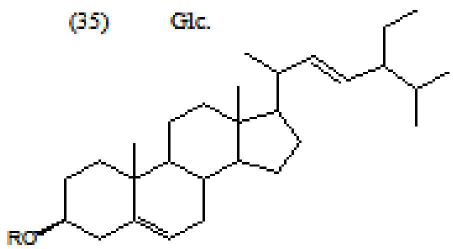
	R1	R2	R3
(37)	Me	Me	H
(38)	Me	Me	Me
(41)	Me	H	Me



	R
(33)	H
(35)	Glc.

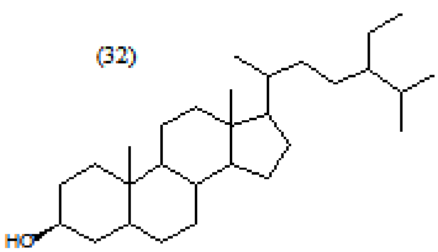


	R1	R2
(39)	H	Me
(40)	Me	Me



	R
(24)	H
(26)	Glc.

(32)



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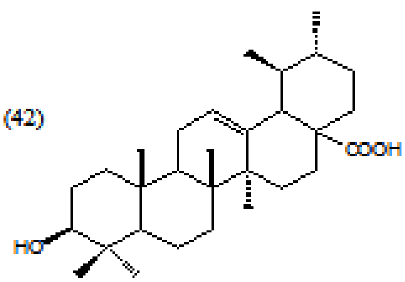

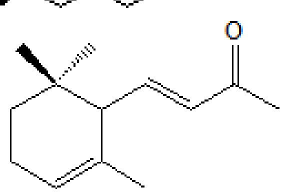

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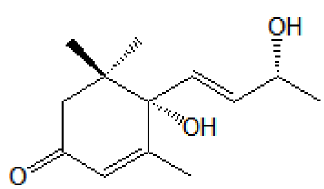

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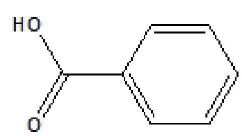

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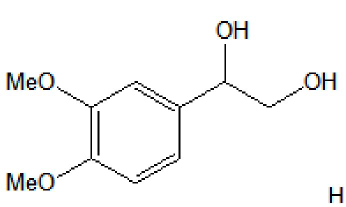

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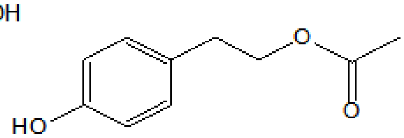

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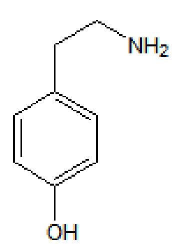

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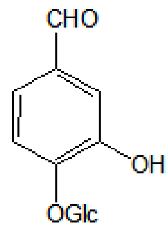

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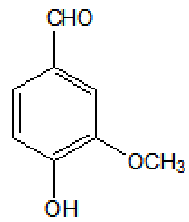

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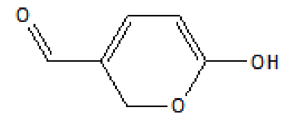

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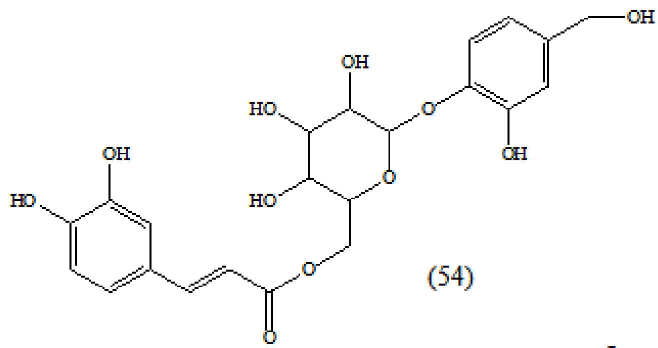

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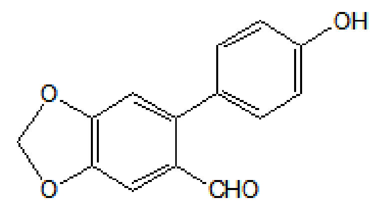

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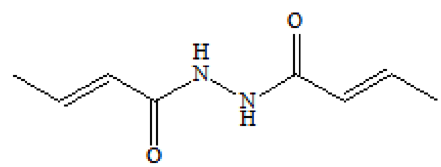

(62)

FIGURE 1: NON-ALKALOIDAL COMPOUNDS ISOLATED FROM DIFFERENT *CRINUM* SPECIES

CONCLUSION: During the last decade, *Crinum* species have widely attracted the attention of phytochemists. The extensive survey of literature demonstrated that the chemical analyses of *Crinums* have yielded a vast array of phytocompounds including about 180 bases belonging to different types of Amaryllidaceae alkaloids. The phytochemical studies were primarily concentrated on alkaloids, while the non-alkaloidal constituents were only touched limitedly. Crinine-, lycorine- and tazettine-types were found to be the most common groups among the isolated alkaloids.

On the other hand, despite being less considered in phytochemical investigations, about 100 non-alkaloidal compounds representing eleven different structural classes were isolated and identified. The non-alkaloidal constituents isolated so far were represented by a number of flavonoids, chromones, coumarins, terpenoids, steroids, simple glycosides, ionones, alcohols, aldehydes, ketones, acids, esters and long chain hydrocarbons. Phenolics prevail among the non-alkaloidal constituents identified. Moreover, analysis of the volatiles prepared from some *Crinum* species revealed their richness in various compounds belonging to different structural types. That's why, *Crinum* plants seem to be an endless source of bioactive principles, especially Amaryllidaceae alkaloids.

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