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Pelagia Research Library

Der Chemica Sinica, 2013, 4(1):1-11

Der Chemica Sinica
Pelagia Research Library
ISSN: 0976-8505
CODEN (USA) CSHIA5

Phytochemical constituents from different species of parmelia genus: A review

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ABSTRACT

Lichens are complex plants living in symbiotic relationship with fungi and algae, and the pertinent partners are defined as mycobiont and phycobiont, respectively. In all lichens, the fungus forms a thallus or lichenized stroma that may contain characteristics secondary compounds. These secondary metabolites are unique with respect to those of higher plants; also lichens are used in folk medicines by many people. To this end, we prepared a data base of genus Parmelia (Family: Parmeliaceae) a potent lichen. In the same order the present review summarizes 71 species of Parmelia genus with their phytochemicals and pharmacologically active constituents.

Key words: Parmelia, lichen, phytochemical constituents, biological activity.

INTRODUCTION

A considerable number of species of lichen forming fungi have wide geographical distribution and are used in the traditional system of medicine. Lichens are symbiotic combination of algae and fungi. They are well known to produce a variety of compounds with remarkable biological activities [1-3]. The adaptability of lichens to extreme environmental conditions is remarkable and interesting. The beautiful hills of Uttarakhand (In India) are the best source of lichens due to varied temperature difference in day and night. Lichens are used as traditional food by Rai and Limbu communities of east Nepal [4]. Parmelia genus belongs to family Parmeliaceae and commonly known as Charila in India. The survey of the literature reveals that more than 71 species of Parmelia genus have been identified so far and only few of them have been analysed chemically. The compounds isolated from Parmelia genus have been summarized in table.

PHARMACOLOGICAL ACTION

Parmelia species have been used in diarrhoea, dyspepsia, spermatorrhoea, ammenrrhoea, dysentery and as wound healer [5]. Some of the species of the lichens are being used by cosmetic industries as skin lightening agent. The phytochemicals isolated from lichen have melanin inhibiting activity [6]. Many species of genus Parmelia exhibited strong antimicrobial activity[7]. Methyl β-orcinolcarboxylate isolated from *Parmelia furfuracea* exhibited modest antifungal activity [7]. *Parmelia furfuracea* extracts is being used as base materials in perfume industries[7]. Aqueous extract of *Parmelia pulla* showed haemolytic activity [8, 9]. An antibiotic component usnic acid was isolated from aqueous extract of *Parmelia tinctorum* [10, 11]. The Ethereal extract of *Parmelia caperata* showed remarkable local anaesthetic activity better then procaine or antazoline [12]. The major constituent isolated was caperatic acid and have shown antispasmodic and spasmolytic activity [13]. *Parmelia caperata* used in Siddha system (an alternative system of medicine in India) under the trade name of Karpasi, and reported for interesting cytotoxic activity against various human cancer cell lines [14]. The water extract of *Parmelia cirrhatum* is reported to have potential antifungal activity [15]. *Parmelia nepalensis* was also evaluated for cytotoxic activity against various human keratinocytes cell lines [16].

Table: Phytochemicals from different species of genus, Parmelia

S. No.	Name of Lichen	Isolated Compounds	Ref.
1	*P. acetabulum*	Linolenic Acid **(1)**, Linoleic Acid **(2)**	[17]
2	*P. adpicta*	Divaricatic Acid **(3)**, Stenosporic Acid	[18]
3	*P. birulae*	Biruloquinone **(4)** (1,8-Dihydroxy-2-methoxy-7-methylphenanthrene-9,10-dione-5,4-carbolatone) , Islandicin **(5)**, α-Alectoronic Acid **(6)**, Usnic Acid **(7)**, Fumarprotocetraric Acid **(8)**, β-Callatolic Acid , β- Alectoronic Acid , α-Callatolic Acid , Atranoric Acid , Methyl 2,4-dihydroxy-3, 6- di-methyl benzoate	[19, 20]
4	*P. bolliana*	Lecanoric Acid **(9)**, Protolichesterinic Acid **(10)**, Usnic Acid ,	[21, 22]
5	*P. borreri*	Orcinyllecanorate, 2^{l}-O-methylmicrophyllinic Acid, Norcolensoic Acid	[23, 24]
6	*P. brattii*	4-O-methylolivetoric Acid **(11)**, Microphyllinic Acid **(12)**, Perlatolic Acid **(13)**	[25]
7	*P. caperata*	4-Orsellinic acid **(14)**, n-Octacosanol **(15)**, β-Sitosterol **(16)**, Caperatic acid **(17)**, Atranorine **(18)**, Pinastric acid **(19)**, Ergosterol **(20)**, β-Sitosterol 3β-D-glucopyranoside,	[12, 13] [26, 27]
8	*P. caraccensis*	Usnic Acid, Fumarprotocetraric Acid, Salazinic acid **(21)**, (+) - Usnic Acid	[28]
9	*P. centrifuga*	α-Carotene **(22)**, Zeaxanthin **(23)**, β-Carotene, Robixanthin, α-Cryptoxanthin, Lutein, Luteinepoxide, canthaxanthin, Astaxanthin, β- Cryptoxanthin, Rhodoxanthin, Neoxanthin, Violaxanthin, Mutatoxanthin, Auroxanthin, Luteoxanthin , β-Apo-2^{l}-carotenal, β-Citraurin, β-Cryptoxanthin	[29]
10	*P. cirrhata*	DL - Usnic Acid, Atranorin, Salazinic acid, Cystine, Lysine, Serine, Tryptophan, Proline	[30, 31]
11	*P. clavulifera*	Chloroatranorin **(24)**, Consalazinic acid **(25)**, Atranorin, Salazinic acid	[32]
12	*P. commensurata*	Norlobaridone **(26)**, Neoloxodic Acid	[33]
13	*P. comtseliadalis*	18-Bromo-(5E,17E)-octadeca-5,17-diene-15-ynoic acid methyl ester **(27)**, 18-Bromooctadeca-5,7,17-triynoic acid methyl ester **(28)**,	[34]

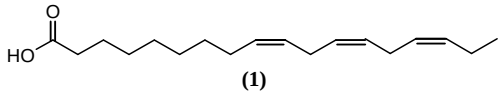
		16,18-Dibromo-(15E,72Z)-octadeca-15,17-diene-5,7-diynoic acid methyl ester **(29)**, 18,18-Dibromo-17-octadecene-5,7-diynoic acid methyl ester **(30)**, 6-Bromo-(5E,15Z)octadeca-5,15-diene-11,13,17-triynoic acid methyl ester **(31)** Stictic acid **(32)**,	
14	*P. conspersa*	Salacinic acid, Fumarprotocetraric Acid, Usnic Acid	[35]
15	*P. cunninghamii*	Atranorin, Salazinic acid	[36]
16	*P. damaziana*	2,4-Di-O-methylgyrophoric acid **(33)**, 2,4,5-Tri-O-methylhiascic acid **(34)**, Gyrophoric acid **(35),** Ursolic acid **(36)**, Atranorin, Chloroatranorin, 5-O-Methylhiascic acid Glomelliferic acid **(37)**,	[37]
17	*P. delisei*	Glomellic acid **(38)**, Loxodellic acid **(39)**	[25]
18	*P. diffractaica*	Diffractaic acid **(40)**, Atranorin	[33]
19	*P. enteromorpha*	Physodic acid **(41)**, Oxyphysodic acid, Physodalic acid, Triophaninic acid, Atranorin, Ventosic acid, D-arabitol, Usnic Acid	[38-41]
20	*P. entotheiochroa*	Zeorin **(42)**, Leucotylin **(43)**, Leucotylic acid **(44)**, Atranorin, Secalonic acid,	[42, 43]
21	*P. erumpens*	Atranorin **(45)**, Lobaric acid **(46)**, Protocetraric acid **(47)**, Chloroatranorin,	[44]
22	*P. flaventior*	Salazinic acid, Consalazinic acid Usnic Acid, Atranorin	[45]
23	*P. formosana*	4,8-Dihydroxy-3-methoxy-11-oxo-1,6-Dipentyl-11H-dibenzo (b, e) (1, 4) dioxepin-7-carboxylic acid **(48)**, 8-Hydroxy-3,4-dimethoxy-11-oxo-1,6-Dipentyl-11H-dibenzo (b, e) (1, 4) dioxepin-7-carboxylic acid **(49)**, Lividic acid [1^{I}-Carboxy -2^{I}, 3- di-hydroxy-4-methoxy-6-(2^{II}-oxoheptyl)-6-pentyldepsidone]	[46, 47]
24	*P. furfuracea*	Methyl β-orcinolcarboxylate **(50)**, Atranorin, 5-Chloroatranorin	[07]
25	*P. gigas*	Atranorin, Electoronic acid	[48]
26	*P. globrans*	Alectoronic acid **(51)**	[49]
27	*P. glomellifera*	Glomellic acid **(52)**, Divaricatic acid, Gyroproric acid	[25, 50]
28	*P. horrescens*	4,5-Di-O-methylhiascic acid **(53)**	[50]
29	*P. hypoleucites*	Licanoric Acid	[22]
30	*P. hypoprotocetrarica*	Hypoprotocetraric acid **(54)**	[51]
31	*P. isidiata*	Norstictic acid **(55)**, Salacinic acid, Stictic acid, Fumarprotocetraric acid, Usnic acid,	[35]
32	*P. leucotyliza*	Atranorine Leucotylic acid	[52]
33	*P. linctina*	16,18-Dibromo-(15E,72Z)-octadeca-15,17-diene-5,7-diynoic acid methyl ester, 18-Bromo-(5E,17E)-octadeca-5,7-diene-15-ynoic acid methyl ester	[34]
34	*P. livida*	4,8-Dihydroxy-3-methoxy-11-oxo-1,6-Dipentyl-11H- dibenzo(b,e)(1,4) dioxepin -7-carboxylic acid, 8-Hydroxy-3,4-dimethoxy-11-oxo-1,6-dipentyl-11H- dibenzo(b,e)(1,4) dioxepin-7-carboxylic acid, Atranorin,	[46, 53]
35	*P. loxodella*	Lividic acid [1^{I}-Carboxy-2^{I},3-dihydroxy-4-methoxy-6-(2^{II}-oxoheptyl)-6-pentyldepsidone] Glomelliferic acid **(56)**,	[25]

36	*P. loxodes*	Glomellic acid **(57)**, Loxodellic acid **(58)**, Gyroproric acid, Divaricatic acid Olivetoric acid **(59)**, Glomelliferic acid, Glomellic acid , 4-O-methylolivetoric Acid, Loxodellic acid, Anzioic acid, 4-O-Demethylglomelliferic acid, Perlatolic acid, Stenosporic acid	[54]
37	*P. luteonotata*	Oxostenosporic acid **(60)**, Stenosporic Acid **(61)**, 4-O-Demethyldivaricatic acid, Divaricatic Acid	[18]
38	*P. madagascariacea*	(-)-2-Methylene-3(R)-carboxy-18(R)-hydroxynonadecanoic acid Ethyl haematomate **(62)**,	[55]
39	*P. nepalensis*	Methyl β-orcinolcarboxylate, Atranorin, (+) Protolichesterinic acid	[16, 56]
40	*P. norcrambidiocarpa*	Echinocarpic acid [1l,4l-dihydroxy-6l-methoxy-3´-oxo-1l,3l-dihydroisobenzofuran-5´-ylmethyl 2,4-Di-hydroxy-3,6-dimethylbenzoate] Atranorin, Chloroatranorin	[57]
41	*P. notata*	4-O-Methylhypoprotocetraric acid **(63)**, Notatic acid **(64)**, 8-Hydroxy-3-methoxy-1,6,9-trimethyl-11-oxo-11H- dibenzo(b,e)(1,4) dioxepin-7-carboxylic acid[Isonottatic acid], 8-Hydroxy-3-methoxy-1,6-dimethyl-11-oxo-11H- dibenzo(b,e)(1,4) dioxepin-7-carboxylic acid [Subnotatic acid]	[58, 59]
42	*p. olivetorum*	Atraric acid **(65)** [Benzoic acid , 2,4-dihydroxy-3,6-dimethyl-methyl ester] Barbatic acid **(66)**,	[60]
43	*P. physcioides*	Obtusatic acid **(67)**, 4-O-Demethylbarbatic acid **(68)** Atranorin	[61]
44	*P. pictada*	4-O-demethyldivaricatic acid, Divaricatic acid, Oxostenosporic acid, Stenosporic acid	[18]
45	*P. pokornyi*	4-O-demethyldivaricatic acid, 4-O-demethylstenosporic acid, Divaricatic acid, Gyrophoric acid, Oxostenosporic acid, Stenosporic acid	[18]
46	*P.praesorediosa*	Protolichesteric acid, Caperatic acid	[62]
47	*P. pseudofatiscens*	4,5-Di-o-methylhiascic acid	[50]
48	*P. pulla*	4-O-demethyldivaricatic acid, Divaricatic acid, Gyrophoric acid, Oxostenosporic acid, Stenosporic acid	[18]
49	*P. pustulifera*	4-O-Methylphysodic acid **(69),** Lividic acid	[63]
50	*P. pustulosa*	Anzioic acid, Glomelliferic acid, Glomellic acid, Loxodellic acid, Perlatolic acid	[18]
51	*P. quercina*	Atranorin, Lecanoric acid	[64]
52	*P. reticulata*	Salazinic acid	[33]
53	*P. rigida*	Alectoronic acid	[49]
54	*P. ryssolea*	4-O-demethyldivaricatic acid , 4-O-demethylstenosporic acid, Divaricatic acid, Gyrophoric acid, Oxostenosporic acid, Stenosporic acid	[18]
55	*P. saxatilis*	Linolenic Acid, Linoleic Acid, Salazinic acid,	[17, 36, 65]

		Atranorin, Lobaric acid	
56	*P. signifera*	Atranorin, Salazinic acid	[36]
57	*P. simulans*	Caperatic acid	[33]
58	*P. stenophylla*	Salacinic acid, Fumarprotocetraric Acid, Usnic Acid	[35]
59	*P. subfatiscens*	3-Methoxy-2,4-di-O-methylgyrophoric acid **(70)**	[66]
60	*P. subramigera*	(+) - Usnic Acid, Salazinic acid, Protocetraric acid, Norstictic acid	[67]
61	*P. subrudecta*	Linolenic Acid, Linoleic Acid	[17]
62	*P. substygia*	Ovoic acid **(71)** [2^{l}-O-methylgyrophoric acid]	[68]
63	*P. subverrucella*	4-O-demethyldivaricatic acid, Divaricatic acid	[18]
64	*P. sulcata*	Benzo[α]Pyrene **(72)**, Linolenic Acid, Linoleic Acid, Atranorin, Salazinic acid	[17, 36, 69]
65	*P. tenuirima*	Atranorin, Salazinic acid	[36]
66	*P. tinctina*	Usnic Acid	[70]
67	*P. tinctorum*	(+) - Usnic Acid, Methyl β-orcinolcarboxylate, Methyl haematomate, Lecanoric acid, Atranorin, Chloratranorin, Diffractaic acid, Gyrophoric acid, Divaricatinic acid, Divaricatic acid	[09,16] [56,71]
68	*P. vagans*	Usnic Acid, Salacinic acid, Norstictic acid, Linoleic acid, Palmitic acid, Oleic acid	[72,73]
69	*P. vittata*	Vittatolic acid **(73)**, 2^{l}-O-Methylphysodic acid **(74)**, Physodic acid, Atranorin, Oxyphysodic acid	[74,75]
70	*P. waiporiensis*	Glomelliferic acid, Glomellic acid, Loxodellic acid	[25]
71	*P. xanthiana*	(-)-2-Methylene-3(R)-carboxy-18(R)-hydroxynonadecanoic acid	[55]

Diffractic acid isolated from a number of *Parmelia* species are well known for their analgesic and antipyretic activity [11]. Another compound gyrophoric acid isolated from Parmelia species has potent inhibitor of the growth of human keratinocytes and also having beneficial effects against hyperproliferative skin disease such as psoriasis [11]. Usnic acid, the major constituent was isolated from various species of Parmelia exhibited antimitotic effects, antitumor and antimycobacetrial activities [11].

Phytochemical structures:



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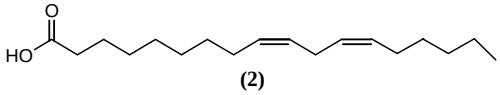

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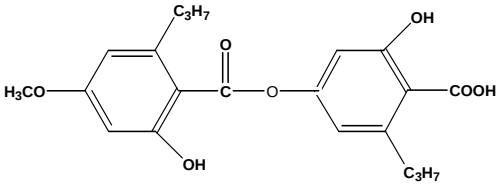

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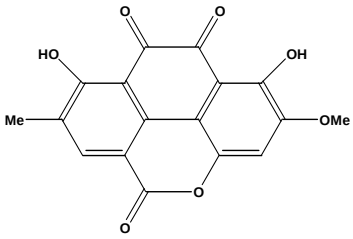

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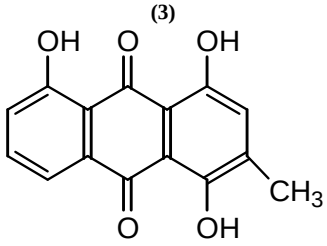

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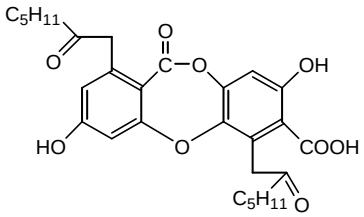

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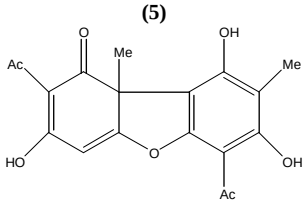

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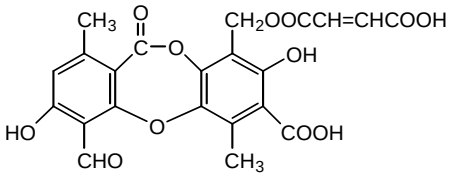

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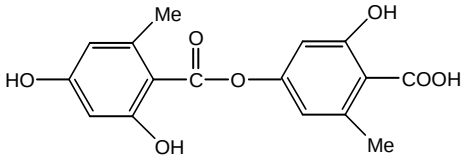

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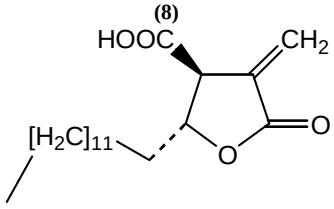

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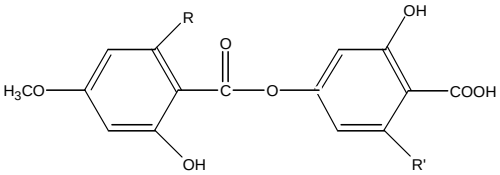
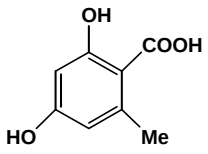


(11) **R= $CH_2COC_5H_{11}$, R'= C_5H_{11}**
(12) **R=R'= $CH_2COC_5H_{11}$**
(13) **R=R'= C_5H_{11}**



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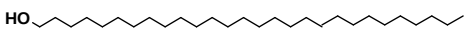

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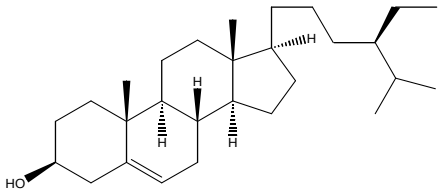

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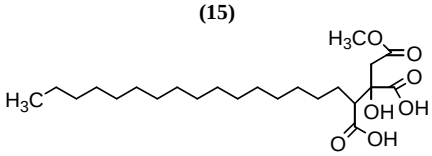

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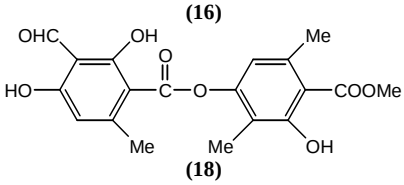

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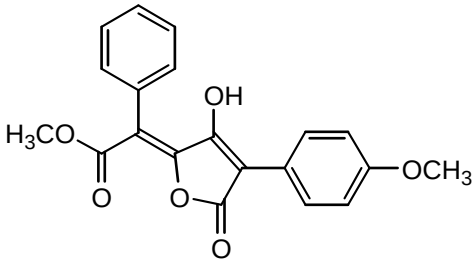

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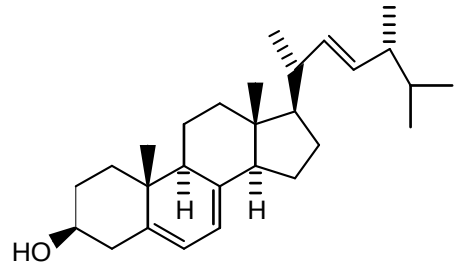

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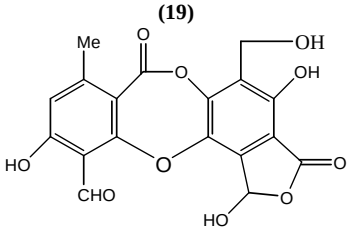

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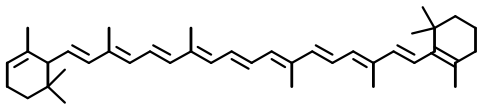

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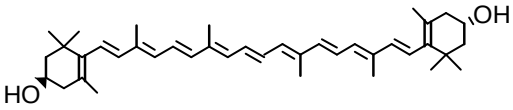

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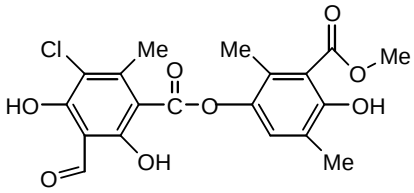

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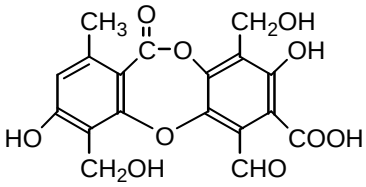

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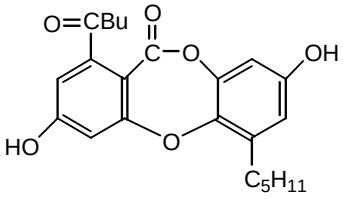

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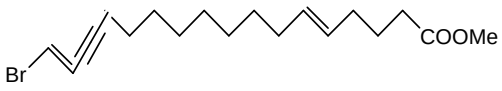

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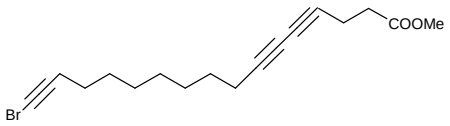

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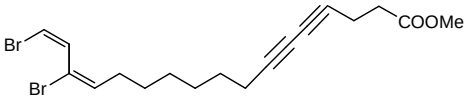

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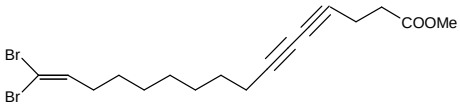

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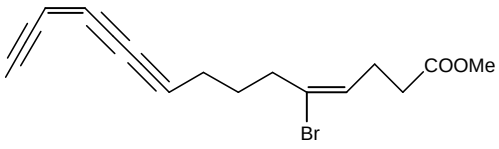

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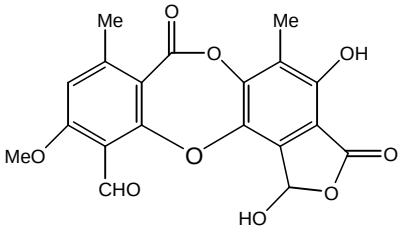

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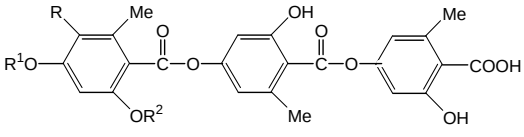
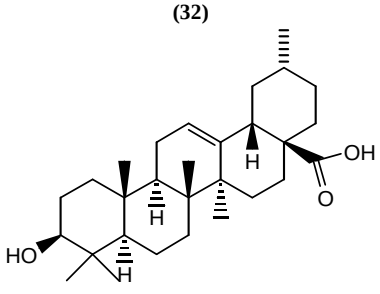
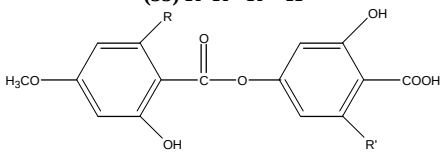


(33) R= H , R^1= Me , R^2= OMe
(34) R=R^2= OMe , R^1= Me

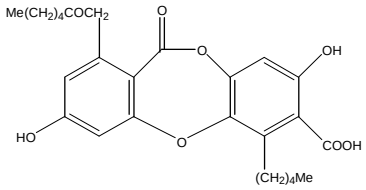


(36)

(35) R=R^1=R^2= H



(37) R= $CH_2COC_3H_7$, R'= C_5H_{11}
(38) R= R'= $CH_2COC_3H_7$
(39) R= $CH_2COC_3H_7$, R'= C_3H_7



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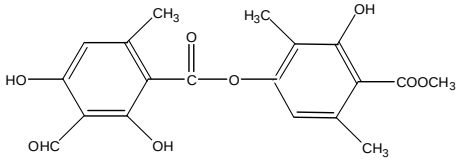

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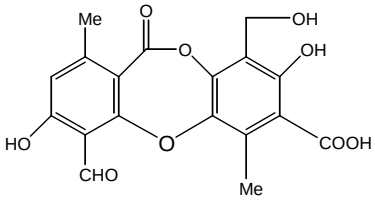

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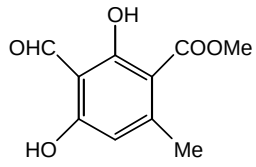

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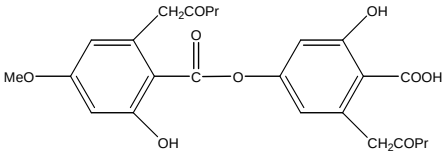

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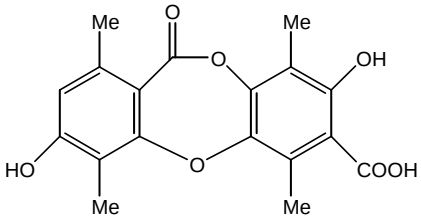

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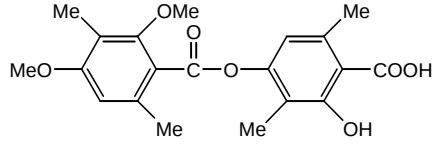

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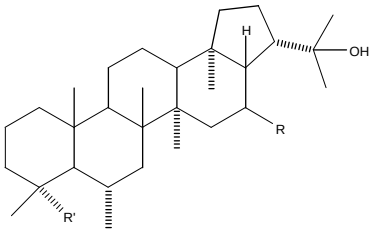
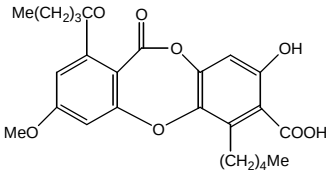
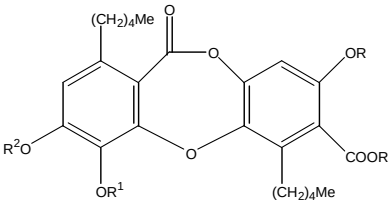


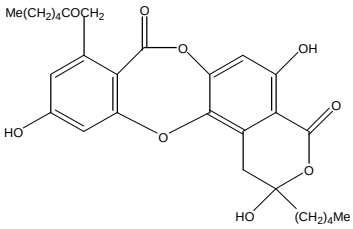
(42) R= H , R'= CH_3
(43) R= OH , R'= CH_3
(44) R= OH , R'= COOH



(46)



(48) R = R^1 = H , R^2 = Me
(49) R = H , R^1 = R^2 = Me



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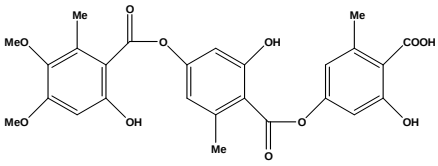
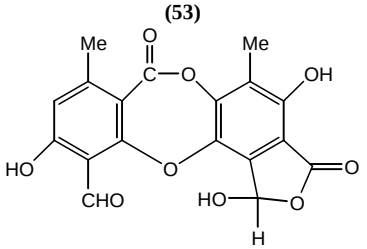


(53)



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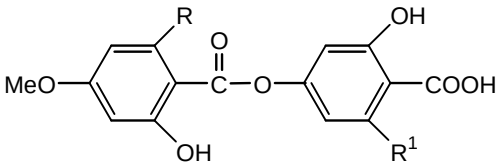
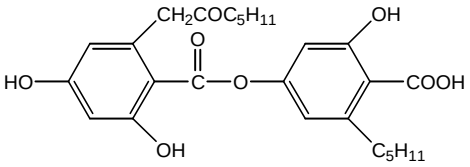


(56) R = $CH_2COC_3H_7$, R^1= C_5H_{11}
(57) R = R^1= $CH_2COC_3H_7$
(58) R = $CH_2COC_3H_7$, R^1= C_3H_7



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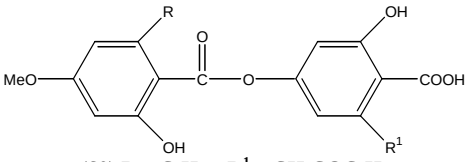
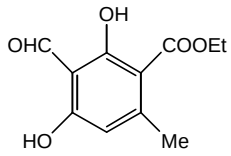
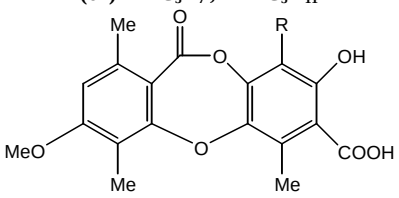


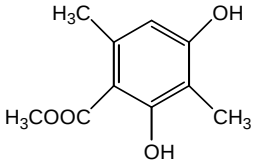
(60) R = C_3H_{11} , R^1 = $CH_2COC_3H_7$
(61) R = C_3H_7 , R^1 = C_5H_{11}



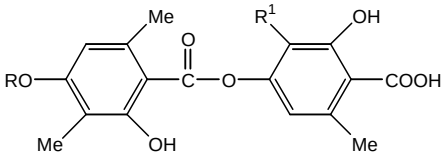
(62)



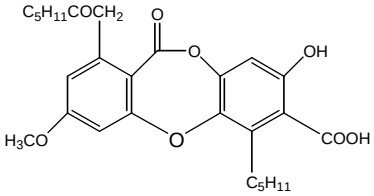
(63) R = Me
(64) R = H



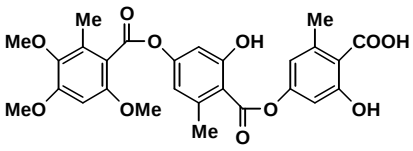
(65)



(66) R= Me , R^1= Me
(67) R= Me , R^1= H
(68) R= H , R^1= Me



(69)



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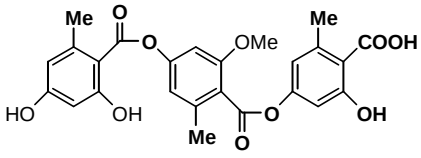

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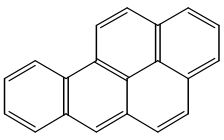
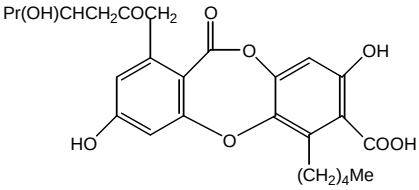
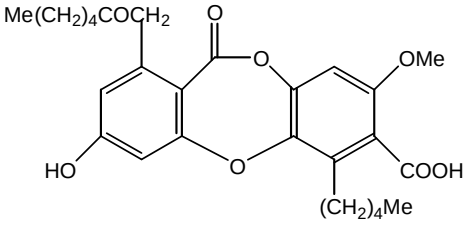


(72)



(73)



(74)

CONCLUSION

More than 75% of drugs are plant products or derivatives of plant's products. So for new researchers in the field of drug development, phytochemical reviews are so supportive. In this sequence we prepare a phytochemical review of genus, Parmelia. In this review we prepare a data base of isolated phytochemicals with their remarkable pharmacological actions.

Acknowledgement
Authors wish to thanks Head, Department of Chemistry, University of Rajasthan for providing library facilities.

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