A Review on Phytochemicals from Some Medicinal Plants of Bangladesh

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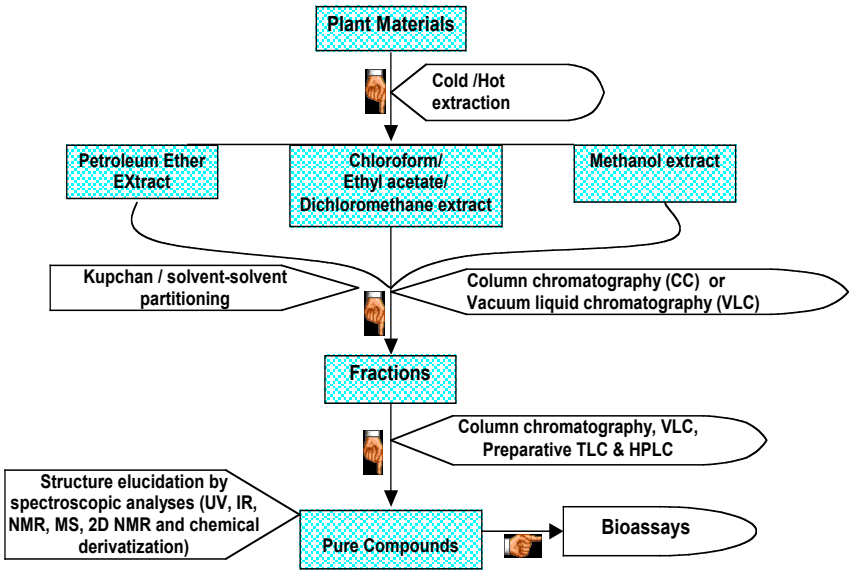
Abstract: Natural products, especially those derived from higher plants, have attracted scientists from ancient time because of their potential therapeutic values. Drug development from natural sources showed that natural products or natural product-derived drugs comprised about 28% of all new chemical entities launched to the market. These are originated from terrestrial plants, microbes, marine organisms, etc. However, until recently an insignificant part of the plants has been scientifically evaluated for their medicinal properties. Bangladesh is a rich repository of medicinal plants, many of which are widely used in the Ayurvedic, Unani, herbal and other traditional systems of medicines. In our laboratory, we have extensively investigated over 48 medicinal plants and several microbial strains that have resulted in the isolation and characterization of 133 compounds, including 33 new molecules. Terpenoids, alkaloids, flavonoids and glycosides were the major classes of constituents. The crude extractives and several purified molecules demonstrated statistically significant inhibition of growth of microorganisms. On the other hand, usnic acid obtained from the lichen, *Parmelia kamtschandalis*, demonstrated even better of inhibition of microbial growth as compared to the standard antimicrobial agents, whereas dehydroaltenusin extracted from a *Streptomyces* sp. exhibited significant HIV-inhibitory activity.

INTRODUCTION

Bangladesh being a subtropical country is a good repository of plants. There are around 5,000 angiosperms distributed among 200 families. Approximately, 500 of these are being used in the traditional medicines for the treatment of different types of diseases. Here, we describe the chemistry and antimicrobial activity of some of the isolated constituents from 48 medicinal plants of Bangladesh.

METHODOLOGY

The chemical investigation of a plant involved collection and proper identification of the plant materials, extraction, fractionation, purification & isolation of compounds and structural characterization of the purified compounds. Various chromatographic techniques were utilized for isolation and purification of the plant constituents. On the other hand, the structures of the purified compounds were determined by extensive analyses of UV, IR, NMR and mass



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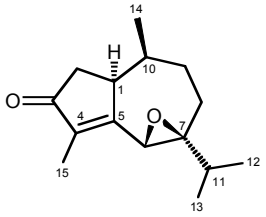
spectroscopic data as well as by chemical derivatization, when needed. The whole process can be explained in the following way:

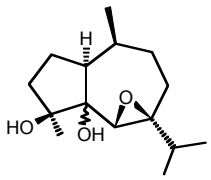
RESULTS & DISCUSSION

Extensive chromatographic separation and purification of the extracts obtained from 48 medicinal plants of Bangladesh afforded a total of 133 pure chemical entities, including 33 new molecules. The structures of these compounds were elucidated by spectroscopic studies and chemical derivatization wherever needed. Some of the isolated compounds exhibited significant antibacterial and antifungal activities, when subjected to antimicrobial screening by disc diffusion technique. The structures of some of the isolated compounds are shown below:

Sesquiterpenes from Amoora rohituka (Meliaceae) [1]

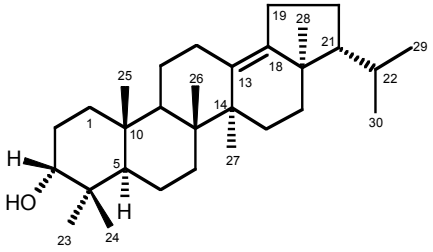


6β7β-epoxyguai-4-en-3-on

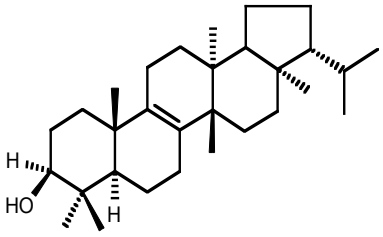


6β7β-epoxy—4β5-dihydroxyguaiane

Terpenoids from Melicope indica (Rutaceae) [2]

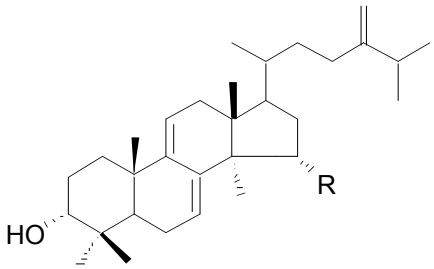


Neohop-13(18)-en-3α-ol



Fern-9(9)-en-3β-ol

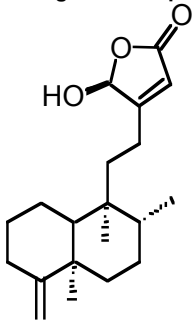
Steroids A and B from Artabotrys odoritissimus [3] and Desmos longiflorus (Annonaceae) [4], respectively



(A) R = H, 24-methylene-lanosta-7,9(11)-dien-3β-ol

(B) R = OH, 15α-hydroxy-24-methylene-lanosta-7,9(11)-dien-3-one

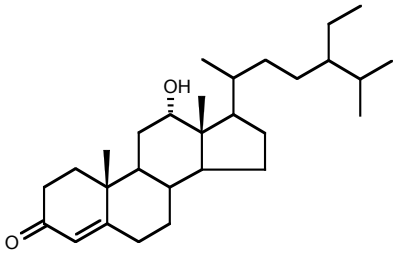
Diterpene from Polyalthia longifolia var. pendulla (Annonaceae) [5]



16β -Hydroxykolava-4,3Z-dien-15,16-olide

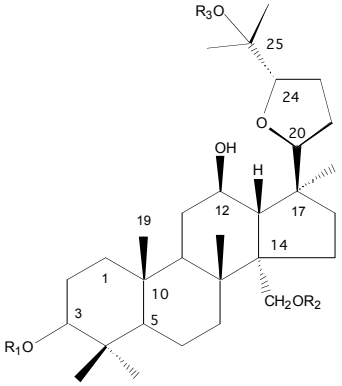
contd…..

Steroid from Toona ciliata (Meliaceae) [6]



12α-Hydroxystigmast-4-en-3-one

Triterpene glycosides Corchorus capsualris (Tiliaceae) [7, 8]

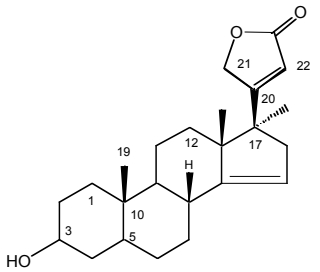


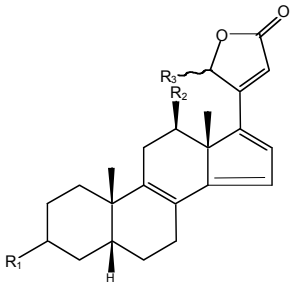
$R_1 = R_2 = R_3 = H$; capsugenine

$R_1 = R_3 = H$, R_2 = glucose; capsugenine-30-O-β -glucopyranoside

$R_1 = H$, $R_2 = R_3$ = glucose; capsugenine-25, 30-O-β-glucopyranoside

Steroids from Nerium oleander (Apocynaceae) [9, 10]



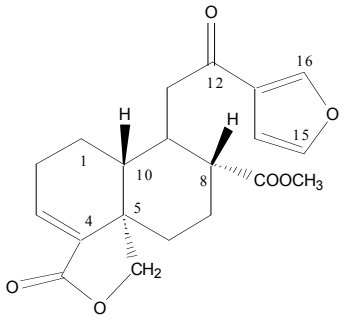


R_1=R_2=H; 3β-hydroxy-5(-carda-14(15),20(22)-dienolide R_1=OH, R_2=R_3=H; 3β-hydroxy-5(-carda-8,14,16,20(22)-tetraenolide

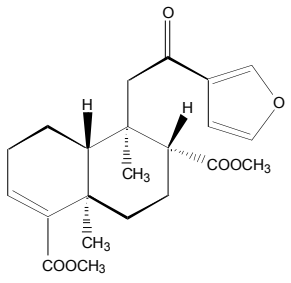
R_1=R_3=H, R_2 = OH; 12(-hydroxy-5(-carda-8,14,16,20(22)-tetraenolide

R_1=glu, R_2=H, R_3=OH; 3(̃-digitaloside)-21-hydroxy-5(-carda-8,14,16,20(22)-tetraenolide

Diterpenoids from Barringtonia recemosa (Lecythidaceae) [11]



Nasimalun A



Nasimalun B

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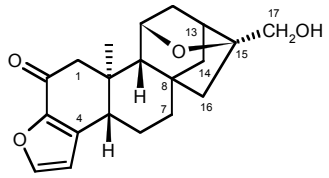
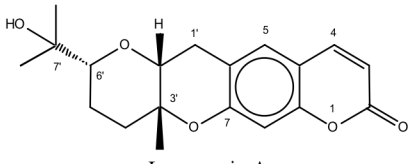
Terpenoids from *Coffea bengalensis* (Rubiaceae) [12]

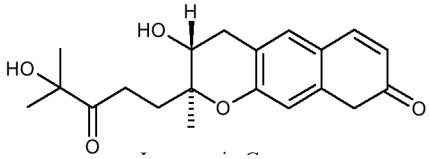


Bengalensol

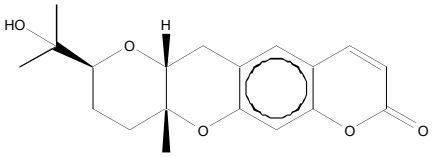
Coumarins (Lunamarins A-C) from *Claussena heptaphylla* and *Micromelum minutum* (Rutaceae) [13]



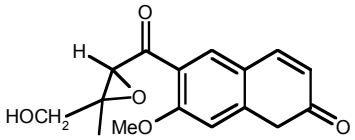
Lunamarin A



Lunamarin C

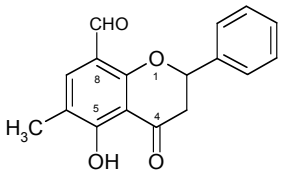


Lunamarin B

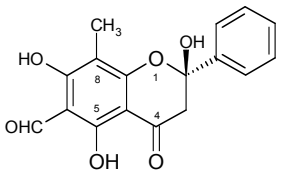


Hopeyhopol

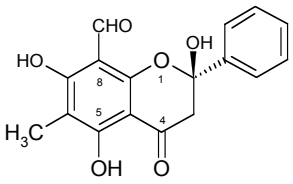
Flavonoids from *Unona discolor/ Uvaria chinensis* (Annonaceae) 14]



8-Formyl-6-methyl-5-hydroxyflavone

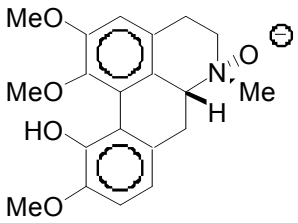


6-Formyl-8-methyl-2β,5,7-trihydroxyflavanone



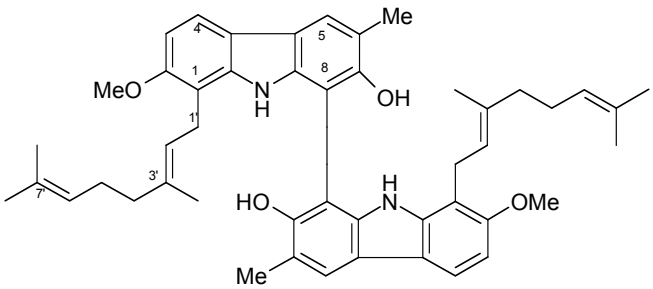
8-Formyl-6-methyl-2β,5,7-trihydroxyflavanone

Alkaloid from *Milusa velutina* (Annonaceae) [15]



(+) Isocorydine-*N*-oxide

Coumarins from *Murraya koenigii* (Rutaceae) [16]



Bismurrayafoline

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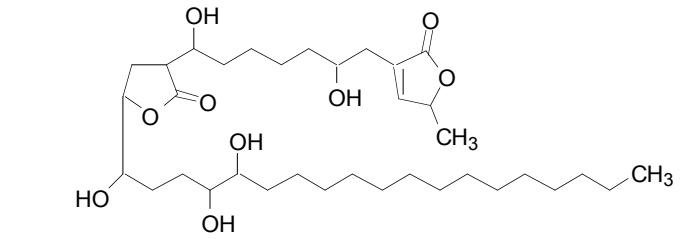
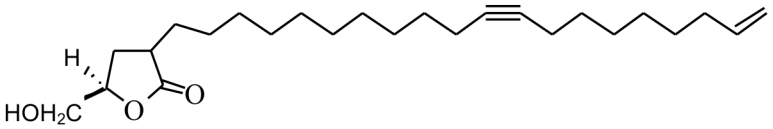
Acetogenins A from *Goniothalmus sesquipedalis* [17] and

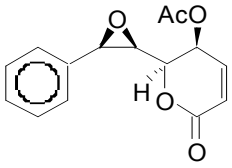
B from *Milusa* velutina (Annonaceae) [18]





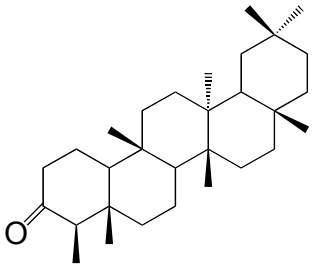
Gigantopentocin (A)
Isogoniothalamusin (B)

Styryl lactone from *Goniothalmus sesquipedalis* (Annonaceae) [18]

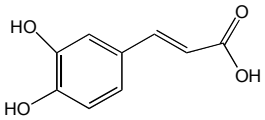


5-Acetoxyisogoniothlamine oxide

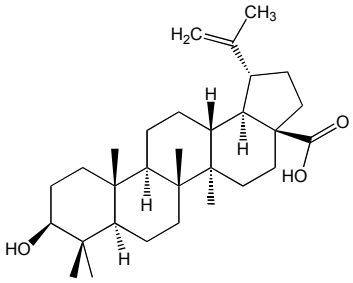
Triterpenes and phenylpropanoid from *Amoora cucullata* (Meliaceae) [19]



Stereochenol A

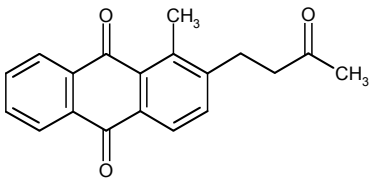


Caffeic acid

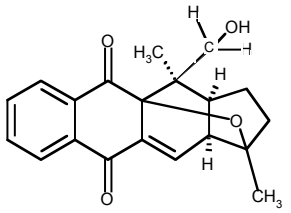


Stereochenol B

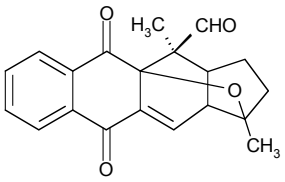
Anthraquinones and napthaquinones from *Stereospermum chelonoides* (Bignoniaceae) [20]



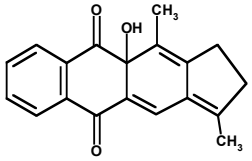
Sterekunthal B



Sterequinone C



Fredelin



Betulinic acid

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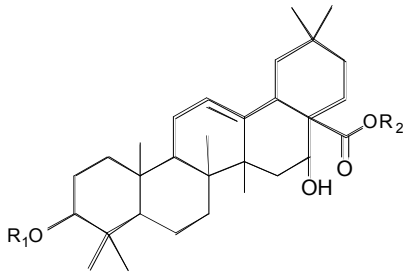
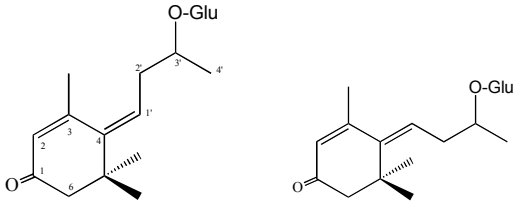
Saponins from *Eclipta prostrata* (Asteraceae) [21]

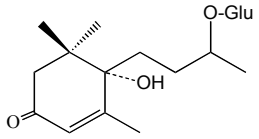


R_1 = β-D-glucose, R_2 = H; eclalbasaponin I
R_1 = R_2 = β-D-glucose; eclalbasaponin II

Glycosides from *Pterospermum semisagittatum* (Sterculiaceae) [22]

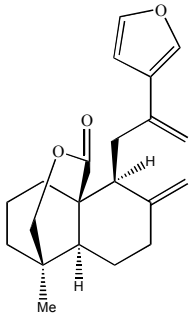


(*Z*)-4-[3′-(β-D-glucopyranosyloxy)butylidene]-3,5,5-trimethyl-2-cyclohexen-1-one
(*E*)-4-[3′-(β-D-lucopyranosyloxy)butylidene]-3,5,5-trimethyl-2-cyclohexen-1-one

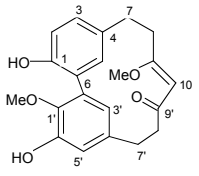


(*E*)-4-hydroxy-4-[3′-(β-D-glucopyranosyloxy)butylidene] -3,5,5-trimethyl-2-cyclohexen-1-one

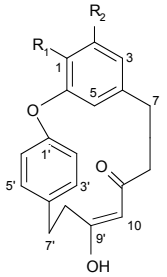
Diterpenoids from *Potamogeton nodosus* (Potamogetonaceae) [23]



Diarylheptanoids from *Garuga pinnata* (Burseraceae) [24]



6'-Hydroxygaruganin V



R_1 = OMe; R_2 = H, 9'-Desmethylgarugamblin
R_1 = OH; R_2 = OMe, 1,9'-Didesmethylgaruganin

BIOLOGICAL ACTIVITIES

The compounds isolated from different plant were screened for antibacterial and antifungal activities. The results of those screenings are shown in the following tables:

Table-1: Antibacterial Activity of Purified Alkaloids at 100 μg/disc

Name of bacteria	Diameter of zone of inhibition in mm						
	Xy	Lir	Lan*	Lan	Ox*	Ox	Am
Gram positive							
Bacillus cereus	15						
B. subtilis	19	14	16	12	21	16	-
B. megaterium	12	15	19	14	10	16	15
B. polymyxa	13	15	NT	NT	NT	NT	10
Streptococcus-β-haemolyticus	44	13	NT	NT	NT	NT	-
Staphylococcus aureus	17	12	NT	NT	NT	NT	-
Sarcina lutea	-	-	15	11	20	15	20
	16	17	NT	NT	NT	NT	-
Gram negative							
Escherichia coli	18	17	NT	NT	20	17	-
Shigella boydii	NT	NT	NT	11	NT	NT	-
Sh. dysentriae	17	16	16	NT	NT	18	-
Sh. flexneri	17	16	NT	12	NT	NT	18
Sh. sonnei	-	-	NT	NT	NT	NT	-
Pseudomonas aeruginosa	18	15	NT	NT	18	14	33
Salmonella typhi B	-	-	14	NT	21	17	27
Sal. paratyphi A	18	17	NT	10	NT	NT	21
Sal. paratyphi B	18	16	15	NT	18	14	-

Xy = Xylopine, Lir = Liriodenine from *Cananga odorata*, Lan = Lanuginosine from *Ellipeiopsis cherrevensis*, Ox = Oxostephanine, Am = Ampicillin (30 μg/disc), NT = not tested; - = Not sensitive; * = at 200 μg/disc

Table-2: Antibacterial Activity of Non-Alkaloidal Compounds at 100 μg/disc

Bacterial strain	Diameter of zone of inhibition in mm								
	Oxc*	Oxc	Kol	Gt	Kan	Hyd	Gigt	Acg	Am
Gram positive									
Bacillus cereus	14	12	11	18	14	15	15	18	-
B. subtilis	25	18	13	15	15	18	25	22	15
B. megaterium	20	18	10	18	15	16	NT	NT	10
B. polymyxa	27	20	12	12	14	22	NT	NT	-
Streptococcus β-haemolyticus	22	21	10	-	19	18	NT	NT	-
Staphylococcus aureus	16	13	NT	11	23	-	19	17	20
Sarcina lutea	20	18	-	11	18	18	23	15	-

(Table 2). contd…..

Bacterial strain	Diameter of zone of inhibition in mm								
	Oxc*	Oxc	Kol	Gt	Kan	Hyd	Gigt	Acg	Am
Gram negative									
Escherichia coli	11	12	NT	14	14	13	16	14	-
Shigella boydii	30	27	12	18	14	25	NT	NT	-
Sh. dysentriae	17	13	10	17	15	15	25	12	-
Sh. sonnei	22	19	-	15	10	-	23	12	18
Sh. shiga	21	27	12	12	17	18	NT	NT	-
Pseudomonas aeruginosa	20	11	NT	20	22	14	6	-	NT
Salmonella typhi-A	19	16	11	18	19	14	24	10	29
Salmonella typhi-B	17	14	NT	20	14	16	NT	NT	-
Sal. Typhi B-52	16	14	NT	12	22	17	NT	NT	NT
Sal. Typhi B-56	12	12	NT	12	21	21	NT	NT	NT
Sal. Typhi B-62	21	19	10	14	18	19	NT	NT	NT
Vibrio cholerae	21	15	NT	-	NT	18	NT	19	27

Oxc-1=16-oxocleroda-3,13E-dien-15-oic-acid from *Polyalthia longifolia* var. *pendulla*, Kol=Kolavenic acid from *Polyalthia longifolia* var. *pendulla*, Gt=Goniothalamin from *Goniothalamus sesquipedalis*, Hyd=16β-hydroxycleroda-3,13-dien-15,16-olide from *Polyalthia longifolia* var. *pendulla*, Gigt = Gigantetrocin, Gigp = Giganpetocin, Acg = 5-Acetoxygoniothalaminoxide from *Goniothalamus sesquipedalis*, Kan= Kanamycin (30μg/disc), Am = ampicillin (30μg/disc), NT= Not tested ; - = not sensitive, * = at 200 μ g/disc

Antifungal Activity of Isolated Alkaloidal Compounds at 100 μg/disc

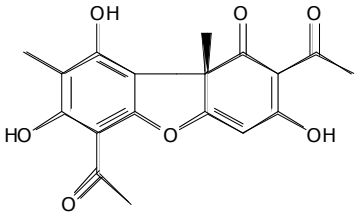
Name of fungi	Diameter of zone of inhibition in mm							
	Xy	Lir	Lan	Gri	Oxoc	Kol	Hyd	Kan
Rhizopus oryzae	12	-	12	-	NT	NT	NT	NT
R. oligosporous	NT	NT	11	-	NT	NT	NT	NT
Aspergillus niger	16	17	-	-	NT	NT	NT	NT
A. Fumigatus	18	22	NT	-	18	-	13	-
A. Krusii	-	-	-	-	NT	NT	NT	NT
Candida albicans	-	-	-	-	10	-	8	-
Trichoderma sp.	NT	NT	13	-	NT	NT	NT	NT
Saccharomyces cerevisiae	12	-	NT	-	11	9	13	-
S. rosea	NT	NT	NT	NT	12	-	13	11
S. caulbequence	NT	NT	NT	NT	11	10	12	-

Xy = Xylopine, Lir = Liriodenine, Lan = Lanuginosine,Oxoc = 16-oxocleroda-3,13-*E*-dien-15-oic-acid, Kol = Kolavenic acid, Hyd=16β-hydroxycleroda-3,13-dien-15,16-olide, Gri = Grisofulvin, Kan = Kanamycin (30 μg/disc), NT = Not tested; - = not sensitive

CONCLUSION

A total of 48 plant species have been investigated. Many structurally unique and diversified compounds having interesting biological activities were isolated from these plants [27]. Our studies showed that Bangladeshi plants could be a promising source of novel drug candidates. Some of these results were in conformity with the traditional and folk uses of the investigated plants.

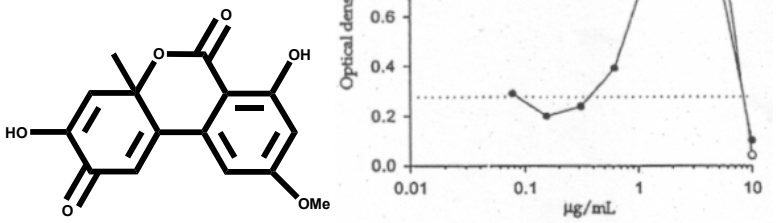
Comparative Antibacterial Activity of Usnic Acid and the Standard Antibiotics [25]



Usnic acid **(49)**

Name of microbes	Diameter of zone of inhibition (mm)			
	Usnic acid	**Amoxycillin**	**Streptomycin**	**Tetracycline**
	30 µg/ disc	**10 µg/ disc**	**10 µg/ disc**	**30 µg/ disc**
Bacillus subtilis	23	33	26	34
Escherichia coli	25	08	22	18
Staphylococcus aureus	24	-	-	10
Stap. epidermidis	23	39	12	24

Anti-HIV activity of Dehydroaltenusin from *Streptomyces* sp. [26]



Dehydroaltenusin: Graph showing the effects of dehydroaltenusin upon uninfected CEM-SS (o) and HIV-1 infected CEM-SS cells ( ), as determinded after 6 days of culture. The higher optical density represents better anti HIV activity exhibited by the test compound.

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