Chemical Constituents from *Abutilon* Species

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(Received 15th October, 2004, revised 13th May, 2005)

Introduction

The genus *Abutilon* belongs to the family *Malvaceae* which is a large family with 88 genera and more than 2,300 species. The genus *Abutilon* comprises of about 150 species occurring in the form of perennial herbs, shrubs and rarely small trees inhabiting the tropical and sub-tropical regions of Asia and other parts of the world. Generally the leaves, roots and stems of *Abutilon* species contain considerable amounts of mucilage due to which these find use in indigenous medicine for the treatment of rheumatism and as demulcents, emollients and diuretics. Some of these are also prescribed in fever as cooling medicine [1-3]. The multifold uses of these species have created wide interest in their phytochemistry.

From this genus the presence of sesquiterpenes, triterpenes, steroids, flavonoid aglycones and flavonoid glycosides have been reported. The phytochemical studies on its species started as far back as 1929 when Kosakal [4] reported the presence of anthocyanins in *A. avicennae*. In 1950 Gupta and Saharia isolated sitosterol and its acetyl derivative from *A. indicum* [5] while in 1952 raffinose (**1**) and different fatty acids were reported by Gambhir and Joshi from the same species [6]. In 1956 Nakaoki and co-workers reported [7] rutin (**2**) from *A. avicennae*. The natural occurrence of gossypetin-7- and 8-glucosides (**3** and **4**) and cyanidin-3-rutinoside (**5**) in *A. indicum* was communicated [8] by Sankara and Nair in 1972. In 1982 Jain and co-workers [9] isolated different chemical constituents from *A. glaucum* and *A. indicum*. These included β-pinene (**6**), eudesmol (**7**), farnesol (**8**), borneol (**9**), geraniol (**10**), β-caryophyllene (**11**) and their derivatives. The presence of β-sitosterol (**12**), β-amyrin (**13**) and different fatty acids in the roots of *A. indicum* was reported in 1984 by Dennis and Kumar [10]. Two years later Fatima, Zulekha and Yasmeen reported [11] β-sitosterol, β- and α-amyrins (**13,14**), hentriacontane (**15**), ceryl alcohol (**16**), caffeic, vanillic, p-coumaric, p-hydroxy benzoic and p-β-D-glucosyloxy benzoic acids (**17-21**) besides glucose (**22**), galactose (**23**), fructose (**24**), arabinose (**25**) and a variety of free amino acids including leucine (**26**), histidine (**27**), threonine (**28**), serine (**29**), glutamic and aspartic acids (**30-31**) from *A. pakistanicum*. In 1988 Singh and co-workers reported [12] that quercetin (**32**) and kaempferol (**33**) are the major flavonoids in the fruits of *A. pannosum*. In 1989 Sharma and Ahmad reported gallic acid (**34**) as an analgesic constituent of *A. indicum* [13] while in the year 2000 Ahmed and co-workers claimed eugenol (**35**) as an analgesic principle from the same species [14].

Sharma and Ahmad also presented the first report of the occurrence of sesquiterpene lactones in the genus *Abutilon* and in the family Malvaceae in 1989 [15] by reporting alantolactone (**36**) and isoalantolactone (**37**) from *A.indicum*. In the same year Gottsberger and co-workers studied intraspecific variation in the amino acid content of floral nectar in *Malvaceae* and *Onagraceae* species and reported that *Abutilon* species have remarkably higher amount of γ-aminobutyric acid [16].

In the years 1990 and 1991 we reported a new pentacyclic triterpene, pakistanol (**38**), a new cholestane derivative (**39**), tetradecanyltriacontanoate (**40**), lupeol (**41**) and taraxasterol (**42**) from *A. pakistanicum* and *A. indicum* [17,18]. In 1996 Jain and Arora reported [19] that ethanolic extract of aerial parts of *A. bidentatum* exhibited fungicidal activity with a maximum activity against *Fusarium moniliforme* and they also reported a new cholestane derivative (**43**) from this species. In 1997 and 1998 Khanna reported [20,21] a process of preparing anti-AIDS Ayurvedic pharmaceutical compositions by

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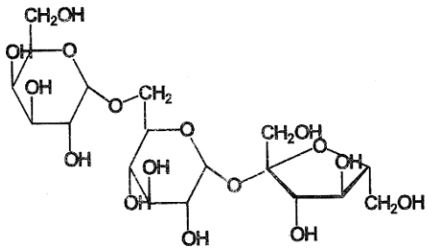

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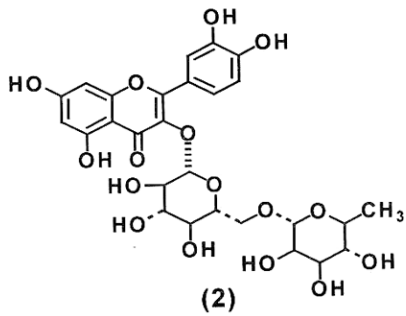

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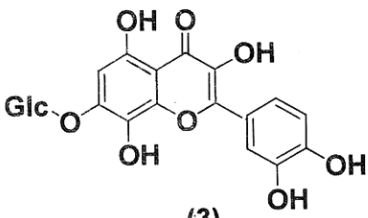

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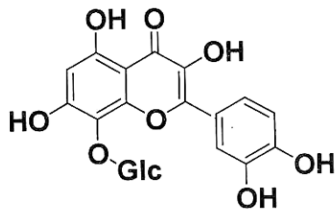

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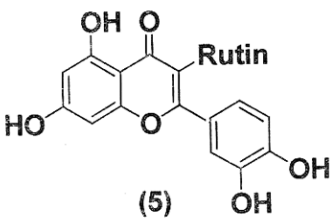

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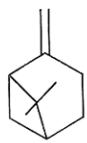

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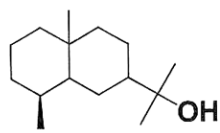

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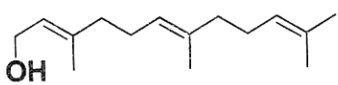

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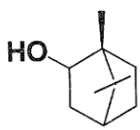

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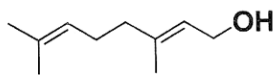

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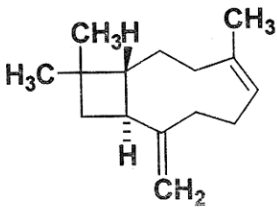

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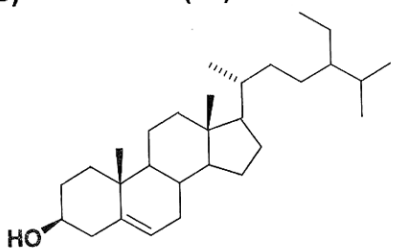

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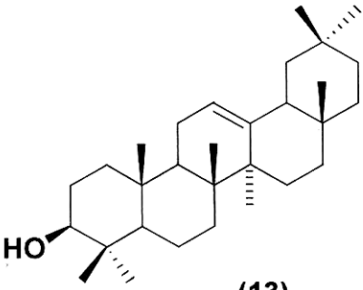

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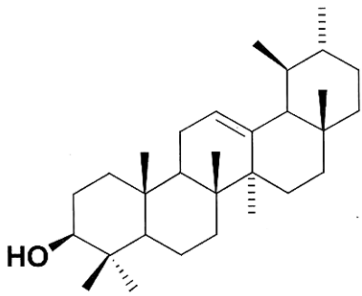

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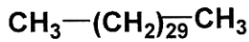

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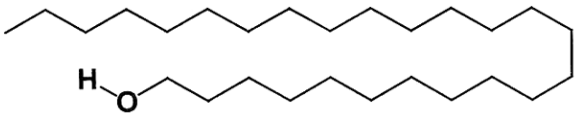

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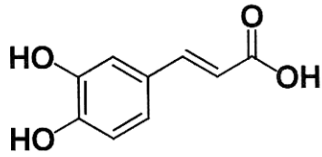

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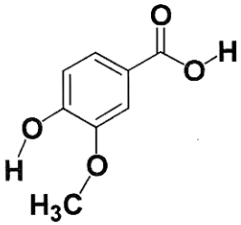

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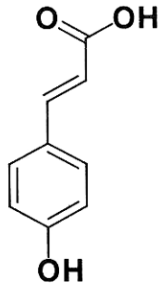

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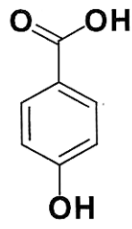

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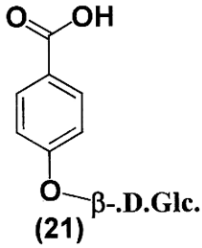

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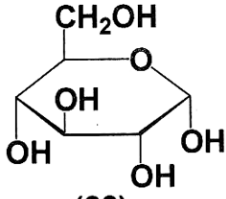

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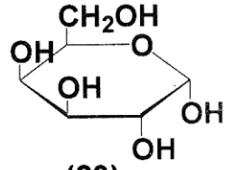

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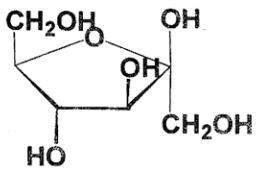

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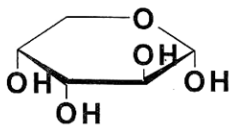

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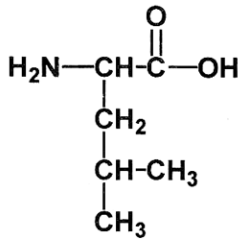

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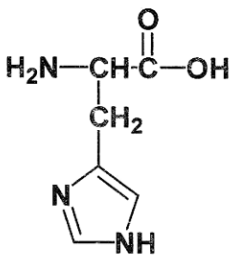

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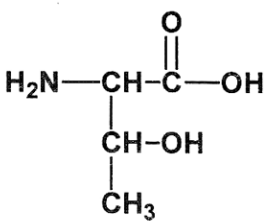

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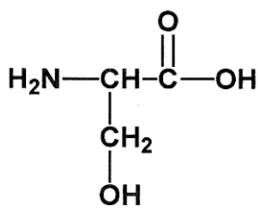

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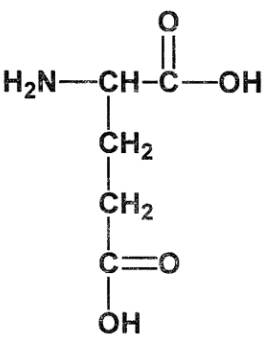

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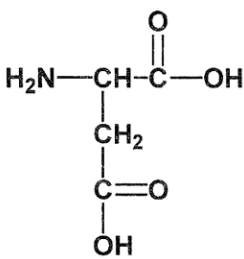

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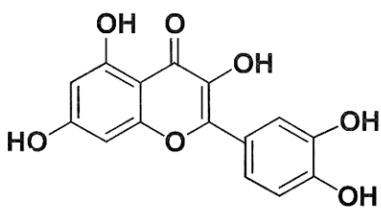

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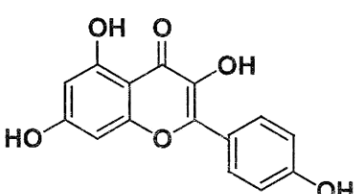

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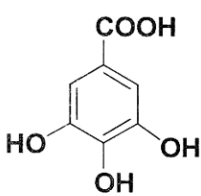

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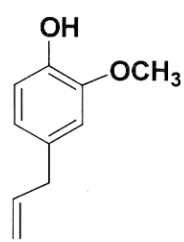

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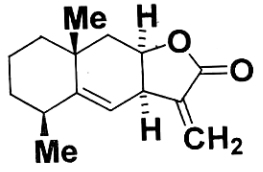

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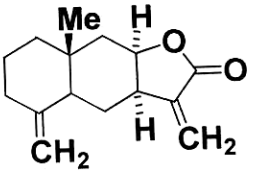

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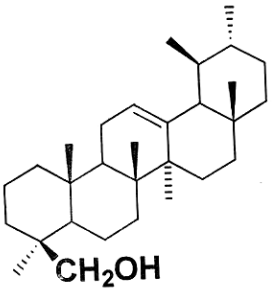

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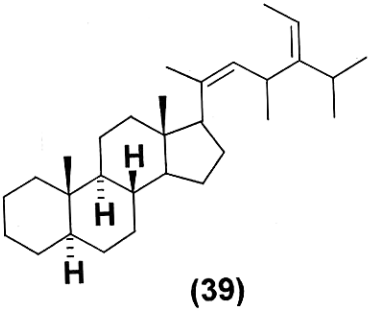

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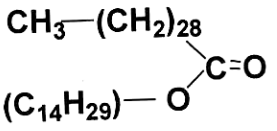

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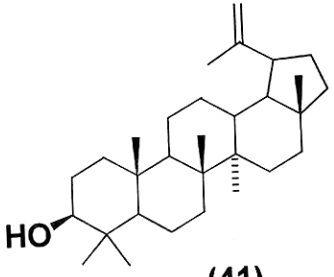

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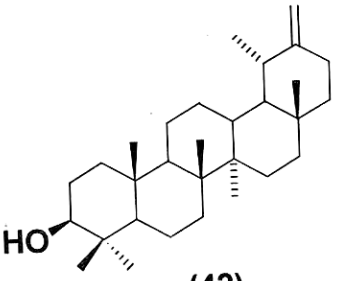

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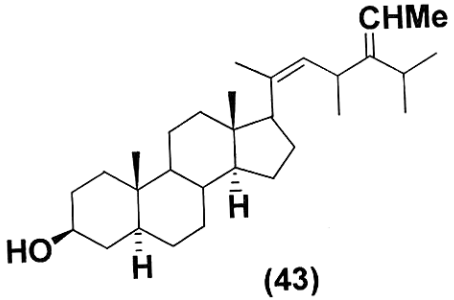

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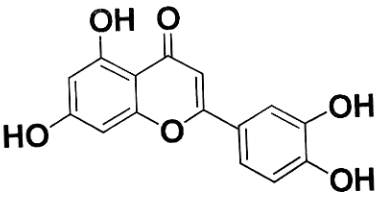

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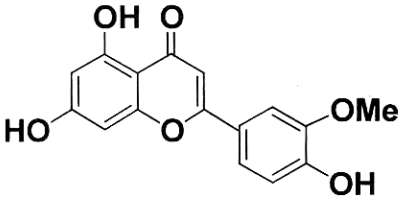

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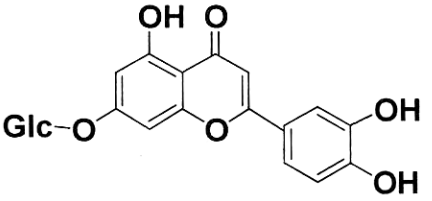

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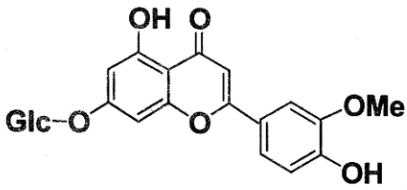

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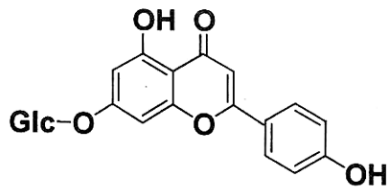

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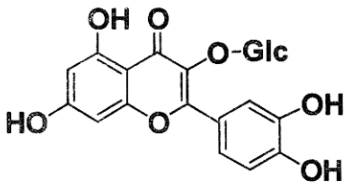

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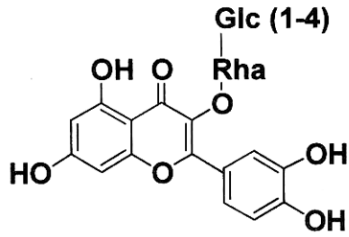

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Table 1 : List of the chemical constituents from *Abutilon* species

S.No.	Name of the compound	Molecular formula	Molecular weight	Physical data bp(°C), mp(°C) $[\alpha]_D$(°)	Source	Ref.
1.	Anthocyanins	-	-	-	*A. avicennae*	[4]
2.	Sitosterol	$C_{29}H_{50}O$	414.71	-	*A. indicum*	[5]
	Acetyl sitosterol	$C_{31}H_{52}O_2$	456.80	-		
3.	Raffinose (**1**)	$C_{18}H_{32}O_{16}$	504.44	-	*A. indicum*	[6]
	Linoleic acid	$C_{18}H_{32}O_2$	280.44	230/-5/-		
	Linolenic acid	$C_{18}H_{30}O_2$	278.43	231/-11/-		
	Palmitic acid	$C_{16}H_{32}O_2$	256.42	271/-159/-		
	Oleic acid	$C_{18}H_{34}O_2$	282.46	360/13/-		
	Stearic acid	$C_{18}H_{36}O_2$	284.47	361/67-69/-		
4.	Rutin (**2**)	$C_{27}H_{30}O_{16}$	610.52	-/193-195/-	*A. avicennae*	[7]
5.	Gossypetin-7-glucoside (**3**)	$C_{21}H_{20}O_{13}$	480.38	-/221/-12.4	*A. indicum*	[8]
	Gossypetin-8-glucoside (**4**)	$C_{21}H_{20}O_{13}$	480.38	-		
	Cyanidin-3-rutinoside(**5**)	$C_{27}H_{31}O_{15}$	595.00	-		
6.	β-Pinene (**6**)	$C_{10}H_{16}$	136.23	45/-/-	*A. glaucum* & *A. indicum*	[9]
	Eudesmol (**7**)	$C_{15}H_{28}O$	224	-		
	Farnesol (**8**)	$C_{15}H_{26}O$	222.37	-		
	Borneol (**9**)	$C_{10}H_{18}O$	154.25	-		
	Geraniol (**10**)	$C_{10}H_{18}O$	154.25	229/-/-		
	β-Caryophyllene (**11**) & their derivs.	$C_{15}H_{24}$	204.35	-		
7.	β-Sitosterol (**12**)	$C_{29}H_{50}O$	414.71	-/140/-37	*A. indicum*	[10]
	β-Amyrin (**13**) and fatty acids	$C_{30}H_{50}O$	426.72	-/197/88.4		
8.	α-Amyrin (**14**)	$C_{30}H_{50}O$	426.72	-/186/83	*A. pakistanicum*	[11]
	Hentriacontane (**15**)	$C_{31}H_{64}$	436.84	-/67-68/-		
	Ceryl alcohol (**16**)	$C_{26}H_{54}O$	382.72	240/78-82/-		
	Caffeic acid (**17**)	$C_9H_8O_4$	180.16	-/194-198/-		
	Vanillic acid (**18**)	$C_8H_8O_4$	168.15	-/210-214/-		
	p-Coumaric acid (**19**)	$C_9H_8O_3$	164.14	-/214/-		
	p-Hydroxybenzoic acid (**20**)	$C_7H_6O_3$	138.12	-/214-217/-		
	p-β-D-glucosyloxybenzoicacid (**21**), glucose (**22**), galactose (**23**), fructose (**24**), arabinose (**25**), leucine (**26**), histidine (**27**),					

Table 1 (continued)

S.No.	Name of the compound	Molecular formula	Molecular weight	Physical data bp(°C), mp(°C) $[\alpha]_D$(°)	Source	Ref.
	threonine **(28)**, serine **(29)**, glutamic acid **(30)**, aspartic acid **(31)**, β-sitosterol and β-amyrin					
9.	Quercetin **(32)**	$C_{15}H_{10}O_7$	302.00	-/ >300/-	*A. pannosum*	[12]
	Kaempferol **(33)**	$C_{15}H_{10}O_6$	286.24	-/283-285/5.0		
10.	Gallic acid **(34)**	$C_7H_6O_5$	170.12	-	*A. indicum*	[13]
11.	Eugenol **(35)**	$C_{10}H_{12}O_2$	164.20	73-75 /-/-	*A. indicum*	[14]
12.	Alantolactone **(36)**	$C_{15}H_{20}O_2$	232.32	-/78-79/219.3	*A. indicum*	[15]
	Isoalantolactone **(37)**	$C_{15}H_{20}O_2$	232.32	-/111-113/188.3		
13.	γ-Aminobutyric acid	$C_4H_9NO_2$	103.12	-/194/-	*Abutilon* sp	[16]
14.	Pakistanol **(38)**,	$C_{30}H_{50}O$	426.38	- /-/32.96	*A. pakistanicum*	[17]
	Cholestane deriv. **(39)**	$C_{30}H_{50}$	410.39	- /182-184/-		
	Tetradecanyltriacontanoate **(40)**	$C_{44}H_{88}O_2$	648.68	- /84-86/-		
	Lupeol **(41)**	$C_{30}H_{50}O$	426.72	- /215-216/26.4	*A. indicum*	[18]
	Taraxasterol **(42)**	$C_{30}H_{50}O$	426.72	- /221-222/96.3		
15.	Cholestane deriv. **(43)**	$C_{30}H_{50}O$	426.72	-	*A. bidentatum*	[19]
16.	Ayurvedic Anti-AIDS pharmaceutical preparations	-	-	-	*Different herbs*	[20,21]
17.	Anthelmintic essential oil	-	-	-	*A. indicum*	[22]
18.	Amino acids, aliphatic compounds, sugars, polyphenols, flavonoids, alkaloids and glycosides	-	-	-	*A. indicum*	[23]
19.	Luteolin **(44)**	$C_{15}H_{10}O_6$	286.24	- /328-330/-	*A. indicum*	[24]
	Chrysoeriol **(45)**	$C_{16}H_{12}O_6$	300.26	- /336-337/-		
	Luteolin-7-gluc. **(46)**	$C_{21}H_{20}O_{11}$	448.00	- /-/-		
	Chrysoeriol-7-gluc. **(47)**	$C_{22}H_{22}O_{11}$	462.40	-/173-175/-		
	Apigenin-7-gluc. **(48)**	$C_{21}H_{20}O_{10}$	432.38	- /-/-		
	Quercetin-3-gluc. **(49)**	$C_{21}H_{20}O_{12}$	464.38	-/284-285/-66.2		
	Quercetin-3-rham.(1→4) gluc.**(50)**	$C_{27}H_{30}O_{16}$	610.52			
20.	Cellulose, pentosan galactan, pectin and lignin	-	-	-	*A.avicennae*	[25]
21.	Ammonia and amines vapours	-	-	-	*A. avicennae*	[26]
22.	Linoleic acid				*A. theophrasti*	[27]
23.	Oxalic acid	$C_2H_2O_4$	90.04	-/189-191/-	*A. malvifolium*	[28]
24.	Amino sugar, muco- polysaccharide and uronic acid	-	-	-	*A. striatum*	[29]
25.	Pentoses, hexoses, pentosans, methyl pentosans, and uronic acids	-	-	-	*A. theophrasti*	[30]
26.	Sucrose glucose and fructose	$C_{12}H_{22}O_{11}$	342.29	-/190-192/66.5	*A. hybridum* *A. venosum*	[31]
27.	Asparagine	$C_4H_8N_2O_3$	132.13	-/220/-	*A. striatum*	[32]
28	Linolenic linoleic,palmitic,oleic and stearic acids				*A. indicum*	[33]
29.	Fumaric acid	$C_4H_4O_4$	116.07	-/295-300/-	*A. indicum*	[34]
	gluco-vanylloyl glucose vanillic, p-coumaric, p-hydroxybenzoic, caffeic, and p-β-D-glucosyloxy-benzoic acids, alkane mixture, alkanol,fructose, glucose, galactose, glucuronic acid,leucine, histidine, threonine, serine, glutamic and aspartic acids β-sitosterol	-	-	-		
30.	Dihydrosterculic acid dihydromalvalic acid and cyclopropanated fatty acids	-	-	-	*A. auritum*	[35,36]
31.	Alanine	$C_3H_7NO_2$	89.09	-/272-275/-	*A. glaucum &*	[37]

Table-1 (continued)

S.No.	Name of the compound	Molecular formula	Molecular weight	Physical data bp(°C), mp(°C) $[\alpha]_D$(°)	Source	Ref.
	Arginine	$C_6H_{14}N4O_2$	174.20	-/228-232/-	*A. indicum*	
	Valine	$C_5H_{11}NO_2$	117.15	-/283-285/-		
	glutamic acid, glucose fructose and galactose					
32.	Sterculic acid malvalic acid dihydrosterculic, linoleic,oleic,stearic and palmitic acids	-	-	-	*A. pannosum*	[38]
33.	Lysine	$C_6H_{14}N_2O_2$	146.19	-/170/-	*A. graveolens*	[39]
	Phenyl alanine	$C_9H_{11}NO_2$	165.19	-/266/-		
	threonine, histidine and epoxy acids					
34.	Linoleic, malvalic and sterculic acids				*A. crispum*	[40]
35.	Cyclopropenoid fatty acids, palmitic, stearic, oleic, linoleic and linolenic acids	-	-	-	*A. ramosum*	[41]
36.	Cyclopropene fatty acids,	-	-	-	*A. amplum*	[42]
37.	Apigenin,	$C_{15}H_{10}O_5$	270.24	-/352/-	*Abutilon* sp	[43]
	hypolactin, gossypetin kaempferol, quercetin luteolin and chrysoeriol					
38.	Galactomannan	-	-	-	*A. indicum*	[44]
39.	Gossypium				*Abutilon* sp	[45]
40.	Glycinebetaine				*Abutilon* sp.	[46]

extraction of different herbs including *A. indicum*. This herbal extract is in powder form which is formulated in capsules by using lactose as the excipient. Gharia and co-workers communicated in 2002 [22] that the essential oil from *A. indicum* possessed considerable anthelmintic activities against earth worm, tape worm, hook worm and nodular worm. In the same year Nguyen reported [23] that *A. indicum* contains amino acids, aliphatic compounds, sugars, polyphenols, flavonoids, alkaloids and glycosides. Among these polyphenols are very high, 16.92 - 28.62 mg/g, and of it flavonoids are 30-40 %, distributed in trunk, roots and fruits with characteristic absorption at 270-290 nm (flavonone). These findings are supported by the report of Matlawska and Sikorska who isolated 7 flavonoids namely luteolin **(44)**, chrysoeriol **(45)**, luteolin-7-glucoside **(46)**, chrysoeriol-7-glucoside **(47)**, apigenin-7-glucoside **(48)**, quercetin-3-gluc **(49)** and quercetin-3-rham. (1→4) gluc. **(50)** from the flowers of *A. indicum* in the same year [24].

From the foregoing review it has been noted that the chemical studies on the *Abutilon* species have been mostly carried out on the dried plant materials and that there are wide variations in the findings reported by various workers. This may apparently be due to the structural changes mainly brought about by enzymes in the drying process which may complicate the isolation procedures, adversely effecting the yields of pure compounds, also often resulting in the artifacts. The chemical work on *Abutilon* species up to the year 2003 has been summarized in Table 1.

Acknowledgement

One of us (D. N. Z) gratefully acknowledges financial support from the Higher Education Commission, Islamabad, Pakistan.

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