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Pharmacological and Phytochemical Studies of Genus Zizyphus

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Abstract: The genus Zizyphus belongs to family Rhamnaceae which comprises of 58 genera and almost 900 species. This genus is represented by 100 species through the world but in Pakistan 6 species are indigenous. In traditional system of medicines this genus has a key role in management or treatment of various ailments like analgesic, antipyretic, anti-inflammatory, sedative, antioxidant, antibacterial, GIT protective, antispasmodic, antidiabetic and antifungal. Most of the species have been validated for their ethnomedicinal uses and lots of species are still to be explored for its various pharmacological properties. Phytochemically this genus is famous for its cyclopeptide alkaloids and polysaccharides. However, large number of flavonoids, tannins and saponins has been isolated from various species of this valuable genus.

Key words: Zizyphus · Rhamnacea · Phytochemical · Pharmacological profile

INDRODUCTION

The family Rhamnaceae is a large family comprising of 58 genera and almost 900 species. These are represented in Pakistan by 6 genera and 21 species. It is also known as buckthorn family. It is distributed in many parts of the world but mainly populates in tropic and warm temperate region. These are mainly trees or shrubs but sometime climbing. The leaves of these plants are simple, alternate, opposite, evergreen, generally stipulate and sometime they are modified to form spines. The flowers are bisexual, small and greenish. Calyx in many cases is 5-lobed petals but in very rare cases it has 4 or 6 lobed. Corolla contains 5 petals in very small cases they are 4 or 6. Stamens 5 in number located opposite and are folded by pastels. A single compound pestle (2-4 carpels) form the gynaecium, ovary is superior while in rare cases it is inferior. Fruit often drupaceous, pyrenes 1-3 (-4), 1-2 seeded, or capsule, rarely samaroid. Seeds with a large erect embryo, endosperm copious or scanty [1].

From economic point of view Rhamnaceae family is important because it has ornamental properties providing some very good green and yellow dyes. Also it is good source of timber. Before the discovery of propellants the wood of Rhamnus was used to produce charcoal.

Genus Zizyphus: This genus is represented by 100 species through the world but in Pakistan 6 species are indigenous as shown in the Table 1. India, Pakistan, indo Malaysia, tropic America, Mediterranean regions is the area where this genus is distributed.

Trees or shrubs, mostly armed with a pair of stipular spines, one usually long and straight and the other short recurved. Leaves mostly distichous to subdistichous, alternate 3(-5)-nerved, usually leathery and oblique at the base, entire serrate or serrulate. Flowers in axillary cymes, 5-merous, regular, greenish yellow, mostly bisexual. Calyx 5-fid, saucer-shaped, lobes keeled. Petals 5, rarely absent, cucullate, disc pitted or flat 5-10 lobed, mostly lining the calyx tube. Stamens enclosed within the petals. Ovary immersed in disc, 2-4 celled, style 2(-3)-partite, stigma papillose, small. Fruit drupaceous, fleshy, succulent, globose-oblong, pyrenes 1-4, rugose or tuberculate, 1-seed in each stone. Seed plano-convex, mostly with very scanty endosperm [1a].

Pharmacological Studies

Anti-inflammatory Effect: When various fraction of extract of Zizyphus lotus were given intra peritoneally to mice at three different doses (50, 100 and 200 mg/kg body weight), these fraction a very good anti inflammatory

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Table 1: Zizyphus species indigenous to Pakistan.

S.No.	Name of specie.	Distribution	Medicinal uses
1	*Zizyphus jujuba* Mill	Hazara, Mansehra, Kashmir, Swat.	Fruit is edible; honeybees visit flower, analgesic, antidiabetic and antipyretic [42].
2	*Zizyphus mauritiana* Lam	Hyderabad, Khairpur, Karachi.	Tonic, antibacterial, antipyretic, analgesic, bronchodilator, emollient, anti-vomiting, sedative and abdominal pain in pregnancy [43].
	Ziziyphus nummularia (Burm .f)	Attock, D.G.Khan, dhado, Hazara, Karachi, Peshawar, Malakand.	Tonic, antipyretic, antibacterial and analgesic and antidiabetic [42].
3	*Zizyphus oxyphylla* Edgew	Buner, Hazara, Swat, Garhi Habibullah.	Digestive disorders, weakness, liver complaints, obesity, urinary troubles, diabetes, skin infections, fever, diarrhea and insomnia [21].
4	*Zizyphus rugose* Lam	Hyderabad.	Bodyache [45]
5	*Zizyphus spina-christi*	Karachi, Sukkur, Sandeman (Baluchistan)	It is used in traditional folk medicine for treatment of some diseases such as stomach pain and other gastrointestinal tract ailments, diabetes and diarrhea. It is believed that its leaves have blood pressure reduction properties as well [46]
6	*Zizyphus sativa*	Karachi	Fruit is edible, anti diabetic, used for cough and fever, honeybees visit flowers [42]

Table 2: Summary of isolated compounds

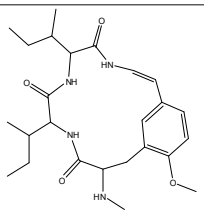
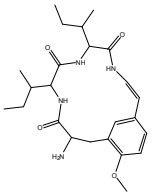
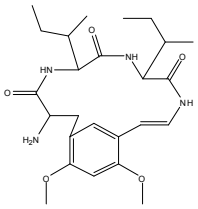
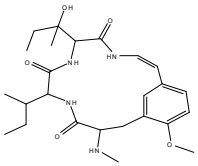
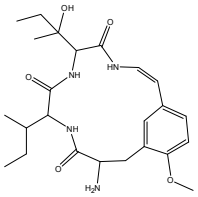
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
1	Abyssenine B		C25H38N4O4458.6	[47]
2	Abyssinine C		C24H36N4O4444.573	[47]
3	Mucronine G		C25H38N4O5474.599	[47]
4	Zizyphine D		C25H38N4O5474.599	[48]
5	Zizyphine E		C24H36N4O5460.572	[27]

Table 2: Continued

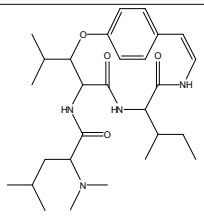
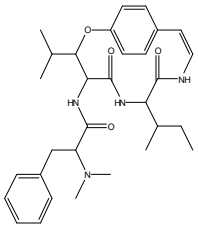
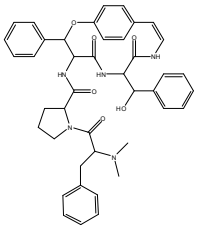
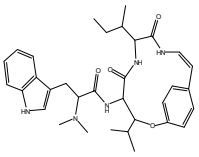
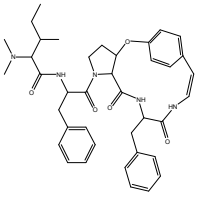
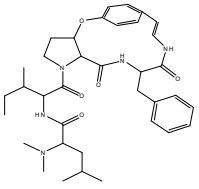
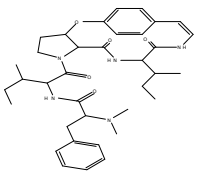
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
6	Adouetine X		C28H44N4O4 500.6	[49]
7	Lotusanine A		C31H42N4O4 534.697	[50]
8	Oxyphylline A		C42H45N5O6715.847	[26]
9	Amphibine A		C33H43N5O4 573.734	[51]
10	Amphibine B		C39H47N5O5 665.831	[51]
11	Amphibine C		C36H49N5O5631.814	[51]
12	Amphibine D		C36H49N5O5 631.814	[51]

Table 2: Continued

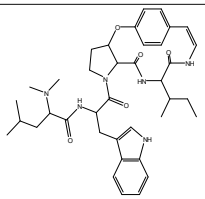
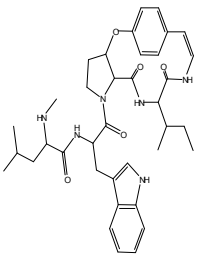
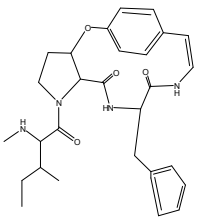
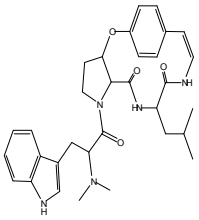
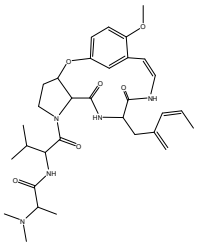
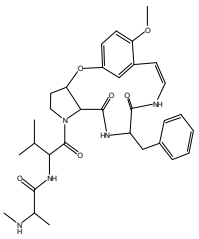
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
13	Amphibine E		C38H50N6O5 670.85	[52]
14	Mauritine J		C37H48N6O5 656.823	[53]
15	Amphibine F		C29H36N4O4504.628	[54]
16	Amphibine G		C32H39N5O4 557.691	[54]
17	Amphibine H		C33H43N5O6 605.733	[55a]
18	Nummularine B		C32H41N5O6 591.706	55b

Table 2: Continued

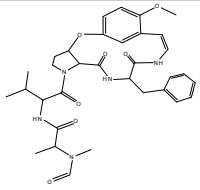
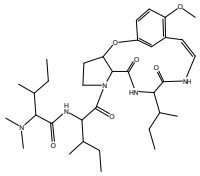
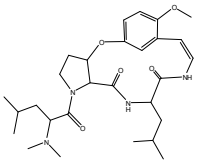
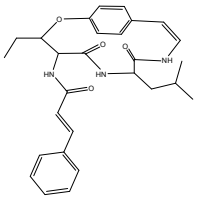
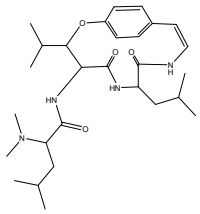
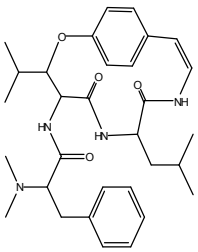
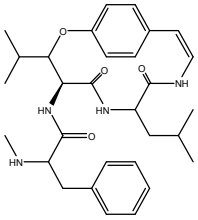
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
19	Nummularine T		C33H41N5O7 619.716	[32]
20	Daechuine S3		C34H53N5O6 627.823	[56]
21	Daechuine S7		C28H42N4O5 514.664	[56]
22	Sanjoinenine		C29H35N3O4 489.613	[57]
23	Franganine		C28H44N4O4 500.68	[58]
24	Frangufoline		C31H42N4O4534.697	[59]
25	Sanjoinine B		C30H40N4O4 520.67	[57]

Table 2: Continued

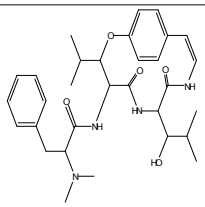
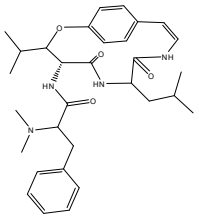
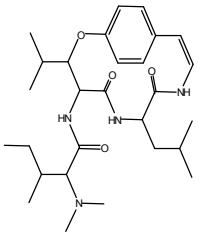
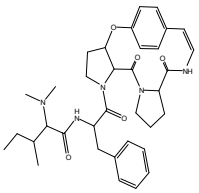
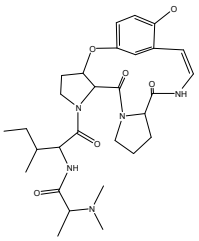
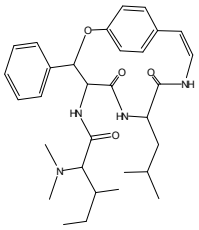
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
26	Sanjoinine F		C31H42N4O5 550.697	[57]
27	Sanjoinine Ah1		C31H42N4O4 534.697	[56]
28	Frangulanine		C28H44N4O4 500.68	[60]
29	Hysodricanine A		C35H45N5O5 615.771	[61]
30	Hysodricanine B		C30H43N5O6 569.7	[64]
31	Integerrenine		C31H42N4O4 534.697	[62]

Table 2: Continued

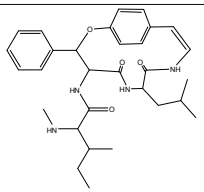
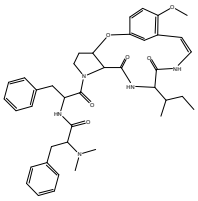
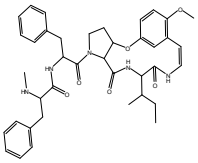
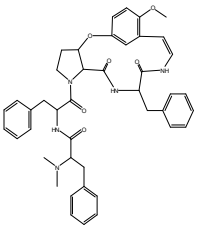
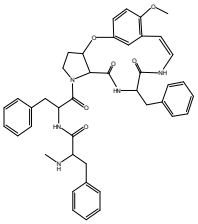
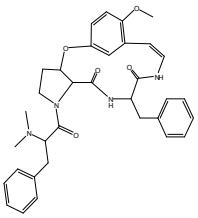
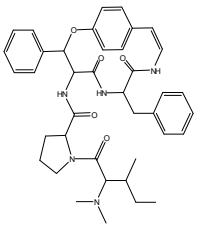
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
32	Nummularine D		C30H40N4O4520.67	[63]
33	Jubanine A		C40H49N5O6695.857	[64]
34	Nummularine H		C39H47N5O6681.83	
35	Jubanine B		C43H47N5O6729.874	[64]
36	Nummularine O		C42H45N5O6715.847	[65]
37	Xylopyrine B		C34H38N4O5582.698	[66]
38	Jubanine C		C39H47N5O5665.831	[35]

Table 2: Continued

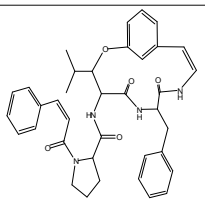
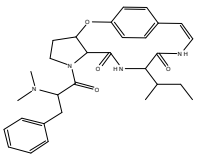
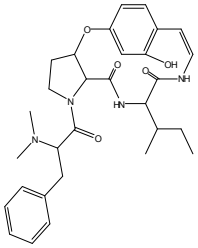
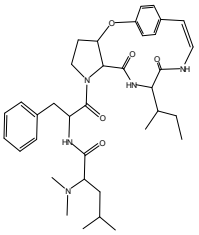
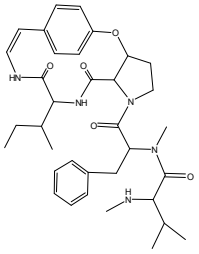
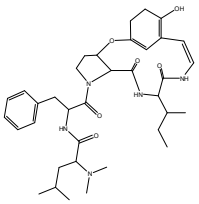
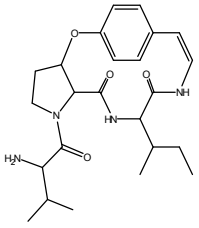
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
39	Lotusanine B		C37H40N4O5620.747	[59]
40	Lotusine A		C30H38N4O4518.655	[34]
41	Ramosine C		C30H38N4O5534.654	[67]
42	Lotusine B		C36H49N5O5631.814	[33]
43	Lotusine C		C35H47N5O5617.787	[33]
44	Lotusine E		C36H49N5O6647.813	[33]
45	Lotusine G		C24H34N4O4442.557	[68]

Table 2: Continued

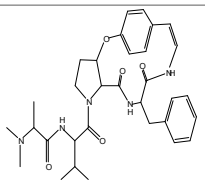
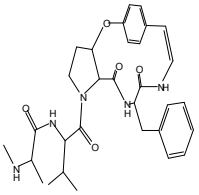
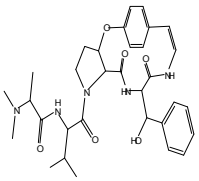
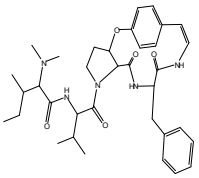
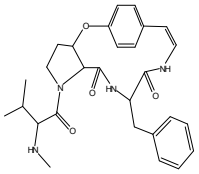
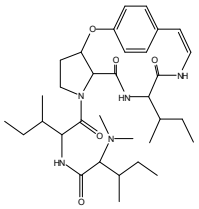
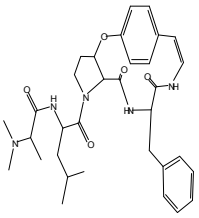
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
46	Mauritine A		C32H41N5O5575.706	[69]
47	Mauritine F		C31H39N5O5Molecular Weight: 561.68	[69]
48	Mauritine E		C32H41N5O6591.706	[69]
49	Mauritine B		C35H47N5O5617.787	[69]
50	Mauritine C		C28H34N4O4490.601	[52]
51	Mauritine D		C33H51N5O5597.796	[52]
52	Mauritine H		C33H43N5O5 589.733	[47]

Table 2: Continued

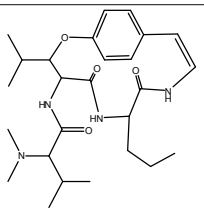
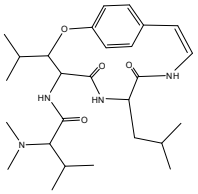
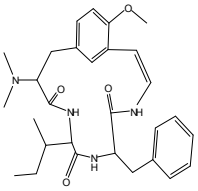
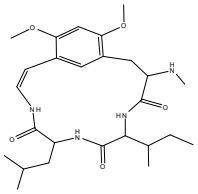
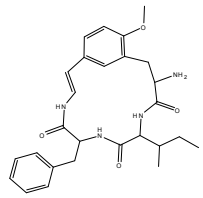
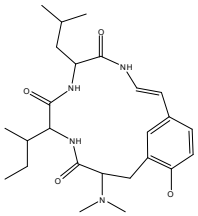
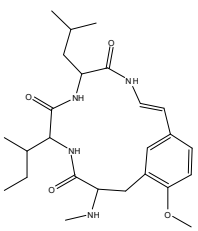
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
---	---		C27H42N4O4 486.653	[70]
54	Daechuine S5		C27H42N4O4486.653	[57]
55	Mucronine A		C29H38N4O4 506.644	[71]
56	Mucronine B		C28H36N4O4492.617	[71]
57	Mucronine H		C27H34N4O4 478.59	[71]
58	Mucronine C		C26H40N4O4 472.626	[71]
59	Abyssenine A		C25H38N4O4 458.6	[47]

Table 2: Continued

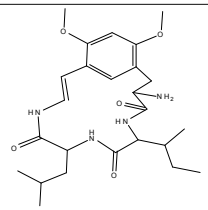
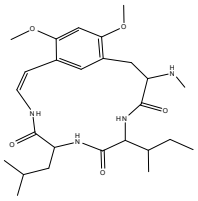
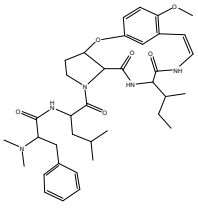
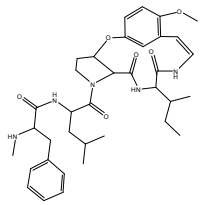
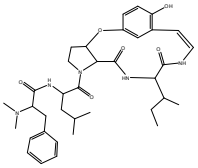
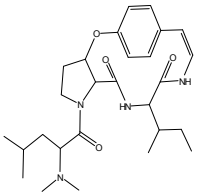
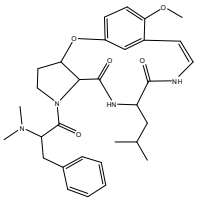
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
60	Mucronine E		C26H40N4O5488.626	[47]
61	Mucronine F		C25H38N4O5 474.599	[47]
62	Mucronine D		C37H51N5O6 661.84	[72]
63	Nummularine A		C36H49N5O6 647.813	[51]
64	O-Demethylmucronine D		C36H49N5O6 647.813	[73]
65	Mucronine J		C27H40N4O4 484.637	[72]
66	Nummularine C		C31H40N4O5548.681	[27]

Table 2: Continued

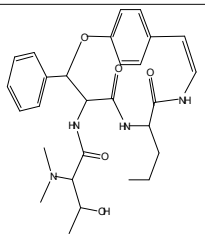
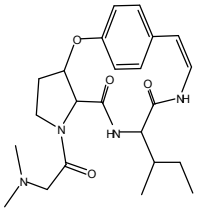
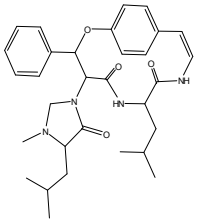
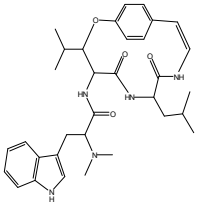
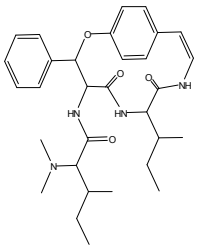
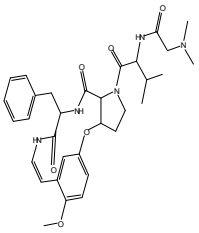
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
67	Nummularine E		C29H38N4O5522.643	[79]
68	Nummularine F		C23H32N4O4428.53	[79]
69	Nummularine G		C31H40N4O4 532.681	[51]
70	Nummularine K		C33H43N5O4 573.734	[74]
71	Nummularine M		C31H42N4O4534.697	[55]
72	Nummularine N		C32H41N5O6591.706	[55]

Table 2: Continued

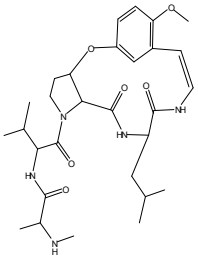
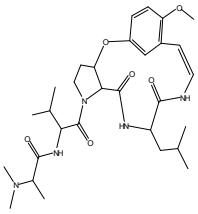
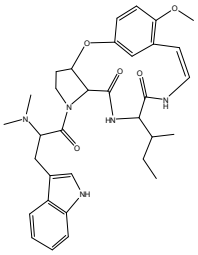
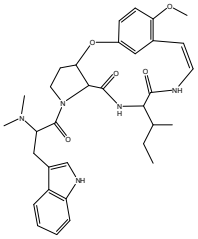
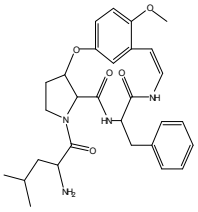
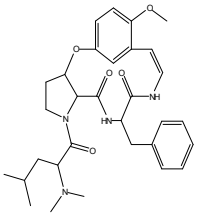
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
73	Nummularine P		C29H43N5O6557.689	[54]
74	Rugosanine A		C30H43N5O7585.699	[73]
75	Nummularine R		C33H41N5O5 587.717	[30]
76	Daechuine S10		C33H41N5O5587.717	[50]
77	Nummularine S		C29H36N4O5520.627	[76]
78	Xylopyrine A		C31H40N4O5548.681	[66]

Table 2: Continued

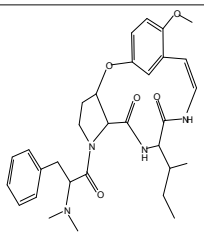
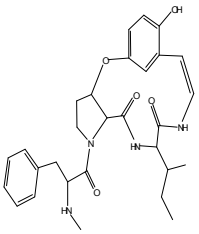
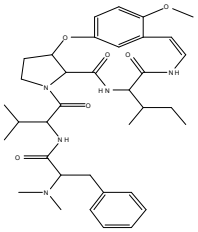
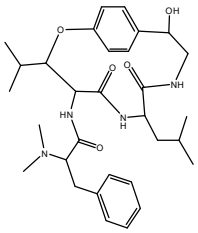
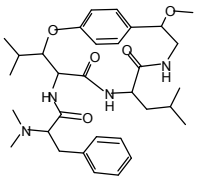
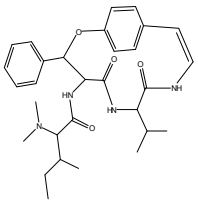
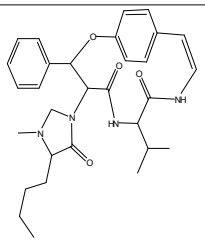
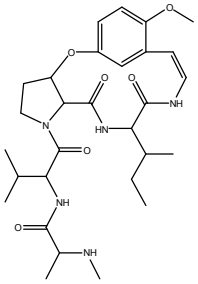
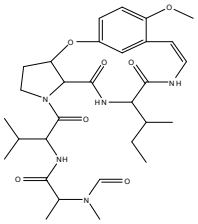
S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
79	Paliurine E		C31H40N4O5548.681	[77]
80	Lotusine F		C29H36N4O5520.627	[33]
81	Jubanine D		C36H49N5O6647.813	[64]
82	Sanjoinine G1		C31H44N4O5 552.712	[57]
83	Sanjoinine D		C32H46N4O5566.739	[78]
84	Sativanine A		C30H40N4O4520.67	[79]

Table 2: Continued

S. No.	Compound	Structure	Mol. Formula &Mol. Mass, m/z	Reference
85	Sativanine B		C30H38N4O4518.655	[79]
86	Sativanine C		C29H43N5O6557.689	[29]
87	Sativanine M		C30H43N5O7585.699	[80]

response. But it was found that this response was dose dependant. it means that roots of *Zizyphus lotus* can be used to reduce inflammation [2]. literature has also shown that when the falvonides and saponins fraction of the extract from the leaves and roots bark were tested in a dose of 200 mg/kg by using various protocols such as carrageenan induced paw edema in rats [3].

Analgesic Effect: The crude methanolic extract of the leaves of Zizyphus oxyphylla was tested for anti inflammatory and analgesic activity it was found that this extract contained both anti inflammatory and analgesic activity [4]. on acetic acid-induced algesia in mice. It was found that both fractions showed significant activity. Methanolic extract of roots was more effective as compared to the leaves extract in inhibiting the oxazalone induced DTH [5]. The crude extract of *Zizyphus spins-Christi* has also been reported to show dose dependant response in hot plate method and acetic acid induced writhing method [6].

Anti-Diabetic Effect: This genus is also very famous for its anti diabetic activity. According to [7]. When the crude extract was used as plain or formulated it showed a very good hypoglycemic response by improving the utilization of glucose. It increased the insulin secretion in mice. It was stipulated that saponins and poly phenols of the extract are responsible .it was due to reduction in the absorption of glucose contained in the food. Similarly in one of his study on the hypoglycemic effect of various Indian medicinal plants Mukarjee and his coworkers found that *Zizyphus sativa* was able to reduce blood glucose level [8].

Hepatic Protective Effect: Hepatic protection is one of the major and important activities of this genus. It is evident from the work of Chen and his co-workers. Water extract of *Zizyphus jujube* was able to reduce the liver injury induced by ischemia or perfusion when the crude extract was given. It showed its effect possibly due to the antioxidant potential of this extract [8]. *Zizyphus jujube*

fruit extract was also found to have the property of attenuating the histopathology of the liver when used in a dose of 200 mg/kg [9].

Effects on CNS: This genus has also been reported to have effects on central nervous system (CNS). Azdu and his co worker worked on the effect of aqueous extract of roots of *Zizyphus spina-christi* against exploratory behavior, spontaneous motor activity (SMA) pentobarbital-induced hypnosis and motor coordination (Rota-rod performance). It was found that this extract prolonged the pentobarbital sleeping time in experimental mice. It means that this extract has a CNS depression activity [11]. The sedative effect of this genus has also been established as reported in Cho et al. Not only the crude extract but the pure compound also has anxiolytics activity [12].. Anti-convulsant activity of *Zizyphus spina-christi* extract was also found it inhibited the neurotransmitters at different brain regions [13]..

Antipyretic Effect: A methanol extract of Zizyphus oxyphylla Edgew leaves has been investigated for its analgesic antipyretic activity in adult Wistar of either sex at 50, 100 and 200 mg/kg orally. The extract demonstrated marked antipyretic activity against Brewer's yeast-induced pyrexia in rats [4].

Free Radicals Scavenging Effect: One other prominent activity of this genus is the antioxidant activity. It was found that Zizyphus *jujube* had a good antioxidant activity against DPPH. It was found that there is a direct correlation between the anti oxidant activity and phenolic contents [14]. Similarly oils from the seed of *Zizyphus jujube* also showed anti oxidant activity in the superoxide redical scavenging activity [15].

Antiulcerinic Effect: Zizyphus lotus was found to have antiulcerinic activity. When roots leaves and stem crude extracts were administered orally it was found that they showed significant response by inhibiting the ulcer produced by the HCL/Ethanol solution [16]. The isolated compounds also has antiplasmodial activity [17].

Anti-Microbial Effects: Anti microbial activity is also shown by these species against Gram +ve and gram -ve bacteria. According to study conducted by Naggla showed that lipid fraction of the edible portion of the fruit of *Zizyphus spina-christi* showed anti microbial activity against G+ive Bacillus subtilus, and Streptococcus pyogenes, G-ive Escherichia coli . While fatty acid fraction showed anti microbial activity against Bacillus subtilus and Escherichia coli which was very high [18] while both the crude extract and oil fraction of Zizyphus jujube was found to have a good antibacterial activity against some pathogens such as *Staphylococcus aureus, Listeria monocytogenes, Bacillus subtilus, Pseudomonas aeruginosa, Salmonella typhimurium* and *Escherichia coli* [19]. Some compounds (theasinensin A, a polyphenol formed from (-) - epigallocatechin gallate, proanthocyanidins) isolated from the fruits of *Zizyphus jujbe* were very much active against methicillin resistant Staphylococcus aureus [20]. *Zizyphus oxyphylla* was have been reported with for its antibacterial effect, the result revealed that ethyl acetate fraction showed some good activity (16 mm zone of inhibition) against *Bacillus subtilus* and (18 mm zone of inhibition) *Staphylococcus aureusus* while all the other fractions along with the crude did not show any inhibition. In the case of antifungal activity the results revealed that maximum antifungal activity (35%) was shown against. Microsporum canis by crude, n-hexane and aqueous fraction each while chloroform and butanolic fraction showed 30 and 20% antifungal activity, respectively. Ethyl acetate and n-hexane fraction showed low activity against *Aspergillus flavus* from 10% to 20% respectively. Crude extract showed 10% inhibition against *Fusarium solani* [21].

Phytotoxic Effect: The crude methanolic extract and its various solvent fractions of *Zizyphus oxyphylla* has been reported with significant phytotoxic effect. Crude along with all other fraction showed significant activity at highest concentration (1000 μg/ml), maximum activity was shown by crude extract at this concentration that is 90% growth regulation while 60% was the lowest activity as shown by aqueous fraction. The results clearly indicated that phytotoxic activity is dose dependent i.e., high phytotoxcicity at high concentrations and vice-versa.

Urease Inhibition Effect: Methanolic extracts and subsequent fractions of *Zizyphus oxyphylla* stem and three isolated compounds from roots of *Zizyphus oxyphylla* obtained through column chromatography were subjected to in-vitro urease inhibition. Three fractions (n-hexane, ethyl acetate and butanol fractions) showed good to excellent activity while chloroform fraction showed non-significant activity. Amongst isolated compounds Oxyphylline D was the most active of the three isolated cyclopeptide alkaloids followed by Nummularin R and Nummularin C [22].

Nutritious Values: The proximate composition of five cultivars of Chinese jujube, along with mineral, vitamin and total phenolic contents was determined. Investigations showed that Chinese jujube contained 80.86–85.63% carbohydrate, 57.61–77.93% reducing sugar, 0.57–2.79% soluble fiber, 5.24–7.18% insoluble fiber, 4.75–6.86% protein, 0.37–1.02% lipid, 17.38–22.52% moisture and 2.26-3.01% ash. The soluble sugars of Chinese jujube included fructose, glucose, rhamnose, sorbitol and sucrose. Fructose and glucose were identified as the major sugars while sorbitol was present in much lesser amounts. Potassium, phosphorus, calcium and manganese were the major mineral constituents in Chinese jujube. Iron, sodium, zinc and copper were also detected in appreciable amounts. The contents of vitamin C, thiamine and riboflavin were found to be 192–359, 0.04–0.08 and 0.05–0.09 mg/100 g, respectively.

Anticancer Effect: According to a study Zizyphus has a heeling effect in many cancer cases. It can have some effects such as it can delay the progression of cancer, can decrease the intensity and frequency of pain, can enhance the immune response an increase life expectancy [23]. Furthermore *Zizyphus jujube* has shown marked protection against the genotoxicty produced by the hydroquinone [24].

Antispasmodic Effect: Antispasmodic activity of this genus is also reported [24].

Photochemistry: Although *Zizyphus oxyphylla* Edgew has not been explored well as compared to the other species of this genus but still up till now one new compound Oxyphylline A and one know alkaloid has been isolated from the roots of this plant [26].

Cyclopeptide Alkaloids: Many a species of Zizyphus are famous for Cyclopeptide alkaloids. It is evident from the fact that I almost 170 different types of Cyclopeptide alkaloids are isolated up till now from various families of plants and about 50% (81) have been isolated from various species of Zizyphus. Amongst these 81 Cyclopeptide alkaloids 35 are 13-membered, 39 are 14 memebered and 15 belong to 15 member Cyclopeptide alkaloids [17]. Cassels and co workers worked on the isolation of alkaloids from *Zizyphus eonoplia* [27]. Two other nsolatedew 14 member cyclopeptide alkaloids were added to the group of these valueable compound in 1979. The source of these alkaloids was *Zizyphus sativa* and names of the compounds were sativanine-A and sativanine-B [28] In the year 1984, sativanine-C was obtained as a new compound from the bark of *Zizyphus sativa* .this was another addition into the group of 13 member cyclopeptide alkaoids. Its structure was detrmined by using various techniques such as spectroscopy, transformational products and also by chemical ionization and degradation [29]. According to [30] cyclopeptide alkaloids from different species of Zizyphus have isolated namemly frangufoline, amphibine-H and nummularine-K and nummularine-R from *Zizyphus jujuba*, *Z. nummularia* and *Z. nummularia* respectively. *Zizyphus spina* christi was also not far behind othe species because some alkaloids were aslo isolated from it [31]. In 1994 *Zizyphus nummularia* was searched for the isolation of Cyclopeptide alkaloid which was successful in isolating a new Cyclopeptide alkaloid by using silica gel column chromatography and preparative TLC while the solvent system used was chloroform in methanol different ration fro coloumn and PTLC.This Cyclopeptide alkaloid was given the name of Nummularine-T which was a 13 member Cyclopeptide alkaloid isolated from the bark of this plant [32]. *Zizyphus lotus* was searched for Cyclopeptide alkaloids Ghedira and his co workers which have yielded into 4 Cyclopeptide alkaloids. These four new compounds included lutisine B, C, E and F. For structure determination both homo and hetero nuclear NMR techniques were used. Roots bark was the part of the plant used For isolation and purification centrifugal TLC was utilized [33]. Two other new alkaloids isolated from the same plant were lotusine A and lotusine D [34]. In 2001, from *Zizyphus jujuba* one new Cyclopeptide alkaloid (jubanine-C) along with 2 already know compounds (scutianine-C and zizyphine-A) were isolated by using silica gel column chromatography followed by preparative TLC. Elution system consisted of different combinations of chloroform and methanol and the structure was determined by routine spectroscopic techniques [35]. In the next year of 2002 another one new alkaloid was isolated from *Zizyphus lotus* roots bark. Some other efficient techniques like centrifugal partition chromatography were used in pH refining mode. This process resulted in a new Cyclopeptide alkaloid named lotusine G. with the use of this technique some other already known compounds such as lotusines D, E, F were isolated with higher yield [36]. Similarly four new Cyclopeptide alkaloids were isolated from *Ziziphus oenoplia.* Ethyl acetate fraction of the roots of the plant was subjected to column chromatography which resulted in the purification of 4 (13) Cyclopeptide alkaloids ziziphine N, P, O and Q [17].

Polysaccharides: Polysaccharides have also been isolated from these species such as a novel water soluble polysaccharide (ZSP3) has been isolated from *Zizyphus jujuba cv. Jinsixiaozao.* Various special techniques were used for the isolation of this poly saccharide. This poly saccharide contained three mono saccharide units, l-rhamnose, d-arabinose and d-galactose (1:2:8). DEAE-SepharoseCL-6Banion-exchange, SepharoseCL-6BandSephadexG-200column chromatography. High-performance gel permeation chromatography was used to isolate these compounds [37]. similarly from the fruits of *Zizyphus jujuba* more polysaccharides have been isolated. There average molecular weight was found to be in the range of 40,566 to 129,518 Da. These polysaccharide fractions contained rhamnose, arabinose, xylose, mannose, glucose and galactose mono saccharide [38]. Saponins and tannins have also been isolated from various species of this plants [39]. 2-O-protocatechuoylaliphitolic acid, 2á-hydroxypyracrenic acid and 3-O-protocatechuoylceanothic acid along with 2 other known compounds have been isolated from the roots of *Zizyphus jujuba.* These compounds come in the range Diterpenoids ester [39 c].

Triterpenoids: Similarly triterpenoids have also been isolated from the leaves of Zizyphus species [40]. Not only alkaloids are isolated from this genus *Zizyphus* other group of compounds such as falvonids , saponins, tannins and polysaccharides have also been isolated from various species of *Zizyphus*. Quercetin, kaempferol, and phloretin are the example of falvonids isolated from the fruits of *Zizyphus jujuba* Miller and *Zizyphus spina* christi. HPLC/ESI-MS was used to identify these compounds. These were characterized by NMR [41].

It may be said that literature showed that Zizyphus can produce almost all type of compounds. In the above discussion we have just focused on photochemical literature about this genus. But this genus showed many remarkable biological activities which have been mentioned in the literature survey of the genus.

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