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Saponins from Genus *Albizia*: Phytochemical and Biological Review

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Abstract

Albizia is a large genus that belongs to family Fabaceae; most of *Albizia* species are rich in triterpenoidal saponins. These species were used in folk medicine for the treatment of rheumatism, stomach ache, cough, diarrhea, wounds, and as an anthelmintic. Many pharmacological activities were reported for the fractions or extracts containing saponins. Also, various pharmacological activities were reported for the pure isolated saponins. This review focuses on the distribution of saponins among the different species of genus *Albizia* and their pharmacological activities.

Keywords: *Albizia;* Cytotoxicity; Echinocystic acid; Oleanolic acid

Abbreviations: A549: Human Lung Epithelial cancer; A278: Human Ovarian Cancer; Bel-7402: Hepatocellular Carcinoma; BGC-823: Human Gastric Cancer; B16-F10, SK-MEL-28: Melanoma Cells; HCT-8, HCT 116: Human Colon Cancer; HepG-2: Hepatocellular Carcinoma; HT-29: Human Colon Cancer; JMAR, MDA1986: Human Head and Neck Squamous Cells; KB: Oral carcinoma; MCF-7: Human Breast Adenocarcinoma

Introduction

Albizia is a large genus belonging to the family Fabaceae, which comprises about 150 species that are widely distributed in in Africa and Central South America. Most of these plants are fast-growing sub-tropical and tropical trees and shrubs. Phytochemical investigation of different *Albizia* species revealed the presence of different classes of secondary metabolites, such as saponins, terpenes, alkaloids and flavonoids, but most of the phytochemical studies done on different *Albizia* species lead to the isolation of saponins. Saponins are secondary metabolites of a glycosidic nature that are widely distributed among plant kingdom. The aglycon part maybe a steroidal or triterpenoidal nucleus which is attached to one or more sugar residues in a straight chain or a branched form, most often composed of D-glucose, L-rhamnose, D-galactose, D-glucuronic acid, L-arabinose, D-xylose or D-fucose. Saponins have been used extensively in drug-related industry due to their pharmaceutical properties; which has driven the emergence of new extraction technologies with the main purpose of optimizing the yield in order to accommodate their need [1].

Pharmacological activities of extracts containing saponins from different *Albizia* species

Anti-inflammatory activity: The aqueous ethanolic extract of *A. amara* roots exhibited significant anti-inflammatory effect in rats at dose of 200 mg/kg administrated compared to the standard dose of aspirin (100 mg/kg). The anti-inflammatory effect was evaluated using carrageenan- induced paw oedema where the percentage inhibition of oedema was 61.91% [2].

The aqueous ethanolic extract of *A. lebbeck* bark showed significant anti-inflammatory effect at dose of 400 mg/kg administrated to rats compared to the standard dose of indomethacin (10 mg/kg).The anti-inflammatory effect was evaluated using carrageenan, dextran, and cotton pellet- induced paw oedema where the percentage inhibition of oedema was 59.57%, 52.93%, and 53.57%, respectively [3].

Analgesic activity: The aqueous ethanolic extract of *A. amara* roots showed analgesic effect at dose of 200 mg/kg administrated to rats compared to the standard dose of aspirin (100 mg/kg). The analgesic effect was evaluated using hot plate method test [2].

The aqueous and ethanolic extracts of *A. lebbeck* leaves revealed analgesic effect at doses of 50, 100, and 200 mg/kg administrated to rats. The analgesic effect was evaluated using the hot plate test and tail flick method [4].

Nootropic and anxiolytic activity: The *n*-butanolic fraction of the methanolic extract of *A. lebbeck* leaves showed nootropic and anxiolytic activity at dose of 25 mg/kg administrated to albino mice. This effect was evaluated using the elevated plus maze test [5].

Anti-histaminic activity: The ethanolic extract of *A. lebbeck* stem bark inhibited histamine signaling in sensitized rats at a dose of 200 mg/rat through suppression of H1 receptors and histidine decarboxylase genes (HDC) transcriptions [6].

Anti-microbial activity: The 70% aqueous ethanolic extract of *A. ferruginea* stem bark and leaves showed antimicrobial activity against *Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, Candida albicans, Aspergillus niger,* and *Penicillium notatum*. The anti-microbial activity was evaluated by calculating zone of inhibition were the leaves extract was more active and *P. aeruginosa* was resistant to both extracts [7].

Anti-spermatogenic activity: Oral administration of 50 mg/kg of a saponin-rich fraction obtained from the *A. lebbeck* stem bark for 60 days to male rats led to decrease in the weights of testes, epididymides, seminal vesicle and ventral prostate also the production of round spermatid was reduced by 73.04% [8]. Pharmacological activity wasn't only evaluated on extracts containing saponins, but it was also evaluated on pure isolated saponins. Table 1 and Figures 1-7 shows

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Species	Investigated Part(s)	Isolated saponins	Pharmacological activity	References
A. adiantifolia	Root	Adianthifoliosides A [1 in Figure 1] Adianthifoliosides B [2 in Figure 1] Adianthifoliosides D [3 in Figure 1]	Compound [1 in Figure 1] and compound [3 in Figure 1] induced apoptosis in Jurkat cells at concentration of 5 µM and 1 µM, respectively.	Haddad et al. [15]
A. chinnensis	Stem bark	Albizoside D [4 in Figure 1] Albizoside E [5 in Figure 1] Julibroside J8 [6 in Figure 1]	Compounds [4 in Figure 1] and [5 in Figure 1] showed cytotoxic activity on HCT-8, Bel-7402, BGC-823, A549, andA2780 cell lines. The IC_{50} values for compound [4 in Figure 1] were: 7.7, 0.7, 0.08, 0.30 and 0.9 µM, on the five mentioned cell lines respectively. The IC_{50} values for compound [5 in Figure 1] were: >10, 0.6, 0.03, 1.2, and 0.3 µM, respectively.	Liu et al. [20]
A. coriaria	Root	CoriariosideA [7 in Figure 2] Coriarioside B [8 in Figure 2] Gummiferasoide C [9 in Figure 2]	Compound [7 in Figure 2] and [9 in Figure 2] showed cytotoxic activity on HCT 116 and HT-29 cell lines The IC_{50} values for compound [7 in Figure 2] were 4.2 µM and 6.7 µM, respectively. The IC_{50} values for compound [9 in Figure 2] were: 2.7 µM and 7.9 µM, respectively.	Noté et al. [19]
A. gummifera	Stem bark	3-*O*-{β-D-glucopyranosyl(1→2)-[α-L-arabinopyranosyl(1→ 6)]-β-D-glucopyranosyl}-oleanolic acid [10 in Figure 3] β-D-glucopyranosyl(1→2)-β-D-glucopyranosyl 3-*O*-{β-D-glucopyranosyl(1→2)-[α-L-arabinopyranosyl(1→6)]-β-D-glucopyranosyl}-oleanolate [11 in Figure 3] 3-*O*-{β-D-glucopyranosyl-(1→2)-[*O*-α-L-arabinopyranosyl(1→6)]β-D-glucopyranosyloxy}-machaerinic acid γ-lactone [12 in Figure 3] 3-*O*-{β-D-glucopyranosiduronic acid (1→2)-β-D-glucopyranosyloxy}-machaerinic acid γ-lactone [13 in Figure 3]	No reports were traced for the pharmacological activity.	Debella et al. [14]
A.grandibracteata	Leaves	GrandibracteosidesA [14 in Figure 4] GrandibracteosidesB [15 in Figure 4] GrandibracteosidesC [16 in Figure 4]	Compounds [14-16 in Figure 4] showed cytotoxic activity on KB and MCF-7 tumor cell lines. The IC_{50} values for compound [14 in Figure 4] were: 1.3 µM and 0.4 µM, respectively. The IC_{50} values for compound [15,16 in Figure 4] were: 2.3 µM and 1.7 µM, respectively.	Krief et al. [21]
A. inundata	Aerial parts	3-*O*-[α-L-arabinopyranosyl (1→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl oleanolic acid [17 in Figure 5] 3-*O*-[α-L-arabinopyranosyl(1→2)-α-L-arabinopyranosyl(1→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl acacic acid lactone [18 in Figure 7] 3-*O*-[α-L-arabinopyranosyl (1→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl echinocystic acid [19 in Figure 6] 3-*O*-[β-D-xylopyranosyl (l→2)-α-L-arabinopyranosyl(l→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl acacic acid lactone (concinnoside D) [20 in Figure 7] 3-*O*-[β-D-glucopyranosyl(l→2)]-β-D-glucopyranosyloleanolic acid [21 in Figure 5] 3-*O*-[α-L-arabinopyranosyl(1→2)-α-L-arabinopyranosyl(l→6)]-β-D-glucopyranosyl oleanolic acid [22 in Figure 5] 3-*O*-[β-D-xylopyranosyl(1→2)-α-L-arabinopyranosyl(l→6)]-β-D-glucopyranosyl oleanolic acid [23 in Figure 5] 3-*O*-[α-L-arabinopyranosyl(l→2)-α-L-arabinopyranosyl(1→6)-[β-D-glucopyranosyl(l→2)]-β-D-glucopyranoside echinocystic acid [24 in Figure 6] 3-*O*-[β-D-xylopyranosyl(l→2)-α-L-arabinopyranosyl(1→6)-[β-D-glucopyranosyl(l→2)]-β-D-glucopyranoside echinocystic acid [25 in Figure 6]	Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B16-F10, SK-MEL-28 cell lines. The IC_{50} values for compound [17 in Figure 5] were: 4.7 µM, 8.7 µM, 7.3 µM, and 12.4 µM, respectively. The IC_{50} values for compound [19 in Figure 6] were: 5.1 µM, 2.8 µM, 1.8 µM, and 9.2 µM, respectively. The IC_{50} values for compound [22 in Figure 5] were: 6.9 µM, 10.1 µM, 9.0 µM, and 8.6 µM, respectively. The IC_{50} values for compound [23 in Figure 5] were: 6.3 µM, 11.5 µM, 8.2 µM, and 8.1 µM, respectively.	Zhang et al. [16]
A. julibrissin	Stem bark	Julibroside J5 [26 in Figure 1] Julibroside J8 [6 in Figure 1] Julibroside J12 [27 in Figure 1] Julibroside J13 [28]	The Inhibition (%) against Bel-7402 cell line for the compounds [6, 26-28 in Figure 1] at a concentration of 100 µg/mL was 58.29, 86.66, 63.98, and 93.33, respectively.	[Kun Zou et al. 2005]
A. mollis	Bark	Molliside A [29 in Figure 7] Molliside B [30 in Figure 7] Concinnoside A [31 in Figure 7] Albiziasaponin A [32 in Figure 7]	No reports were traced for the pharmacological activities.	Cheng et al. [22]

A. procera	Bark	3-*O*-[β-D-xylopyranosyl-(1→2)-α-L-arabinopyranosyl-(1→6)-2-acetamido-2-deoxy-β-D-glucopyranosyl] echinocystic acid [33 in Figure 6] 3-*O*-[α-L-arabinopyranosyl-(1→2)-β-D-fucopyranosyl-(1→6)-2-acetamido-2-deoxy-β-D-glucopyranosyl] echinocystic acid (34 in Figure 6) 3-*O*-[β-D-xylopyranosyl-(1→2)-α-L-arabinopyranosyl-(1→6)-2-acetamido-2-deoxy-β-D-glucopyranosyl] acacic acid lactone [20 in Figure 7]	Compounds [33 in Figure 6] and [20 in Figure 7] showed cytotoxic activity on HepG2 cell line. The IC_{50} value for compound [33 in Figure 6] was: 9.13 µg/mL. The IC_{50} value for compound [20 in Figure 7] was: 10 µg/mL.	Melek et al. [18]
A. subdimidiata	Whole plant	Albiziatrioside A [35 in Figure 6] Albiziatrioside B [36 in Figure 5]	Compounds [35 in Figure 5] and [36 in Figure 5] Showed cytotoxic activity on A2780 cell line with IC_{50} values of 0.9 µg/mL, and 0.8 µg/mL, respectively.	Abdel-Kader et al. [13]

Table 1: Distribution of saponins among Albizia species and their pharmacological activities.

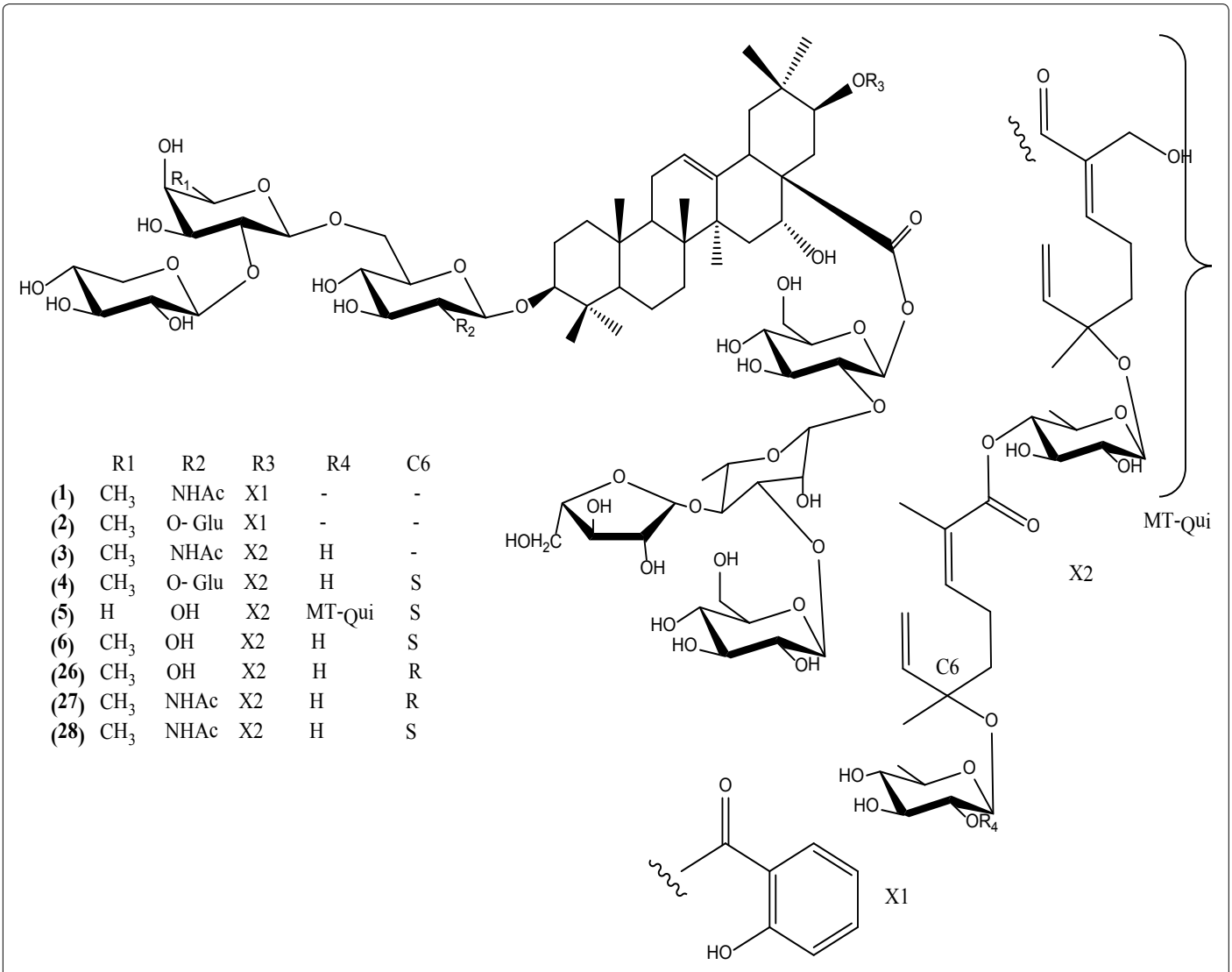


Figure 1: Structures of the saponins isolated from genus *Albizia*.

the distribution of saponins among different *Albizia* species and their pharmacological activities.

Results and Discussion

Plants of the genus *Albizia* have been used in the traditional medicine worldwide for the treatment of rheumatism, stomach ache, and cough, diarrhea, for wound- healing and as an anthelmintic. In traditional Indian and Chinese medicine, *Albizia* plants have been used to treat insomnia, irritability, wounds, tuberculosis, as anti-dysenteric and as antiseptic.

Literature revealed that *Albizia* is rich in triterpenoidal saponins in which the aglycon part may be oleanolic acid, echinocystic acid, acacic

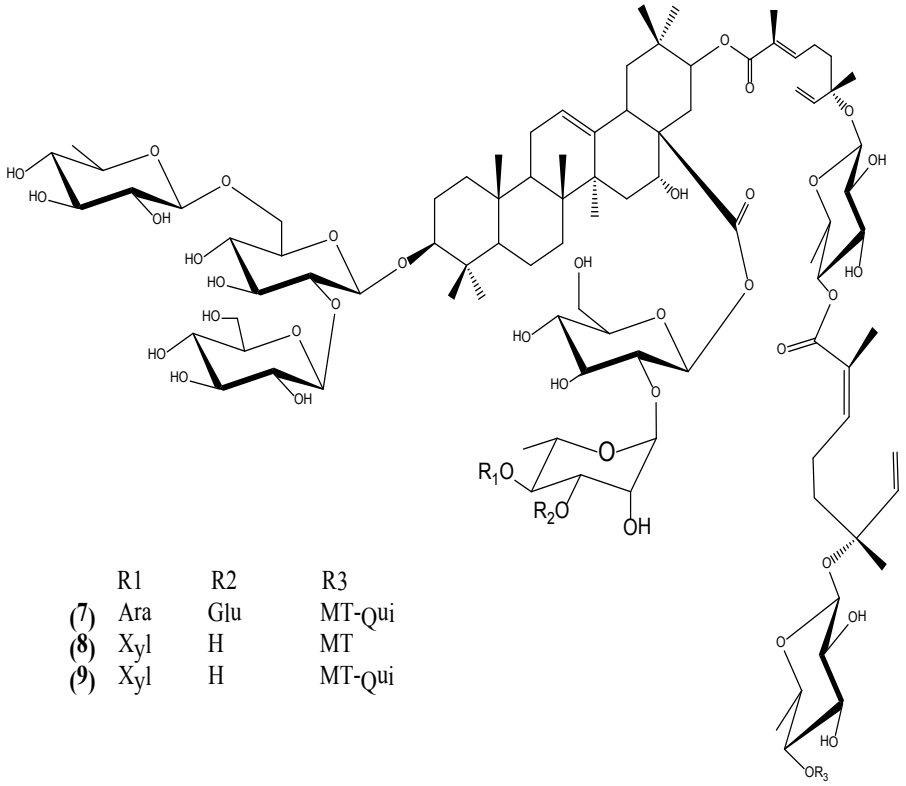


Figure 2: Structures of the saponins isolated from genus *Albizia*.

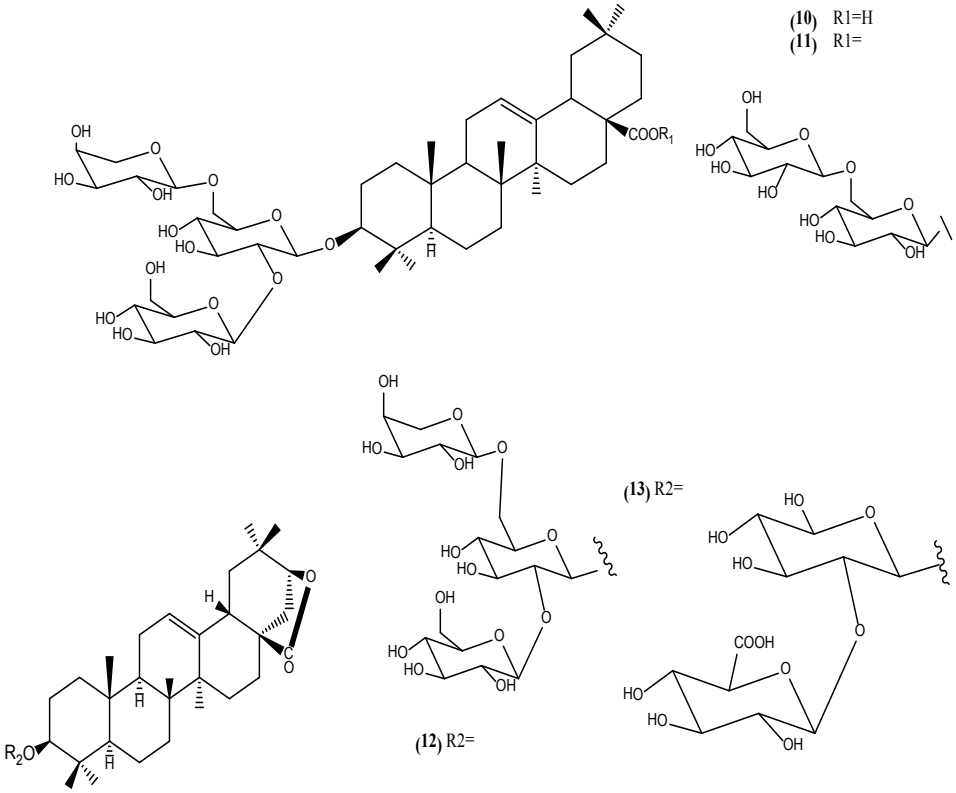
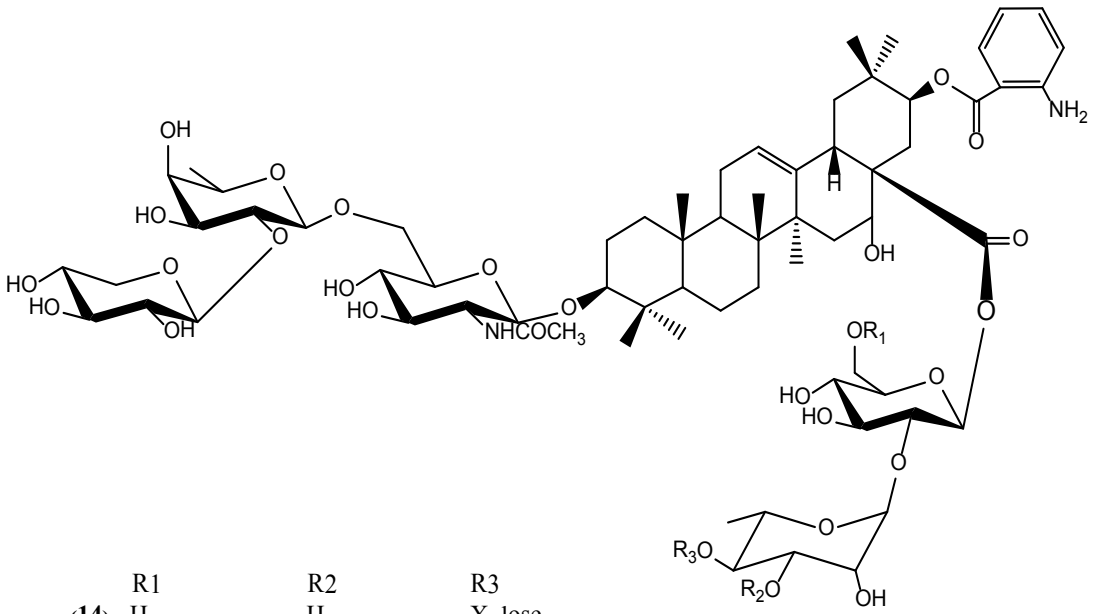


Figure 3: Structures of the saponins isolated from genus *Albizia*.



	R1	R2	R3
(14)	H	H	Xylose
(15)	Glu	H	Xylose
(16)	H	Glu	Arabinofuranose

Figure 4: Structures of the saponins isolated from genus *Albizia*.

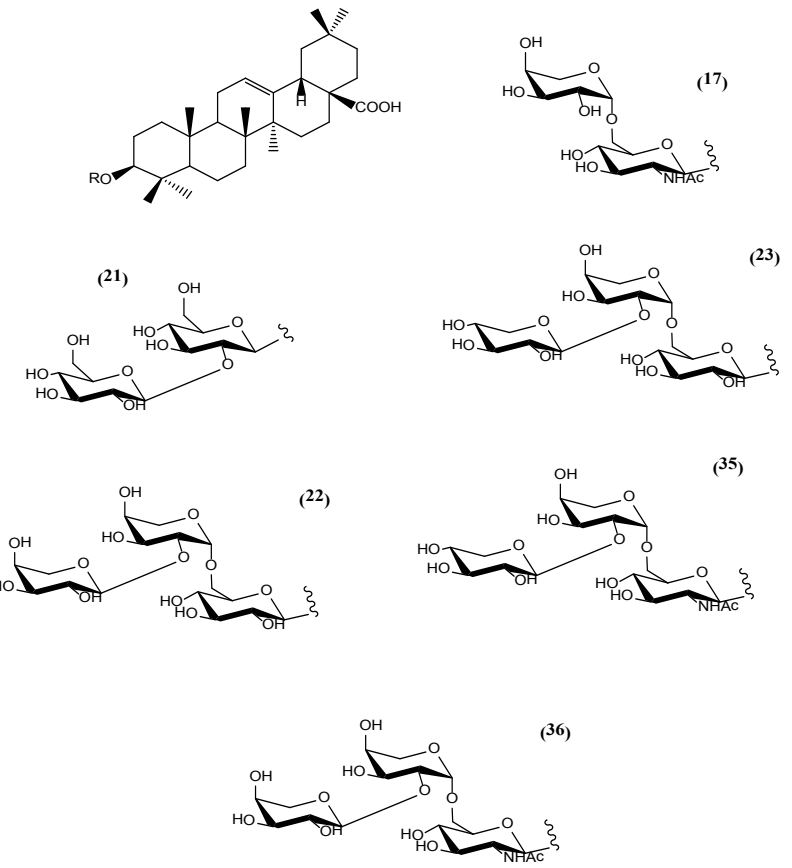


Figure 5: Structures of the saponins isolated from genus *Albizia*.

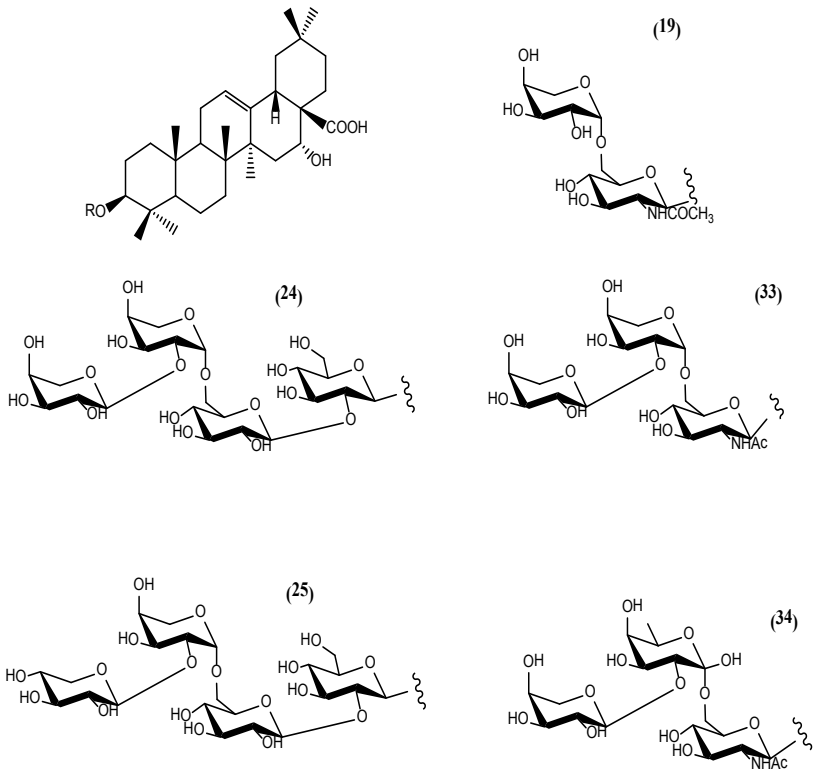


Figure 6: Structures of the saponins isolated from genus *Albizia*.

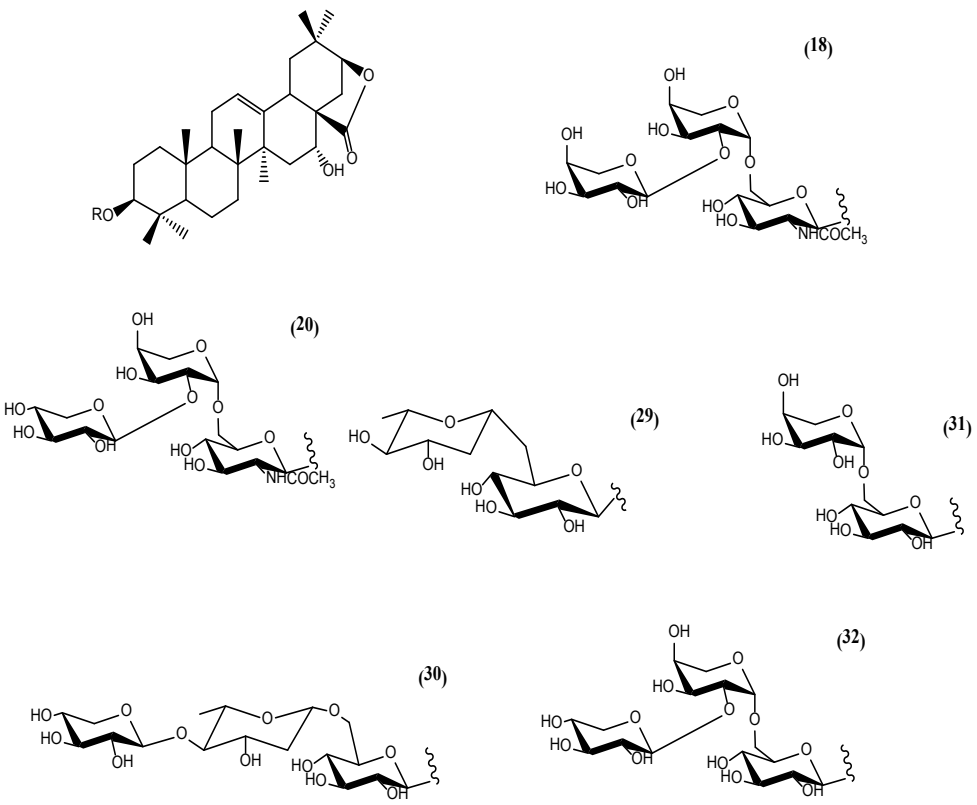


Figure 7: Structures of the saponins isolated from genus *Albizia*.

acid lactone or machaerinic acid γ-lactone while the sugar residue may be arabinose, xylose, rhamnose, fucose, glucose or 2-acetamido-2-deoxy glucose.

Most of these saponins have been reported to have cytotoxic activity on different cell lines, which highlights the importance of performing more in-depth studies in order to know the mechanism of the cytotoxic activity of these saponins and the structure activity relationship. Also, many extracts of different species of genus *Albizia* have been reported to have many pharmacological activities, such as antimicrobial activity of *A. ferrugenia* [9] and *A.lebbeck* [10], Anti-diabetic activity of *A.odoratissima* [11], and anti-depressant activity of *A. julibrissin* [12].Therefore, further studies are required to determine whether these pharmacological activities are attributed to saponins or not [13-22].

References

1. Cheok CY, Salman HAK and Sulaiman R (2014) Extraction and quantification of saponins: A review. Food Research International 5: 16-40.
2. Khan A, Shah RD, Pallewar S (2010) Evaluation of Anti-inflammatory and Analgesic Activity of Ethanolic extracts of Inularacemosa and Albizia amara. International Journal of Pharmacognosy and Phytochemical Research 3: 22-27.
3. Babu NP, Pandikumar P, Ignacimuthu S (2009) Anti-inflammatory activity of Albizia lebbeck Benth, an ethnomedicinal plant, in acute and chronic animal models of inflammation. J Ethnopharmacol 125: 356-360.
4. Meshram GG, Kumar A, Rizvi W, Tripathi CD, Khan RA (2015) Central analgesic activity of the aqueous and ethanolic extracts of the leaves of Albizia lebbeck: role of the GABAergic and serotonergic pathways. Z Naturforsch C 70: 25-30.
5. Une HD, Sarveiya VP, Pal SC, Kasture VS, Kasture SB (2001) Nootropic and anxiolytic activity of saponins of Albizzia lebbeck leaves. Pharmacol Biochem Behav 69: 439-444.
6. Nurul IM, Mizuguchi H, Shahriar M , Venkatesh P, Maeyama K, et al. (2011) Albizia lebbeck suppresses histamine signaling by the inhibition of histamine H1receptor and histidine decarboxylase gene transcriptions. International Immunopharmacology 11: 1766-1772.
7. Agyare C, Koffuor GA, Mensah AY, Agyemang DO (2006) Antimicrobial and uterine smooth muscle activities of Albizia ferruginea extracts. BoletínLatinoamericano and Caribbean Medicinal Plants and AromáticasMarzo 5: 31-35.
8. Gupta RS, Chaudhary R, Yadav RK, Verma SK, Dobhal MP (2005) Effect of Saponins of Albizia lebbeck (L.) Benth bark on the reproductive system of male albino rats. J Ethnopharmacol 96: 31-36.
9. Sarkiyayi S, Karago J and Hassan R (2011) Studies on Anti Typhoid Properties of Aqueous Methanol Leaves Extract of Albizia ferruginea (Musase). International Journal of Biochemistry Research & Review 1: 24-30.
10. Bobby, Wesely MN, Johnson EG and Antonisamy M (2012) In vitro anti-bacterial activity of leaves extracts of Albizia lebbeck Benth against some selected pathogens. Asian Pacific Journal of Tropical Biomedicine 2: 859-862.
11. Kumar D, Kumar S, Kohli S, Arya R, Gupta J (2011) Antidiabetic activity of methanolic bark extract of Albizia odoratissima Benth. in alloxan induced diabetic albino mice. Asian Pac J Trop Med 4: 900-903.
12. Kim JH, Kim SY, Lee SY, Jang CG (2007) Antidepressant-like effects of Albizzia julibrissin in mice: involvement of the 5-HT1A receptor system. Pharmacol Biochem Behav 87: 41-47.
13. Abdel-Kader M, Hoch J, Berger JM, Evans R, Miller JS, et al. (2001) Two bioactive saponins from Albizia subdimidiata from the Suriname rainforest. J Nat Prod 64: 536-539.
14. Debella A, Haslinger E, Schmid MG, Bucar F, Michl G, et al. (2000) Triterpenoid saponins and sapogenin lactones from Albizia gummifera. Phytochemistry 53: 885-892.
15. Haddad M, Laurens V, Lacaille-Dubois MA (2004) Induction of apoptosis in a leukemia cell line by triterpene saponins from Albizia adianthifolia. Bioorg Med Chem 12: 4725-4734.
16. Zhang H, Samadi AK, Rao KV, Cohen MS, Timmermann BN (2011) Cytotoxic oleanane-type saponins from Albizia inundata. J Nat Prod 74: 477-482.
17. Zou K, Tong WY, Liang H, Cui JR, Tu GZ, et al. (2005) Diastereoisomeric saponins from Albizia julibrissin. Carbohydr Res 340: 1329-1334.
18. Melek FR, Miyase T, Ghaly NS, Nabil M (2007) Triterpenoid saponins with N-acetyl sugar from the bark of Albizia procera. Phytochemistry 68: 1261-1266.
19. Noté OP, Mitaine-Offer AC, Miyamoto T, Paululat T, Mirjolet JF, et al. (2009) Cytotoxic acacic acid glycosides from the roots of Albizia coriaria. J Nat Prod 72: 1725-1730.
20. Liu R, Gang Ma S, Liu YX, Yu SS, Chen XG, et al. (2009) Albizosides D and E, two new cytotoxic triterpenesaponins from Albiziachinensis. Carbohydrate Research 72: 632-639.
21. Krief S, Thoison O, Sévenet T, Wrangham RW, Lavaud C (2005) Triterpenoid saponin anthranilates from Albizia grandibracteata leaves ingested by primates in Uganda. J Nat Prod 68: 897-903.
22. Cheng ZQ, Yang D, Ma QY, Yi XH, Zhang NL, et al. (2011) Triterpenoid Saponins from Albiziamollis. Bull Korean Chem 32: 1403-1409.

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