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 aches, 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 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-xylene 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-butanol 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 where 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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<td>Haddad et al. [15]</td>
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<td>A. chinensis</td>
<td>Stem bark</td>
<td>Albizoside D [4 in Figure 1]</td>
<td>Compounds [4 in Figure 1] and [5 in Figure 1] showed cytotoxic activity on HCT-8, Bel-7402, BGC-832, A549, and A2780 cell lines.</td>
<td>Liu et al. [20]</td>
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<td>Albizoside E [5 in Figure 1]</td>
<td>The IC50 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.</td>
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<td>Julibroside J8 [6 in Figure 1]</td>
<td>The IC50 values for compound [5 in Figure 1] were: &gt;10, 0.6, 0.03, 1.2, and 0.3 µM, respectively.</td>
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<td>A. coriaria</td>
<td>Root</td>
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<td>Compound [7 in Figure 2] and [9 in Figure 2] showed cytotoxic activity on HCT-116 and HT-29 cell lines The IC50 values for compound [7 in Figure 2] were 4.2 µM and 6.7 µM, respectively.</td>
<td>Noté et al. [19]</td>
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<td>Coriarioside B [8 in Figure 2]</td>
<td>The IC50 values for compound [9 in Figure 2] were: 2.7 µM and 7.9 µM, respectively.</td>
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<td>Gummiferaside C [9 in Figure 2]</td>
<td>No reports were traced for the pharmacological activity.</td>
<td>Debella et al. [14]</td>
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<td>A. gummifera</td>
<td>Stem bark</td>
<td>3-O-[β-D-glucopyranosyl(1→2)-α-L-arabinopyranosyl(1→6)]-oleanolic acid [10 in Figure 3]</td>
<td>Compounds [14-16 in Figure 4] showed cytotoxic activity on KB and MCF-7 tumor cell lines. The IC50 values for compound [14 in Figure 4] were: 1.3 µM and 0.4 µM, respectively.</td>
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<td>Leaves</td>
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<td>Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines. Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines.</td>
<td>Krief et al. [21]</td>
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<td>Grandibracteosides B [15 in Figure 4]</td>
<td>Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines. Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines.</td>
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<td>Grandibracteosides C [16 in Figure 4]</td>
<td>Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines. Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines.</td>
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<td>A. inundata</td>
<td>Aerial parts</td>
<td>3-O-[β-D-glucopyranosyl(1→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl acetic acid lactone [17 in Figure 5]</td>
<td>Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines. Saponins [17,19, 22 and 23] showed cytotoxic activity on JMAR, MDA1986 and B10-16-F10, SK-MEL-28 cell lines.</td>
<td>Zhang et al. [16]</td>
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<td>3-O-[β-D-glucopyranosyl(1→2)-α-L-arabinopyranosyl(1→6)]-2-acetamido-2-deoxy-β-D-glucopyranosyl acetic acid lactone [18 in Figure 7]</td>
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<td>A. julibrissin</td>
<td>Stem bark</td>
<td>Julibroside J5 [26 in Figure 1]</td>
<td>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.</td>
<td>[ Kun Zou et al. 2005]</td>
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<td>Julibroside J8 [6 in Figure 1]</td>
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<td>Julibroside J12 [27 in Figure 1]</td>
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<td>Julibroside J15 [28]</td>
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<td>A. mollis</td>
<td>Bark</td>
<td>Molliside A [29 in Figure 7]</td>
<td>No reports were traced for the pharmacological activities.</td>
<td>Cheng et al. [22]</td>
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<td>Molliside B [30 in Figure 7]</td>
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<td>Cimicifugoside A [31 in Figure 7]</td>
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<td></td>
<td></td>
<td>Albiziasaponin A [32 in Figure 7]</td>
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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 acid lactone [20 in Figure 7]

Compounds [33 in Figure 6] and [20 in Figure 7] showed cytotoxic activity on HepG2 cell line. The IC50 value for compound [33 in Figure 6] was: 9.13 µg/mL. The IC50 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 IC50 values of 0.9 µg/mL, and 0.8 µg/mL, respectively. Abdel-Kader et al. [13]
Figure 2: Structures of the saponins isolated from genus Albizia.

Figure 3: Structures of the saponins isolated from genus Albizia.
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 y-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].

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