Review Article

A brief review on phytopharmacological reports on *Albizia procera*

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Received: 20 February 2020 Revised: 1 April 2020 Accepted: 2 April 2020

Abstract

Albizia trees are portrayed as a pioneer species in deciduous or monsoon woodland and savanna and scrub vegetation. *Albizia procera* commonly known as Safed siris naturally occurs throughout South-East Asian countries to northern Australia and has been introduced into number of African countries. All parts of the plant have utility in some or the other way. From being used traditionally as pain reliever to exhibiting various pharmacological activities, the plant may be contemplated as a favourable plant against various diseases. In this review, various phytochemicals and pharmacological studies of *A. procera* were studied and presented. The leaves and pods of *A. procera* are eatable portions whereas its wood is a reasonable material for paper pulp. The bark of plant has spermicidal action and is also given for rheumatism and haemoerrhage. *A. procera* exhibits various pharmacological activities such as CNS activity, cardiotonic activity, anti-oxidant property etc. The habitat for *A. procera* ranges from monsoon forest, pyrogenic grassland; dry to stunted gullies and seasonal swamp forest. It is a little tree 7-15m tall belonging to fabaceae family. Phytochemical examination reported various secondary metabolites such as saponins, terpenes, alkaloids and flavonoids. It is a plant of great importance. All parts of the plant have utility in some or the other way and is also used traditionally.

***Keywords*:** Safed siris, convulsion, CNS activity, cardiotonic, anti-oxidant

Introduction

Albizia procera (family: Fabaceae; subfamily: Mimosoideae) commonly known as Safed siris naturally occurs in India, northern Australia, southern China which also includes Hainan and Taiwan. It has also been instigated into few African countries along with Panama and Puerto Rico (Blair et al., 1988).

Albizia trees are portrayed as a pioneer species in open, primary or secondary deciduous or monsoon woodland and savanna and scrub vegetation (Chauhan et al., 1986). The habitat extents from monsoon rainforest to seasonal swamp forest, igneous/pyrogenic grassland and parched to stunted gullies. It appears upto 1500 m height/ altitude in the tropics and 1200 m in the subtropics. The mean annual rainfall is 1700mm, the mean lowest temperature is 21 °C and the utmost temperature is 32°C annualy (Blair et al., 1988).

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In India, this species inclines toward very much depleted sandy topsoil soils in doughy places along streams and even in marshy circumstances and sawed-off zones, but on the other hand, is fit for growing in poor soils (Chauhan et al., 1986).

Description

A. procera; normally a little tree which is 7-15m tall can however achieve 30 m height with a 9 m extended or screwy bole which can be 35-60 cm in measurement. The bark is leveled/smooth, subtle dark green, yellowish-green with level furrows. The undersurface of the bark is green which changes to orange; inward bark is pinkish or may be straw-hue (Ahlawat and Sharma, 1997). The light- brown to light chocolate brown heartwood is moderately hard, straight grained, strong, durable and resistant to dry wood termites (Parrotta, 2015). The compound leaves have 2-5 sets of sub-inverse pinnae with a 5.5-12 cm long petiole. Petiole has a vast, dark colored, oval organ (4-10mm long) close to the base; organ barely curved, level and circle like or sunken with elevated edges (Ahlawat and Sharma, 1997). The efflorescence is made from pedunculate bunches (1.5-2.3cm long, 2 -5 together) gathered in an axillary panicle up to 30cm

DOI: https://doi.org/10.31024/ajpp.2020.6.2.9

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long; 15-30 flowers for every group (the central flowers typically bigger than the borderline ones), and bisexual. The fruits are rich red or reddish colored flattened pods (10–20) by 2–2.5cm, slender and fragile, with particular spots over the seeds. The fruits mature 6 to 9 months in the wake of blooming, amid the dry season, and typically stay on the tree uptil the entire stem bearing the pods is shed. Each developed pod contains 6–12 seeds. The seeds are small, greenish dark colored, elliptical to round, level, with a hard, smooth seed-coat (Simpson, 2018). Germination is epigeal, and happens from 2 to 21 days in the wake of sowing, provided soil moisture is adequate. In plantations set up on grass-dominated areas, weeding is suggested amid the initial 2 years (Parrotta, 1964).

Phytochemical constituents

Phytochemical examination of various species of Albizia meets diverse category of secondary metabolites, for example, saponins, terpenes, alkaloids, and diverse category of secondary metabolites, for flavonoids. Few bioactive compounds separated and recognized were triterpenoid saponins (julibroside), new/novel macrocyclic alkaloids like budmunchiamines A, B, and C and two flavonol glycosides such as quercitrin and/or isoquercitrin) (Figure 1) (Kokila et al., 2013). There are reports in the literature of seven isolates triterpenoids glycosides from the *A. procera* bark (Figure 2) (Barbosa, 2014). Also, the bark, leaf, and root of the *A. procera* contain saponin whose hydrolysis produces machaerinic acid. The tree also contains a small number of hydrogen cyanide (HCN). Leaves and fruits have shown positive results for haemolysis. Procera acide; a recent pentacyclic triterpenic acid was extracted from the seed (Duke, 1983). Four new oleanane-type triterpene glycosides, proceraosides A−D were also isolated (Yoshikawa et al., 1998). Also, Perceragenin ($C_{30}H_{46}O_4$) is reported from the seed**.** The gum holds aldobiuronic acid and 3-0-D-galactopyranosyl-L-arabinose (disaccharide)**.** The deteriorated gum from the plant contains D-galactose, D-mannose, D-glucuronic acid, and 4 0-methyl-D-glucuronic acids. Absolute methylation and successive

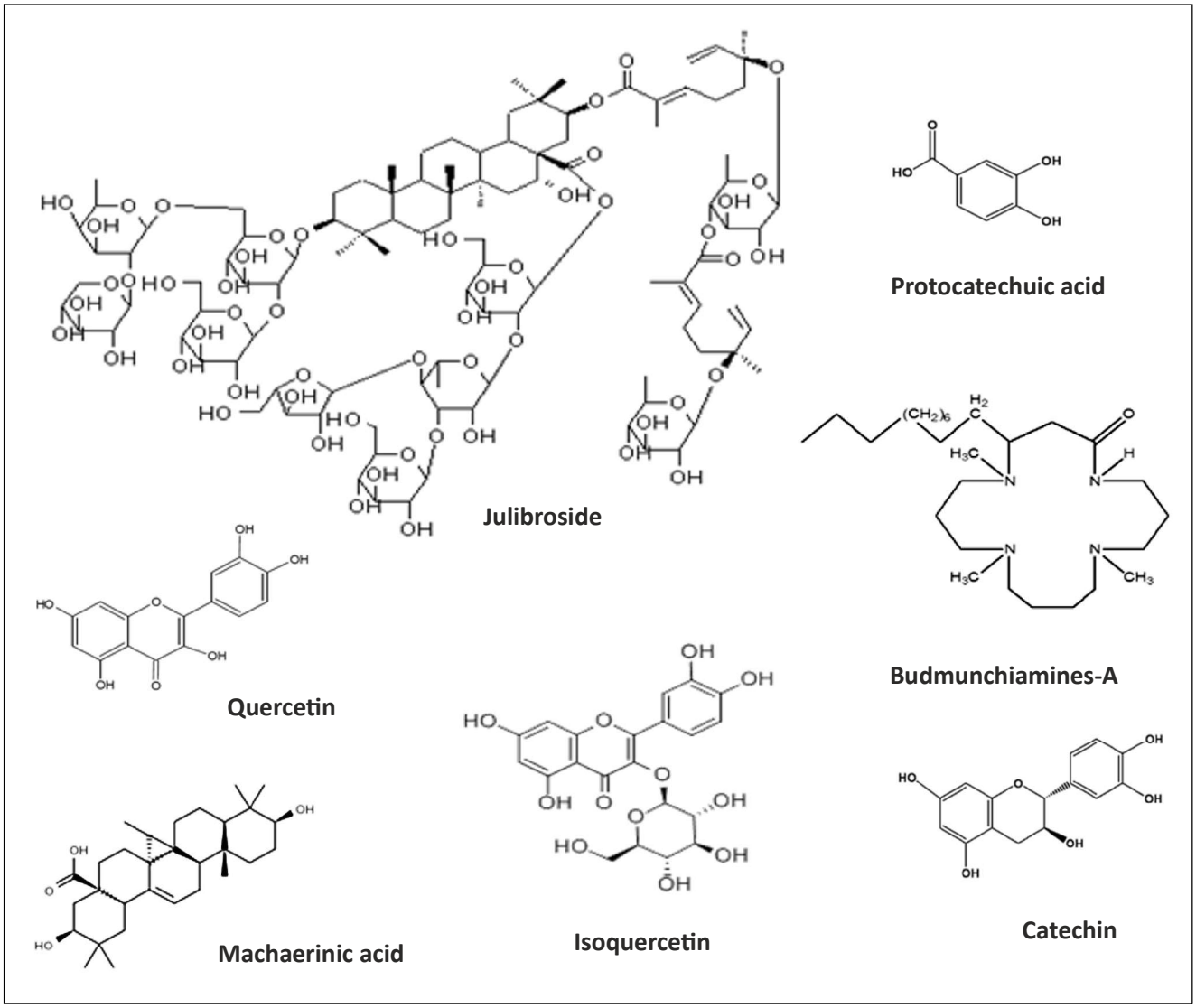


Figure 1. Phytoconstituents reported in *Albizia procera* (Kokila et al., 2013)

hydrolysis of the product bear 2, 4-di-0-methyl-D-galactose, 3,4,6-tri-0-methyl-L-arabinose (Duke, 1983). Digestibility analysis of leaves of *A. procera* furnishes 64% neutral and 65% acid detergent fiber, 4% ash, 42% lignin, and 5.5% lipids. The raw fiber and lignin quantity in the leaves shows poor digestibility. The content of oil in the seed is about 7.5%. The wood of the tree is impervious to several species of termites, which includes *Bifiditermes beesoni*, *Cryptotermes cynocephalus* and *Coptotermes curvignathus*. The latter is described as a pest of the tree in India.

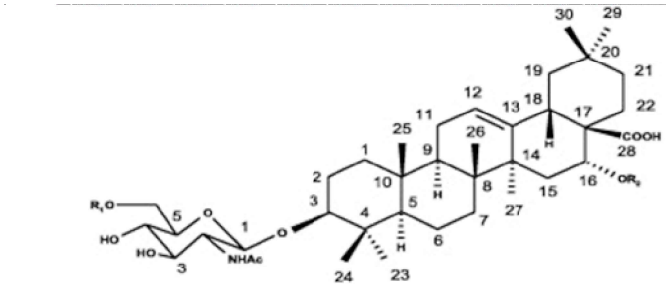
Traditional Uses

A. procera is planted for fuelwood and also for rehabilitation of eroded and degraded soils (Blair et al., 1988). The excessive rate of biomass (fuel) production (124 t/ha oven-dry at 5.5 years) and a high percentage of biomass in stem and branches (91%) recommend the species for fuelwood production.

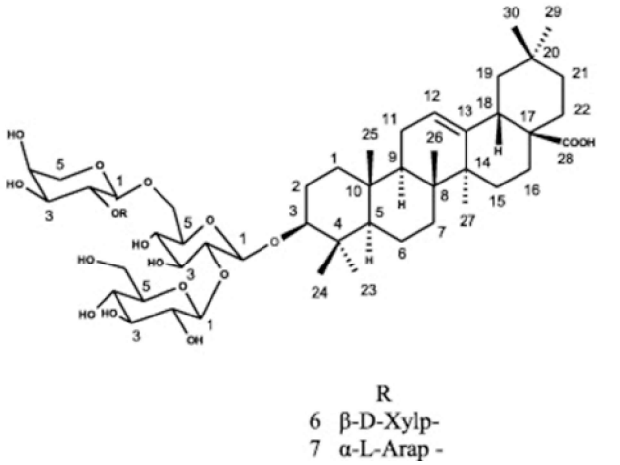
It is utilized as a shade tree over coffee in Cuba whereas it has been tried successfully in Himachal Pradesh, India as an 'agroforestry species' in an alley cropping system with rainfed wheat (Ahlawat and Sharma, 1997).

Leaves and pods are the eatable portions of the plant. The cooked leaves are consumed as a vegetable. In the midst of shortage, the bark is grounded into powder, blended with flour and eaten. Its leaves are esteemed as livestock feed and are additionally utilized in conventional Indian medicine (Parrotta, 1964) whereas in Nepal it is used as an insecticide (Blair et al., 1988). The mineral substance N, K, Ca and Mg of the leaves is sufficient for animal production, yet Na and P are insufficient. This recommends that this species can be utilized for fodder in blends with other feed species rather than using it.

A. procera creates a decent cabinet, timber for furniture, and is likewise appropriate for conventional development; horticulture actualizes shafts, household products and posts, truck and transport bodies, and packing cases alone (Ahlawat and Sharma, 1997). The chemical examination of the wood reveals it as a reasonable material for paper pulp. The agreeable yields of bleached pulp (50.3%) can be developed from *A. procera* wood by the sulfate action. It is reasonable for writing and printing paper (average fiber length and width is 0.9mm and 0.021 mm respectively). The calorific estimation of parched sapwood is 4870kcal/kg whereas 4865kcal/kg is that of heartwood. 39.6% fantastic charcoal can be composed from the wood, and thus it is broadly utilized as a heat source.



	R_1	R_2
1	β-D-Xylp-(1→2)-β-D-Galp-	β-D-Glcp-
2	β-D-Xylp-(1→2)-α-L-Arap-	β-D-Glcp-
3	α-L-Arap-(1→2)-α-L-Arap-	β-D-Glcp-
4	β-D-Xylp-(1→2)-α-L-Arap-	H
5	α-L-Arap-(1→2)-α-L-Arap-	H



	R
6	β-D-Xylp-
7	α-L-Arap -

Figure 2. Triterpenoids saponins isolated from *A. procera* (Miyase et al., 2010; Barbosa, 2014)

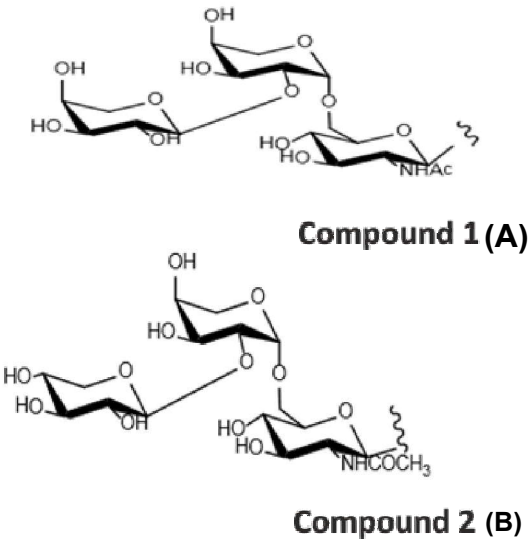


Figure 3. (A) 3-O-[α-L-arabinopyranosyl-(1→2)-β-Dfucopyranosyl-(1→6)-2-acetamido-2-deoxy-β-Dglucopyranosyl] echinocystic acid (Compound 1); **(B)** 3-O-[β-D-xylopyranosyl-(1→2)-α-Larabinopyranosyl-(1→6)-2-acetamido-2-deoxyβ-D-glucopyranosyl] acacic acid lactone (Compound 2)

Medicinal uses

Every part of the plant demonstrates anti- cancer action. It is also traditionally used in pain, convulsions, delirium, and septicemia (Sivakrishnan and Muthu, 2014). The roots contain α-spinasterol and saponin that is reported to have spermicidal action at a dilution of 0.008%. *A. procera* is ordinarily utilized in conventional meds. The bark is known to be a wellspring of tannin but the yields are moderate. The crushed bark is utilized as a toxin for fish and the leaves are utilized as a pesticide in Nepal. A decoction of the bark is provided for rheumatism and hemoerrhage (Orwa et al., 2009). Also; it is viewed as valuable in the treatment of issues of pregnancy and stomach-throb. Additionally, the bark is used as a medicine for water buffalo when given with salt. In India, their leaves are poultice onto blisters (Ahlawat and Sharma, 1997). Also; they are vastly used for the care of a variety of injury/lesions (Blair et al., 1988). Seeds are used in amoebiasis in powdered form. It also heals urinary tract infections, glycosuria, hemorrhoids, and fistula and worm infestation. It also restrains skin diseases (Sivakrishnan and Muthu, 2014).

Pharmacological activities

A. procera was stated to exhibit diverse pharmacological activities namely CNS activity, cardiotonic activity, lipid-lowering activity, anti-oxidant activity, hepatoprotective activity, hypoglycemic activity, antimicrobial activity and so on (Sivakrishnan and Muthu, 2014), (Rafique et al., 2019).

Antidiabetic activity

In an *in-vitro* study, ethanol extract and n-butanol fraction of stem bark of *A.procera* consisted of active constituents like flavonoids and tannins. The extract showed good inhibitory activity against α-amylase and α-glucosidase. Thus, this demonstrates that the plant exhibits good antidiabetic activity (Anand et al., 2018).

Antimicrobial activity

It was reported that methanolic extracts *of A. procera* showed antimicrobial activity against Gram-positive [Staphylococcus aureus, Bacillus cereus] and four Gram-negative [Escherichia coli, Pseudomonas aeruginosa, Shigella boydii, Shigella soneii,] bacteria (Khatoon et al., 2014). Plants were fetched from Palni hills of Southern Western Ghats whereas ethno botanical details were collected from conventional healers who occupied the study area. The methanolic abstract were acquired by cold percolation and by using the paper disc diffusion method, anti-microbial activity was found (Duraipandiyan et al., 2006). Another study also concluded that leaves extract of the plant show antibacterial activity and its active constituents would be helpful in treating various kinds of plant diseases as well as seed borne diseases (Shinde, 2018).

Hepatoprotective

Ethanolic extract *of A. procera* aerial parts was evaluated against Paracetamol induced hepatotoxicity in male albino wistar rats (Himaja and Shama, 2015). Ethanolic extract was obtained by the hot continuous percolation method in the Soxhlet apparatus for 24 hrs. The extract was then subjected to column chromatographic separation using normal phase silica gel column and squalene was isolated with a solvent system of ethyl acetate: ethanol 70:30 v/v (Sivakrishnan and Muthu, 2014). Protective effect of *A. procera* was shown by lowering the elevated level of ALT, AST, ALP, and TB. The effects produce comparable with standard drug silymarin (Himaja and Shama, 2015). Based on the findings, squalene isolated from Albizia procera also enhanced the ability of the kidneys to remove waste products (urea and creatinine) from the blood and confer a protective effect on the kidney. The results of acute toxicity study carried out as per OECD-423 guidelines uncovered that LD50 values of squalene were high and apparently displayed the safety of extract (Sivakrishnan and Muthu, 2014).

Antioxidant properties

Khatoon et al. contemplated the antioxidant property of *A. procera* leaves via DPPH reducing power and complete antioxidant capacity (Kokila et al., 2013). Antioxidant action of the methanol extract and its procured fractions; petroleum ether (APP), carbon tetrachloride (APC), dichloromethane (APD), ethyl acetate (APE), and residual aqueous fraction (APA) of the leaves of *A. procera* was carried out by *in-vitro* chemical analysis (Khatoon et al., 2013). The ethanolic extract indicated strong scavenging action against free radicals contrasted with different standards which may be useful in preventing different oxidative stresses. Their leaf extricates displayed IC_{50} estimation of around 90% among that of DPPH radicals (Kokila et al., 2013).

Anticancer properties

According to a literature, the plant is traditionally used in anticancer (Sukhadiya et al., 2019). Melek et al. reported 2 recent saponins from the bark of *A. procera* i.e. 3-O-[α-L-arabinopyranosyl-(1→ 2)-β-Dfucopyranosyl-(1→ 6)-2-acetamido-2-deoxy-β-Dglucopyranosyl] echinocystic acid (compound 1) (Figure 1) and 3-O-[β-D-xylopyranosyl-(1→ 2)-α-Larabinopyranosyl-(1→ 6)-2-acetamido-2-deoxyβ-D-glucopyranosyl] acacic acid lactone (compound 2) (Figure 2) (Singab et al., 2015). They served as anti-tumor agent and manifested cytotoxicity against HepG2 cell line (Kokila et al., 2013). The IC50 value for both the compounds 1 and 2 were 9.13µg/mL and 10µg/mL, respectively (Singab et al., 2015).

Anti-inflammatory properties

Stem of *A. procera* contains a novel flavonol glycoside which indicated the moderate anti-inflammatory activity by utilizing non-immunological carrageenan induced hind paw edema method on albino rats (Kokila et al., 2013).

Analgesic activity

Khatoon et al. experimented that 3 fractions of methanol extract i.e. EAF (ethyl acetate fraction), DCMF (dichloromethane fraction) and CTCF (carbon tetrachloride fraction) of *A. procera* leaves remarkably suppressed the number of acetic acid-induced writhing in rats after administering the drug orally. EAF showed the highest writhing hindering among the three methanolic fractions which was very near to the standard drug used in the experiment. The results acquired showed that the extracts hampered the late phase procedure of pain (induced due to distinct inflammatory mediators, such as histamine, prostaglandins, serotonin, and bradykinins), recommending that the plant extract may behave as steroids and NSAIDs.

CNS depressant activities

The extracts of *A. procera* were used to determine the depressive action on CNS in rats using an open field test. Extracts demonstrated an observable decline in the movement of the test animals. Test animals showed a significant reduction in the number of locomotion in the dosages of 500 mg/kg (Khatoon et al., 2014).

Spermicidal activity

Sapogenins isolated from seed and root (Shaik et al., 2017) of *A. procera* had been assessed for *in vitro* spermicidal activity inimical to human spermatozoan (Kamboj and Dhawan, 1982) and semen coagulating activity (Azamthulla et al., 2015). A blend of oleanolic acid and proceric acid obtained from seeds of *A. procera* were found to be potent extremely. Oleanolic acid induced immediate immobilization of spermatozoan within a minute whereas other sapogenins had reduced potency (Kamboj and Dhawan, 1982).

Anti-diarrheal activity

A. procera contains pharmacologically active substances (tannins, alkaloids, saponins, flavonoids, steroids, and terpenoids) (Prasanth et al., 2014) that are effective for the management of diarrhea. The antidiarrheal activity of the plant extract efficaciously antagonizes the diarrheal activity encouraged either by castor oil, elevated biosynthesis of prostaglandins or cholera toxin either by spasmolytic pathway or because of anti-secretory activity in diarrheal animal model (Azam and Azad, 2018).

Anti-HIV-1 integrase activity

A. procera bark has the possibility to be served as an anti-HIV1 integrase agent. Hence, this plant can be used in treating HIV infection. The IC50 value of ethanolic extract of *A. procera* was 19.5mg/mL though ethyl acetate had an IC50 value of 19.1mg/mL which exhibited the most potent activity. Further, the ethyl acetate fraction was segregated to give two compounds; catechin and protocatechuic acid utilising bioassay-guided isolation. Catechin was found to connect with Thr66, Gly148, and Glu152 in the principal domain of integrase enzyme, whilst protocatechuic acid could attach with Thr66, His67, Glu152, Asn155, and Lys159. This revealed that the above two compounds bind with the Glu152, which is among the amino acid residues in the catalytic triad of the HIV-1 integrase principal domain. Catechin exhibited higher activity against HIV-1 integrase but protocatechuic acid (Figure 1) showed only gentle activity. This is due to lower binding energy (-5.16kcal/mol) of catechin than that of protocatechuic acid (-4.85kcal/mol) (Panthong et al., 2015).

Conclusion

Albizia procera possesses numerous pharmacological properties. The investigation proves that the chemical constituents of almost all parts contain bioactive and pharmacological compounds. Bioactive compounds separated and recognized were triterpenoid saponins, macrocyclic alkaloids, and flavonol glycosides. Its pharmacological activities such as anticancer, antimicrobial, antioxidant, anti-HIV-1integrase, antidiarrhoeal, anti-inflammatory, hepatoprotective, analgesic properties, etc give us a solid basis for the development and utilization of *A. procera* as a pharmaceutical product. Adequate clinical trials are also required for the evaluation and safety of the aforementioned natural compounds. The investigation in this area can help us to thoroughly understand this plant and provide a foundation for safe and efficient use.

It may also be inferred that *A. procera* shall be regarded as a promising plant with diverse therapeutic properties and can be additionally explored pharmacologically against several ailments and for free radical-mediated diseases.

Conflict of interest: None

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