Entada Adans, an ethnopharmacologically important genus: A review

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ABSTRACT

Entada Adans is a genus with pantropical distribution comprising of some gigantic woody climbers with huge fruits. Many species are well documented and used in traditional medicine (Ayurveda) in the treatment of arthritis, joint pain, liver disorders, diarrhea, paralysis, and eye diseases. Many of these ethnomedicinal properties have been experimentally proven in different animal models and are compiled in a comprehensive approach in this review. Compounds recorded to be present in different species of the genus mainly include saponins, flavonoids, phenols, alkaloids, tannins, triterpenoids, steroids, proteins, and carbohydrates. This study is an effort to collect inclusive scientific data published till March 2020, providing a summarized report on the chemical constituents, ethnobotany, ethnopharmacology, toxicology, pharmacology, and related therapeutic potential of important species of genus *Entada*. The present literature study was extensively explored by databases such as Scifinder, books, Google, Google Scholar, Web of science, Science direct, journals, and other literatures. The present review article highlights this genus of endangered species as source of medicinally and nutritionally valued plants by focusing on pharmacological studies that validates their folklore uses. Furthermore, it draws attention for its conservation as it is the need of the hour to utilize different conservational strategies and save this medicinal wealth from extinction. The present piece of writing on genus *Entada* would be a useful edition to envisage the future line of investigations.

Key words: *Entada* Adans, ethnopharmacology, folklore uses, phytochemistry

INTRODUCTION

Endata Adans is a small pantropical genus comprising 30 species of woody vines in the pea family Fabaceae, in the mimosoid clade of the subfamily Caesalpinioideae. The plants are with small, sessile flowers in spikes and gigantic woody pods up to 1.5 m (4.9 ft) length, containing highly polished, flat, and big round seeds. The terminal pinnae of the *Entada* species are modified into tendrils and the stems are often more than 30 cm in diameter. Members of this genus are frequently found among streamside forests, coastal thickets, riverine vegetation, sandy soils, and the seeds are dispersed by water. The plant grows toward light and changed its direction by its twisted shaped stem thus covers other trees too.[1] Based on the palaeontological data, the genus is presumed to have existed since the Oligocene to Miocene.

Records on the previous phytochemical investigations on this genus are indicative of the presence of saponins, triterpenes, flavonoids, and amino acids as major constituents. Saponins having entagenic acid as an aglycone are rarely encountered in nature. Entagenic acid is found to be occurring in *Entada pursaetha* (Ep), *Entada phaseoloides* (Eph), *Entada polystachya* (Epo), and other species of *Entada* and thus could represent a chemotaxonomic marker for this genus. Studies on different extracts from species of *Entada* and their isolated compounds have demonstrated the therapeutic potential of members this genus. Some pharmacological activities such as antimicrobial, analgesic, anti-inflammatory, antioxidant, antitumor, molluscicidal, antimalarial, antiulcer, and antidiabetic have been proved by *in vitro* and *in vivo* preclinical studies. Members of the genus *Entada* have been used as traditional medicine, especially by local people in Africa, Asia, and America as a remedy for pain, liver

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disorders, sleeping sickness, stomach ache, hemorrhoids, rheumatism, etc. Some species are also used as food, soap, fish poison, and natural fibers source.[2-4]

The present review is aimed to summarize the current advances on biological and botanical characterization, ethnopharmacology, traditional uses, chemical constituents, pharmacological activities, and toxicology of important species of genus *Entada*. The potential and perspectives for complete utilization of the different species of *Entada* as nutraceuticals and therapeutic agents are also discussed. This article will be providing valuable comprehensive scientific information for exploring future prospective investigations on the ecological, economical, and pharmaceutical aspects of these very important ethnomedicinal plants.

METHODS

A literature search was conducted using the keywords "*Entada*", "phytochemicals" and "biological activities" on electronic databases (Web of Science, PubMed, Scopus, Science Direct, Google scholar, Springer Link, and ACS Publications) and referring books and thesis to compile published research works till March 2020. Moreover, bibliographies of the cited articles were also tracked to document total literature.

BOTANICAL CHRACTERISATION

Different species of the genus *Entada* are trees, shrubs, suffrutices or lianas, mostly armed with prickles or unarmed; leaves bipinnate, pinnae pairs several, the uppermost pair sometimes modified into tendrils; flowers bisexual or unisexual in axillary spiked racemes or terminal panicles, calyx gamosepalous with 5 teeth, corolla with 5 petals, free, stamens 10; pods subsessile or stalked, straight or curved often very large, with valves splitting transversely into 1-seeded segment, that leaves persistent empty frame [Figure 1]. *Entada* exhibits a particularly great variation in seed characters,[5] which have been used to recognize sections and subsections.[6] Indeed, in several instances they also permit identification to species level [Table 1]. E. pursaetha DC (Ep) (syn.: E. rheedii Spreng., E. monostachya DC., E. scandens auct. non Benth., Mimosa entada L.); E. phaseoloides (L.) Merr. (Eph) (syn.: E. scandens L.) Benth., M. scandens L.); E. polystachya (L.) DC. (Epo) (syn.: M. polystachya L.); E. gigas (L.) Fawc. & Rendle (Eg) (syn.: M. gigas L); E. abyssinica Steud. ex A. Rich (Eaby) and E. africana Guill. & Perr. (Ea) are some important ethnomedicinal plants of the genus reviewed[7].

DISTRIBUTION AND ECOLOGY

Based on the palaeontological data, the genus is presumed to have existed since the Oligocene to Miocene. Of the 30 species of lianas and scandent shrubs or subshrubs of the genus *Entada*, about 21 species are found to be occurring only in tropical and subtropical regions of Africa, six in Asia, two in the American tropics and one has a pan tropical distribution.[1,14] Four species of *Entada* occurs in India. This pantropical genus should be typified by one of these three closely related giant-podded species that have a very wide distribution namely, Ep. that is widely distributed in forests of tropical and subtropical countries of East Africa, tropical Asia, Australia, and Indian Ocean Islands, subtropical evergreen forests of the Western Ghats and Eastern Ghats of India, Thailand, Malaysia, Papua New Guinea, Philippines, Sri Lanka, and Vietnam; Eg in the Central and West Africa, Central America, the West Indies and Colombia; and Eph (L.) Merr. from Southeast Asia to the Western Pacific region.[6] Ea is commonly found to be growing in Nigeria, Sudan zone, Southern Sahel, Burkina Faso, Senegal, Cameroon, Uganda, Republic of Congo and Zaire; and Epo is a native and widespread plant in coastal thickets from Western Mexico through Central America to Northern South America.[11,15] Eaby is a tree widely spread in tropical Africa.[16]

All the species are found in a wide variety of habitats, ranging from freshwater swamp and inland from the mangrove up to montane forests, at elevations up to 900 m and occasionally to 1700 m.[6,15] The seeds do not lose germination ability even if they have drifted on salt waters for a long time, thus facilitating water dispersal and establishment close to streams and rivers and coastal forests.

USABILITY

All the parts of different species are valued amongst indigenous tribes in Africa, America, and Asia for multiple purposes. The stem, bark, and seeds are rich sources of saponins which are used as detergent for washing clothes, hair and skin, and sold to soap industries.[17] The plant is used in preparing huts, rope, fish poison, for tying and marking fish lines and also for firewood. The kernels are used by local people (Western Cameroon) as a musical instrument for traditional dances. The large, smooth, and shining seeds are used as beads to play. The seeds are believed to possess magical abilities and so to bring good luck to the owner they are worn as necklaces and bracelets. Seeds of this genus are used for hallucinatory effects by tribals of Africa. Traditional healers smoke tobacco made from seed powder before bed time to induce vivid dreams of communicating efficiently with their ancestors.[8,18,19]

Tribal's world over, value roasted, and detoxified seeds as dietary supplement and use as pulse[10,15,20]. In Australia, the seeds are leached in water to remove toxic secondary metabolites and they are cooked and consumed as a vegetable by the Aborigines. Semi ripe seeds are sometimes used as a coffee substitute.[21] Seeds of Ep are known in the Egyptian herbal market as dietary supplement and in weight gain preparations.[22]

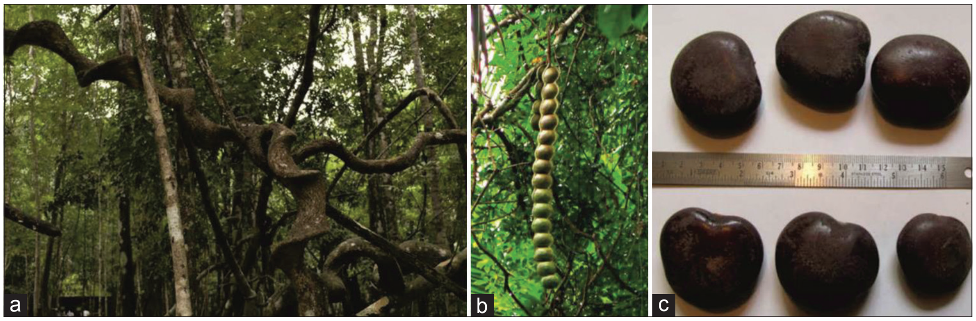


Figure 1: Morphology of Entada plant (a) Stem (b) Pod (c) Seeds

Table 1: Morphological details of different species of *Entada* genus

Entada Species	Elephant creeper (Ep)	Matchbox Beans (Eph)	*Entada africana* (Ea)	*Erythrina abyssinica* (Eaby)	Calling Card Wine (Epo)	Monkey ladder vine (Eg)
Size	A large unarmed twisted liana with angled stems	Very large woody climber with flattened and twisted stem	A small tree that grows up to 4–10 m in height and has branches low down with a crown	A small deciduous tree, unarmed with compound bipinnate leaves	A woody climber with glabrous branches	A large unarmed liana up to 25 m high
Leaves	1–2 pairs of pinnae, 3–5 leaflets; rachis glandular, ending in a forked tendrils	Bipinnate with about 8–16 leaflets with transversely wrinkled stalks, leaflet blades show scattered large clear glands	3–9 pairs of bipinnate alternate leaves with 8–24 pairs of leaflets, a 15–45 cm glabrous common stalk and rachis with 2–9 pairs of pinnae	Compound bipinnate leaves	Bipinnate leaves with 2–6 pairs of pinnae, leaflets petiolate and in 6–8 pairs	Leaflets 3–5 pairs, glabrous above except for the puberulous midrib; rachis of leaves with 1–2 pairs of pinnae, ending in a forked tendril
Flowers	Long, axillary spikes up to 23 cm, cream to pale yellow	More or less cup-shaped, pink to red	Creamy-white or reddish yellow, densely clustered in a spike-like racemes	Flowers creamy-white to yellowish in long fluffy spikes	Sessile in racemes of brilliant yellow green campanulate flowers	Creamy to greenish or yellowish
Pods	Huge, up to 2 m × 15 cm in size, woody, breaking down into single-seeded segments	Flattened, about 100 × 12 cm, constricted at intervals and divided into 12 segments	15 cm, very persistent, flat and fragile with 10–15 broad elliptic flat seeds	A large papery pod 15–38 cm long, breaking up into one-seeded segments	Subcoriaceous, 30–45 cm long and 5–10 cm wide, flat, thin curved, each segment of broken pod is of the size of the calling card	Gigantic, 0.4–1.2 m. long 7.5–12 cm wide, less woody than Ep, twisted into a single/ double lax spiral, with often twisted sides
Seeds	Hard, flat, round disc shaped, 10 cm in diameter, with shiny and glabrous testa	Laterally compressed, about 5–6 cm in diameter and 1–1.5 cm thick	Broad elliptic flat seeds about 12 mm long	Mahogany brown, smooth elliptically flattened		Shiny, dark brown about 4–5.5 cm. in diameter
Reference	[6,8]	[9]	[10]	[10]	[11]	[12,13]

TRADITIONAL AND FOLK USES

The seeds and roots of *Entada* species, Ep, Eph, Eaby, Eg, and Ea are used in traditional medicine for the treatment of liver diseases, stomach-ache, cold, hemorrhoids, arthritis, rheumatism, pulmonary problems, diarrhea, dysentery, cutaneous parasitic infections, venereal diseases, sleeping sickness, epilepsy, convulsions, etc.[5,9,16,18,22,23]

Seeds of these woody lianas are used by traditional healers as an analgesic, counter irritant, hair growth promoter, emetic and in skin diseases and cerebral hemorrhage.[17,19] Seeds are also documented to be useful as narcotic, analgesic, tonic, emetic, anthelmintic, febrifuge, anti-rheumatic, anti-inflammatory, musculoskeletal problems, scabies, alexiteric, oral contraceptive, and antiperiodic.[17-19] All the parts of different species contain saponins and are used in the soap industry; roasted seeds are well known as tribal pulse.[18,24]

In Asia, paste made from the leaves, bark and roots of Ep are used to clean wound, treat burns, and cure jaundice in children.[25] Tea made from the whole plant is used to improve blood circulation in the brain and heal post stroke effects. The bark of Ep and Eph is used to treat ulcers, scabies, diarrhea, dysentery, and parasitic infections.[9,19,26] Furthermore, the leaves are smeared with warm coconut oil and placed on the head of a child for infantile cold.[23] Root extract of Ep is taken to cure pyorrhea.[19] In South India, the tribal community women consume the seeds paste of Ep to improve lactation[27] and for post-delivery recuperation. It is given with jiggery after menstruation period to induce permanent sterility.[19,20] In Nagaland, the seed of Ep is known as Keling and its extract is used as hair wash to treat lice and dandruff.[28] Decoction of Epo root is used to relieve urinary burning, especially in venereal diseases and as a diuretic.[29] Traditional healers in Uganda use Eaby for the treatment of sleeping sickness.[30]

CONSERVATION

Major species Ep, Eph, and Ea are rated as endangered due to obliteration of tropical evergreen forests and unscientific exploitation of the plant parts such as roots, bark, and seeds for pharmaceutical and cosmetic purpose, which has resulted in the falling of population in the wild.[31,32] Moreover, these species can be propagated only through seeds which are largest (6–10 cm diameter) among the angiosperms. The seed coat is very thick and hard. *Entada* species show great dormancy, period of dormancy prolong up to 5 years.[33] Dormancy of seeds leads to leaving the species for ageing and death without replacements and make the species endangered. Studies have been done to evaluate the germination capacity of *Entada* seeds and conserve these rare and important plants genetic resource through dormancy breaking methods.[24]

PHYTOCHEMISTRY

Phytochemical investigation with an aim to isolate a novel bioactive molecule has been the pursuit of many researchers. Studies on chemical constituents of members of *Entada* are indicative of the presence of saponins, flavonoids, amino acid glycosides, and sulfur containing glycosides as major compounds along with phenols, tannins, and minerals [Table 2].

Minerals

Seeds of *Entada* species are rich in potassium (K), magnesium, and phosphorous (P), followed by calcium (Ca), sodium (Na), and Iron (Fe).[12,13,14-33,54]

Fixed Oil

Seeds of Ep, Eph, and Eaby are reported to contain (6–10%) oil comprising triglycerides diolein, dilinolein, oleolinolein, dioleolinolein, triolein, oleodilinolein, and trilinolein. Fatty acids such as oleic, linoleic, linolenic, myristic, palmitic, stearic, arachidic, and behenic acids have been reported in seed oil hydrolysate. Linoleic acid is the most abundant (>60 %) polyunsaturated fatty acid in kernel and pods Ep, Eph, Eaby, and Eg.[9,48,50,53,55] Leaf of Eaby is reported to yield bis-[(*S*)-(2,3-dihydroxypropyl)] hexacosanedioate.[53]

Polysaccharides

Sugars such as D-glucose, L-arabinose, D-xylose, galactose, rhamnose, arabinose, glucuronic acid, and glucose are reported in Ea and Ep in root and seed.[3,22] Arabino-galactan type II polysaccharide and rhamno-galacturonan type I are reported in the Ea roots.[22]

Amino Acids

Amino acids (24%) form an important part of Ep seed constituents.[12] The major essential amino acids shown to be present include leucine (2.597 g/100 g), followed by phenylalanine (2.116 g/100 g) and lysine (1.776 g/100 g) in seed. It is also reported to be a potential source of the main non-essential amino acid glutamic acid (3.737 g/100 g seeds).[12] Furthermore, seeds of Eph contain isoleucine, leucine, tyrosine, threonine, proline, glutelins, and phenylalanine.[48,50,51,53,55] Seeds of Eg have shown glutamic acid, methionine, lysine.[52] Seed and stem extracts of Ep and Eph have been shown to contain L-tyrosine-O-glucoside and dopamine 3-O-glycoside.[41,56]

Tryptophan derivatives, tryptorheedei A (N-sulfonyl-L-tryptophan), and tryptorheedei B (3-(N-sulfonylindolyl-D-lactic acid) together with 5-O-β-D-glucopyranosyl-2-hydroxyphenylacetic acid, 1-O-methylglucopyranoside have been isolated and characterized from seed kernels of Ep.[36]

Flavanoids

Epicatechin

Echin, liquiritigenin, iso-liquiritigenin, glabridin, 4′-O-methylglabridin, hispaglabridin A from the ethyl acetate soluble fraction of the methanol: dichloromethane (1:1) extract, and shinflavanone from dichloromethane soluble fraction are isolated and identified from the stem bark of Ep.[42] Protocatechuic acid, protocatechuic acid methyl ester, and

Table 2: Phytoconstituents distribution of *Entada* Genus

Class of compound	Compound	Part of plant	Species	References
Triterpenoidal saponin	Phaseoloideside A-D (1-4)	Seed kernels	Eph	[34]
Triterpenoidal saponin	Phaseoloideside E	Seeds kernels	Eph	[34]
Triterpenoidal saponins	Pursaethosides A(I)-E (1-5) Rheediinoside A and B Rheedeiosides A—D	Seed kernels	Ep	[35] [36] [37]
Saponins	3-O[β-D-xylopyranosyl (1 → 2)-α-L-arabinopyranosyl (1 → 6)] [β-D-glucopyranosyl (1 → 4)]-2-acetamido-2-deoxy-β-Dgluco pyranosyl-28-O-[β-D-apio furanosyl (1 → 3)-β-D-xylopyranosyl (1 → 2)] [(2-O-acetoxyl)-β-D-glucopyranosyl-(1 → 4)] (6-O(R) (-)2,6--dimethyl-2-trans-2,7-octadienoyl)-β-D----glucopyranosylechinocystic acid	Bark and seed	Eph	[38]
	Phaseoloidin (homogentisic acid 2-O-fl-D-glucose)	Seeds	Eph	[39]
	Entagenic acid	Bark	Eph	[4]
	Entagenic acid	Stem	Eph	[34]
Saponins	Entagenic acid	Bark and Seed	Ep	[35]
Saponins and a glucoside of the sulfur-containing amide	Entadosides A-D	Kernel nuts	Eph	[40]
Glycosides	L-Tyrosine O-glucoside (I), dopamine 3-O-glycoside (II)	Seeds	Ep	[36]
	4'-O-(6''-O-galloyl-β-D-glucopyranosyl)-2',4-dihydroxychalcone (1)	Stems	Eph	[41]
	4'-O-(6''-O-galloylβ-D-glucopyranosyl)-2'-hydroxy-4-methoxychalcone (2)	Stems	Eph	[41]
Flavonoids	Epicatechin, Liquiritigenin, Glabridin, 4'-O-methylglabridin, Isoliquiritigenin, HispaglabridinA, Shinflavanone	Bark	Ep	[42]
Phenolic acid glucosides	2-hydroxy-5-methylbenzoyl-β-L-glucopyranoside (*p*-cresotylglucoside, 1), 2-hydroxy-5-methylbenzoyl-β-L-glucopyranosyl (2 → 1)-β-L-glucopyranosyl (2 → 1)-β-L-glucopyranoside (*p*-cresotyltriglucoside, 2), and 2-hydroxybenzoyl-β-L-glucopyranosyl (2 → 1)-β-L-glucopyranosyl (2 → 1)-β-Lglucopyranosyl (2 → 1)-β-L-glucopyranoside (salicylic acid tetraglucoside, 5),	Seeds	Eph	[43]
Sulfur-contg. Amide compds	Entadamide A-β-Dglucopyranosyl-(1->3)- β -D-glucopyranoside , entadamide A , entadamide A-β-D-glucopyranoside, clinacoside C.	Seeds	Eph	[44]
	Entadamide B (N-(2-hydroxyethyl)-3,3-bis(methylthio)propanamid)	Dry seed	Eph	[45]
	Entadamide A	Dry seed	Eph	[44]
	Entadamide C	Leaves	Eph	[45]
	Entadamide C Entadamide A	Seed	Ep	[46] [42] [36] [47]

(Contd...)

Table 2: *(Continued)*

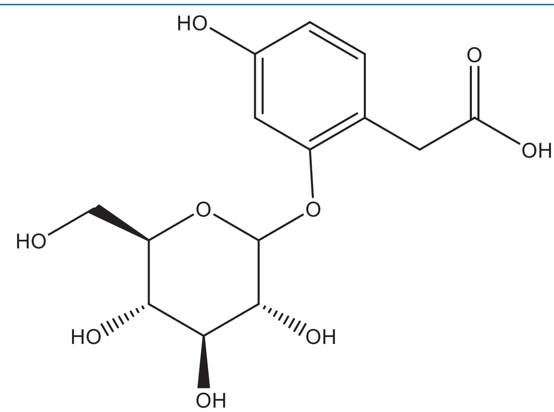
Class of compound	Compound	Part of plant	Species	References
Protein	Albumin, Globulins, Prolamins, Glutelins	Seeds kernel	Eph	[35]
Fatty acids	Diolein, dilinolein, oleolinolein, dioleolinolein, trioleein, oleodilinolein, trilinolein, oleic, linoleic, myristic, palmitic, stearic, arachidic, behenic, and linolenic acids	Seed	Ep	[49]
	Myristic, palmitic, stearic, arachidic, behenic, oleic, linoleic, and linolenic acids	Seeds kernel and pods	Eph	[48]
	Oleic acid, lauric acid, MYRICTIC acid, Palmitic acid, Stearic acid, Arachidic acid, Palmitoleic acid, Linolenic acid, Linoleic acid, Behenic acid--	Seed oil	*E. gigas*	[50]
Triglycerides	Monosaturatediolein, monosatd. Dilinolein, saturated oleolinolein, dioleolinolein, triolein, oleodilinolein, and trilinolein.	Seed oil	Eph	[48]
Minerals	Calcium (Ca), Phosphorus, Potassium (K), Magnesium, Sodium, Iron, Zinc, Copper, Manganese	Seed	Eph	[51] [48]
	K, phosphorous (P), Ca, sodium	Seed	Ep	[46] [11]
	Magnesium, Sodium, Phosphorus, Ca, K	Seed oil	*E. gigas*	[50]
Amino acids	Isoleucine, Leucine, Tyrosine, Threonine, Proline, glutelins, and Phenylalanine.	Seed	Eph	[51] [52]
Polysaccharide	D-glucose L-arabinose D-xylose	Seeds	*E. scandens*	[3]
	Arabinose Rhamnose Galactose Glucose Glucuronic acid	Root	Ea	[22]
Miscellaneous	Diterpene	Stem bark	Eaby	[53]
	Flavonol glycoside	Stem bark	Eaby	[53]
	Phytosterol glycoside	Stem bark	Eaby	[53]
	1',26'-bis-[(S)-2,3-dihydroxypropyl] hexacosanedioate	Stem bark	Eaby	[53]
	Entadanin	Stem bark	Eaby	[53]
	Prosapogenin A	Seeds	*E. scandens*	[3]
	β -sitosterol	Seeds	*E. scandens*	[3]
	Lupeol	Seeds	*E. scandens*	[3]

Eph: *Entada phaseoloides*, Ea: *Entada africana*, Ep: *Entada pursaetha*, Epo: *Entada polystachya*

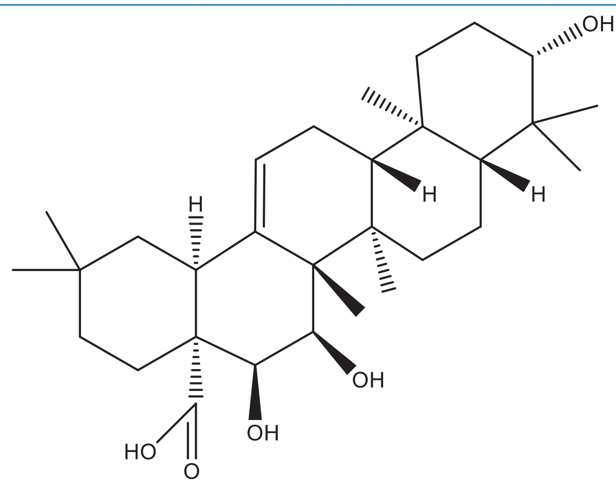
1,3,4 trihydroxybenzene glucoside have been reported from 70% ethanolic extract of the seeds;[46] Ethanolic extract of the stem of Eph is reported to yield 3,4”,7-trimethylquercetin, 5-hydroxy-3,4”,7-trimethoxyflavone, quercetin, (þ)-3,3”,5”,5,7-pentahydroxy flavanone, luteolin, (þ)-dihydro kaempferol, dehydro dicatechin A, apigenin, epicatechin, catechin, 3-deoxysappanchalcone, naringenin, rhamnocitrin, 4”,7-dihydroxyflavone, protocatechuic acid, vanillic acid, 4”,5,7-trihydroxy-3”-methoxyflavonol, galangin, rutin, 3”,5,5”,7-tetrahydroxyflavanone, and 2”,5,5”-trihydroxy-3,4”,7-trimethoxyflavone-2”-O-β-D-glucoside and epigallocatechin.[9] Apigenin, robinetin and three myricetin-derived flavonols, and naringenin-7-O-glucoside have been isolated from the root and leaf of Ea.[9] 4’-O-β-D-glucopyranosyl-2’-hydroxy-4-methoxychalcone,4’-*O*-(6”-*O*-galloyl-β-D-glucopyranosyl)-2’,4-dihydroxychalcone and 4’-*O*-(6”-*O*-galloylβ-D-glucopyranosyl)-2’-hydroxy-4-methoxychalcone have been isolated from the stem of Eph.[41] Catechuic acid and gallic acid are noted to be obtained from the root bark of Ea.[10] Quercitrin and quercetin-3-O-β-D-glucosyl (1→4)-α-l-rhamnoside and entadanin are found to be isolated from Eaby leaves.[16,53]

Saponins

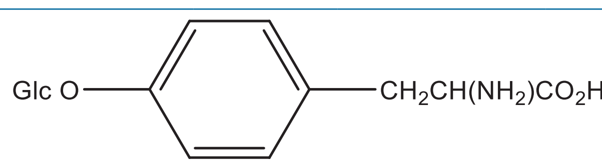
The bark, seed kernels, and seeds of Ep, Eph, and Epo, and other species contain significant amounts of saponins [Figure 2] including an anti-tumor saponin, Entanin and its hydrolyzed product is entagenic acid. Triterpene saponins, phaseoloideside A-D, phaseoloideside E, and pursaethosides A (I)-E based on entagenic acid as an aglycone are reported to be isolated from Ep and Eph.[34,35,37] Pursaethosides A-E, as white amorphous powders and glycoside phaseoloidin, are reported to be isolated from the methanoli cextract of the seed kernels on successive partitioning between hexane, ethyl acetate, and n-butanol. The ethyl acetate fraction is shown to afford phaseoloidin (homogentisic acid 2-O-fl-D-glucose), while, a crude saponin mixture after evaporation of the n-butanol layer is reported to yield pursaethosides A-E on fractionation by vacuum-liquid chromatography.[35,47] Pursaethoside A ($C_{59}H_{95}NO_{25}$), is 3-O-*β*-D-xylopyranosyl-((1→3)-[R-L-arabinopyranosyl-((1→6)] 2-acetylamino-2-deoxy- *β* -D-glucopyranosyl oleanolic acid 28 O- *β* -D-apiofuranosyl-((1→3)- *β* -D-glucopyranoside; pursaethoside B ($C_{59}H_{95}NO_{26}$), a 3-O *β* -D-xylopyranosyl-((1→3)-O-[R-L-arabinopyranosyl-((1→6)] 2-acetylamino-2-deoxy- *β* -D-glucopyranosyl echinocystic acid 28-O- *β* -D-apiofuranosyl-((1→2)- *β*-D-glucopyranoside; pursaethoside C ($C_{59}H_{95}NO_{27}$), a 3-O-*β*-D-xylopyranosyl-((1→3)-O[R-L-arabinopyranosyl-((1→6)]-2-acetylamino-2-deoxy- *β* –D-glucopyranosyl entagenic acid 28-O- *β*-D-apiofuranosyl-((1→2) *β* -D-glucopyranoside; pursaethoside D ($C_{64}H_{103}NO_{31}$), a 3-O- *β* D-xylopyranosyl-((1→3)-[R-L-arabinopyranosyl-((1→6)]-2-acetylamino-2-deoxy- *β* -D-glucopyranosyl entagenic acid 28-O-*β* D-apiofuranosyl-((1→2) - [*β* -D-apiofuranosyl- ((1→ 4)]- *β* –D glucopyranoside, and pursaethoside E ($C_{70}H_{113}NO_{36}$), a 3-O- *β* -D-xylopyranosyl ((1→3)-[R-L-arabinopyranosyl-((1→6)]-2-acetylamino-2-deoxy *β* -D-glucopyranosylentagenic acid 28-O- *β* -D-apiofuranosyl ((1→



Phaseoloidin



Entagenic acid



Tyrosine O-glucoside

Figure 2: Bio-active phyto-constituents of *Entada* species

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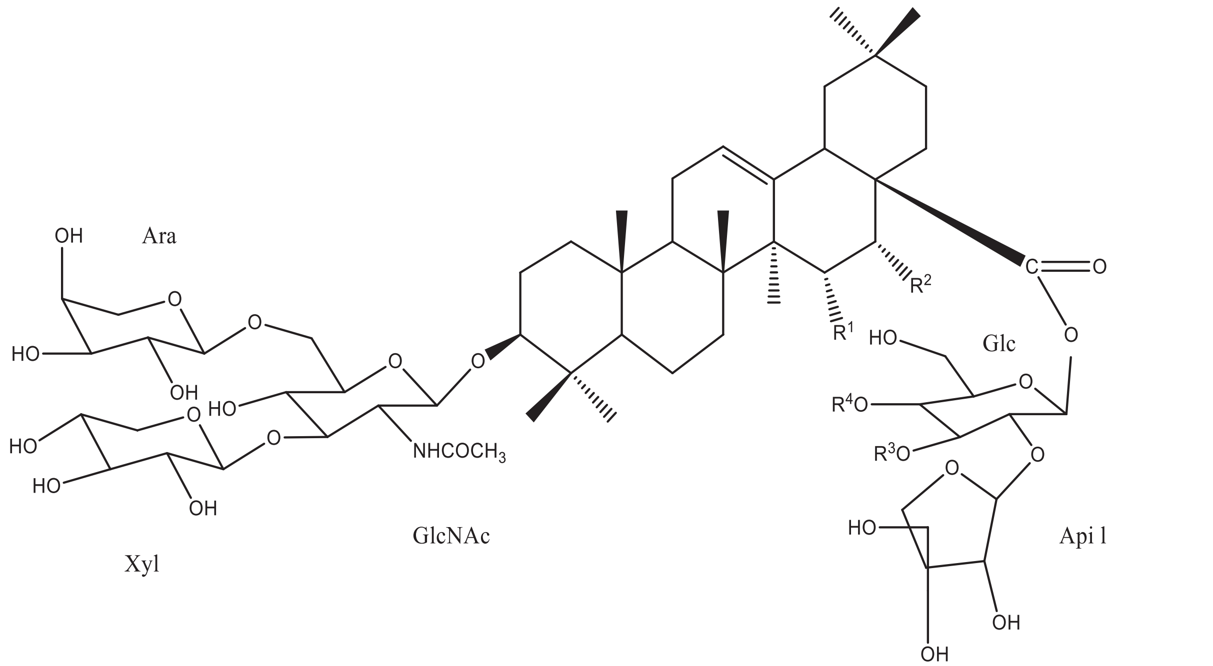
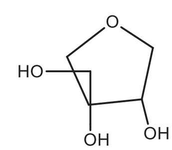
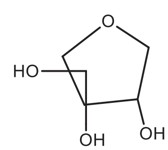
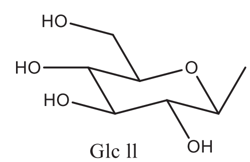
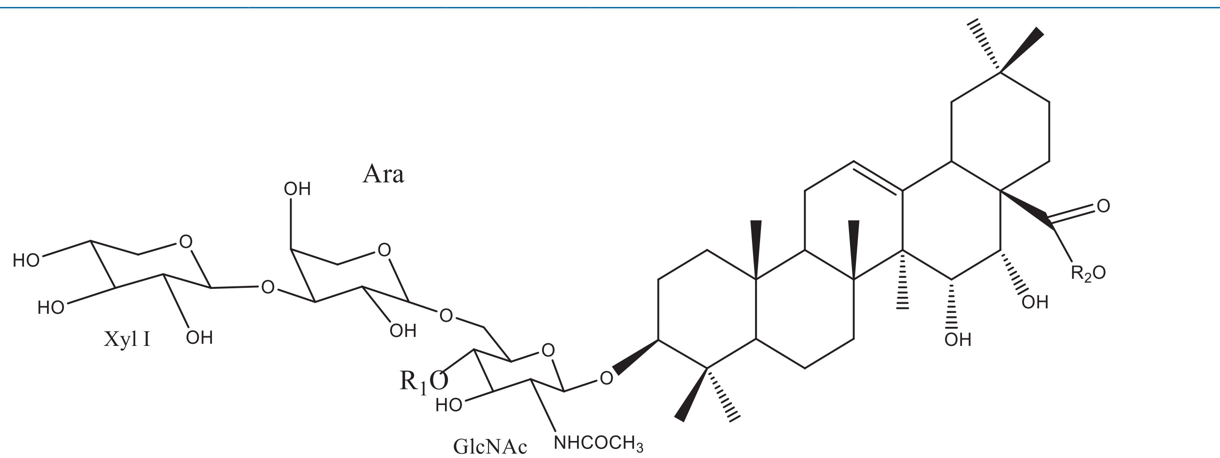


Pursaethosides

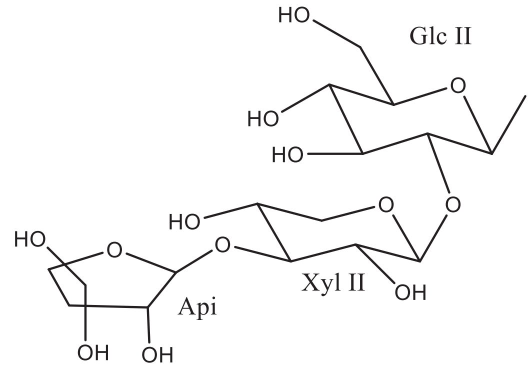
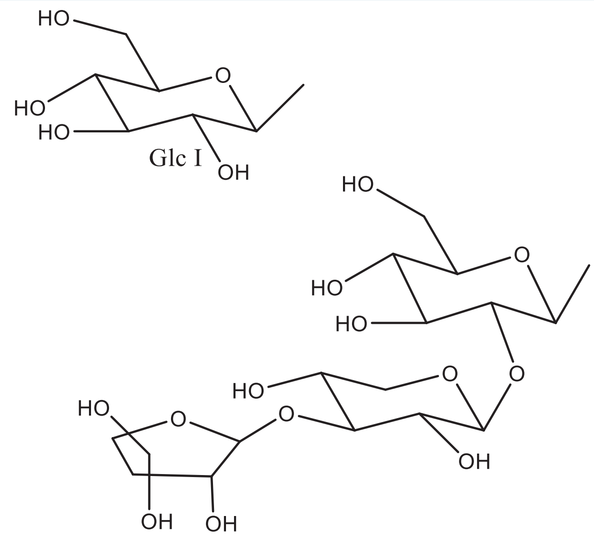
Sr No.	**Pursaethosides A-E**	**R1**	**R2**	**R3**	**R3**
1	A	H	H	H	H
2	B	H	OH	H	H
3	C	OH	OH	H	H
4	D	OH	OH	H	 Api ll
5	E	OH	OH	 Api ll	 Glc ll

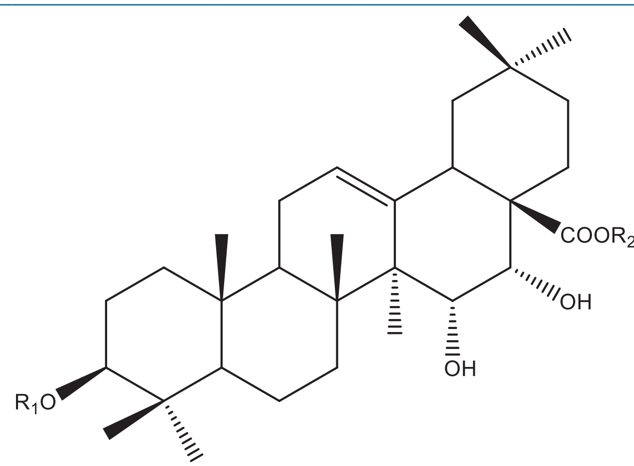


5) Rheediinosides A & B

Figure 2: *(Continued)*
Abbreviation: GlcNAc: *β*-D-N-Acetylglucosaminoside, Glc: *β*-DGlucopyranoside, Xyl: *β*-D-Xylopyranoside, Api: *β*-DApiofuranoside

(Contd...)

Sr No	Rheediinosides A&B	R1	R2
1	A	H	
2	B	B	



Rheedeiosides A-D

Sr No	**Rheedeiosides A-D**	**R1**	**R2**
1	A	GlcNAc(3-1)Xyl (6-1) Glc(3-1)Xyl (6)Ac	Glc(2-1)Xyl (3-1)Api
2	B	GlcNAc(3-1)Xyl (6-1) Glc(3-1)Xyl	Glc(2-1)Xyl (3-1)Api
3	C	GlcNAc(3-1)Xyl (6-1) Glc(3-1)Xyl	Glc(2-1)Xyl (3-1)Xyl
4	D	(6)Ac GlcNAc (6-1) Ara(2-1)Xyl	(6)Ac Glc(2-1)Xyl (3-1)Api

Figure 2: *(Continued)*

2)-[β - D-apiofuranosyl-((1→3)]-[β -D-glucopyranosyl ((1→3)] β -D-glucopyranoside.

Saponins 3-O [β-D-xylopyranosyl (1 → 2)-α-L-arabinopyranosyl (1 → 6)] [β-D-glucopyranosyl (1 → 4)]-2-acetamido-2-deoxy-β-Dglucopyranosyl-28-O-[β-D-apiofuranosyl (1 → 3)-β-D-xylopyranosyl (1 → 2)] [(2-O-acetoxyl)-β-D-glucopyranosyl-(1 → 4)] (6-O(R) (-)2,6--dimethyl-2-trans-2,7-octadienoyl)-β-D-glucopyranosyl echinocystic acid.[38] Bidesmosidic triterpenoids saponins, rheediinoside A and B are the reported to be isolated from the *n*-BuOH extract of seed kernels by column chromatography over Sephadex LH-20 after removal of free sugars. Rheediinoside A is 3-*O*-β-D-xylopyranosyl- ((1→3)-*O*- α -L-arabinopyranosyl-((1→6)-2-acetylamino-2-deoxy-β-D-glucopyranosylentagenicacid 28-*O*-β-apiofuranosyl-((1→3)-β-D-xylopyranosyl-(1→ 2)-β-D-glucopyranoside and Rheediinoside B is 3-*O*-β-D-glucopyranosyl-((1→4)-*O*-[β -D-xylopyranosyl-((1→3)- α -L-arabinopyranosyl((1→6)]-2-acetylamino-2-deoxy-β -D-glucopyranosyl entagenic acid 28-*O*-β -apiofuranosyl-((1→3)-β -D-xylopyranosyl-((1→2)-β -D-glucopyranoside.[57] Oleanane-type triterpene saponins, rheedeiosides A-D have been isolated from the methanol soluble fraction of hexane extract of the seed kernels.[37] Rheedeioside A is entagenic acid 3-O-β -D-xylopyranosyl-(1→3)-6-O-acetyl-β -D-glucopyranosyl (1→6)-O-[β –Dxylopyranosyl (1→3)]-2-acetylamino-2-deoxy- β -D-glucopyranoside 28-O-[β -D-xylopyranosyl (1→2), β -D-apiofuranosyl (1→3)]- β -D-glucopyranosyl ester; rheedeioside B is entagenic acid 3-O- β -D-xylopyranosyl-(1→3)-β -D-glucopyranosyl (1→6)-O- [β -D-xylopyranosyl (1→3)]-2-acetylamino-2-deoxy- β -D-glucopyranoside 28-O-[β-D-xylopyranosyl (1→2), β -D-apiofuranosyl (1→3)]- β -D-glucopyranosyl ester; rheedeioside C is entagenic acid 3-O- β -D-xylopyranosyl-(1→3)-6-acetyl- β -Dglucopyranosyl-(1→6)-O-[β -D-xylopyranosyl-(1→3)]-2 acetylamino-2-deoxy- β-D-glucopyranoside, 28-O- β -D-xylopyr anosyl-(1→2)-[β -D-xylopyranosyl-(1→3)]- β -D-glucopyranosyl ester and rheedeioside D is entagenic acid 3-O- β -D-xylopyranosyl- (1→2)-α -L-arabinopyranosyl-(1→6)-2-acetylamino-2- deoxy- β -D-glucopyranoside, 28-O- β -D-xylopyranosyl- (1→2)-[β -D-apiofuranosyl-(1→3)]-6-acetyl- β -D-glucopyranosyl ester.[37] Saponins and glucoside of the sulfur-containing amide such as entadosides A-D have been obtained from the kernel of Eph, the structures of which are similar to rheedeiosides, except for sugar-chain binding at the 28-carboxyl group through an ester bond.[58] The presence of oleanolic acid, echinocytic acid, entagenic acid, monodesmoside, benzene acetic acid, and homogentisic acid along with 3-O-β-D-glucopyranosyl-β-sitosterol have been documented in seeds of different species of *Entada*.[4,55,36,38,47,57] A triterpenoid saponin, polystachyasaponin, 15,16-dihydroxy-3-[[O-β -D-xylopyranosyl-(1→2)-*O*-α-L-arabinopyranosyl-(1→6)-2-(acetylamino)-2-deoxy-β-D-glucopyranosyl] oxy]-(3β, 15α,16α)-olean-12-en-28-oic acid O-D-apio- β-D-furanosyl-(1→3)-O-β -D-xylopyranosyl-(1→2)-O-[β -D-glucopyranosyl-1→4)]-6-O-[(2*E*,6*R*)- 6-hydroxy-2,6-dimethyl-1-oxo-2,7-octadienyl]-β -D-glucopyranosyl ester is isolated from leaves of Epo.[5] Betulin was isolated dichloromethane extract of the stem bark.[59] Nine triterpene ester saponins are reported to be isolated from the roots of Ea based on the aglycones echinocystic acid and acacic acid.[60]

Glycosides

The methanolic fraction of hexane extract of the Ep seed kernels has been shown to led to the isolation of 1-(3,4-dimethoxyphenyl) propan-9-ol O-(6”-O-α-L-arabinopyranosyl)-β-D-glucopyranoside, 1-(3,4,5-trimethoxyphenyl) prop-7-en-9-ol O-(6”-O-α-L-arabinopyranosyl)-β-D-glucopyranoside, N-(2’-hydroxyethyl)-7-phenylacetamide 2’-O-β-D-glucopyranoside.[40]

Sulfur Containing Amide Compounds

The seeds and leaves of Ep and Eph are reported to contain thioamide glycosides, entadamide A, cis-entadamide A-β-D-glucopyranoside,[37] entadamide A 2’-O-(4”-O-β-D-glucopyranosyl)-β-D-glucopyranoside, 2’-O-(6”-O-β-D-glucopyranosyl)-β-D-glucopyranosides and corchoionoside C.[40] Clinacoside C, entadamide B (N-(2-hydroxyethyl)-3,3-bis (methylthio) propanamid), entadamide C, and phenylpropanol β-D-glucopyranoside are also reported.[36,42,44,45,46,47]

Phenolic Acid Glucosides

The seeds of Eph have been shown to have p-cresotyl glucoside (2-hydroxy-5-methylbenzoyl-β-L- glucopyranoside), p-cresotyl triglucoside (2-hydroxy-5-methylbenzoyl-β-L-glucopyranosyl (2→1)-β-L-glucopyranosyl (2→1)-β-L-glucopyranoside), and salicylic acid tetraglucoside (2-hydroxybenzoyl-β-L-glucopyranosyl (2→1)-β-L-glucopyranosyl (2→1)-β-Lglucopyranosyl (2→1)-β-L-glucopyranoside).[43]

Miscellaneous

Gas chromatography mass spectrometry analysis of the ethanol extract of the seeds of Ep has revealed presence of benzene dicarboxylic acid, di-isooctyl ester (69.52%) as major components, followed by n-hexadecanoic acid (4.48%), azulene, 1,4-dimethyl 1-7- (1-methylethyl)- (3.86%), and undecanoic acid (2.46%).[55] A monoglyceride, l’,26’-bis-[(S)-2,3-dihydroxypropyl] hexacosanedioate and the peltogynoid, entadanin, along with three clerodane diterpene derivatives 8S-kolavic acid 18-Me ester, 8S-kolavic acid 15-Me ester, and 8S-kolavenol; pentacosanoic acid, methyl gallate, ursolic acid, lupeol, *β*-sitosterol, and stigmasterol have been isolated from the stem bark of Eaby.[53,61]

PHARMACOLOGICAL STUDIES

Modern studies manifested that members of *Entada* possesses bioactivities such as hepatoprotective, anti-inflammatory, antibacterial, antioxidant, wound healing, anthelmintic, anti-diarrheal, and so on [Table 3].

Analgesic Activity

The ethanolic extract of the seeds of Ep has been shown to exert significant peripheral antinociceptive activity ($P < 0.001$) comparable to diclofenac Na treatment (80.30%).[46]

The ethyl acetate extract of the stem bark, the ethanol leaf extract of Ea, and saponins of Eph have shown significant ($p < 0.05$) and dose-dependent inhibition of the abdominal constrictions induced by acetic acid.[80] The aqueous extract of the root has shown to reduce endometriosis related writhing frequency.[81]

Anti-angiogenic Activity

Ea root extracts (*n*-hexane, chloroform, chloroform/or, and methanol) are reported to reduce on capillary formation in chick chorioallantoic membrane post-treatment.[73]

Antidiabetic Activity

Total saponins of the Eph seed (TSEP) have been demonstrated to reduce fasting blood glucose level in type 2 diabetic rats by significantly inhibiting glucose production and the gluconeogenic gene expression. Furthermore, treatment with TSEP is noted to elevate the phosphorylation of AMPK, leading to promote the phosphorylation of acetyl CoA and Akt/glycogen synthase kinase 3*β* (GSK3*β*), respectively. It is also observed that the saponins reduced lipid accumulation and improved insulin sensitivity in hepatocytes.[74]

Antidiarrheal Activity

The ethanolic extract of the seeds has shown dose dependent activity at 250–500 mg/kg b. wt.[65]

Anti-inflammatory Activity

Ep seed ethanol extract is reported to exhibit potent anti-inflammatory activity at 400 mg/kg against carrageenan induced paw edema when compared with indomethacin.[49] Further, the ethanol extract and its column eluted fraction ($CHCl_3$: CH_3OH, 7:3) are reported to show anti-inflammatory activity in macrophage RAW 264.7 cells by inhibiting COX-2. The fraction is also observed to significantly down regulate nitric oxide (NO) production in RAW cells without altering the normal growth of cells.[49] An experimental study using both *in vivo* and *in vitro* models is suggestive of anti-inflammatory potential of the ethanolic extract of stem.[63] The methanolic extract of the aerial parts of Ep and saponins of Eph have been shown to exhibit significant anti-inflammatory activity against carrageenan induced paw edema by acting on "proliferative phases of inflammation.[80] CH_2Cl_2/MeOH (5%) fraction of the stem bark of Ea is reported to suppress lipopolysaccharide-induced inflammation in RAW 264.7 cells and inhibited the production of NO with IC_{50} (¼) 18.36 µg/mL and had 89.068% inhibition.[64] Further the fraction also showed inhibition of the expression of inducible NO synthase in a concentration-dependent manner and stimulated the expression of anti-inflammatory cytokines (Interleukin [IL] 10 and IL13) and caused 30% inhibition of the activity of p38 MAPK kinase.[64,82] In a study the leaf ethanolic extract of Ea has shown significant ($P < 0.05$) anti-inflammatory effect at 200 mg/kg dose.[80]

The defatted methanolic extract of Eaby exhibited dose-dependant inhibition of carrageenan-induced rat paw edema and granuloma tissue formation in rats. The inhibition of acetic acid-induced vascular permeability in a dose-dependent fashion in mice was also reported.[83]

Antimicrobial Activity

Different Ep leaf extracts (methanol, ethanol, chloroform, and isopropanol) have been shown to possess antimicrobial activity against *Escherichia coli*, *Bacillus subtilis*, *Salmonella typhi,* and *Pseudomonas aeruginosa* even at low concentrations.[66] The bark and seed ethanolic extract, protocatechuic acid, entadamide C, entagenic acid, and phaseoledin have been revealed to exhibit strong antibacterial activities in agar well diffusion assays.[46,47,66] Among the three seed kernel isolates entadamide, phaseoloidin, and entagenic acid, the later has been found as the most active against *B. cereus* and *B. subtilis* and moderately active against *Staphylococcus aureus, P. aeruginosa, Alcaligenes faecalis, Proteus vulgaris*, and *E. coli*, least active against *Enterobacter aerogenes.*[47]

Different extracts of the stem bark of Ea have been reported to inhibit growth of *Enterococcus faecalis, E. coli, and S. typhi* significantly.[39,84] Betulin isolated from the dichloromethane soluble portion of the methanol/acetone (1:1 v/v) extract of Ea stem bark inhibited growth of E. *coli*, K. *pneumonia, S. typhi, and S. aureus.*[59] Scientific reports on antimicrobial fungi static and fungicidal potential of the stem bark of *Ea* against multidrug-resistant Gram-negative bacteria in *E. coli* AG100A and *Vibrio cholerae*[76,85] have been also studied. In an antimicrobial study, the methanol extract *of Eaby* stem bark, its fractions, namely, *n*-hexane, ethyl acetate, *n*-butanol and aqueous fractions, and isolated compounds (5S, 6R, 8aR) -5- (carboxymethyl) -3, 4, 4a, 5, 6, 7, 8, 8a- octahydro-5, 6, 8a trimethyl naphthalene carboxylic acid (compound 1), methyl 3, 4, 5-trihydroxybenzoate, benzene-1, 2, 3-triol, and 2,3- dihydroxypropyl triacontanoate when tested by broth micro-dilution techniques on bacteria and yeasts, fractions *n*-hexane and ethyl acetate are shown to exhibit higher antibacterial potential compared to the methanol extract, while higher antifungal activity was noted with ethyl acetate, *n*-butanol, and aqueous fractions. The isolated compounds were found to be more active as anti-bacterial (9.7–156.2 μg/ml) than yeasts (78.1–312.5 μg/ml). Apart from compound 1, the three others displayed DPPH radical scavenging activity.[75,86]

Antioxidant Activity

The methanolic extract of Ep is shown to scavenge DPPH radical, superoxide radical, and hydroxyl radical and thus has been proven to possess antioxidant potential.[67,75] Protective effect of the alcoholic extract of Ep stem in mice model of DSS- induced colitis, which was associated with reduced inflammation and peroxidative damage and improved antioxidant status.[87] The methanolic extract of Eph bark and seed is shown to have antioxidant potential in different *in vitro* assays.[88] *Ea* methylene chloride/methanol (1:1 v/v) extract of the stem bark iss reported with good hepatoprotective and antioxidant activities for *in vitro* and *in vivo* experimental models.[67,68]

Anti-plasmodial Activity

In a study Ea is reported to show antiplasmodial activity for chloroquine-sensitive strain HB3 and chloroquine-resistant strain FcM29 of *P. falciparum* possibly through the inhibitory effect on heme detoxification.[80]

Antitussive Activity

Ea has been shown to reduce bronchoconstriction induced by histamine in comparison with untreated group ($P < 0.05$).[78]

Antiulcer Activity

The ethanolic extract (70%) of *Ep* seeds and its isolated actives protocatechuic acid, protocatechuic acid methyl ester, 1,3,4-trihydroxybenzene glucoside, phaseoloidin, entadamide A, entadamide A-*β*-d-glucopyranoside, entadamide C, rheedeioside A, and rheedeioside B have been evaluated for the antiulcerogenic activity using ethanol-induced ulcer model. EE, phaseoloidin, entadamide A, and rheedeioside A are found to have significant ($p < 0.05$) anti-ulcer activity.[46]

Antiulcer activity of the ethanolic extract of Eph seeds is reported against aspirin plus pylorus ligation induced gastric ulcers in rats, HCl-ethanol induced ulcer in mice and water immersion stress-induced ulcers in rats.[89]

Antiviral

The acidified methanol and 70% acetone extracts of Ep seeds Have been shown to display 89% and 34.82% inhibition of *α*-amylase activity respectively.[69] The ethanol extract of the seed kernels has been reported to exert strong *α*-glucosidase inhibitory activity with inhibition to cell viability and HIV infectivity.[69] Phaseoloidin is shown to exert very strong antiviral activity against Coxsackie B4 virus, while EE and entadamide A-*β*-D glucopyranoside reduced the activity of Coxsackie B4 virus by 35 and 19%, respectively.[46] Tryptophan derivatives from the seed kernels were studied and found to have potential therapeutic activity for cancer and AIDS.[36] The ethanolic extract of seed coat, cotyledon, and pericarp demonstrated significant *α*-glucosidase inhibition activity (IC_{50} values of 98.73 ± 0.46, 28.08 ± 11.28, and 74.01 ± 2.02 mg/mL, respectively).[69] The ethanolic extract of Ea roots was found to inhibit growth of Herpes simplex virus type 1 and the African Swine Fever Virus.[77]

Cytotoxicity

The methanolic leaf extract is reported to possess promising anticancer activity in brine shrimp lethality assay as well as significant cardioprotective activity *in vitro* when tested on human blood.[70] The methanolic extract of the root was reported to have cytotoxic potential when tested on HepG2 cell lines.[90] The chloroform soluble fraction of the methanol extracts of the bark, seed and leaf showed significant cytotoxicity in brine shrimp assay, while highest antioxidant and membrane stabilizing potential were reported to be exhibited by ethyl acetate soluble fraction.[42] The ethanolic extract of the seeds showed significant toxicity in the brine shrimp lethality bioassay (LC_{50}. 20 μg/ml and LC_{90}. 80 μg/ml).[79] Triterpenes isolated from the seeds have antiproliferative and antioxidant activities. Rheediinoside A and B [Figure 2] were studied for their anti-proliferative activity against T98G, A431, PC3, and B16-F1 cell lines, and further for their antioxidant properties. Moderate cytotoxic potency and antioxidant properties were found for these compounds, rheediinoside B being more active than rheediinoside A[57] Rheedeioside A, C, and D have been shown to be strongly active ($IC_{50:}$ 3.9, 10.8, and 9.9 μM, respectively) and it has been suggested that the acetyl group of 6‘-glucopyranoside is an important part for its activity. The The petroleum ether soluble fraction of the methanol extract of both the seed and the bark of Eph is noted to exhibit significant cytotoxicity.[78] Phaseoloideside E (PE), an oleanane-type triterpene saponin isolated from the seed kernels of *Eph* has been shown to have strong cytotoxic activity against an array of malignant cells through upregulation of cellular reactive oxygen species production.[75] In a study on cytotoxicity, antimicrobial and antioxidant activities of the terpenoid and flavonoid isolated from Eaby that includes ursolic acid, quercetin-3-O-*α*-L-rhamnoside or quercitrin, quercetin 3-O-*β*-D-glucosyl (1→4)-*α*-L-rhamnoside, (8S)-kolavic acid 15-methyl ester, 13,14,15,16-tetranor-3-clerodene-12,18-dioic acid, methyl gallate, entadanin, bis-[(S)-(2,3-dihydroxypropyl)] hexacosanedioate, entadanin is shown to demonstrate the strongest activity against S. *typhimurium* and ursolic acid is reported to be the most potent cytotoxic compound against THP-1 and RAW.[16]

Hepatoprotective Activity

The alcoholic extract of the Ep stem is shown to have significant dose dependent (30, 100, and 300 mg/kg b. wt.) hepatoprotective effect comparable to standard (silymarin), against carbon tetrachloride (CCl_4)-induced hepatotoxicity in male albino rats.[88] Ea root extracts showedsignificant protection in CCl_4-induced acute liver damage according to its therapeutic indication in various liver diseases in traditional medicine.[71]

Molluscicidal Activity

The methanolic extract of the bark of Ep is shown to exhibit the molluscicidal activity with LC_{50} is 1,611 ppm and LC_{90} is 4266 ppm that could be attributed to the presence of saponins.[72] *Ea* methanol extract has been shown to give on 100% mortality on snails *Biomphalaria pfeifferi* and *Bulinus truncates*.[9]

Wound Healing Activity

Wound healing potential ofthe seed kernel actives entadamide, phaseoloidin, and entagenic acid has been evaluated by molecular docking and in *in vivo* wound healing experimental models. Amongst the three compounds studied, entagenic acid is shown to have minimum binding and docking energy and thus can be considered as a good inhibitor of GSK3- *β*, the protein whose inhibition promotes wound healing through b-catenin-dependent Wnt signaling pathway. In correlation to the observation of docking study, entagenic acid is also found to exhibit highest potential in *in vivo* wound healing experimental models.[47]

Miscellaneous

A diastereoisomer of the clerodane type diterpene, kolavenol isolated from the root bark extract of Eaby is reported to show trypanocidal activity with an 2.5 µg/mL IC_{50} (8.6 µM dose) against *Trypanosoma brucei* rhodesiense, causing acute form of human African trypanosomiasis.[52] A kolavic acid derivative, monomethyl ester-15-kolavic acid isolated and characterized from the stem bark of Eaby has been shown to display strong inhibition of bloodstream form of *T. brucei* and related glycolytic enzymes.[61]

DISCUSSION

Popularly it is called soap plant as all of its parts are used in the soap industry. It has diverse array of chemical compounds of abundant usefulness from tribal native to the various area. Saponins having entagenic acid as aglycone are rarely encountered in nature. Entagenic acid is found to be occurring in Ep and other species of *Entada*[2-4] and thus could represent a chemotaxonomic marker for this genus. Most of its traditional uses are scientifically validated such as anti-inflammatory,[49] wound healing[47] and antidiarrheal activities[65] and folklore uses in stomach problems[62,65] and as antimicrobial[36,39,47,75,76,84-86] also were investigated. The seeds of different species of *Entada* are rich in K and P, followed by Ca and Na. Richness of these elements in the seeds probably accounts for their medicinal as well as dietary values. Ca, Mg, and P obtained from the plant have healing action for osteoporosis and slow teething. Na and K like minerals help in management of water content, muscle tones and heart rhythm. Furthermore, it is to be noted that Entada seeds can nourish infant, child, and adult with essential amino acids. The presence of relatively high levels of phenyl alanine in *Entada* seeds probably explains its use in folk medicine specially for treating arthritis and other rheumatoid diseases. The seeds are also a potential source of glutamic acid, the main non-essential amino acid, which is important in the metabolism of sugars and fats and used in treatment of ulcers. The protein content of the seeds, for example, Ep contains 23.6 g/100 g dry matter. The seeds have fairly high crude fiber content and endosperm contains considerable amount of unsaturated fatty acids and carbohydrate (45.35 g/100g). The research work index [Figure 3] indicates maximum research done in the past two decades. Taking into consideration the various physiological contributions of reported nutrients found in the seeds, it may be inferred that seeds can supply these essential elements if consumed. Thus, looking in to the high potential and increasing realization of members of *Entada* as pharmaceutical and nutraceuticals, there a need for their conservation and preservation.

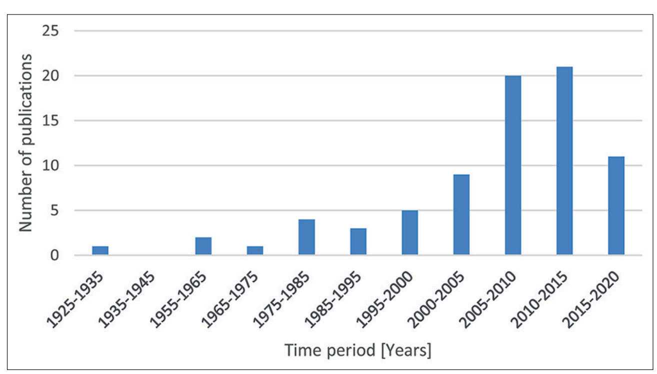


Figure 3: Entada genus plants Research work Index

CONCLUSION

Medicinal plants have served as important source of lead compounds in drug discovery. *Entada* species have been widely used in the treatment of various ailments by tribal people globally. Studies report identification of characteristic saponins, glycosides, flavonoids, minerals, proteins, carbohydrates in the seeds, leaves, stem, bark, and roots. Most of the medicinal claims have been validated by pharmacological investigations using both *in vitro* and *in vivo* studies. Thus, proper understanding of the safe use of these members of *Entada* as neutraceuticals and medicinal can be promoted. This review paper provides information that may be helpful in exploring tribal uses of the plant. It is significant role of tribal people who did the study, conservation and protection of such vital plants (Genus *Entada*) from further extinction. The genus thus is needed to be further explored at scientific level.

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