In any phytochemical investigation of medicinal plants, their botanical identification forms the most crucial and basic as any erroneous identity here will render all further studies on chemistry, pharmacology and clinical trial irrelevant.

3.1 *Berberis aristata* DC. Var. *aristata* Fam:- *Berberidaceae*

**Regional and Other Names**

**Ben.**: Daruharidra, Darhaldi; **Eng**: Indian Berberry; **Guj.**: Daruharidra, Daruhuladur; **Hind.**: Daruhaldi, Kashmal, Rasaut, Daruhal, Darhald, Kashmar, Rasvat, Chitra, Chotra; **Kan.**: Maradarishana, maradarishina, Daruhaldi, Doodamaradarisina, **Mal.**: Maramanjal, Maradrisina, Kasturimanjal; **Mar.**: Daruhalad; **Ori.**: Daruharidra, Daruhaldi; **Punj.**: Sumulu, Chitra, Kasmal, Simlu; **Tam.**: Gangeti, Varatiu manjal, Maramanjal, Mullukala, Usikkala, Kasturimanjal; **Tel.**: Manupasupu, Kasturipaspu, Daruharidra.

**Habit and Habitat**

An erect, spinescent shrub, found in Himalayas from Garhwal to Bhutan, at altitude of 1800-3000m.

**Ayurvedic Description**

Sanskrit name : Daruharidra, Rasanjana (dry extract)

Synonyms : Darunisa, Darvi, Pacapaca, Katamkatri, Parjanya, Paita, Pitadaru

Properties : **Rasa**: Katu, tikta; **Guna**: Ruksa;

**Virya**: Usna, Vipaka.

Actions : Kaphapittahara, lekhaniya, sodhani, kanduhara, vranadosahara, varnya, chedana, romasanjanana
Therapeutic uses: Karnaruk, netraruk, mukharuk, kandu, vrana, meharoga, tvagdosa, sotha, Rasanjana Vranadosa and putikarna.

**Therapeutic Uses Mentioned in Ayurvedic Pharmacopoeia**

The stem is used in amatisara (diarrhoea), medoroga (obesity), urustambha (stillness/loss of movement of legs), kapharoga (diseases due to excessive phlegm), karnaroga (diseases of the ear), mukharoga (diseases of oral cavity), netraroga (ophthalmic diseases), kandu (itching), vrana (wounds) and meha (diabetes).¹

**Properties and Uses**

The drug ‘rasaut’ is regarded as bitter tonic and is reported to be used as a cholagogue, stomachic, laxative, diaphoretic, antipyretic and antiseptic. It is administered externally in painful eye affections, indolent ulcers and haemorrhoids.

The fresh berries are laxative and antiscorbutic, useful in piles, sores and eye disease particularly conjunctivitis. Mixed with the bark of Cinnamonum tamala and honey, they are prescribed in leucorrhoea. A decoction is used as mouth was for treating swollen gums and toothache. Decoction of root bark is used in malarial fever.²

**Ethnobotanical Studies**

The Plant is used as antiulcerogenic, antidiabetic, antisyntonic, in ophthalmic, skin diseases³, as antidiarrhoeal, in menorrhagia, jaundice and as alterative, astringent, deobstruent, diaphoretic and antiperiodic. The fruits are used as laxative in leucorrhoea, swelling of gums and toothache and in haemorrhoids whereas berries and laxative and antiscorbuti. The bark is
used as an antimalarial. The root is used in rheumatism, ophthalmic diseases, piles, menorrhagia, blood coagulation and chronic ulcers. Also it is used as an antipyretic, antiulcerogenic, laxative, tonic; antimalarial; antidiarrhoeal, in skin diseases, menorrhagia, jaundice, haemorrhoids and as liver tonic. The root bark is employed in ophthalmic diseases, skin diseases and boils haemorrhoids, to wash ulcers and wounds in liver complaints, as antidiarrhoeal, in ear troubles backache and as a general tonic.

**PHARMACOGNOSTIC STUDIES**

The dried root under ordinary light is brown in whole form, faint yellow in fractured form and greyish brown in powder form. Under ultraviolet light the root appeared brown in whole form, greenish yellow in fractured form and deep green in powder form.

A study on the calcium oxalate crystals of forty five medicinally important barks revealed that the bark contained solitary square rectangular prism shaped calcium oxalate crystals in the cortex region. Under normal light the bark powder appeared dark blond and under ultraviolet light greyish green in colour.

**CHEMICAL STUDIES**

The flowers were reported to yield five polyphenolic compounds, namely E-caffeic acid, quercetin, chlorogenic acid, meratin and rutin. The bark afforded berberine chloride, palmatine chloride and a mixture of palmatine and bebrine chlorides.

The root showed presence of alkaloids, flavonoids, glycosides, saponins and sterol and absence of terpenoids. Another study, however,
A search for hepatoprotective agents of natural origin
reported the presence of alkaloids and tannins in the root but flavonoids and saponinins were reported to be absent.\textsuperscript{11}

‘Rasut’ which is a brown almost solid extract prepared from wood or root of Barbaris sp. was chemically assayed for obtaining an idea of its purity and gross adulteration. Out of fifteen samples collected from the market, seven either did not contain alkaloid or only traces of it. The variation in the alkaloidal content in the rest of the samples was from 1.67 to 4.26 \%\textsuperscript{12}

High performance thin layer chromatography and spectrophotometric methods were described for the estimation of berberine from the root and the average content reported by these methods was 2.76 \% and 2.58 \%, respectively. The sensitivity by HPTLC method was 0.01 mg/ml and that of spectroscopic method was 0.02 mg/ml \textsuperscript{13}. General derivatives of berberine were prepared from dihydroberberine, 8-acetonyldihydroberberine and 8-benzylidihydroberberine by making use of their enamine character and evaluated for their biological activities.\textsuperscript{14}

**PHARMACOLOGICAL AND BIOLOGICAL STUDIES**

Antiarthritic: An emulsion prepared from the gum on oral administration (1 ml) failed to show any significant beneficial effect in formalin-induced arthritis in albino rats.\textsuperscript{15}

Heparin neutralizing Action: Berberine (1-3mg) neutralized in vitro the anticoagulant action of 50 i.u. of heparin/ml on dog and human blood. Larger dose (10mg/ml) had a paradoxical anticoagulant action. The activity was found similar to that produced by protamine sulphate and toluidine blue.\textsuperscript{16}
General Pharmacology

The alcoholic extract showed moderate direct action on the intestine of rabbit and uterus of guinea pigs, while action was observed on heart and rectus abdominus of frog. Its antagonism with barium chloride was found to be negligible, no action was observed with histamine.\textsuperscript{17}

The alcoholic extract of the root was studied on the platelet activating factor (PAF) on rabbit platelets. It inhibited the PAF-induced aggregation of platelets in a dose dependent manner. It also inhibited the [$^3$H]-PAF binding to rabbit platelets in a competitive manner.\textsuperscript{18}

In a preliminary study, the 50 % ethanolic extract of root showed hypoglycaemic activity in rats, effects on CVS in dogs/cats and anticancer activity against human epidermoid carcinoma of nasopharynx in tissue culture. The extract was devoid of antibacterial, antifungal, antiprotozoal, anthelmintic, antiviral, antispirochaetal and antifertility activities and effects on CNS, isolated guinea pig ileum and rat uterus. LD$_{50}$ value of the extract was found to be 20 mg/kg i.p. in mice.\textsuperscript{19}

Antimicrobial

Alcoholic extract of wood powder was found to be active \textit{Staphylococcus aureus} and \textit{Salmonella typhosa}, while water extract did not show any activity against \textit{Salmonella typhosa} but was active against \textit{Staphylococcus aureus}.\textsuperscript{20}

The methanolic extract of rhizomes did not show antibacterial activity against \textit{Escherichia coli} in vitro studies. The extract of tap root showed antibacterial activity against \textit{Shigella flexneri} type IV while it was inactive against all species of \textit{Salmonella} and \textit{Escherichia coli}.\textsuperscript{21}
The aqueous, hexane and alcoholic extracts of root when screened for antimicrobial activity against *bacillus subtilis*, *Escherichia coli*, *Proteus vulgaris*, *Salmonella typhimurium*, *Pseudomonas aeruginose* and *Staphylococcus aureus* did not show any activity.

Insecticidal

The alcoholic extract of root exhibited very mild/negligible insecticidal activity against houseflies *Musca domestica nebulo* and mosquitoes *Aedes aegypti*.

The 50 % ethanolic extract of root, when screened for preliminary biological activities showed effects of CVS in dogs/cats, isolated guinea pig ileum and possessed confirmed anticancer activity against human epidermoid carcinoma of nasopharynx in tissue culture. The extract did not show the other activities tested viz. antibacterial, antifungal, antiprotozoal, anthelmintic, antiviral, antispirochaetal, antifertility and hypoglycaemic activities and effects on CNS. The MTD value of the extract was found to be 250 mg/kg i.p. in mice. In another study, the 50 % ethanolic extract of the plant (excluding root), exhibited CVS effects in dogs/cats and weak diuretic activity in rats, while the extract was devoid of other activities viz., antibacterial, antifungal, antiprotozoal and antiviral activities and effects on CNS in experimental animals and on isolated guinea pig ileum. LD$_{50}$ of the extract to be 316 mg/kg i.p. in mice.

Antimicrobial

Different extracts from stem bark were tested for their antimicrobial activity against *Staphylococcus aureus*, *enterococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter sp.*, *Citrobacter sp.*, *Serratina*
marcescens, Pseudomonas aeruginosa, Proteus vulgaris, Pseudomarribilis, Edwardsiella tanda, Salmonella paratyphi A, Shigella dysentriae, Shigella flexneri, Vibrio cholera, Vib parahaemolyticus, Plesiomonas shigelloides, Aeromonas hydrophylia and Candida albicans. The crude aqueous extract exhibited a zone of inhibition against 11 out of 20 microorganisms. The gram positive bacteria Staphylococcus aureus and Enterococcus faecalis were observed sensitive. Among the gram negative bacteria, Escherichia coli, Klebsiella pneumoniae, Serratia marcescens, Proteus mirabills, Prvulgaris, Salmonella paratyphi A, Shigella dysenteriae and Pseudomonas aeruginosa exhibited a zone of inhibition. The alcoholic extract was found to be the best for Candida albicans. Alkaloid fractions derived from the plant showed stronger activity than pure berberine iodide.24

**CLINICAL STUDIES**

Antidiarrhoeal

Clinical studies with berberine were conducted in 356 patients of cholera and compared with 264 patients treated with chloramphenicol at Chittaranjan Hospital, Kolkata. Berberine was found to be effective in both bacteriologically positive and negative patients. It reduced the mortality rate, volume and duration of diarrhoea, intake of intravenous fluid and the convalescence period. Berberine was found to be better than chloramphenicol in this respect. It showed no side effect of toxicity in the doses tried. Initial dose of berberine hydrochloride was 15 mg (oral), 6 hourly first 2 days, 8 hourly on the 3rd day and only one dose on the 4th day. Later the doses were increased to 50 mg on admission, 50 mg twice daily till the 4th
to 5th day. The possible mechanism of berberine in cholera was proposed to be its neutralizing action on the diarrhoea producing component.25

In a clinical study at Kasturba Hospital, Mumbai, berberine hydrochloride was tried in 100 cases of gastroenteritis for its antidiarrhoeal action and compared with equal number of controls. The drug was given along with routine line of treatment. The recovery in berberine treated groups was faster and quicker. There was no death in the berberine treated group, while there were five deaths in the control group treated with bismuth, kaolin, chloramphenicol and streptomycin. Further, berberine was tried along as an antidiarrhoeal drug in additional 30 cases of gastroenteritis. It arrested diarrhoea in all these patients with no mortality and toxicity.26

Berberine hydrochloride along with uneomycin compound in a dose of 1 ml twice daily on the first day and once daily on second day was found to be most effective when treated for infective diarrhoeas of infancy as compared to the patients treated with uneomycin compound and berberine hydrochloride along.27

In a trial at Cama and Albless Hospital, Mumbai involving 200 children suffering from diarrhoea of various etiologies, berberine tannate was assessed for its antidiarrhoeal effect and compared with equal number of patients receiving chloramphenicol. It was found to be effective. Children receiving berberine tannate recovered faster than the chloramphenicol group. Only in about 3 per cent of the cases, the diarrhoea was not controlled in berberine treated group. In 25 per cent of the cases the diarrhoea was controlled within 24-72h. The drug and probably some antispasmodic and astringent action on the intestinal mucosa with no side effects.28
Berberine tannate (25mg/6hrs.) was clinically tried at Isolation Hospital, Jaipur, in 65 children below 5 years with acute diarrhoea for its antidiarrhoeal action and compared with an equal number of controls on standard antidiarrhoeal drugs. The recovery in berberine treated children was faster. It was found effective against diarrhoeas caused by *Escherichia coli*, *Shigella sp.*, *Salmonella paratyphi*, *Klebsiella aerogenes* and *Faecalis aerogenes*.²⁹

The effect of berberine was studied in the treatment of diarrhoea of infancy and childhood. It was tried in 50 cases of gastroenteritis in children at JLN Hospital, Ajmer and revealed beneficial effect particularly in mild (4-6 loose stools in 24h) and moderate cases (with 6-15 loose stools in 24h with dehydration). In three cases, commuting led to the withdrawal of the drug.³⁰

In another study at M.Y. Hospital, Indore the efficacy of berberine hydrochloride was studied in cases of acute gastroenteritis, acute bacillary dysentery and acute amoebic dysentery alone or in combination with standard antidiarrhoeal drugs. 129 cases of acute diarrhoeal disorders were selected for the trial which consisted of 57 cases of acute enteritis, 37 cases of acute bacillary dysentery and 35 cases of acute amoebic dysentery. Berberine hydrochloride given orally in doses of 100 mg. t.i.d. showed curative action in acute gastroenteritis, acute bacillary dysentery and acute amoebic dysentery. Berberine hydrochloride when given in combination with chloroamphenicol and streptomycin had better curative action in cases of acute gastroenteritis and acute bacillary dysentery than berberine hydrochloride alone or chloroamphenicol and streptomycin in combination. Combination of berberine hydrochloride with iodochlorhydroxyquinoline and...
sulphadimine showed better curative action in acute amoebic dysentery than any of the drug given alone. Berberine hydrochloride showed antispasmodic effect in addition to its antidiarrhoeal action.\textsuperscript{31}

Antigiardiasis

Twenty five patients (between the ages 1-10 years) of giardiasis were treated at AIIMS, New Delhi with berberine in a dose of 5 mg/kg/day for 6 days, and the results were compared with those of metronidazole given in a dose of 10 mg/kg/day in nine patients. Twenty patients receiving vitamine B complex syrup for 6 days served as the placebo controls. Relief of clinical symptoms was observed in twelve patients receiving berberine, three receiving metronidazole and three receiving vitamine B complex. The stool became free of giardia in seventeen patients receiving berberine, six receiving metronidazole and five receiving vitamin B complex after 6 days of treatment.\textsuperscript{32}

Trachoma Lesion

Patients with clinically active trachoma lesion (stage I and II) were treated for 8 wk with eye drops of either 0.2 % berberine or 20 % sulphacetamide or a combination of both. There was marked clinical improvement in all the patients treated. The sulphacetamide eye drops gave the best clinical results but the conjunctival scrapings of these patients were invariably positive for inclusion bodies of Chlamydia trachomatis and there infection.\textsuperscript{33}

Antimalarial

The barberine sulphate in a doses of 3 to 7 grains t.i.d. on three consecutive days failed to arrest paroxysms of malarial fever and reduced
number of malarial parasites present in the blood. In nine cases of malaria at Carmichael Hospital, Kolkata for Tropical Diseases, in which barberine sulphate was tried, in no instance was there any change in the signs and symptoms produced by the disease.2

Oriental Sores

‘Rasaut’ on continuous local application was claimed to have carrying degree of beneficial effect in some cases of oriental sores34. Infiltration of beberine sulphate was reported to have beneficial effect in oriental sores.35

Berberine sulphate inhibited the growth of Leishmania tropica in vitro studies. Local injection (1% solution of Berberine sulphate was reported to cure oriental sources within 2 or 3 wk. Berberine hydrochloride (2% solution) was used in 54 cases of oriental sore which were positive for Leishmania tropica and devoid of secondary infection. Cure rate was 67% with an average cure rate time of about 4 wk. Face lesions showed marked inflammatory reaction and slow response to treatment. The drug was otherwise well tolerated and found safe.36

3.2. **Acacia nilotica** Linn. Fam.: - Mimosaceae

**Regional and Other Names**

**Ben.** : Babla, Babul; **Eng.** : Babul, Black Babool, Indian Gum Arabic tree; **Guj.** : Babaria, Baval, Kaloabaval; **Hind.** : Babul Kikar; **Kan.** : Gobbli, Karijali; **Mal.** : Karivelan, Karuvelum; **Mar.** : Babhul, Vedibabul, Babhula; **Ori.** : Bambuda, Baubra; **Punj.** : Sak; **Tam** : Karuvelamaram, Karrivelei, Karuvael, Karuvelam; **Tel.** : Nallatumma, Tumma, Tuma.
Habit and Habitat

A moderate-sized tree with a spreading crown and feathery foliage found throughout the drier parts of India.

Ayurvedic Description

<table>
<thead>
<tr>
<th>Sanskrit name</th>
<th>Babbula</th>
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<tbody>
<tr>
<td>Synonyms</td>
<td>Barbura, Kinkirata, Yugmakanta, Sukmapatra, Pitapuspa</td>
</tr>
<tr>
<td>Properties</td>
<td>Rasa: Kasaya; Guna: Guru, ruksa; Virya: Sita; Vipaka: Katu</td>
</tr>
<tr>
<td>Actions</td>
<td>General: Kaphara, grahi, visaghna</td>
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<tr>
<td></td>
<td>Gum: Grahi, vrsya, sonitasthapanu</td>
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<td></td>
<td>Fruit: Stambhana, asthisandhanakara</td>
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<tr>
<td>Therapeutic uses</td>
<td>General: Kasa, amatisara, raktatisara, krimi, kustha, raktapitta</td>
</tr>
<tr>
<td></td>
<td>Gum: Raktatisara, meharoga, pradara, bhagna</td>
</tr>
<tr>
<td></td>
<td>Flower: Netraroga, prameha</td>
</tr>
</tbody>
</table>

Properties and Uses

The gum obtained from the tree is useful in diarrhoea, dysentery, diabetes mellitus and sore throat. The extract of the gum is styptic, tonic and astringent. The bark is reported to be astringent, demulcent and aphrodisiac. The pods are expectorant.

Ethnobotanical Studies

The parts of the plant find use in diabetes, skin diseases and leucorrhoea. These are also used as an antidiarrhoeal, antidysenteric. The
stem bark is demulcent\textsuperscript{40} used in diabetes as astringent\textsuperscript{41}, anthelmintic, in skin diseases, cough and bleeding piles gonorrhea\textsuperscript{42} and as an antiasthmatic\textsuperscript{43}. The tender twigs are used as toothbrushes\textsuperscript{44} while the thorns are used for joint pains and in oral cavity lesions. The seeds and leaves extracts are used for general body vigour\textsuperscript{45}. The leaves are used in diarrhoea\textsuperscript{46}, dysentery\textsuperscript{47} in headaches\textsuperscript{48}, eczema\textsuperscript{49}, abscess and ophthalmic disorders\textsuperscript{50}. The root is used for wound healing\textsuperscript{51} and for burning sensation.\textsuperscript{52}

**PHARMACOGNOSTIC STUDIES**

The gum of the plant as such and in fractionated form appears golden yellow to brown under ordinary light while it appears lemon yellow with bright white patches under ultraviolet light. In the powdered form the gum appears brownish yellow and light yellow, respectively under ordinary and ultraviolet light.\textsuperscript{53}

Gum arabic has been identified as one of the constituents of a Unani compound drug preparation ‘hab-e-bukhar’, specially given in fever due to elephantiasis and malaria.\textsuperscript{54}

**Chemical Studies:**

The acetone extract of the flowers contained stearic acid along with three phenolic components viz. kaempferol-3-glucoside, isoquercetin and leucocyanidin\textsuperscript{55}. The pods showed the presence of steroids/terpenoids, tannins, phenolics and saponins but were devoid of alkaloids and flavonoids\textsuperscript{56}. The seeds contained fatty oil which showed the presence of capric, lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidic acids. Trace quantities of epoxy and hydroxy fatty acids were also detected.\textsuperscript{57, 58}
A search for hepatoprotective agents of natural origin

The shoot and seeds in preliminary chemical studies showed the presence of saponins, flavonoids and alkaloids\textsuperscript{59,60}. The seeds in addition contained many amino acids. The total essential amino acid content was 30.37g. Other constituents were also quantitatively analyzed. These included ether extractive, crude protein, fibre, total ash, calcium, phosphorous, iron, niacin and ascorbic acid.\textsuperscript{61}

The free vitamin C and carotene content of the leaves,\textsuperscript{62} crude protein, hemicellulose and cellulose were quantitatively estimated. The total ash, silica, dry matter and neutral as well as acid detergent fibre contents were also determined\textsuperscript{63}. The leaves contained alkaloids and saponins\textsuperscript{64}. A large variation was seen in the chemical constituents of the leaves.\textsuperscript{65}

Several polyphenolic compounds were reported from the bark which were identified as quercetin, gallic acid, (+)-catechin, (-)-epicatechin, (+) dicatechin and (+)-leucocyanidin gallate\textsuperscript{66}. Bark was also reported to contain (-)-epi-gallocatechin\textsuperscript{67}. The total water soluble extractives and tannin content in the bark of trunk as well as the branches were found to be 18.44 % and 11.02 % and 27.36 % and 14 %, respectively.\textsuperscript{68}

Phytochemical analysis of the polyphenolic complex present in the bark of the plant revealed the presence of phenols, flavones, tannins and glycosides. The total phenolic and tannin contents in the dried bark were found to be 9.86 %, respectively; while the total flavonols and total O-dihydric phenols including chlorogenic acid were 0.0025 % and 0.013 % respectively. The bark contained asponins.\textsuperscript{64}
A search for hepatoprotective agents of natural origin

The benzene extract of the root bark of the plant was found to contain octacosanol, β-amyrin, β-sitosterol, betulin while the petroleum ether extract of the root heartwood contained β-amyrin and β-sitosterol. The detected mineral elements in the plant were calcium, copper, iron, magnesium, zinc, potassium, sodium, aluminium, manganese and cerium.

Pharmacological Studies:

Antidiabetic

The bark in the form of decoction (20 ml/kg) as well as the standard drug tolbutamide produced a significant reduction in blood glucose levels in mild alloxonised diabetic rabbits fasted for 18h. The maximum reduction was 2h after the administration of the plant extract in rabbits as compared to the controls.

The three leuminous seeds viz., A. benthami, A. modesta and A. nilotica ssp. indica fed for one week were found to exhibit hypoglycaemic effect (blood sugar lowered by 29.99 %, 27.68 % and 25.05 %, respectively) in normal rats, but did not show any significant hypoglycaemic effect in alloxanised diabetic rats (blood sugar lowered by 3.69 %, 2.24 % and 2.14 %, respectively). The hypoglycaemic effect of these legumes was due to their direct or indirect stimulation of β-cells of islets of langerhans to secrete more insulin. In alloxanised rats, since β-cells of langerhans were destroyed there was no hypoglycaemic effect observed when the animals were fed on leguminous seed diets.

Antimutagenic

The methanolic extract of the bark decreased the UV-induced mutagenicity using the Escherichia coli WP-2 in a dose of 5 mg/plate. This
decrease might be due to some enzymatic action which reverted the formation of pyrimidine dimmers.\textsuperscript{73}

Antiproteolytic

Inhibition of total proteolytic (caseinolytic), trypsic (by hydrolysis of benzoyl arginine p-nitroanilide) and chymotryptic (by hydrolysis of acetyl ethyl ester) activities by ten species of legume seeds on human and bovine pancreatic proteases were studied. Acacia seed extracts displayed more pronounced action on human trypsin and chymotrypsin. It was more effective in inhibiting the total proteolytic activity of the bovine system.\textsuperscript{74}

Antifertility

The aqueous extract of the flowers showed 11.5 \% abortifacient activity in rats. It was further screened for teratological abnormalities in failure cases (where pregnancy was not prevented) in pregnant rats. The fetuses showed gross external morphological and skeletal defects. The extract of the stem bark at 2 \% concentration revealed semen coagulant activity in a preliminary screening.\textsuperscript{75}

Nutritional Value

Nutritional evaluation of the refined seed oil was done by rat bioassay and using peanut oil as control. The animals fed on 10 \% seed oil diet showed poor growth performance and low feed efficiency ratio. The digestibility of the seed oil was 90 \% as compared to 94 \% for peanut oil. The seed oil in the diet of rats for 4wk did not produce any abnormal serum lipids or histopathological findings. The seed oil was apparently non toxic.\textsuperscript{58} The deoiled seed cake contained 21.9 \% protein and balanced amino acids but also contained antinutritional factors, tannins (4.2 \%) and saponins (2.4 \%).
The nutrient and amino acid composition of the detoxified seed meal (PAM) was almost similar to that of unprocessed seed meal except for antinutritional factors. PAM was nutritionally evaluated using rat bioassay procedure in a comparative study with cesain as standard. Nutritional indices, biochemical parameters and histopathological findings indicated the possibility of using PAM as supplementary feed for livestock animals.\textsuperscript{76}

General Pharmacology

The 50\% ethanolic extract of the stem bark in a preliminary biological screening exhibited antiprotozoal activity against Entamoeba histolytica, CVS effect in dog/cat, antispasmodic activity in guinea pig ileum and CNS depressant activity as evidenced by amphetamine hyperactivity test in mice. The extract was devoid of antibacterial, antifungal, antiviral, hypoglycaemic and anticancer activities. The LD\textsubscript{50} was found to be 500 mg/kg i.p. in mice\textsuperscript{77}. A quaternary base picrate, (mp 242-44°C) isolated from 11 species including the stem bark of the plant was reported to be pharmacologically identical to choline\textsuperscript{78}. The saline extract of the pollen grains stimulated the ileum of guinea pig which was blocked by mepyramine and atropine. The petroleum ether extract stimulated the rat uterus and the heart of pila which was blocked by 2-bromo LSD. The effect of acid treated acetone extract was blocked by mepyamine.\textsuperscript{79}

Antimicrobial & Antibacterial

Air dried and powdered alcoholic and water extracts of the bark exhibited significant in vitro antibacterial activity against Streptococcus pyogenes, Staphylococcus aureus, Escherichia coil, Salmonella typhimurium, Pseudomonas aeruginosa and Klebsiella sp. using the disc
method. Pseudomonas aeruginosa was found to be resistant to both the extracts. Further, both the extracts were highly inhibitory to the gram positive organisms in comparison with gram negative organisms tested. All the microorganisms showed resistance against the petroleum extract.\textsuperscript{80}

The alcoholic extract of the gum, leaf and fruit revealed in vitro antibacterial activity against Staphylococcus aureus (zone of inhibition 10-19 mm) using agar diffusion method while it was devoid of any activity against the other bacteria Bacillus subtilis, Escherichia coli, Proteus vulgaris, Salmonella typhimurium and Pseudomonas aeruginosa. The hexane and aqueous extracts were completely devoid of any activity.\textsuperscript{81}

\textbf{Antifungal}

The acetone extract of the bark inhibited the condial germination of Pyricularia oryzae and Colletotrichum falcatum at the concentration of 10.0 g/l and to a lesser extent at a concentration of 1.0g/l. It was toxic at the concentration of 0.1 g/l.\textsuperscript{82} The ethyl acetate soluble fraction exhibited fungitoxicity against Pyricularia oryzae comparable to that exhibited by condensed type of tannins obtained from the bark.\textsuperscript{67}

The bark and leaf decoction of the plant inhibited the polygalacturonase enzyme activity of Alternaria tenuis indicating the presence of tannins or phenolic compounds.\textsuperscript{83} The polyphenolic complex of the bark at a concentration of 50 \% showed maximum growth inhibition (56 \%) as compared to controls against Fusarium oxysporum. The extract at 10 and 25 \% dilution showed 24.0 \% and 37.0 \% inhibition, respectively in in vitro studies.\textsuperscript{84}
Combined Studies

In vitro antibacterial and antifungal activities of some metal arabates (mercury, silver and copper) prepared from arabic acid of gum acacia showed antimicrobial activity against Escherichia coli, Bacillus subtilis, Bac anthracis, Bac pumilus, Salmonella typhosa, Staphylococcus aureus, Micrococcus pyogenes, Proteus vulgaris and Aspergillus niger, A. flavus, Trichophyton equingia, Fusarium oxysporum and Cryptococcus neoformans. Both the activities were less as compared to the standard drugs penicillin and salicylic acid respectively. The fatty oil and unsaponifiable matter of the seeds possessed antibacterial activity against Escherichia coli, Bacillus anthracis, Bac subtilis, Corynebacterium pyogenes, Pseudomonas aeruginosa and Staphylococcus aureus and antifungal activity against Fusarium solani, F. moniliforme, Helminthosporium oryzae, H. turcicum, Alternaria helianthi and Collectotrichum capsici. The fatty oil and the unsaponifiable matter were less active as compared to penicillin and streptomycin (antibacterial) and salicylic acid and resorcinol (antifungal) as standards.

Nematicidal

The aqueous leaf extract of the plant as also of A. Senegal showed nematicidal activity against Meloidogyne incogenita as it inhibited its hatching.

Antiplaque Activity

The plant extract showed promising antiplaque activity in 12 male students ranging from 19 to 24 years having healthy gingivae in a comparative study made with eight new formulations of tooth powders.
3.3. *Balanites roxburghii* linn. Fam: Balanitaceae, Simaroubaceae

**Regional and Other Names**

Sansk.: Angavriksha  
Hind.: Hingan, Hingoli.  
Kann.: Ingalore, Ingalkai  
Mar.: Hinganbet  
Mal.:Nanjunta  
Guj.: Ingoriyo  
Tel.: Gara  
Ori.: Ingudihala,  
Beng.: Hingon

**Habit and Habitat**

It is distributed in the drier parts of Peninsular India, western Rajasthan and from South-East Punjab to West Bengal and Sikkim.  

**Chemical studies**

The fruit pulp contains five steroidal saponins, designated as balanitism A, B, C, D and E. Balanitism A has been identified as diosgenin-3-O-α-D-glucopyranosyl(1-3)-O-α-D-glucopyranosyl(1→4)-O-L-rhamnopyranoside. The diosgenin content of the fruits varies from 0.3 to 3.8 %.  

The leaves contain saponin of diosgenin, sigmasterol and free diosgenin. Seeds are rich in protein, the amino acid composition of which is reported. The oil from kernel contains linoleic acid, oleic, palmitic acid, steric acid and balanitisins F and G. Deltoin, protodeltoin and a new saponin, (25R and S)-spirot-5-en-3β-01; balanitos are present in stem bark, balanitisin H and I are in stem-wood, 3-O-α-rhamnopyranosyl, (1→2)-β-D-glucopyranosyl, (1→3)-β-D-glucopyranosyl, (1→4)-β-D-glucopyranoside are reported in root-wood and six flavonoid glucosides have also been reported.  

Diosgenin (1.26%) are isolated from plant grow in Sudan. Diosgenin content in leaves was lowest in May (0.05%) and highest in December (0.47%). Two new saponins I & II characterized as 25(R) and 25(S) spirot-5-en-3β-01-3-O-α-L-rhamnopyranosyl (1→2]-[β-D-glucopyranosyl (1→3]-β-D-glucopyranosyl (1→4)]-β-D-glucopyranoside respectively are present in stem.
bark in the ratio of 1.5:1. Deltonin and prodeltonin are also isolated. Quercetin-3-glucopyranoside, quercetin-3-rutinoside, isorhamnetin-3-glucoside and isorhamnetin-3,7-diglucoside are isolated from leaves and branches whereas isorhamnetin-3-rutinoside and 3-rhamogalactoside are isolated from leaves, branches and fruits. Compounds isolated from stem bark exhibited insect antifeedant activity.

Dawidar and his co-workers compared diosgenin content of Balanites roxburghii plant grow in Sudan as that of Egypt. They studied fleshy parts of the fruits (epicarp and mesocarp) as a diosgenin source. Their results revealed that the fleshy parts of the fruits of *Balanites aegyptiaca* grown in Sudan contain an attractive % of diosgenin as a sole product nearly 1.267 while fruit from Egypt contains 0.3.92

Dawidar and Fayez found five diosgenin glucosides from leaves and kernels of *Balanites aegyptiaca* including di, tri- and tetraglucoside. On hydrolysis of the saponins they got 25D-spirosta-3,5-diene and 3β-chloro-25D-spirost-5-ene as artifacts accompanying diosgenin. The unsaponifiable fraction of the leaf fat contains two C29 sterols, one of which has an 8: 14 double bond as suggested by mass spectroscopy.93

Yamogenin was isolated as major sapogenin in these plant parts from root, soft fruit wall (epicarp and mesocarp) and the stem bark. Infrared spectrophotometric analysis showed 1% total steroidal sapogenin in the root, 0.7% in the stem bark and 1.2% in the soft fruit wall of *Balanites aegyptiaca* Del, on moisture free basis. Elemental analysis of the sapogenin
and its derivatives as well as Mass, I.R. and NMR spectroscopy data show that major sapogenin in this plant part is Yamogenin.\textsuperscript{94}

Five new saponins named as Balanitisin A, B, C, D and E were isolated from \textit{Balanites roxburghii} (Planch) by Varshney and Co-workers\textsuperscript{95}. Balanitisin A contains 2 moles of glucose and 1 mole of rhamnose attached at C-3 hydroxyl group of Diosgenin. The structure of Balanitisin A has been established as diosgenin-3-O-\alpha-D-glucopyranosyl(1\rightarrow3)-O-\alpha-D-glucopyranosyl(1\rightarrow4)-OH-L-rhamnopyranoside.

Diosgenin from \textit{Balanites roxburghii} leaves and kernels is also reported\textsuperscript{96}. The alcoholic extract of the crushed kernel of \textit{Balanites roxburghii} yielded an amorphous saponin which on acidic hydrolysis gave mixture of three genins, out of which only the major one could be identified as Diosgenin through mp and superimposable I.R. spectra.\textsuperscript{96}
The isolation of the steroidal sapogenin, Diosgenin (25(R) spirost-5en-3-β-ol], Yamogenin, β-sitosterol, Stigmasterol and β-sitosterol-3-O-β-D-glucoside were recorded from the stem bark of *Balanites roxburghii*.95

The new saponin with insect antifeedant activity has been isolated from the stem bark of *Balanites roxburghii* and characterized as (25(R) spirost-5en-3-β-ol], 3-O-[α-L-rhamnopyranosyl (1→2)]-[β-D-glucopyranosyl (1→3)- β-D-glucopyranosyl (1→4)]- β-D-glucopyranoside. In addition, two other saponins were identified as the known saponins Deltonin and Prideltonin.97

Brain and co-worker have performed rapid quantitative estimation of 25 α and 25 β-sapogenin individually and together in a crude plant extract. The procedure is appropriate for the study of the variation in the C25 epimers in morphological parts and with season, as well as for routine screening for steroidal sapogenin of economic importance.

Five steroidal glycosides were isolated from the fresh caudex of *Yucca gloriosa* together with YG-I and PS-I previously obtained form flowers and the structures of these glycoside were established. These are named as YS-II,YS-III,YS-IV and YS-V. On acid hydrolysis five signals of steroidal sapogenins was detected.98

**Therapeutic Uses:**

**Fruits:** Unripe fruits are anthelmintic and cathartic, useful in curing skin diseases and whooping cough when ripe; massage on chest with the pulp mixed with goat-milk is known to be highly beneficial in the treatment of pneumonia in children. The acidic fruit juice is used to remove stains on clothes and for cleaning silk and cotton as detergent.
Seeds: Expectorant, efficacious in colic and whooping cough, oil having antibacterial and anti-fungal properties is used for burns, excoriations, freckles and other skin diseases.

Leave and Bark: Anthelmintic and purgative root emetic.  

Wood: The wood is used for making walking sticks and handles for implements.

PHARMACOLOGICAL STUDIES

The kernels yield bland, yellow oil (36-43%), which possesses antibacterial and anti-fungal activity and is reported to be used in the treatment of skin diseases, burns, excoriations and also freckles. It can be used for production of soap.

The defatted seed meal is rich in protein (54.6%), having high content of lysine. Other amino acids present are alanin 3.77 %, isodanine 4.12 %, aspartic acid 9.21 %, Cysteine 0.56 %, glutamic acid 20.22 %, glycine 4.22 %, hystidine 1.4 %, leucine 7.9 %. The defatted seeds are source of diosgenin. Also the fruit wall, which contains 1.5 % diosgenin on fresh weight basis. The diosgenin content of the roots varies from 0.3 to 1.5%.

Efficacy of daily oral feeding of crude alcohol extract from the pericarp of unripe fruits of *Balanites roxburghii* at a dose of 500mg/kg for 45 days has been reported with respect to epididymal and testicular histophysiology, metabolism and the fertilities potential of mice, following withdrawal study. The testicular and cauda epididymal parameters revealed altered physiology and metabolism resulting in a reduction in fertility of extract fed mice.
3.4. *Achyranthus aspera* Linn. Fam.: *Amaranthaceae*

### Regional and Other Names

**Ben.** Apang, Chirchiti; **Eng.**: Prickly-Chaff Flower, Rough Chaff tree; **Guj.**: Angheda, safed Aghedo, Anghedo; **Hind.**: Chirchira, Chirchitta, Latjira, Apamarg; **Kan.** Utranigida, Utтарane; **Mal.**: Kadaladi; **Mar.**: Aghada; **Ori.**: Apamarganga, Apamargo; **Punj.**: Chichra, Kutri; **Tam.**: chirukadaladi, Naayurivi, **Tel.**: Apamargamu, Uttareeni, Uttaraene, Uttareni

### Habit and Habitat

An erect or procumbent, annual or perennial herb, often with a woody base commonly found as a weed on waysides and wet places throughout India up to an altitude of 2100m.

### Ayurvedic Description

**Sankrit name** : Apamarga  
**Synonyms** : Sikhari, Adhahsalya, Mayuraka, Pratyakpuspa, Kharamanjari  
**Properties** :  
- **Rasa**: katu, tikta; **Guna**: laghu, tiksna, sara;  
- **Virya**: Usna; **Vipaka**: Katu  
**Action** : Dipana, pacana, kaphamedahara, vamanopaga, vranasodhaka, raktasamgrahi, visaghna.  
**Therapeutic uses** : Krm, arsa, kandu, asmari

### Therapeutic Uses

The dried plant is used in sula (colic), udararoga (diseases of the abdomen), apaci (lymphadenitis-cervical), arsa (haemorrhoids), kandu (itching), medoroga (obesity). The dried root of the plant is used in chardi (vomiting), adhmana (tympanitis), kandu (itching), sula (colic), apaci
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(lymphadenitis), granthi (tumor), bhagandara (fishula-in-ano), hrدارoga (diseases of heart), jwara (pyrexia), switra (leucoderma), vadhiriya (deafness), udararoga (diseases of the abdomen), yakratroga (disorders of the liver), dantaroga (diseases of tooth), raktavikara (blood disorders).

Properties and Uses Ascribed

The plant is reported to be pungent, astringent, pectoral and diuretic. It is used as an emmenagogue in piles and skin eruptions. The decoction of the plant is useful in pneumonia and renal dropsey while the juice of the plant is used in ophthalmia and dysentery. The leaves are used as a cure for gonorrhoea and excessive perspiration. Their extract is used for leprosy and the heated sap for tetanus. The root is astringent, the paste is applied to clear opacity of cornea and to wounds as a haemostatic. The root is also reported to be useful in cancer. A decoction of the root is used for stomach troubles and an aqueous extract for stones in the bladder. The flowers, ground and mixed with curd and sugar are given for menorrhagia. The flower tops are stated to be employed for the treatment of rabies. Powdered seeds are soaked in butter milk and given for biliousness. The seeds are said to be emetic and used in hydrophobia.

Ethnobotanical Studies

The plant is used in dropsy, piles, skin eruptions, colic, as a diuretic, astringent and purgative in heart diseases, ascites, uterine-bleeding as diuretic, in piles, dysentery, in fractured bones, intestinal parasites, whooping cough, respiratory troubles, for asthma, in abdominal disorders and as antitumour agent, in renal disorders, mild and malarial fever, as a laxative and in leucoderma. The inflorescence is
used in cough. The stem is used in pyorrhoea and scorpion bite while the
twigs are used in toothache, in arthritis. Fruits are used in hydrophobia.
The seeds are employed in bleeding piles, as an emetic, purgative, cathartic,
in gonorrhoea, for insect bites, snake bite and in hydrophobia, for scorpion
sting, in skin diseases, cough including whooping cough, as an
antiasthmatic, in diarrhoea, as an astringent, diuretic and laxative. These
are also used in renal dropsy, bronchitis, as antileprotic and in gastric
troubles. The leaves are used in wounds, injuries, as an antidote to insect
bite and scorpion sting, in cough, toothache, excessive bleeding in
menstruation, in urination, as eye drops, in breast ulcers, backache, cuts,
bolus, blisters; inhaled ears and eyes, leucoderma, amoebiasis, dysentery,
diarrhoea, dog bite, as antimalarial, for aprains, as antipyretic and
antirickettsial, in skin diseases and liver enlargement, in stomachache and
in typhoid. The root is used in body pain including waist and ribs pain,
labour pain, as antipyretic, antirickettsial, as a tonic, in pyorrhoea, as a
contraceptive, for ante-partum treatment, whooping cough, tonsillitis, in
diarrhoea, menstrual disorder; burn healing, for snake bite and scorpion
sting, as an astringent, chronic fever, renal troubles, sensitive gums,
haemorrhage, leucorrhoea, in cough, hydrophobia, as antiasthmatic, as a
galactagogue, for dental problems, spermatorrhoea, cataract, stomach ache,
in constipation, piles, as haemostatic, in malarial fever, diarrhoea, vomiting;
as diuretic, diaphoretic, antisyphilitic, in toothache, for dandruff, hair
problems, acne/pimples, in leprosy and as an antiseptic after delivery.
CHEMICAL STUDIES

The plants were reported to yield a water-soluble base and a chloroform-soluble base. The former was earlier designated as achyranthine\textsuperscript{116} and was characterized as a betaine derivative of N-methylpyrrolidine-3 carboxylic acid. Later studies showed that the water-soluble base was betaine and not achyranthine\textsuperscript{117}. The chloroform-soluble basic fraction was shown to be a mixture of two uncharacterized alkaloidal entities.\textsuperscript{118}

The ethanolic extract of the plant parts contained alkaloids and saponins while flavonoids and tannins were found absent.\textsuperscript{119}

The shoot yielded a new aliphatic dihydroxyketone, characterized as 36, 47-dihydroxyhenpentacontan-4-one together with tricontanol; an essential oil, a new long chain alcohol characterized as 17-pentatriacontanol, four new compounds characterized as 27-cyclohexylheptacosan-7-ol, 16-hydroxy-26-methylheptacosan-2-one, 4-methylheptatriacont-1-en-10-ol and tetracontanol-2.\textsuperscript{120}

Various parts of the plant viz. seeds, stem, leaves and root were reported to contain ecdysterone. The chloroform extract of the stem led to the isolation of pentatriacontane, 6-pentatriacontanone, hexatriacontane and triacontane. The inflorescence was reported to contain flavonoids and alkaloids.\textsuperscript{121}

The food value of the seeds in terms of its protein quality was studied. The composition of the seeds showed close similarity to Bengal gram with a protein content of 24.8% and calorific value of 3.92/g. The hydrolysate contained the usual amino acids. The values obtained for ten essential amino
acids and cystin showed that the seed protein compared favourable with Bengal gram in its leucine, isoleucine, phenylalanine and valine content, while its tryptophan and sulphur amino acid (methionine and cystine) content were higher than most of the pulses. It was, however, deficient in arginine, lysine and threonine as compared to the whole egg protein.\(^{122}\)

The defatted seeds were reported to yield a saponin in an yield of 2 % which was identified as oleanolic acid, oligosaccharide. The sugar moiety of the saponins was composed of glucose, galactose, xylose and rhamnose\(^{123}\). Khastgir and associates isolated a crude sapogenin fraction from the seeds, which yielded oleanolic acid. Later, investigations led to the isolation of two oleanolic acid based saponins, saponin A and saponin B which were characterized as $\alpha$-L rhamnopyranosyl (1\(\rightarrow\)4) - $\beta$-D-glucopyranosyl (1\(\rightarrow\)4)- $\beta$-D-glucuronopyranosyl (1\(\rightarrow\)3)- oleanolic acid $\beta$-D-galactopyranosyl (1\(\rightarrow\)28) ester of saponin A, respectively\(^{124}\). In another study, the total saponins were hydrolysed with acid and the genin was identified as oleanolic acid\(^{125}\). A rapid procedure for the separation of triterpenoid saponins based on partition chromatography from the plant has been described\(^{126}\). The seeds contained hentriacontne, 10-octacosanone, 10-triacontane and 4-tritriacontanone.\(^{127}\)

The fatty oil constituents of the seed oil comprised of lauric, myristic, palmitic, stearic, arachidic, behenic, oleic and linoleic acids.\(^{128}\)

The unripe fruits yielded two new saponins (C and D ) which were identified as $\beta$-D-glucopyranosyl ester of $\alpha$-L-rhamnopyranosyl (1\(\rightarrow\)4) -$\beta$-D-glucuronopyranosyl (1\(\rightarrow\)3)-oleanolic acid and $\beta$-D-glucopyranosyl ester of $\alpha$-
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L-rhamnopyranosyl (1→4) -β-D- glycopyranosyl(1→4) -β-D-glucuronopyranosyl (1→3) oleanolic acid respectively.\(^{129}\)

The chemical constituents of the root varied in different preliminary studies carried out. The root was found to contain oleanolic acid as the aglycone from the saponin fraction\(^{130}\). Both root and shoot of the plant were found to contain saponins and alkaloids but no flavonoids\(^{131}\). In another study the root of the plant was found to contain alkaloids but indicated absence of saponins and tannins\(^{132}\). In yet another preliminary chemical study the root was reported to contain alkaloids, flavonoids, sapoinis, steroids and terpenoids. Glycosides were found to be absent\(^{133}\). Isolation of β-sitosterol was also reported from the root.\(^{134}\)

**PHARMACOLOGICAL AND BIOLOGICAL STUDIES**

General pharmacological studies of the plant did not elicit any exciting activity. However, the antifertility activity needs to be looked into. The plant seems to lower lipids.

**Antifertility**

The alkaloidal fraction obtained from the alcoholic extract of the root bark inhibited the response of oxytocin in isolated rat uterus. This fraction did not inhibit the responses to serotonin and acetylcholine in rat uterus and to histamine in guinea pig uterus.\(^{135}\)

The crude benzene extract of the stem was found to have potent abortifacient effect in mice.\(^{136}\) In an attempt to locate the active principle, various chromatographic fractions were tested for antifertility activity in female mice. The maximal activity was found to be located in the fraction eluted with 50 percent benzene in petroleum ether.\(^{137}\)
A search for hepatoprotective agents of natural origin

The benzene eluate of the benzene extract of the plant showed 100% abortifacient activity in rabbit at the single dose of 50 mg/kg b.w. In a study on the possible mode of action, the extract was found neither estrogenic nor antiestrogenic or androgenic in mice. No teratogenicity was observed. The benzene extract of the plant (excluding root) also revealed 66.6% antiimplantation activity in female albino rats. The ethanolic extract of the plant (excluding root) at a dose of 100-200 mg/kg b.w. administered orally revealed 60% antifertility activity on early pregnancy in rats. Further, the plant also showed potent activity at secondary testing level.

The methanolic extract of the root revealed 60% antiimplantation activity in rats while the acetone extract of the root prevented implantation in 50% of rats.

The n-butanol fraction of the aerial parts prevented pregnancy in adult female rats when administrated orally daily dose of 75 mg/kg or more on 1-5 day post coitum, but was ineffective in hamsters up to 300 mg/kg dose. Antifertility activity was not observed in the aqueous fraction in either rats or hamsters. In ovariectomized immature female rats, the extract exhibited potent estrogenic activity at the dose of 75 mg/kg. It induced even at a does of 3.75 mg/kg.

Antitumour

In an antitumour evaluation of Acryanthus aspera, a sterol glycoside (mp 280-85°C) isolated from the plant did not show any antitumour activity against P-388 tumour in mice.
Liver and Lipids

The alcoholic extract of the plant at 100 mg/kg dose lowered total serum cholesterol (TC) and phospholipids (PL), triglyceride (TG) and total lipids (TL) levels by 60, 51, 33 and 53 %, respectively in triton-induced hyperlipidemic rats. The chronic administration of the extract at the same doses to normal rats for 30 days, lowered serum TC, PL, TG and TL by 56, 62, 68 and 67 % respectively followed by significant reduction in the levels of hepatic lipids. The faecal excretion of cholic acid and deoxycholic acid increased by 24 and 40 % respectively under the action of the drug. The possible mechanism of action of cholesterol lowering activity of the plant might be due to rapid excertion of bile acids causing low absorption of cholesterol.

Antiinflammatory

The water soluble alkaloid achyranthine was screened for its anti-inflammatory and antiarthritic activity against carrageenan-induced foot oedema, granuloma pouch, formalin-induced arthritis and adjuvant arthritis in rats. It showed significant anti-inflammatory activity in all the four models employed but was less active than phenylbutazone and betamethasone. Further, achyranthine significantly reduced the weight of adrenal gland, thymus, spleen and raised the adrenal ascorbic acid and cholesterol contents. The effects were qualitatively similar to betamethasone. All the three drugs tested reduced food intake but had no significant effect on urinary and faecal output and on mortality rate. Incidence of gastric ulcers was maximum with betamethasone and minimum with achyranthine.
Diuretic

Earlier studies by Bhide et al on potassium diuretics indicated that the diuretic activity of the ash of the plant may be due to high potassium (44\%) content.\textsuperscript{146}

Effect of a saponin isolated from the seeds on urine output in albino rats has been investigated in comparison to mersalyl and acetazolamide. The saponin in 10-20 mg/kg i.m. doses caused significant increase in urine output after 2, 6 and 24h as compared to untreated control rats. The diuretic effect was comparable to that observed with 3 mg/kg dose of mersalyl. The optimum dose of the saponin was 10 mg/kg. After oral administration of the saponin (5-10 mg/kg) in rats a significant increase in urine output was observed which was comparable to that of 10 mg/kg oral dose of acetazolamide. The diluretic effect of the saponin like acetazolamide was associated with an increase in the excretion of sodium and potassium in the urine.\textsuperscript{147}

General Pharmacology

In a preliminary study the aqueous and alcoholic extracts of the root caused a sharp and transient fall in blood pressure without any significant action on the respiration of anaesthetized dogs. In higher doses there was slight respiratory depression. Atropine sulphate blocked the hypotensive effect of the extracts. On frog’s heart the extracts had a temporary negative inotropic and chronotropic effects. The extracts produced spasm of isolated rabbits ileum increased the tone and amplitude of contractions in gravid and non-gravid uteri of albino rats, guinea pigs and rabbits. Oral administration of the drug significantly increased the urinary output in rabbits.\textsuperscript{148}
The total chloroform soluble basic fraction (alkaloidal residue) obtained from the plant raised the blood pressure of anaesthetized dog caused initial transitory stimulation of respiration and increased the amplitude of cardiac contractions of isolated guinea pigs heart. It showed spasmolytic action against various spasmogens on intestine and uterine muscles of guinea pigs and a slight antidiuretic action in rats. No specific CNS effects were observed in mice. The fraction did not possess analgesic activity in rats. The water soluble alkaloid, achyranthine isolated from the plant was found to lower blood pressure, depress the heart, dilate the blood vessels and increase the rate and amplitude of respiration in anaesthetized dogs. It showed spasmogenic effect on frog’s rectus muscle and diuretic as well as purgative active in the albino rats. No effect was observed on isolated rabbit, guinea pig and rat ileum and on CNS. The drug exerted a slight antipyretic effect.\textsuperscript{149,150}

The mixture of saponins isolated from the seeds caused a significant increase in force of contractions of the isolated heart of frog, guinea pig and rabbit. The stimulant effect of the lower dose (1 to 50 µg) of the saponins was blocked by pronethalol and partly by mepyramine. The effect of higher doses was not blocked by pronethalol. The saponin increased the tone of the hypodynamic heart and also the force of contraction of failing papillary muscle. The effect was quicker in onset and shorter in duration in comparison to that exerted by digoxin\textsuperscript{151}. The effect of saponin on the phosphorylase activity of the perfused rat heart has been investigated and compared with that of adrenaline. The saponin has been found to stimulate
the phosphorylase activity of the heart and its effect was comparable to that of adrenaline.\textsuperscript{152}

The ethanolic extracts of the plant\textsuperscript{153} and leaves\textsuperscript{154} were screened for preliminary biological activities. The former extract showed hypoglyceamic activity in rat. It was devoid of antibacterial, antifungal, antiprotozoal, anthelmintic, antiviral and anticancer activities and effects on isolated guinea pig ileum, respiration, CVS and CNS in experimental animals. The MTD of the extract was found to be 1000 mg/kg b.w. orally in mice. The leaf extract was found to be devoid of antiprotozoal and antiviral activities and effects on respiration, preganglionically stimulated nictitating membrane, CVS and CNS in experimental studies. The LD\textsubscript{50} of the latter extract was greater than 100 mg/kg i.e. in mice.\textsuperscript{154}

Toxicity

An alkaloid isolated from the plant was tested for its acute, subacute and chronic toxicity in rats. During acute toxicity test, there was a slight increase in sedation and slight loss in wrighting region at 6.0 mg/kg dose level which became prominent at 7.0 mg/kg dose level. At higher doses, significant depletion in wrighting region, depression in respiration, remarkable increase in sedation and diarrhoea was observed. Subacute toxicity test revealed (5.0 and 6.0 mg/kg) a significant increase in sedation and hypnosis, depletion in respiration and loss of brighting reflexes. At 6.0 mg/kg dose, it also caused remarkable increase in salivation and diarrhoea. Chronic toxicity showed (3.0 mg/kg) an increase in sedation, hypnosis, salivation and diarrhoea. These was a significant depression of respiration and loss of body weight.\textsuperscript{155}
Antimicrobial

The aqueous solution of the base achyranthine as well as the entire plant showed antibacterial activity against *Staphylococcus aureus*, *Streptococcus haemolyticus* and *Bacillus typhosus*\(^{156}\) while the alcoholic and the aqueous extract of the leaves showed antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*\(^{157}\).

The seeds growing on cattle dunk revealed antibacterial activity against bacterial strains of *Bacillus subtilis*, *Pseudomonas cichorii* and *Salmonella typhimurium*\(^{158}\). In another study, the 80% ethanolic extract of the leaves and stem of the plant inhibited *Bacillus subtilis* and *Staphylococcus aureus* bacterial strains at a concentration of 25 mg/ml\(^{159}\).

The aqueous leaf extract in *in vitro* studies showed antibacterial activity against *Proteus vulgaris* at concentration of 5000 ppm. The extract inactive against *Klebsiella aerogenes*, *Pseudomonas aeruginosa* and *Escherichia coli*\(^{160}\). The aqueous residues of another sample of the plant levels were found devoid of any activity against *Alkaligenes viscolactis*, *Aeromonas hydrophila*, *Cytophaga sp.*, *Vibrio parahaemolytica*, *Vib damsela*, *Bacillus cereus* and *Streptococcus pyogenes* in addition to *Escherichia coli*, *Klebsiella aerogenes*, *Pseudomonas aeruginosa*\(^{161}\). In another study the extract of the leaves was found to be active against the isolated bacteria *Escherichia coli*, *Staphylococcus citri* and aerobic spore formers from soft drinks\(^{162}\).

The deproteinised leaf extract of the plant affected the spore germination of the plant fungi viz., *Alternaria brassicicola*, *Helminthosporium*...
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apattarnae, Pestalotia sp., Penicillum purpurogenum, Aspergillus niger, Trichothecium sp., Neurospora sp., Fusarium sp., Trichoderma sp. and Rhizopus sp.\textsuperscript{163}. The aqueous extract of the leaves in treated bananas showed poor activity against the infested fungi Botryodiploidia theobromae, Fusarium oxysporum, Helminthosporium speciferum, curvalaria lunata, Aspergillus flavus and Trichothecium roseum causing banana rot.\textsuperscript{164}

The extract of the leaves revealed colatile fungitoxiccity against the damping off fungi Pythium aphanidermatum, P. debaryanum and Rhizoctonia solani. The extract was neigther inhibitory nor stimulatory against the conidial germination of Drechslera oryzae.\textsuperscript{165,166}

The essential oil isolated from the shoot was reported to have antifungal activity against Aspergillus carneus at various concentrations. The oil showed 85-100 per cent inhibition of the mycelial growth at concentration ranging between 1000-5000 ppm.\textsuperscript{167}

In a comparative study of herbal agents used for fumigation in relation to formalin, the plant reduced the microbial colony counts in air samples considerably.\textsuperscript{168}

Anthelmintic

Alcoholic extract of the plant did not show any effect on human Ascaris lumbricoides in vitro\textsuperscript{169}. The leaf extract at a dilution of 1:5 showed 100 % mortality against Meloidogyne Javanica.\textsuperscript{170}

Insecticidal

The crude extract of the plant did not show juvenoid activity against nymphus of Dysdercus cingulatus.\textsuperscript{171}
CLINICAL STUDIES

The plant was subjected to wide clinical evaluation with special reference to its use in leprosy, bronchial asthma and fistula-in-ano. Diuretic activity could not be confirmed.

Leprosy

The effect of oral decoction of *Acryanthus aspera* in the treatment of leprosy was studied (uncontrolled) in 19 patients who were found to have positive stain smears at the S.S. Hospital, Varanasi. Fourteen patients were in stage of reaction and rest of them had active lesions but none of them was in quiescent stage. The study revealed encouraging results in both lepra reaction as well as the quiescent stage of lepromatous leprosy. Skin lesions and ulcers had tendency to subside quickly with the treatment. The bacteriological index had also improved.\(^{172}\)

In an attempt to get additional data on the efficacy of the decoction of *Acryanthus aspera*, a study was undertaken for its role in the management of reactions in leprosy. An open clinical trial was conducted on twelve cases selected from the leprosy clinic of S.S. Hospital, Banaras Hindu University, Varanasi. Out of the twelve cases, six were of acute and subacute type of lepra reaction, three of acute and subacute type of border line reaction, and three of subacute type of tuberculoid reaction. It was observed that the decoction was useful in the treatment of reactions in leprosy particularly in subacute and mild type. When administered in conjunction with the antileprosy drug diaminodiphenylsulphone (DDS), it was found that the chances of reaction becomes less and rate of improvement was faster. No
toxic manifestation which could be attributed to *Acryanthus aspera* was noted during the trial.\textsuperscript{173}

In another study, at S.S. Hospital, Varanasi, thirty-six patients of advanced, infiltrative and nodular type of lepromatous leprosy, who had no previous treatment (as revealed by their histories), were selected for the trial. The patients were randomly divided into three groups and administered (a) the decoction of the plant in group 1; (b) DDS in group 2 and (c) the decoction of the plant along with DDS in group 3. The decoction was administered orally in a dose of 1.0 oz twice daily. Clinical and bacterial assessments were carried out every three months and finally after one year. During the whole treatment period a statistical change was noted in the clinical condition, bacterial status and general health. All the patients, irrespective of their grouping, showed clinical improvement of varying degrees. It was observed that those patients who received DDS alone could make a better clinical progress compared with those who received the decoction of *apamarga* alone, whereas the patients who received the different drugs separately. The patients who received only the decoction showed no improvement in their bacterial index. In fact most of them showed slight deterioration. The patients on DDS alone and those on a combined therapy of the decoction and DDS showed definite improvement in their bacterial index, the latter group showed a greater improvement. An improvement in general health was observed in all the patients receiving the decoction. Those patients who were on DDS alone did not show any improvement in general health. *Apamarga* did not produce any toxic manifestation in any patient and was well tolerated. The study revealed that
decoction of the plant had clinical effectiveness in the therapy of leprosy, prevented the antileprosy action of DDS and reactions in leprosy.\textsuperscript{174}

Fistula-in-ano

There have been a number of studies on the use of \textit{Kshaarasootra} (a medicated thread prepared by coating the latex of \textit{Euphorbia neriifolia}, alkaline powder of \textit{Acryanthus aspera} and \textit{Curcuma longa} in the treatment of fistula-in-ano. The studies revealed that the long term use of \textit{Kshaarasootra} was quite effective in treatment of various fistulous tracks. The standardization of \textit{Kshaarasootra} the methods of identification and assay of the individual constituents were studied.\textsuperscript{175, 176,177}

\textit{Kshaarasootra} has also been found to given encouraging results in five patients of chronic non healing milk-fistula ‘stannadi-varna’ with additional local application of ‘\textit{jatyaditaila}’ and oral administration of ‘\textit{shigru guggulu}’ (two tablets t.i.d) during the course of treatment.\textsuperscript{178}

Diuretic

A clinical trial was undertaken at the Government Ayurvedic College Hospital, Gwalior, involving fifteen cases of general anasarca (shoth) to evaluate the diuretic effect of \textit{Acryanthus aspera}. The decoction of plant, its seed or saponin did not possess a significant diuretic property (immediate or late or late diluresis) in cases of general anasarca.\textsuperscript{179}

Bronchial Asthma

A pilot study was carried out at the Central Research Institute for Siddha in Madras on fifteen cases of bronchial asthma. The oil obtained from the root soaked in cows urine was smeared on betal leaf and administered thrice a day to these patients. In most of the cases symptoms like wheezing,
gasping, dyspnoea, sneezing and cough disappeared. A fall in the total WBC and eosinophil counts and ESR was observed.\textsuperscript{180}

**TOXICOLOGICAL STUDIES**

The allergenic pollens of the plant are common in the area of Pondicherry. The period of anthesis has been found to be between November and December.\textsuperscript{181}

3.5. *Nyctanthes arbor-tristis* Linn. Fam: - Oleaceae

**Habit and Habitat**

Drug consists of the dried leaf of *Nyctanthes arbor-tristis* Linn.Fam. Oleaceae. A small tree occurring wild in the outer Himalayan ranges from Kashmir to Nepal and almost throughout India up to 1000m. It is also cultivated in gardens and elsewhere.

**Regional and Other Names**

**Beng.** -Sephalika, Seoli **Eng.** -Coral Jasmine **Guj.** -Jayaparvati **Hind.** -Harsinghar, Seoli, Siharu **Kan.** -Harsing, Parijata **Mal.** -Pavizhamalli, parijatakom **Mar.** -Khurasli, Parijatak **Ori.** -Godokodiko, Gunjoseyoli, Singaroharo **Tam.** -Manjhapu, Pavazhamalligai, Pavalamallikai **Tel.** -Parijatamu, Pagadamalli

**Chemical Studies:**

Nicotiflorin\textsuperscript{182,183}, nyctanthic acid\textsuperscript{182,184} are major constituents besides this others are Astragalin\textsuperscript{182}, friedelin, mannitol, Beta-sitosterol, lupeol, oleanolic acid\textsuperscript{182}, arborside A,B,C\textsuperscript{185}, nyctoside\textsuperscript{186}, desrhamnosylverbascoside\textsuperscript{186,187}, benzoic acid, hentriacontane, Beta- amyrin, D- mannitol, glucose, fructose\textsuperscript{188}, 6,7-di-O-benzoynyctanthoside, 6-O-trans-
cinnamoyl-6B-hydroxyloganin, 7-O-trans-cinnamoyl-6 B-hydroxyloganin are also found.

**Pharmacological studies**

The extract of the leaves showed tranquillizing, hypothermic and purgative effects. The extract exhibited significant antipyretic, analgesic, and ulcerogenic activities. The alcoholic extract produced anti-inflammatory activity and blocked the stimulatory response of acetylcholine and histamine in isolated rabbit ileum. Oral administration of the extract produced depletion of tumour necrosis factor alpha, reduced plasma interferon-gamma and showed immunostimulant property. The leaf extract showed antileishmanial activity in hamsters. The alcoholic extract possessed antimalarial, antitrypanosomal and antiamoebic activities.

**Major Therapeutic Claims**

Sciatica

**Safety Aspects**

Oral administration of the leaf extract for fix consecutive days induced gastric ulcers in rats. The extract also produced histological changes in kidney, thymus, lymph node and lachrymal gland in rats.

**Dosage**

Juice of leaves: 10 to 20 ml.
A search for hepatoprotective agents of natural origin

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