Preface

Since the publication of the first edition of *Medicinal Plants of the World: Chemical Constituents, Traditional and Modern Medicinal Uses* in 1999, there has been a significant growth in the amount of new data on the herbs covered in this volume. The references used to compile this new edition have more than doubled.

As a biologist with the US Food and Drug Administration I have been involved in toxicological research. On one occasion, while investigating herbal products sold in the United States as foods or food supplements, I realized that there was an abundance of information on plants that are commonly used as food and medicine. However, the material available was not compiled to optimally serve my interest. Most such books addressed the subject as folklore, and their information was not prepared as an educational resource on plant materials that are used as foods and food supplements by the general public. As a result, to obtain a fair knowledge of any specific plant, information from several books and journal articles had to be put together. It is this experience that guided me to compile Medicinal Plants of the World. The feedback I have received from readers of the first edition has inspired me to update the information on this important collection of plants.

No current text describes the traditional medicinal uses, the chemical constituents, the pharmacological activities, and the clinical trials of those plants that are commonly used around the world as medicine. The objectives that guided the writing of this book were to create a reference for research scientists, phytochemists, toxicologists, physicians, pharmacists, and other health care providers; to integrate traditional and modern pharmacopoeias in order to develop a more efficient medicine; to build confidence and self-reliance in the use of medicinal plants; to revive an awareness of the importance of plants as sources of medicine; and to encourage their utilization and conservation.

Around the world, and even within countries, different names are used for the same plant, and different plants may be referred to by the same name. In an effort to familiarize readers with the International Code of Botanical Nomenclature system, the code's Latin binomial is used for each plant. The common names, together with the countries with which they are associated, are also listed. Color illustrations of the plants are provided to assist in their identification by those who are not familiar with the botanical name or any of the common names. For the non-botanist, the chapter on nomenclature and descriptive terminology, the botanical description, and the origin and distribution of each plant will be useful in the practical identification of the plants.

Since medical doctors are often reluctant to prescribe medicinal plants without supporting scientific data, the sections on pharmacological activities and clinical trials, as well as those on chemical constituents, constitute most useful references. These sections will also be of value to scientists with an interest in drug development. The section on traditional medicinal uses, listed by countries, will provide support and build confidence and self-reliance in the traditional uses of medicinal plants. Throughout, the book pre-

sents vital information that will find much use by students, practitioners, or researchers interested or engaged in the development, evaluation, or use of herbal medicines. The text presumes that the reader has had little to no experience or knowledge of medicinal plants. A bibliography of approximately 3000 references is presented for readers interested in more detailed information. It represents a diversity of disciplines that reflect the complexity of the field and the variety of interests in medicinal plants.

It is my hope that readers will find in *Medicinal Plants of the World* a wealth of practical ideas and theoretical information that will expose new information and little-known facts, as well as the significant applications of plants in medicine, thereby helping us become healthier people, better students, teachers, farmers, clinicians, researchers, and entrepreneurs.

Ivan A. Ross, *PhD*

2 Abrus precatorius L.

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Common Names

Aainud-dik	India	Jequirity plant	Philippines
Aregllisse	West Indies	Jequirity	Taiwan
Benambo	Guinea-Bissau	Jequirity	India
Buck bean	Guyana	Jiquiriti	Brazil
Chanoti	Pakistan	Jumble bean	Virgin Islands
Chasm-I-kharosh	Pakistan	Jumble bean	Ivory Coast
Chirmu	Pakistan	Kalyani	India
Chunhati	India	Kikerewe	Tanzania
Crab's eye	Guam	Kolales halomtanto	Guam
Crab's eye	India	Koonch	India
Crab's eye	Nepal	Krikpe	Ivory Coast
Crab's eye	USA	Kunni	India
Crab's eye	Thailand	Laboma	Ivory Coast
Crab's stone	India	Latuwani	India
Damabo	Ivory Coast	Love bean	USA
Gaungchi	India	Lufyambo	East Africa
Gchi	India	Lyann legliz	Haiti
Ghongchi	India	Ma klam taanuu	Thailand
Ghumchi	India	Minimini	Mozambique
Ghun	India	Mishquina	Peru
Goassien	Ivory Coast	Miski miski	Peru
Guinea pea	India	Motipitipi	East Africa
Gunch	India	Moudie-bi-titi	Ivory Coast
Gunchi	Pakistan	Mwanga-la-nyuki	East Africa
Gundumani	India	Mwangaruchi	Tanzania
Gunja	India	Namugolokoma	Mozambique
Guri-ginja	India	Ndebie ni	Guinea
Gurivinda	India	Olho de pombo	Brazil
Gurje-tiga	India	Olinda	India
Habat al arus	Sudan	Ombulu	East Africa
Habat-elmlook	Sudan	Orututi	Tanzania
Indian licorice	India	Osito	East Africa
Indian licorice	Nigeria	Prayer bean	USA
Jequiriti bean	Taiwan	Precatory bean	USA

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Rati gedi	Nepal	Saga	Indonesia
Rati	India	Saga saga	Philippines
Ratti	Pakistan	Sanga	Ivory Coast
Rosary bean	Pakistan	Sonkach	India
Rosary bean	USA	Sus	Egypt
Rosary pea	Egypt	Weglis	West Indies
Safed chirami	India		

BOTANICAL DESCRIPTION

A woody twinning plant of the LEGUMINOSAE family, with characteristic red and black seeds. The leaves are pinnate and glabrous, with many leaflets (12 or more) arranged in pairs. The leaflets are oblong, measuring 2.5-cm long and 1.5-cm wide. The plant bears orange-pink flowers, which occur as clusters in short racemes that are sometimes yellowish or reddish purple in color, small and typically pea-like. The plant produces short and stout brownish pods, which curl back on opening to reveal pendulous red and black seeds, 4 to 6 peas in a pod.

ORIGIN AND DISTRIBUTION

It grows wild in thickets, farms, and secondary clearings, and sometimes in hedges. It is most common in rather dry areas at low elevation throughout the tropics and subtropics.

TRADITIONAL MEDICINAL USES

Afghanistan. Dried seeds are taken orally as an aphrodisiac[AP063].

Brazil. Leaves and stem are said to be toxic when eaten by cattle[AP041]. Water extract of dried leaves and root is taken orally as a nerve tonic[AP063].

Cambodia. Hot water extract of seeds is taken orally for malaria[AP047].

Central Africa. Root is chewed as a snake bite remedy[AP045]. Seeds are taken orally by several Central African tribes for intestinal worms and as an oral contraceptive. The effect of a single dose (200 mg) is said to be effective for 13 menstrual cycles[AP045].

East Africa. Decoction of the aerial parts is taken orally for gonorrhea. A decoction of the plant plus 3 or 4 seed pods is taken. Fresh leaf juice is taken orally for gonorrhea, bilharziasis, stomach troubles, and as an antiemetic. Powdered leaves are applied to cuts and swellings. Decoction of leaves is taken orally for chest pains. For inflamed eyes, steam of boiling leaves is used. Water extract of dried seeds is applied to the eyes for purulent eye infections; the seeds are macerated in the water[AP106]. Fresh root is chewed as an aphrodisiac[AP045,AP056].

Egypt. Seeds are taken orally with honey as an aphrodisiac[AP082].

Guam. Seeds are reported to be toxic; half of one seed is reported as lethal. Seed coat must be broken to be toxic. Symptoms include acute gastroenteritis with vomiting, nausea, and diarrhea, followed by dehydration, convulsions, and death[AP044].

Guinea-Bissau. Leaf pulp is taken orally by men as an aphrodisiac and by women to facilitate childbirth. Seeds taken orally are considered an aphrodisiac and abortive[AP002].

Haiti. Decoction of leaves is taken orally for coughs and flu[AP109].

India. Hot water extract of dried leaves and roots are applied to the eye for eye diseases[AP105]. Hot water extract of root is taken orally as an emmenagogue[AP003]. Root brew is taken orally to produce abortion[AP022,AP047]. Hot water extract of seeds is taken orally as an antifertility agent[AP003], as an abortifacient[AP013], and to prevent conception[AP022]. Seeds are used as a poultice in the vagina in Ayurvedic and Unani medicine as an abortifacient.

Seeds are boiled in milk and taken orally by males in Unani and Ayurvedic medicine as an aphrodisiac. It is claimed that the boiling destroys the toxic action of Abrin[AP047]. As birth control, one seed completely covered with Jaggary is swallowed during the menstrual period and is sufficient to prevent conception for 1 year[AP111]. Decoction of dried seeds is taken orally to induce abortion[AP062]. Hot water extract of dried seeds is taken orally as a sexual stimulant in the Unani system of medicine[AP084]. It is also taken for tuberculosis, painful swellings[AP104], and as an aphrodisiac and purgative[AP121]. Dried seed oil is taken orally as an abortifacient[AP124]. Plant juice is administered intravaginally to induce abortion[AP117].

Ivory Coast. Water extract of leaves and stem is taken orally by males as an aphrodisiac and by females to facilitate childbirth[AP036].

Jamaica. Decoction of dried leaves and root boiled in milk is used as a tonic[AP063].

Kenya. Fresh leaf juice is taken orally for coughs. Fresh leaves are taken orally for coughs[AP075].

Mozambique. Hot water extract of root is administered orally as an aphrodisiac[AP067].

Nepal. Seeds are taken orally as an aphrodisiac[AP001].

Nigeria. Hot water extract of fresh root is administered orally as an antimalarial and anticonvulsant[AP100].

Pakistan. Hot water extract of seeds is administered orally as an aphrodisiac. Seeds are used as a suppository for inducing abortion[AP027].

Sudan. Hot water extract of the plant is taken orally as an antifertility agent[AP093].

Taiwan. Decoction of dried root is taken orally to treat bronchitis and hepatitis[AP051].

Tanzania. Decoction of roots and leaf sap is taken orally for asthma and as an aphrodisiac[AP106].

Thailand. Leaves crushed with oil are used as a poultice as an anti-inflammatory[AP115].

Virgin Islands. Extract of seeds is taken orally for coughs[AP119].

West Africa. Decoction of dried roots is taken orally as an antiemetic, for bilharziasis, tapeworms, gonorrhea, chest pains and is also used as an aphrodisiac. For snake bites the root is chewed[AP106].

West Indies. Seeds are taken orally as an emetic, purgative, and anthelmintic[AP083].

CHEMICAL CONSTITUENTS

(ppm unless otherwise indicated)

Abrine: Sd 0.85%, Lf, St[AP103]
Abrasine: Rt[AP025,AP004]
Abrectorin: Sd[AP087]
Abridin, Sd[AP112]
Abrin: Sd 0.12%[AP021]
Abrin A: Sd[AP005], Ker 0.10%[AP094]
Abrin B: Sd[AP088], Ker 125[AP094]
Abrin C: Ker 175[AP094], Sd[AP005]
Abrin D: Ker 5[AP094]
Abrin I: Sd[AP049]
Abrin II: Sd[AP049]
Abrin III: Sd[AP049]
Abrulin: Sd[AP023]
Abruquinone A: Rt 0.025–0.45%[AP051]
Abruquinone B: Rt 0.045–1.15%[AP051]
Abruquinone C: Rt 0.5%[AP051]
Abruquinone D: Rt 0.03%[AP051]
Abruquinone E: Rt 0.02%[AP051]
Abruquinone F: Rt 0.01%[AP051]
Abrus agglutinin: Kr 0.1%[AP094]
Abrus agglutinin APA-I: Sd[AP049]
Abrus agglutinin APA-II: Sd[AP049]
Abrus precatorius agglutinin: Sd[AP085]
Abrus precatorius alkaloid A: Sd[A08649]
Abrus precatorius lectin: Sd[AP077]
Abrus precatorius plant growth inhibitor: Sd[AP017]
Abrusgenic acid-methanol-solvate: Rt 0.0166%[AP101]
Abrusin: Sd 48.9[AP076]
Abrusin-2'-0-apioside: Sd 0.58%[AP076]
Abruslactone A: Rt, St[AP096], Lf 83–200[AP068], Rt 0.27%[AP101]
Abrusoside A: Lf 0.03%[AP078,AP072]
Abrusoside B: Lf 0.025%[AP072]
Abrusoside C: Lf 0.037%[AP072]
Abrusoside D: Lf 0.053%[AP072]
Abrussic acid: Pl[AP130]

Alanine: Sd[AP130]
Amyrin, alpha: Sd[AP009]
Amyrin, beta: Sd[AP035]
Anthocyanins: Sd[AP131]
Arabinose: St, Lf, Sd, Rt[AP097]
Arachidic acid: Sd oil 19.2%[AP061]
Arachidyl alcohol: Sd[AP035]
Aspartic acid: Sd[AP016,AP034]
Behenic acid: Sd oil 13.4%[AP061]
Brassicasterol: Sd[AP035]
Callistephin: Sd Ct[AP024]
Campesterol: Sd[AP050]
Centaureidin, demethoxy 7-O-beta-D-rutinoside: Sd[AP087]
Cholanic acid, 5-beta: Sd[AP026]
Cholesterol: Sd[AP035]
Choline: Sd, Rt 4.0%, Lf, St[AP008]
Chrysanthemin: Sd Ct[AP024]
Cycloartenol: Sd[AP035]
Cysteine: Sd[AP034]
Cystine: Sd[AP016]
Decan-1-ol: Sd[AP035]
Delphin: Sd Ct[AP024]
Delphinidin glycoside: Sd[AP123]
Delphinidin, (para-coumaroyl-galloyl) glucoside: Sd[AP095]
Delphinidin-3-sambubioside: Sd[AP095]
Docos-13-enoic acid: Sd[AP035]
Docosadienoic acid: Sd oil[AP037,AP038]
Docosan-1-ol: Sd[AP035]
Docosane, N: Sd[AP035]
Docosatetraenoic acid: Sd oil[AP037]
Docosatrienoic acid: Sd oil[AP037]
Docosenoic acid: Sd oil[AP037,AP038]
Dodecan-1-ol: Sd[AP035]
Dotriacontane, N: Sd[AP035]
Eicos-11-enoic acid: Sd[AP035]
Eicosadienoic acid: Sd oil[AP037,AP038]
Eicosenoic acid: Sd oil[AP037,AP038]
Eicosane, N: Sd[AP035]
Eicosatrienoic acid: Sd oil[AP037,AP038]
Elaidic alcohol: Sd[AP035]
Galactose: St, Rt, Sd, Lf [AP097]
Galacturonic acid: Sd[AP016]
Gallic acid: Sd[AP031]
Glucuronic acid: Sd[AP016]
Glutamic acid: Sd[AP034]
Glutamine: Sd[AP034]
Glycine: Sd[AP034]
Glycyrrhizin: Lf 9.0%[AP092], Rt 1.25%
Hederagenin: Sd 7.3[AP076]
Hemiphloin: Lf 83.3[AP068]
Heneicosan-1-ol: Sd[AP035]
Heneicosane,7,9,15-trimethyl: Sd[AP050]
Heneicosane,N: Sd[AP035]
Heptacosan-1-ol: Sd[AP035]
Heptadecan-1-ol: Sd[AP035]
Hexacosane,N: Sd[AP035]
Hexacosan-1-ol: Sd[AP035]
Hexadec-9-enoic acid: Sd[AP035]
Hexadecane,N: Sd[AP035]
Hexadecan-1-ol: Sd[AP035]
Hexadecenoic acid: Sd oil[AP037,AP038]
Hypaphorine: Sd, Lf, Rt[AP008], St[AP103]
Inositol, D monomethyl ether: Lf[AP128]
Kaikasaponin III: Sd 147.3[AP076]
Lauric acid: Sd oil[AP040]
Lectin (*Abrus precatorius*): Sd[AP054,AP055]
Leucine: Sd[AP016]
Lignoceric acid: Sd[AP035], Sd oil[AP037,AP038]
Linoleic acid: Sd oil[AP040]
Linolenic acid: Sd oil 0.5%[AP061]
Luteolin: Sd[AP087]
Lysine: Sd[AP034]
Montanyl alcohol: Lf [AP035]
Myricyl alcohol: Lf [A15248]
Myristic acid: Sd oil[AP037,AP038,AP040]
Nonacosane, N: Sd[AP035]
Nonadecan-1-ol: Sd[AP035]
Octacosan-1-ol: Sd[AP035]
Octacosane, N: Sd[AP035]
Octadeca-9,12-dienoic acid: Sd[AP035]
Octadecadienoic acid: Sd oil[AP037,AP038]
Octadecatrienoic acid: Sd oil[AP037,AP038]
Octadecane, N: Sd[AP035]
Octadecenoic acid: Sd oil[AP037,AP038]
Octanoic acid: Sd[AP035]
Oleic acid: Sd oil[AP061,AP035,AP040]
Orientin, iso: Sd[AP087]
Orientin: Sd[AP087]
P-Sterone: Sd[AP007]
Palmitic acid: Sd oil 15.8%[AP061]
Pelargonidin-3,5-diglucoside: Sd Ct[AP024]
Pentacosan-1-ol: Sd[AP035]
Pentacosane, N: Sd[AP035]
Pentacosanoic acid: Sd[AP050]
Pentadecan-1-ol: Sd[AP035]
Pentadecanoic acid: Sd oil[AP037,AP038]
Pentatriacontane, N: Sd[AP035]
Phenylalanine: Sd[AP034]
Pinitol: Lf [AP128]
Polysaccharide: Rt[AP129]
Precasine: Rt[AP025,AP004]
Precatorine: Rt 11.0%, Lf, St, Sd 11.0%[AP008]

Precol: Rt[AP025]
Rhamnose: Sd[AP016]
Serine: Sd[AP034,AP016]
Sitosterol, beta: Sd[AP043,AP050,AP035]
Sophoradiol: Sd 737[AP076]
Sophoradiol-22-0-acetate: Sd 31[AP076]
Squalene: Sd[AP035]
Stearic acid: Sd oil 4.9%[AP061]
Stigamsterol: Sd[AP043]
Tetracos-15-enoic acid: Sd[AP035]
Tetracosan-1-ol: Sd[AP035]
Tetracosane, N: Sd[AP035]
Tetradecan-1-ol: Sd[AP035]
Tetradecanoic acid: Sd[AP035]
Tetratriacontane, N: Sd[AP035]
Triacosan-1-ol: Sd[AP035]
Triacontane, N: Sd[AP035]
Tricosane, N: Sd[AP035]
Tridecan-1-ol: Sd[AP035]
Trigonelline: Sd[AP091], Rt, St, Lf [AP103]
Tritriacontan-1-ol: Sd[AP035]
Tritriacontane, N: Sd[AP035]
Tryptophan, N-N-dimethyl metho-cation methyl ester: Sd[AP008]
Tryptophan, trimethyl: Sd 684[AP076]
Tyrosine: Sd[AP016]
Undecan-1-ol: Sd[AP035]
Ursolic acid: Sd[AP009]
Valine: Sd[AP009,AP016]
Xylose: St, Rt, Sd, Lf [AP097]

PHARMACOLOGICAL ACTIVITIES AND CLINICAL TRIALS

Abortifacient effect. Chloroform/methanol extract of seeds, administered subcutaneously to rats at a dose of 50.0 mg/animal, was inactive. Water extract of dried seeds, administered intragastrically to pregnant rats at a dose of 125.0 mg/kg, was active[AP116]. Ethanol (95%) extract of seeds, administered orally at a dose of 200.0 mg/kg, was inactive on pregnant hamsters and active on pregnant rats[AP127]. Petroleum ether extract of seeds, administered orally to rats, was inactive[AP120].

Agglutinin activity. Water extract of fresh seeds, in cell culture at a concentration of 2.0 microliters/ml, was active on human lymphocytes[AP125].

Alkaline phosphatase inhibition. Petroleum ether extract of seed oil, administered orally, was active on the uterus of rats[AP108].

Analgesic activity. Ethanol/water (1:1) extract of the aerial parts, administered intraperitoneally to mice at a dose of 500.0 mg/kg, was inactive vs tail pressure method[AP118].

Anthelmintic activity. Water extract of dried seeds produced weak activity on *Caenorhabditis elegans*, LC_{50} 15.8 mg/ml[AP064]. Extract of stem and root was active on schistosomules of the trematode *Schistosoma mansoni* and cystercoids of the cestode *Hymenolepis diminuta*, in vitro[AP134].

Antibacterial activity. Ethanol/water (1:1) extract of the aerial parts, at a concentration of 25.0 mcg/ml on agar plate, was inactive on *Bacillus subtilis*, *Escherichia coli*, *Salmonella typhosa*, *Staphylococcus aureus* and *Agrobacterium tumefaciens*[AP118]. Ether extract of seeds, on agar plate, was active on *Staphylococcus aureus*. The ethanol (95%) extract was active on *Escherichia coli* and *Staphylococcus aureus*[AP031].

Anticonvulsant activity. Ethanol (70%) extract of fresh root, administered intraperitoneally to mice of both sexes at variable dosage levels, was active vs metrazole-induced convulsions and inactive vs strychnine-induced convulsions[AP100]. Ethanol/water (1:1) extract of the aerial parts, administered to mice intraperitoneally at a dose of 500.0 mg/kg, was inactive vs electroshock-induced convulsions[AP118].

Antidiarrheal activity. Chromatographic fraction of dried seeds, administered intragastrically to rats at a dose of 10.0 mg/kg, was active vs castor oil-induced diarrhea[AP080].

Antiestrogenic effect. Ethanol (95%) extract of root, administered orally to mice at a dose of 10.0 mg/kg, was active[AP015].

Antifertility effect. Chloroform/methanol extract of seeds, administered subcutaneously to female rats at a dose of 50.0 mg/animal, was active[AP081]. Ethanol (80%)

extract of seeds, administered orally and subcutaneously to female rats at a dose of 1.0 mg/animal, was inactive[AP053]. Ethanol (95%) and water extracts of seeds, administered orally to mice, were inactive, and petroleum ether extract was active[AP006]. Ethanol (95%), water and petroleum ether extracts of leaves, administered orally to female mice, were inactive[AP006]. Ethanol extract of seeds, administered intragastrically to male rats at a dose of 100.0 mg/kg for 60 days, was active. There was a significant decrease in the number of pregnant females[AP069]. Ethanol/water (1:1) extract of dried seeds, administered by gastric intubation to male rats at a dose of 250.0 mg/kg, was active. No pregnancies were reported for the 20 females paired with 10 males treated for 60 days; mating probably occurred in all cases, but this is not entirely clear. Pregnancies were again reported after withdrawal of treatment[AP110]. Hot water extract of dried plant, administered orally to human females at a dose of 0.28 gm/person, was active. The extract was administered as a mixture of *Embelia ribes* (fruit), *Piper longum* (fruit), *Ferula assafoetida*, *Piper betele*, *Polianthes tuberosa* and *Abrus precatorius*. One dose was taken, starting from the second day of menstruation, twice daily for 20 days. Sexual intercourse was avoided during the dosing period. The treatment is claimed effective for 4 months. The biological activity has been patented[AP086]. Seed oil, administered orally to female mice at a dose of 25.0 mg/animal, to female mice, and to rats at a dose 150.0 mg/animal, was active. No control animal was used[AP015].

Antifungal activity. Ethanol/water (1:1) extract of the aerial parts, at a concentration of 25.0 mcg/ml on agar plate, was inactive on *Microsporum canis*, *Trichophyton mentagrophytes*, and *Aspergillus niger*[AP118].

Antigonadotropin effect. Ethanol (95%) extract of dried seeds, administered by gastric intubation to mice at a dose of 150.0 mg/kg, was active[AP107].

Anti-implantation effect. Chloroform/methanol (2:1) extract of seeds, administered subcutaneously to pregnant rats at a dose of 50.0 mg/animal, was active[AP081]. Ethanol (95%) extract of root, administered orally to rats at a dose of 100.0 mg/kg, was active[AP015]. Ethanol (95%) extract of seeds, administered orally to rats and hamsters at a dose of 200.0 mg/kg, was inactive[AP127]. Water extract of seeds, administered orally to rats, was inactive, and the petroleum ether extract was active. Ethanol (95%), water and petroleum ether extracts of leaves, administered orally to female rats, were inactive[AP006].

Anti-inflammatory activity. Ethanol/water (1:1) extract of the aerial parts, administered orally to rats at a dose of 500.0 mg/kg, was inactive vs carrageenin-induced pedal edema. Animals were dosed 1 hour before carrageenin injections[AP118]. Triterpenoid saponins isolated from the aerial parts, exhibited anti-inflammatory activity using the croton oil ear model. The acetates indicated greater inhibition than the parent compounds[AP133].

Antimolluscicidal effect. Forty and 80% of the 24 hour LC_{50} of abrin and glycyrrhizin produced a significant decrease in the levels of protein, free amino acid, DNA, and RNA in the nervous tissue of *Lymnaea acuminata*. Abrin produced a significant reduction in phospholipid levels and a simultaneous increase in the rate of lipid peroxidation in the treated snails[AP137].

Antispasmodic activity. Chromatographic fraction (a gel filtration fraction from a methanol-water (1:1) extract) of seeds, at a concentration of 0.2 mg/ml, was active on the uterus of rats vs PGE-2-, ACh-, oxytocin- and epinephrine-induced contractions[AP099]. Ethanol (95%) extract of dried leaves, at a concentration of 1.0 mg/ml, was active on the phrenic nerve-dia-

phragm of rats vs nerve stimulation. The inhibition was potentiated by D-tubocurarine but reversed by physostigmine. Results significant at $P < 0.001$ level. At a concentration of 4.0 mg/ml, the extract was active vs direct muscle stimulation. At 1.0 mg/ml, it was active on toad rectus abdominus muscle vs ACh-induced contractions. Water and hot water extracts of dried leaves, at a concentration of 6.72 mg/ml, were inactive on phrenic nerve-diaphragm of rats vs nerve stimulation and direct muscle stimulation. At concentrations of 16.8 and 16.72 mg/ml, respectively, the extracts were inactive on toad rectus abdominus muscle vs ACh-induced contractions. Petroleum ether extract, at concentrations of 19.2 and 48.0 mg/ml, were inactive on rat phrenic nerve-diaphragm vs nerve stimulation and direct muscle stimulation and on toad rectus abdominus muscle vs ACh-induced contractions, respectively[AP102]. Ethanol/water (1:1) extract of the aerial parts was inactive on guinea pig ileum vs ACh- and histamine-induced spasms[AP118].

Antispermatogenic effect. Ethanol extract of seeds, administered intragastrically to male rats at a dose of 100.0 mg/kg for 60 days, was inactive[AP069]. Ethanol/water (1:1) extract of dried seeds, administered by gastric intubation to rats at a dose of 250.0 mg/kg, was active. Although no significant histologic changes in the testes were reported, sperm concentration was reported to be significantly decreased in both cauda epididymis and testes after dosing for 60 days[AP110]. Sterol fraction of dried seeds administered intramuscularly to rats was active. Testicular lesions marked by the cessation of spermatogenesis and a significant reduction in the diameter of the seminiferous tubules were also noted[AP089].

Antitumor activity. Ethanol (95%) extract of dried leaves, administered intraperitoneally to mice at dose of 100.0 mg/kg was inactive on Sarcoma 180 (ASC) [AP074]. Water extract of seeds, administered intraperitoneally to mice at a dose of 5.0 mcg/kg was active on Sarcoma (Yoshida solid and ASC). A dose of 20.0 mcg/kg administered subcutaneously was inactive on Sarcoma (Yoshida ASC)[AP012]. Protein fraction of seeds, administered intraperitoneally to rats, was active on Sarcoma (Yoshida ASC)[AP019]. Agglutinin protein, crystallized at room temperature with polyethylene glycol 8000 as the precipitant from the seeds, produced a high antitumor activity[AP135].

Antiviral activity. Ethanol/water (1:1) extract of the aerial parts at a concentration of 50.0 mcg/ml in cell culture was inactive on Ranikhet virus and Vaccinia virus[AP118]. Water and methanol extracts of dried seeds in cell culture were inactive on virus-HLTV-1. $IC_{100} > 77.0$ and > 40.0 mcg/ml, respectively, were observed. Activity was not observed below the cytotoxic doses[AP065].

Antiyeast activity. Dried seeds at a concentration of 1.0% on agar plate were active on *Cryptococcus neoformans*[AP122]. Ethanol/water (1:1) extract of the aerial parts at a concentration of 25.0 mcg/ml on agar plate was inactive on *Candida albicans* and *Cryptococcus neoformans*[AP118].

CNS depressant activity. Ethanol (70%) extract of fresh root, administered intraperitoneally to mice of both sexes at variable dosage levels, was active[AP100].

Contraceptive and/or interceptive effect. Petroleum ether extract of seed oil, administered orally to rats, was active[AP108].

Cytotoxic activity. Ethanol (95%) extract of dried stem, in cell culture, was inactive on CA-9KB, $ED_{50} > 30.0$ mcg/ml[AP098]. Water and methanol extracts of dried seeds, in cell culture, produced weak activity on cells MT-4, $IC_{100} > 77.0$, and > 40.0 mcg/ml, respectively[AP065]. Water extract of seeds, in cell culture, produced strong activity on Sarcoma Yoshida ASC, ED_{50} 0.004 mcg/ml[AP029]. Water extract of seeds, in cell cul-

ture, was active on CA-9KB, ED_{50} < 20.0 mcg/ml[AP126]. Water extract of seeds was active on the testes of *Poecilocera picta*[AP039].

Death. Hot water extract of dried leaves, administered intravenously to chicken, was active at a dose of 20.0 mg/kg and caused spastic paralysis and death within 24 hours[AP102]. Seeds taken orally by male human adults were active. Twenty beans mixed with water in a blender and drunk produced death in 2 days. Symptoms included vomiting of blood, pain in eyes, and burning ears[AP046].

Diuretic activity. Ethanol/water (1:1) extract of the aerial parts, administered intraperitoneally to male rats at a dose of 250.0 mg/kg, was inactive. Saline-loaded animals were used. Urine was collected for 4 hours post-drug[AP118].

Embryotoxic effect. Ethanol (95%) extract of seeds, administered orally to pregnant hamsters and rats at doses of 200.0 mg/kg, was inactive[AP127]. Petroleum ether extract, administered orally to rats at a dose of 150.0 mg/kg, was inactive[AP120]. Water extract of dried seeds, administered intragastrically to pregnant rats at a dose of 125.0 mg/kg, was inactive[AP062].

Estrous cycle disruption effect. Seeds, administered orally to female rats at doses of 0.05, 0.5, and 5.0 mg/animal, were inactive[AP066]. Chloroform/methanol (2:1) extract of seeds, administered subcutaneously to rats at a dose of 1.0 mg/animal, was active[AP053]. Seeds, administered by gastric intubation to rats at doses of 10.0, 5.0, and 2.0 gm/kg, were active; 80, 50, and 25%, respectively, of the rats depicted extensive leukocytic smears, but with no significant effect on uterine weight[AP090].

Hemagglutinin activity. Water extract of seeds was active on the red blood cells of ant (leafcutter), buffalo, cat, chicken, dog, duckling, guinea pig, horse, human adult (blood groups A, B, and O), lamb, mice, pigeon, rabbit, rat, and ox; weakly active on cow and ewe and inactive on goat[AP032,AP033].

Hypoglycemic activity. Ethanol/water (1:1) extract of the aerial parts, administered orally to rats at a dose of 250.0 mg/kg, was inactive. Less than a 30% drop in blood sugar level was observed[AP118].

Hypothermic activity. Ethanol/water (1:1) extract of the aerial parts, administered intraperitoneally to mice at a dose of 500.0 mg/kg, was inactive[AP118].

Inotropic effect positive. Hot water extract of dried entire plant, at a concentration of 320.0 microliters, was inactive on guinea pig atria[AP079].

Insect sterility induction. Petroleum ether extract of dried seeds, applied externally at a concentration of 1.0 microliter, was active on *Dysdercus cingulatus*. The extract was active in males alone. The saline extract produced weak activity in both males and females[AP071].

Insecticide activity. Acetone extract of dried root was inactive on *Culex quinquefasciatus*. Acetone extract of dried stem, at low concentration, was inactive on *Culex quinquefasciatus*[AP048]. Seeds, at a concentration of 10.0%, produced weak activity on *Musca domestica*. The activity was less than that of 0.25% DDT[AP030].

Intestinal fluid retention effect. Chromatographic fraction of dried seeds, administered intragastrically to rats at a dose of 10.0 mg/kg, was active on the small intestine vs PGE_2-induced enteropooling. Effect assayed 30 minutes after oral dose of PGE_2[AP080].

Intestinal motility inhibition. Chromatographic fraction of dried seeds, administered intragastrically to rats at a dose of 10.0 mg/kg, was active. Effect was not as great as that of an equal amount of atropine[AP080].

Luteal suppressant effect. Chloroform/methanol (2:1) extract of seeds, administered subcutaneously to rats at a dose of 50.0 mg/animal, was active[AP081].

Microglial cell markers. Lectin from the plant has been used to glycohistochemically identify the microglial cells activation in autopic brain samples from Alzheimer's disease subjects[AP138].

Mitogenic activity. Water extract of fresh seeds, in cell culture at a concentration of 2.0 microliters/ml, was inactive on human lymphocytes[AP125].

Mutagenic activity. Methanol (75%) extract of dried leaves, at a concentration of 10.0 mg/ml on agar plate, was inactive on *Salmonella typhimurium* TM677[AP072].

Neuromuscular blocking activity. Ethanol (95%) extract of dried leaves, at a concentration of 0.5 mcg/ml, was active on phrenic nerve-diaphragm[AP102].

Protease (HIV) inhibition. Water and methanol extracts of dried seeds were inactive, IC_{50} > 500 mcg/ml[AP057].

Reverse transcriptase inhibition. Water and methanol extracts of commercial sample of seeds, in cell culture, were inactive on virus-avian myeloblastosis, IC_{50} > 1000 mg/ml[AP058].

Semen coagulation. Ethanol/water (1:1) extract of the aerial parts, at a concentration of 2.0%, was inactive on rat semen[AP118].

Smooth muscle stimulant activity. Chromatographic fraction (gel filtration 4–9 of a methanol-water (1:1) extract of seeds, at a concentration of 0.2 mg/ml, was active on guinea pig ileum; a concentration of 0.5 mg/ml, was active on the stomach of rats[AP099]. Seed oil, at a concentration of 1.8 mcg/ml, was active on the ileum of guinea pigs[AP113].

Spermicidal effect. Ethanol extract of seeds, administered intragastrically to male rats at a dose of 100.0 mg/kg for 60 days, was active. Impaired sperm motility and structural abnormalities of sperm were observed. Sperm ATPase level was decreased[AP069]. Ethanol/water (1:1) extract of dried seeds was active on the sperm of rats. There was a decrease in motility when sperm was mixed with the extract. When administered by gastric intubation, at a dose of 250.0 mg/kg, there was a large decrease in motility of sperm from the cauda epididymis of the rats given the extract for 60 days[AP110]. Ethanol/water (1:1) extract of the aerial parts, at a concentration of 2.0%, was inactive on the sperm of rats[AP118]. Methanol extract of dried seeds was active on the sperm of human adults, IC_{50} 2.29 mg/ml[AP114].

Taste aversion. Butanol extract, at a concentration of 10.0 mg/ml; ethanol (80%) extract, at a concentration of 2.0 mg/ml; water extract, at a concentration of 10.0 mg/ml of dried leaves, in the drinking water of gerbils, were active. The ether and petroleum ether extracts, at concentrations of 5.0 mg/ml, were inactive[AP073].

Teratogenic activity. Water extract of dried seeds, administered intragastrically to pregnant rats at a dose of 125.0 mg/kg, was active[AP062,AP116].

Toxic effect (general). Seeds, administered orally to horses at a dose of 15.0 gm, were active. Tolerance developed when small, incrementally-increased doses were given[AP010]. Seeds, at a concentration of 0.5% of diet in chicken, were active. Chickens were fed a mixture of *Abrus precatorius* seeds and *Cassia senna* fruit. Toxicity included catarrhal enteritis, hepatocellular necrosis, reduced weight, and anemia[AP059]. Ethanol (95%) extract of seeds, administered subcutaneously to male mice at a dose of 500.0 mg/kg, was active. One hundred percent mortality was observed within 48–49 hours[AP028]. Seeds, administered orally to human adults, were active. Severe gastroenteritis, multiple serosal hemorrhages, swelling and inflammation of the Peyer's patches, swelling and inflammation of retroperitoneal lymph nodes, focal necrosis in the liver and kidneys, retinal hemorrhages early in course of intoxication, nausea, vomiting, diarrhea, dehydration, convulsions, and collapse are possible symptoms. Symptoms

may begin after delay of up to several days and may persist for as long as 10–11 days. Death in children has been reported from eating 1 or more seeds[AP020]. Two children who chewed seeds became irrational, had tetany, flushing of skin, widely dilated pupils, and appeared to hallucinate. Treatment with neostigmine and barbiturates was successful[AP042]. Seeds, administered subcutaneously to male mice at a dose of 0.90 gm/kg, were active. Forty-four deaths were observed in 5–21 hours[AP028]. Seeds administered orally to cows at a dose of 0.09 gm/kg were active. Death was observed in 1 of 44 animals. Methanol (75%) extract of dried leaves, administered intragastrically to mice at a dose of 2.0 gm/kg, was inactive[AP072]. Leaf and stem, administered orally to cows at a dose of 15.4 gm/kg, was inactive[AP041]. Seeds, in the ration of livestock, were active; nitrate poisoning was observed[AP060]. Beans, ingested by human adult, produced pulmonary edema and hypertension[AP132].

Toxicity assessment. Ethanol/water (1:1) extract of the aerial parts, administered intraperitoneally to mice, produced LD_{50} > 1.0 gm/kg[AP119]. Ethanol (95%) extract of dried leaves, administered intravenously to chicken, produced LD_{50} 12 mg/kg[AP102]. Water extract of seeds, administered subcutaneously to female guinea pigs, produced LD_{50} less than 0.40 mg/kg[AP028]. When administered orally to guinea pigs, mice, rabbits, and rats LD_{50} 0.299 gm/kg, 6.638 gm/kg, 48.7 mg/kg and 2.711 gm/kg, respectively, were observed[AP018]. Toxicity of Abrus to goats has been evaluated. Doses of 2, 1, or 0.5 gm/kg/day by stomach tube produced death between days 2 and 5 for those given 2 or 1 gm/kg. One goat that received 0.5 gm died on day 32, and the other was killed on day 33. The main signs of poisoning include inappetence, bloody diarrhea, dyspnea, dehydration, loss of condition, and recumbence. *Abrus agglutinin*, from the plant is less lethal than abrina in mice, LD_{50} is 5 mg/kg vs 20 microgram/kg body weight[AP136].

Toxicity. Fatal incidents have been reported following ingestion of well-chewed seeds of *Abrus precatorius*. Because of its hard seed coat, it can pass through the gastrointestinal tract undigested and remain harmless. The unripe seed has a soft and easily broken seed coat and is thus more dangerous. It has been reported that poisoning has been experienced through a finger prick when stringing the seed. Symptoms may develop after a few hours to several days after ingestion. They include severe gastroenteritis with pronounced nausea and vomiting. Mydriasis will occur, as well, as muscular weakness, tachycardia, cold sweat, and trembling. There is no known physiological antidote. The treatment is essentially symptomatic. Since there is a long latent period associated with abrin poisoning, little value can be placed on induction of emesis or gastric lavage; these measures are useful only if ingestion has just occurred. Bismuth trisilicate may be given during poisoning by *Abrus precatorius* to reduce the degree of gastrointestinal damage. If the emesis and/or diarrhea become excessive, replacement fluids and electrolytes are advocated. If hemorrhage occurs, blood transfusion may be necessary.

Uterine relaxation effect. Chromatographic fraction (a gel filtration fraction from a methanol/water [1:1] fraction) of seeds, at a concentration of 1.1 mg/ml, was active on the uterus of rats[AP099].

Uterine stimulant effect. Chromatographic fraction (gel filtration fractions 4–9 of a methanol/water [1:1] extract) of seeds, at a concentration of 0.2 mg/ml, was active on the uteri of pregnant and nonpregnant rats[AP099]. Ethanol (95%) extract of dried seed oil, administered intravenously to guinea pigs at a dose of 1000 mcg/ml, produced weak activity[AP124]. Seed oil, at a concentra-

tion of 3.6 mg, was active on the uteri of guinea pigs and rats. The action was blocked by indomethacin but not by atropine[AP113]. Water extract of seeds was active on the uterus of guinea pig[AP013].

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