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Acharya Balkrishna
1. Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India
2. University of Patanjali, Patanjali Yogpeeth, Haridwar, Uttarakhand 249405, India

Shalini Singh
Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India

Deepika Srivastava
Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India

Shalini Mishra
Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India

Satyendra Kumar Rajput
Department of Pharmaceutical Sciences, Gurukula Kangri (Deemed to be University), Haridwar, Uttarakhand 249404, India

Vedpriya Arya
1. Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India
2. University of Patanjali, Patanjali Yogpeeth, Haridwar, Uttarakhand 249405, India

Correspondence:
Shalini Singh
Patanjali Herbal Research Department, Patanjali Research Institute, Haridwar, Uttarakhand 249405, India
Email: shalini.singh@prft.co.in
ORCID ID- 0000-0002-3743-8888

Quassia amara L.: A Comprehensive Review of its Ethnomedicinal Uses, Phytochemistry, Pharmacology and Toxicity

Acharya Balkrishna, Shalini Singh*, Deepika Srivastava, Shalini Mishra, Satyendra Kumar Rajput, Vedpriya Arya

ABSTRACT

Quassia amara Linn., is a shrub and world widely known as 'bitter-wood' belongs to Simaroubaceae family. The plant grows in sandy soils of lowland & highland forests, wet forests along riverbanks and, is native to Central Mexico to Southern tropical America and Guadalupe. A Surinamese man named Quassia which gained attention for treating fevers with a secret remedy based on this herb in 18th century, which Rolande took to Sweden in 1756 and disseminated its medicinal reputation across Europe. This species consists of various constituents namely β-carbonite, indole alkaloids & primarily, the bitter compounds known as quassinoids. Various studies indicate that *Q. amara* possess different biological properties namely anti-diabetic, anti-inflammatory, anti-hyperglycemic, anti-leishmanial, anti-malarial, anti-nociceptive, anti-ulcer, anti-fertility and sedative. Fresh bark, leaves or wood extracts are used to treat digestive problems, malaria and hepatic disorders. In-depth literature analysis revealed that the plant is least explored and possess immense medicinal values. These studies pass the new ways to explore biological potential of this plant.

Keywords: *Quassia amara*, Simaroubaceae, Bitter-wood, biological actions, Phytochemistry, Medicinal uses.

INTRODUCTION

An enormous augmentation of health issues and treatment expenditure have transpired in exemplar shift of global interest from prevalent medical science to Complementary and Alternative Medicine in 21st century. This is evident from the change in health policies of individual nations which outreached to the development of Traditional Medicine Policy by WHO [1]. In Europe, *Quassia amara* is a recognised species in the Pharmacopoeias of Spain, Switzerland, Denmark, Belgium, Germany, France, Norway, and Sweden, as well as the British Pharmacopoeia [2].

Q. amara Linn., folklore medicinal plant indigenous to Northern Brazil called as 'quassia' [3]. which is also popularly known as "pau-teniente", "amaro" or "Grande hombre" in tropical regions of Central and South America [4]. This species grows in wet forests at an elevation up to 500 m, which is native to Northern Brazil & Guiana and, widely distributed in different areas of Venezuela, Panama, Colombia, Argentina, Suriname and Mexico [5]. This species is an erect shrub reaching up to 2-3 m, bark is light coloured; leaves are unequally pinnate with broadly winged rachis and leaflets are obovate in shape. Flowers are purple, inflorescence is terminal racemes. Fruits are drupe up to 12-13 mm long, purple black in colour [6].

Ethnomedicinally, this plant has anti-diabetic property due to bitterest substance quassia present in it, due to which it is used in management of type 2 diabetes [6]. In traditional medicine system, leaves, bark and wood extracts are useful in the treatment of malaria, hepatic disorders and gastrointestinal problems. Moreover, this species is utilized as folk medicine to treat gastric ulcer in Brazil and Caribbean.

Bitter wood is a source of different compounds such as β-carboline, cantin-6 alkaloids and, mainly the consist of 'quassinoids' [1]. Further, wood consists of quassinoids such as pardine, quasimetric and quassinol and neoquassin [7,8]. Quasimetric and simalikalactone D are active components isolated from leaves which possess anti-malarial, anti-HIV and anti-tumor properties [9]. It also showed anti-microbial, anti-inflammatory and anti-fungal effects [10]. These compounds are known source of biologically active extracts towards protozoa [11].

Wood of this species is beneficial in cosmetics such as tonic, denaturant and for skin conditioning. It is also accessible in market as shavings or powder and chips. Dry wood is also useful as an insect repellent for aphids, sawflies and cecidomyiid in pome fruits [7]. In addition, plant is useful for the production of

flypaper & methylated spirits [5]. it is cultivated in Indian gardens because of its lovely leaves and spectacsular blooms [6]. It becomes obligatory to further search for medicinal plants with superlative therapeutic potentialities. This scenario has made us to probe into the pharmacological potential and phytochemistry of *Quassia amara* Linn. which might be useful for a wide spectrum of maladies.

Organoleptic Properties

Taste-Bitter (Root & Bark)

Colour- Purple and scarlet (Flowers)

Odour- Slight

Plant Description

It is a shrub or treelet with stem of upto10 cm diameter and with 6 m height, 4-7 cm wide as well as 5-11 cm long, dark green in colour on the upper surface and fairly pale on the inside, obovate to oblong. Flowers bloom in compact panicles, 2.5-4.5 cm in diameter and scarlet is having pink base. Fruits are 1.5 cm oblong, black in colour and is having only 1 seed.

Vernacular Folklore

Q. amara L. has several synonyms, and vernacular names which vary region to region. In Brazil it is known as Maruga, Hombre Grande in Costa Rica and Cuisia in Mexico. Some vernacular names with their distributions are presented in Table 1.

Table 1: Traditional uses of *Quassia amara* L. around the globe [17].

Distribution	Vernacular names	Parts used	Preparation/ Modes of Administration	Therapeutic Properties & Ailments treated
Brazil	Marupa, Leno de quássia, Quinade-caiena	Bark	Decoction, Orally	Gastrointestinal disorders, Gonorrhoea, Malaria, Febrifuge
Dominican Republic	Palo muneco, Pau amarelo, Pau quassia	Wood	Infusion, Orally	Pyrexia, Tonic, Digestive complaints
Chile	Quassia	Bark	Decoction, Orally	Appetizer, Digestive, Pyrexia, Worm infestation, Tonic, Blood purification Tuberculosis
Costa Rica	Hombre grande, Hombron	Stem wood	Infusion, Orally	Diabetes mellitus, Diarrhoea, Fever, Appetite
Guatemala	Hombre grande, Palo grande	Bark/wood/ leaves	Infusion/ decoction, Orally	Constipation, Diabetes mellitus, Hypertension, Nervousness
Guyana	Bitters, Quashi bitter, Quashie (Arawak)	Bark	Infusion, Orally	Gastrointestinal disorders, Pyrexia, Malaria, Worm infestation, Blood purification, Pediculosis
Mexico	Cuasia, Crucete, Quashie bitters	Bark	Infusion, Orally	Dyspepsia, Pyrexia, Gallbladder disease, Worm infestation, Hepatic disorder, Stomachic,
Nicaragua	Hombre grande, Quinina, Chirrión de río	Bark	Infusion, Orally	Astringent, Anaemia, Insect Bites & Stings, Tonic, Malaria, Worm infestation
Nigeria	Omu aja or gboyin gboyin, Amunketa	Bark	Decoction, Orally	Antibiotic, Stomachic, Antianaemic, Malaria
Panama	Cruceta, Hombre grande, Cuasia surinamense, Guabo, Guabo amargo	Wood	Infusion, Orally	Febrifuge & Pyrexia, Malaria, Diabetes, Hepatic disorders, Snakebite
Thailand	Prathatchin	Bark & leaves	Infusion, Orally	Antipyretic
Turkey	Acıağaç, Kassia ağaçı	Wood & fresh roots	Infusion, Orally	Astringents,Diarrhoea, Digestive, Diuretic, Dysentery, Fever, Malaria, Tonic
Venezuela	Cedro blanco, Cuasia, Simaruba	Wood & fresh roots	Infusion, Orally	Diuretic, Dysentery, Pyrexia, Laxative, Tonic, Vermifuge
Suriname	Soemaroepa, Kwasi bita bluem knoppen, Assoumaripa	Stems, Bark & Leaves	Decoction & Infusion, Orally	Fever, vermifuge, tonic, cholagogue, febrifuge
Peru	Amargo, Cuasia, Simaba	Bark	Infusion, Orally	Febrifuge, Hepatitis, Tonic
Colombia	Cuasia, Creceto morado, Contra-cruceto	Bark	Infusion, Orally	Dyspepsia, anorexia, malaria
Honduras	cuasia, hombre grande, limoncillo, tru	Bark	Decoction, Orally	Stomachache, diabetes, urinary problems, diarrhea, migraine and anaemia

METHODOLOGY

This review article was created by gathering and consulting published articles on *Q. amara*'s medical uses and scientific evidence. A total of 25 published papers were consulted using different databases such as Google Scholar, Science Direct, and PubMed. Only published papers in English versions were chosen for running a search target on *Q. amara* across various databases using a combination of key phrases including *Q. amara* ethno-pharmacology; Phytochemistry; Medicinal uses; Vernacular names, History, Traditional and Botanical description. The literature search in this paper was limited to scientific publications that were included in the above-mentioned data bases and may be available to scientific societies for reference; however, we acknowledge that there may be other data in less accessible forms, such as unpublished thesis and reports, that were not considered in this study. All previously published data is compiled into one table (distribution; vernacular names; therapeutic properties/diseases treated) and one graphical abstract of chemo-makers and their therapeutic characteristics. Chemical and structural formulas were drawn and confirmed from PubChem for reported chemical components from this species.

HISTORICAL & TRADITIONAL BACKGROUND

In 18th century, a man from Surinam, named Quassia has gained fame in curing pyrexia with a secret remedy based on this plant, the therapeutic repute of which has spread all around Europe after Rolande brought it to Sweden in 1756. After Quassia, Linnaeus has named this plant *Quassia amara* due its bitter flavour. In 1763, Callous M. Bloom mentioned it as *Lignum quassia*, and immediately, this species has achieved a fame as febrifuge, tonic and dysentery cure [24].

Quassia amara is a medicinal herb that has been used by indigenous South American tribes for centuries. It is well-known for both its bitter and tonic properties. Pitier characterized it as "very rare in the parched woodlands of Costa Rica's Pacific region and one of the primary therapies used by Indian communities." They cut its trunk into 30-60 cm sections, take on their trips and on occasion, they sell in interior markets, which are being used for fevers and as an alcoholic infusion".

Historically, *Q. amara* wood has been misinterpreted with *Picasa excels*, commonly known as Jamaican quassia, quassia-das-Antilles, quassia-nova, and lienholders martin, a therapeutic herb which is widely used in Jamaica and other Caribbean islands. In Latin America, the most popular and commonly used name for *Quassia amara* is Cuisia, followed by hombre Grande (big man), neither of which refers to any specific aspect of the plant. This plant's scientific name is Surinam quassia. The indigenous Costa Rican names quiniela, kin, and kinin all refer to the bitter taste of the tissue as well as the bitter quinine (*Cinchona* spp.).

Simarouba amara and *Simarouba glauca*, both of which exhibit amoebicidal properties and are members of the Simaroubaceae family, have been given the common names ‘quassia amarga’ and ‘quassia Amer’, according to Taylor. In Argentina, this species has been confused with other bitter wood, particularly the Simaroubaceae (*Picrasma crenata*) found in Misiones' humid subtropical environment. The word Quassia-do-Basil, according to Oliveira, Aki sue, and Aki sue, refers to the species *Picrasma crenata*, also known as quassia amarga, pau-teniente, Paramaribo, and pau-quassia. There are two species of false quinine in Brazil: *Q. amara*, which prefers to grow in wild, humid Amazonian areas of Belen and Pará, and *Picrasma crenata*, also known as *Ascherson crenata* and in general, known as Pau-amarelle, which grows wildly in Mata Atlantic. Morton is alluding to the usage of *Paramania antidam*, a small shrub endemic to forest undergrowth in Central America, the Caribbean, and Mexico that is also known as man Grande and cascara amarga [25].

Bitter-tasting plants are essential natural resources in traditional medicine, but their botanical identity has been a matter of controversy. Despite this, the tropics have a long history of using *Q. amara* for its therapeutic purposes, misunderstandings have evolved in the literature due to inconsistent local names and a lack of access to botanical specimens.

A bitter tonic made from the macerated wood is used in Costa Rica to stimulate appetite and treat diarrhoea. Fever, liver and kidney stones, as well as digestive system problems, are believed to benefit from it. In Panama, a wood infusion is used to treat dysentery, dyspepsia, intestinal gases, vesicular colic, malaria, and as a febrifuge, whereas in Brazil, it is recommended as a treatment for dyspepsia, dysentery, vesicular colic, intestinal gases, malaria, as a febrifuge and in Peru, bark is used as a febrifuge and in hepatitis; in Colombia, it is used as a bitter tonic for the management of, anorexia, dyspepsia and malaria. In Honduras, boiling the bark treats stomach-aches, diabetes, urinary difficulties, diarrhoea, and migraines, as well as nourishing the blood, while the root treats snakebites in Nicaragua. A 20 cm piece of root is crushed in water and the obtained beverage is filtered and taken; 2 ounces of bark is sliced, cooked in water and drunk three times daily in malaria. It's a stomach stimulant with anthelmintic properties, according to Barnes, Anderson, and Phillipson. Anorexia, dyspepsia, and worm infestations have all been treated with it in the past (taken orally or rectally). Three times daily infusions of 0.3 to 0.6 g dry wood are recommended [4].

ETHNOMEDICINAL USES

Leaves are used for malaria by herbal medicine practitioners in Umua hia, Abia State, Nigeria [12]. The bitter-wood is used to treat snakebite [13]. It is known to have strong eupeptic, anti-malarial, stomachic, anthelmintic, anti-amoebic, and anti-anaemic properties in Traditional medicine system [14]. Plant extract is also useful for the treatment of diabetes [15].

Root infusion is used to reduce malarial fever. Bark and its decoction is blood purifier, anti-diarrheal, anti-dysenteric and anti-malarial though macerated inner bark decoction is drink to treat colds, by the Guyana Patamona. For the treatment of biliousness, malaria and sores in NW Guyana, wood is used. Wood chips are decocted in lotions for persistent venereal ulcers. The infusion of fresh roots and wood is used for refractory fever, tonic, aperitif and febrifuge. Stem is also used to treat spleen, liver (cirrhosis) and urinary tract diseases. In Surinam, stems are used to make bitters to reduce fever. Decoction of bark and leaves are used as a wash to expel skin of external parasites such as agouti lice. The infusion of bark and leaves are bitter tonic, cholagogue, febrifuge and vermifuge. In Guyana, boiled leaves and bark are useful as liquid bath for the treatment of smallpox and measles. The crusty leaves act as mosquito repellent. Infusion of root, leaves and flower is febrifuge in French Guiana. The flower infusion is drunk to relieve a heavy feeling in the stomach. Seed is used for malaria in NW Guyana [16].

Several stands sell which is locally called "Bitter-cups" & "Kwasi bite baker," small foot cups, roughly carved from white wood in the main markets of Paramaribo (Suriname). However, cups are purely medicinal and seems to be limited to Suriname, while not found in different neighbouring countries like Guyana, French Guiana, etc. [12].

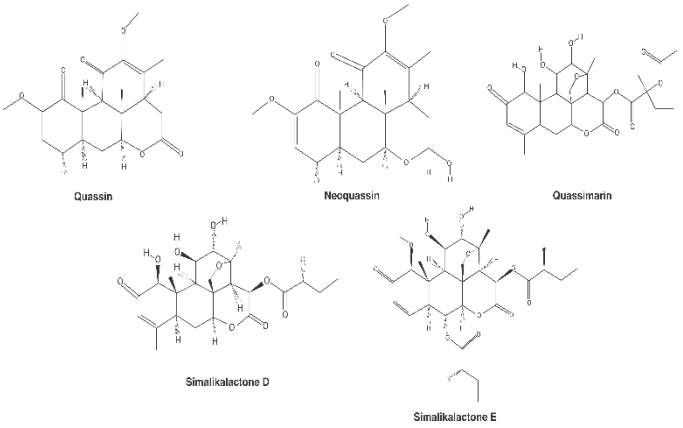
PHYTOCHEMICALS

Quassia includes a large number of active compounds and phytochemicals in all of its components. These active components include alkaloids (indole & β-carbonite), steroids (β-sitosterol, β-sitosterone, camp sterol & stigmasterol), triterpenes, and bitter principles of quassinoids [11]. The leaves contain quasimetric [15]. The root bark consists of volatile oil, malic acid, gallic acid, calcium tartrate and potassium acetate [14]. Some alkaloidal quassinoids have been extracted for the first time from wood of this plant [18]. Quassinoids (triterpenoid compounds) make up 0.25 percent of

Quassia wood's bitter components, with quassia, neoquassin, 18 hydroxy-quassia, and Simalikalactone D accounting for 0.1-0.15 percent of the total. Iroquoian, Parian, quasimetric, quassinol, and quassol are some of the other quassinoids discovered in wood ace. Quassinoids are seco-triterpene-lactones that are mostly found in the Simaroubaceae family. Quassinoids are the major components in this class that have pharmacological action.

More than 170 quassinoids have been identified and characterised at the time. Although Simalikalactone D is of type C-25 and quasimetric is of type C-27, the bulk of quassinoids in Quassia are of type C-20 (quassia, neoquassin, 18-hydroxy-quassin, squashing, Parian, quassinol, quassol). Quassinoids have the same metabolic antecedents as triterpenes and are biosynthetically connected to them. The most effective quassinoids have cyclic systems with a pentacyclic ring, a lactone function, and a cyclic methylene-oxygen bridge between C-8 and C-13 or C-11, according to the structure-activity relationship.

Later, the existence of indole alkaloids from the beta-carboline family, notably 1-vinyl-4,8-dimetroxy-betacarbolene, 1-methoxycarbonyl-betacarboline, and 3-methylcantin-2,6-dione, was identified in *Q. Amara*.



Source: PubChem

PHARMACOLOGICAL DESCRIPTION

The substantial researches using different contemporary research-based techniques were implemented by several researchers on *Q. amara* since it is asserted to be a marvellous herb that can cure various ailments and disorders. A large number of pharmacological effects including pre-clinical & clinical studies of *Q. amara* have been explored in the past few decades mentioned is shown in Figure 1.

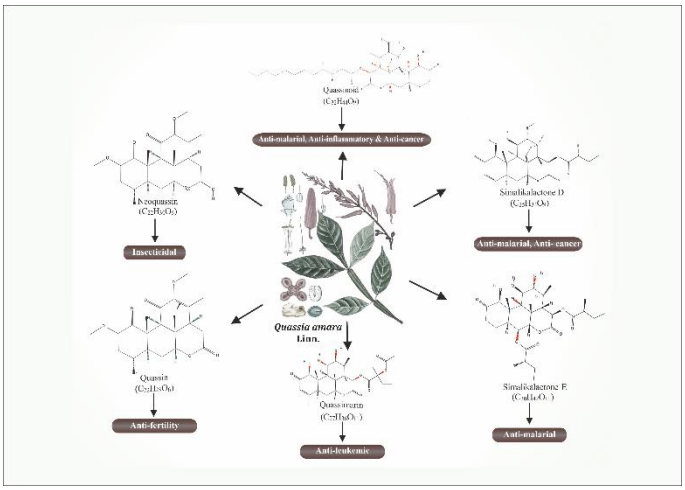


Figure 1: Secondary Metabolites and Pharmacological Properties of *Quassia amara* L.

Pre-clinical Investigations

Pre-clinical studies are the testing of medicine, surgery, or other medical therapy in animals before human trials. Toxic and pharmacological effects of a medicine must be studied in vitro and in vivo laboratory animal testing during preclinical drug development. Several preclinical investigations on various extracts, fractions, and isolated chemicals from *Quassia amara* L. were conducted, and the results might be utilized as evidence and support in FDA applications for the approval of novel medications and medical treatments. Some investigations are as follows.

Anti-diabetic activity

The methanol extract (100 & 200 mg/kg; b.w.) of *Quassia amara* reduced the elevation of fasting blood glucose levels in Nicotinamide–Streptozotocin (STZ)-induced diabetic rats using oral glucose tolerance test. Further, extract at same doses also increased glucose tolerance when compared with vehicle treated groups. The extract and Glipalamide (10 mg/kg; b.w.) used as standard effectively normalized dyslipidaemia associated with STZ-induced diabetic rats [6].

Anti-inflammatory activity

The hexane extract (500 mg/kg; b.w.) from bark of *Quassia amara* showed moderate inhibitory effect of 46.4% inhibition when compared with indomethacin (46.4%) used as positive control towards Carrageenan-induced paw oedema in male Swiss mice [19].

Anti-fertility activity

The methanol extract (25, 50 & 100 mg/kg; b.w.) along with isolated quassia (1 mg/kg; b.w.) from bark of *Quassia amara* showed dose-dependent reduction in sperm count, motility and viability in male Swiss mice, compared to control animals. Extract increased percentage of spermatozoa with abnormal morphologies in mice. Both methanol extract and quassia-treated animals were prematurely released to various degree germ cells from the seminiferous tubules and Leydig cells were vacuolated [20].

Anti-hyperglycaemic activity

The saline treated control group showed an increase in blood glucose level at 30 & 60 min. (230.67±26.12 & 239.17±36.52 mg/dl) after loading glucose orally in rats. After administration of wood powder from *Quassia amara* (200 mg/kg; orally) exhibit anti-hyperglycaemic effect with 126.43±8.48 & 108.00±12.73 mg/dl and, metformin (standard; 500 mg/kg; b.w.) with 117.00±18.84 & 102.00±16.19 mg/dl during same time intervals, although exhibited a prevention of glycaemic rise after glucose load in normal and Alloxan-induced diabetic rats [21].

Anti-leishmanial activity

The dichloromethane fraction (500 µg/ml) from methanol extract of *Quassia amara* showed potent anti-leishmanial effect with MIC values of 62.5 & 31.25 µg/ml towards *Leishmania amanuensis* and *L. infantum* promastigotes, respectively. However, some ultrastructural alterations observed such as intense vacuolization, nuclear chromatin condensation, autophagic & myelin-like figures were observed in dichloromethane fraction treated parasites [11].

Anti-malarial activity

Quassinoids including simalikalactone D & E isolated from hot water extract of *Quassia amara* leaves exhibited good inhibitory effect with IC_{50} of 10 NM for FcB1 *Plasmodium falciparum* chloroquine resistant strain *in vitro*. Further, isolated compounds exert 50% inhibition towards *P. yoelii* rodent malarial parasite at 3.7 mg/kg/day *in vivo* by oral route administration [22].

Anti-nociceptive activity

The hexane extract (500 mg/kg; b.w.) from bark of *Q. amara* showed decrease in number of writhing as well as, percentage of inhibition was 52.6% for acetic acid-induced abdominal writhing test in male Swiss mice, as compared to dipyrone (200 mg/kg) used as positive control was 71.9% inhibition [19].

Anti-ulcer activity

The ethanol (70 & 100%), dichloromethane (100%) and hexane (100%) extracts (5000 mg/kg; oral & 1000 mg/kg; i.e.) from *Quassia amara* bark did not cause toxic effect nor death. Further, ethanol (70 & 100%), dichloromethane and hexane extracts (100 mg/kg; p.m.) inhibit gastric ulcer with percentage of inhibitions were 22.5, 23.4, 50.5 & 46.8%, respectively for Indomethacin/bethanechol-induced gastric ulcer in mouse. All tested doses of extracts reduced gastric injury by 70.7, 80, 60 & 82.7% towards hypothermic restraint–stress test in mice. Pre-treatment with single intra-duodenal extract at 100 mg/kg, only ethanol (70%) did not change any biochemical parameters of gastric juice in pylorus ligature of mouse stomach. In addition, all tested extracts (100%) also decreased gastric juice content and acid output but, increased pH values. All tested extracts except for ethanol extract (70%; 25 mg/kg) exert an increase in free mucous eradicated when pre-treated with Indomethacin in animals. However, synthesis of prostaglandin increased by 52.3% in hexane extract (100 mg/kg) treatment but, effect was abolished with prior treatment of Indomethacin [1].

Cytotoxicity

Different fractions such as chloroform, methanol, hexane along with isolated compound as quassia of *Quassia amara* showed good inhibitory effect with LC_{50} of 93.4569, 172.0463 & 46.1941 µg/ml, respectively for *Artemia salina* nauplii. Further, methanol extract did not show lethality up to 5000 mg/kg; orally in OECD limit test [23].

Sedative activity

The hexane extract (100, 250 & 500 mg/kg; b.w.) from bark of *Quassia amara* dose-dependently prolonged pentobarbital-induced sleeping time in male Swiss mice. Both hexane and morphine used as standard attained an increase in the effectiveness for naloxone (5 mg/kg) pre-treated mice when compared to control in hot-plate test [19].

Clinical Investigations

The clinical investigations are primarily concerned with disease diagnosis, followed by the administration of appropriate treatment care. Traditional analytical procedures use specific indicators or relevant biomarkers of a certain disease to increase diagnostic accuracy. Some clinical studies were conducted during trial period of *Q. amara* L. effectiveness which are as follows.

3 capsules (500 mg each) filled with heartwood powder of *Q. amara* showed effectiveness on delicate to moderate including 58 patients having type 2 diabetes mellitus. Capsules showed reduction of 19.33% for fasting and post-prandial blood sugar level was 220.5%. Similarly, capsules treatment also decreased serum cholesterol level of 9.95 and 13.63% on *S. Triglyceride* level and, 1.52% decrease in body mass index [15].

A randomized, double-blind and comparative study was reported for efficacy and safety of topical gel (4%) from *Q. amara* extract in the treatment of facial Seborrheic dermatitis including 60 patients and, was compared with topical ketoconazole (2%) and cyclopiroxolamine (1%). Out of 60 patients, only 54 patients (90%) completed overall study with three therapeutic properties results to be very effective with a significant advantage in efficacy for 4% Quassia gel [10].

Toxicity profile

The methanol extract from stem bark of *Q. amara* lowered the weight of testes, caudal epididymis, and seminal vesicle, as well as sperm motility, viability, volume, and count in adult male Wistar albino rats. Furthermore, extract lowered epididymis tissue protein in rats, but there was no significant difference in testicular total tissue protein when compared to control. Luteinizing hormone and testosterone levels were both lowered, while follicle stimulating hormone had no effect. When compared to control, epididymis with fewer ducts was loosely packed together in the histological section, with ducts carrying the least amount of ductular eosinophilic material. The ductular epithelium, on the other hand, remains normal, and there is no apparent lesion in the testicular epithelium [1].

CONCLUSION

Quassia amara contains a high concentration of quassinoids & their derivatives, which can be utilised to cure a variety of ailments. In this review, four articles revealed the phytochemicals found in the plant, while seven papers provided information on various biological studies, three historical contexts, and seven papers described the medicinal uses of plant against various diseases such as malaria, diabetes, ulcer, analgesia, fertility, inflammation, and so on. The plant was reported for diabetes and dermatitis in two clinical studies. In addition, one additional study looked at the plant's toxicity in relation to the male reproductive system.

Medicinal herbs play very effective role to human beings in preserving our health. Bitter-wood is of prominent concern due to its commercially valuable isolated compounds such as quassinoids which are widely useful in the treatment of different diseases including cancer, amoebic dysentery and malaria as well as, insecticide and stomachic in South American traditional medicine system. Till date, bitter wood is less explored, not documented and first time to be reviewed in broad way. In concern of new attraction for natural products from bitter-wood, appropriate biological and phytochemical study is compulsory to be explored due to its traditional values, which opens a new biological avenue for this spectacular plant which are beneficial for clinical experimentation and, also in the expansion of novel drugs.

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Conflict of Interest

None declared.

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REFERENCES

1. Remya E, Goyal M. Therapeutic Evaluation of Quassia *amara* LINN. -A Critical Review. Global Journal of Research on Medicinal Plants & Indigenous Medicine. 2017;6(9):109-13.
2. Diehl C, Reznichenko N, Casero R, Faenza L, Cuffini C, Palacios S, *et al*. Novel antibacterial, antifungal and antiparasitic activities of Quassia *amara* wood extract. International Journal of Pharmacology, Phytochemistry and Ethnomedicine. 2016;2:62-71.

3. Fernand VE. Initial characterization of crude extracts from Phyllanthus amarus Schum. and Thonn. and Quassia *amara* L. using normal phase thin layer chromatography. 2003:0407103-163959.
4. American Botanical Council: Quassia *amara* L. (2022). Retrieved from https://www.herbalgram.org/resources/herbalgram/issues/87/table-of-contents/article3558/
5. Burlando B, Cornara L. Revisiting Amazonian plants for skin care and disease. Cosmetics. 2017;4(3):25.
6. Husain GM, Singh PN, Singh RK, Kumar V. Antidiabetic Activity of Standardized Extract of Quassia *amara* in Nicotinamide–Streptozotocin-induced Diabetic Rats. Phytotherapy research. 2011;25(12):1806-12.
7. European Food Safety Authority (EFSA). Outcome of the consultation with Member States and EFSA on the basic substance application for Quassia *amara* L. wood extract for use in plant protection as insecticide and repellent. 2018;e1382.
8. Toma W, de Souza Gracioso J, de Andrade FD, Hiruma-Lima CA, Vilegas W, Brito AR, *et al*. Antiulcerogenic activity of four extracts obtained from the bark wood of Quassia *amara* L.(Simaroubaceae). Biological and Pharmaceutical Bulletin. 2002;25(9):1151-5.
9. Lopez Saez JA, Perez Soto J. Ethnopharmacology and biological activity of Quassia *amara* (Simaroubaceae): State of the art. Boletin Latinoamericano Y Del Caribe De Plantas Medicinales Y Aromaticas. 2008;7(5):234-46.
10. Diehl C, Ferrari A. Efficacy of topical 4% Quassia *amara* gel in facial seborrheic dermatitis: a randomized, double-blind, comparative study. Journal of drugs in dermatology. 2013;12(3):312-5.
11. Gabriel RS, *Amara*l AC, Corte-Real S, Lopes RC, Alviano CS, Vermelho AB, *et al*. Antileishmanial effects of the alkaloid-rich fraction of Quassia *amara* L. Journal of Medicinal Plants Research. 2016;10(42):775-82.
12. Anowi CF, Ekwueme PO. Ethnobotanical Survey of Medicinal Plants Used to Treat Malaria by the Traditional Medicine Practitioners in Umuahia, Abia State, Nigeria. 2019;(14)5:05-37.
13. Coe FG, Anderson GJ. Ethnobotany of the Garifuna of eastern Nicaragua. Economic Botany. 1996;50(1):71-107.
14. Barbetti P, Grandolini G, Fardella G, Chiappini I. Indole alkaloids from Quassia *amara*. Planta medica. 1987;53(03):289-90.
15. Gunjal A, Goyal M, Varsakiya J. A pilot study on Quassia *amara* Linn: a newly emerging drug for type 2 diabetes. International Journal of Research in Ayurveda Pharmacy. 2017;8(5):49-52.
16. DeFilipps RA, Maina SL, Crepin J. Medicinal plants of the Guianas (Guyana, Surinam, French Guiana). Medicinal Plants of the Guianas (Guyana, Surinam, French Guiana). 2004.
17. WHO Traditional Medicine Strategy. 2002-2005. Retrieved from https://apps.who.int/iris/handle/10665/67163
18. Obembe OO, Oloyede GK, Raji Y. Cytotoxicity and acute oral toxicity study on quassin and fractions of Quassia *amara* extract. International Journal of Sciences: Basic and Applied Research. 2014;13(1):139-44.
19. The Wealth of India: Raw materials. New Delhi, India: National Institute of Science Communication and Information Resources. 2003;8:345.
20. Faisal K, Girija R, Akbarsha MA. Aspects of male reproductive toxic effects of Quassia *amara* L.: Histopathological and ultrastructural study in mouse. Journal of Endocrinology and Reproduction. 2015;19:81-99.
21. Ferreira SF, Azevedo SC, Vardanega-Peicher M, Pagadigorria CL, Garcia RF. Anti-hiperglycemic effect of Quassia *amara* (Simaroubaceae) in normal and diabetic rats. Revista Brasileira de Plantas Medicinais. 2013;15(3):368-72.
22. Bertani S, Houël E, Jullian V, Bourdy G, Valentin A, Stien D, *et al*. New findings on Simalikalactone D, an antimalarial compound from Quassia *amara* L.(Simaroubaceae). Experimental parasitology. 2012;130(4):341-7.
23. Muganza DM, Fruth BI, Lami JN, Mesia GK, Kambu OK, Tona GL, *et al*. In vitro antiprotozoal and cytotoxic activity of 33 ethonopharmacologically selected medicinal plants from Democratic Republic of Congo. Journal of ethnopharmacology. 2012;141(1):301-8.
24. Gurney AB. Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture to students of neuropteroid insects, as well as to ento. 1939.
25. Morton, J. F. Atlas of medicinal plants of Middle America: Bahamas to Yucatan. Charles C. Thomas. 1981;1448-563.

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