REVIEW ARTICLE

Phytopharmacology of *Abelmoschus moschatus* medik.: A review

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Abstract

Herbal medicine is playing an essential role in health care, with about 75–80% of the world's population relying mainly on the use of traditional or alternative systems of medicines for their primary health care. *Abelmoschus moschatus* Medik., commonly known as musk okra belonging to the family *Malvaceae*, is used traditionally in the treatment of various health ailments throughout the world. The plant has been extensively studied by various researchers for its biological activities and therapeutic potentials. The present review summarizes information published in various academic journals and books, covering folkloric uses, chemical compositions, pharmacological activities of the extracts and isolated compounds, and safety profile of *A. moschatus* for further research studies.

Key words: *Abelmoschus moschatus*, *Malvaceae*, myricetin

INTRODUCTION

Abelmoschus is a genus of about 15 species of flowering plants belongs to the family of flowering plants called *Malvaceae*. Out of which *Abelmoschus moschatus is* cultivated in the tropical regions of Asia, Africa, and South America for its seeds which are used mostly for the isolation of fragrance components.[1] In India, it is found wild all over the hilly regions of Deccan and Karnataka and also at the foothills of the Himalayas.[2] The plant is traditionally used in the treatment of various health ailments. The plant is rich in a number of phenolic compounds, flavonoids, carbohydrates, proteins, sterols, tannins, fixed oil, and fats. *A. moschatus* has been extensively studied by various researchers for its biological activities and therapeutic potentials such as diuretic, antioxidant activity and free-radical scavenging, antiproliferative, antimicrobial, antilithiatic, hepatoprotective, memory strengthening, antidiabetic, hemagglutinating, anti-ageing, antidepressant, anxiolytic, anticonvulsant, hypnotic, and muscle relaxant activity. The present review summarizes information published in various academic journals and books, covering phytochemical, pharmacognostic, pharmacological, and toxicity updates of *A. moschatus*.

BOTANICAL DESCRIPTION

Taxonomy

Kingdom: Plantae.
Subkingdom: Viridaeplantae.
Infrakingdom: Streptophyta.
Division: Tracheophyta.
Subdivision: Spermatophytina.
Infradivision: Angiospermae.
Class: Magnoliopsida.
Superorder: Rosanae.
Order: Malvales.
Family: *Malvaceae.*
Genus: Abelmoschus Medik.
Species: *A. moschatus* Medik.

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Synonyms

Abelmoschus ficulneus Wight er Arn., *Hibiscus abelmoschus* L., *Hibiscus moschatus* Salisb.

Common Names

Abelmosk seed, ambrette seed, amber seed, musk mallow, musk seed, musk okra.

Vernacular Names

Arabic: Abu-el-misk, abu-el-mosk, bamia.
Brazil (Portuguese): Abelmosco, ambarino.
French: Ambrette, ketmie musquee.
German: Abelmoschus-samen, Ambramalve, Ambrette, Bisamkorner, Muskateller-Eibisch.
Hindi: Algalia, Mushk dana.
Italian: Abelmosco, Ambretta.
Japanese: Ryu kyu-tororo-aoi.
Mexican: Dona Elvira.
Pilipino: Kastuli, dalupang, daopang, marapota.
Russian: Bamiji, hibiskus.
Sanskrit: Latakasturi.
Spanish: Abelmosco, Algalia, Ambarcillo, Ambarina, Café extranjero.
Thai: Chamot-ton, Somchaba, Mahakadaeng.
English: Musk okra, Muskmallow.
Ayurvedic: Lataakasturi, Lataakasturikaa, Kattaphala, Katukaa.
Unani: Mushkdaanaa, Habb-ul-mushk.
Siddha: Kattu Kasturi.

MORPHOLOGICAL CHARACTERS

A. moschatus is annual, erect herb which grows up to 1.6 m in height. Leaves are polymorphous, more or less cordate, the lower ovate, acute or roundish-angled with the upper palmately 3–7 lobed divided nearly to the base. Lobes are narrow-acute or oblong-ovate, crenate, serrate or irregularly toothed, and hairy on both surfaces. Flowers are large, bright yellow with dark purple base in color and usually appear solitary axillary. Capsules are 6.5–7.5 cm long, ovate, acute, and hispid. Seeds are subreniform, black or grayish brown in color, concentrically ribbed, and scented [Figure 1].[3,4]

PROPERTIES AND TRADITIONAL CLAIMS

The seeds are diuretic, aphrodisiac, ophthalmic, cardiotonic, digestive, stomachic, constipating, carminative, pectoral, stimulant, antispasmodic, deodorant, insecticidal, and tonic.[5]

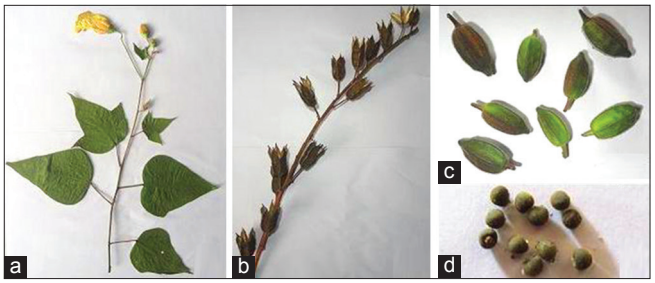

Figure 1: Parts of *Abelmoschus moschatus* L. plant (a) branch showing arrangement of leaves and flower, (b) branch bearing capsule, (c) capsules, (d) seeds

The seeds are useful in perfumery and medicine. They are useful in ophthalmopathy, cardiac debility, cough, asthma, bronchitis, hyperdipsia, burning sensation, nausea, dyspepsia, flatulent colic, diarrhea, strangury, gonorrhea, spermatorrhea, calculi, halitosis, pectoral diseases, ptyalism, vomiting and other neural disorders, pruritus, leukoderma, and general debility. They are inhaled for dryness of the throat. Powdered seeds stepped in alcohol are applied to the bites of serpents and seeds steeped in water are used for asthma, cold, flu, and worms. Seeds rubbed to a paste with milk are used to cure itch. Decoction of the seeds is used in stomach cancer. The mucilaginous seeds are emollient and demulcent. The crushed seeds yield a volatile oil known as musk seeds oil or ambrette oil which is used in perfuming medicinal oils. Mucilage made from root and leaves of the plant is recommended in gonorrhea and venereal diseases. The poultice of leaves and roots is used in cystitis, fever, headache, rheumatism, and for varicose veins and boils.[4-7]

PHYTOCHEMISTRY

The whole plant extracts of *A. moschatus* showed the presence of carbohydrates, proteins, flavonoids, sterols, tannins, phenolic compounds, fixed oil, and fats.[8]

Seed contains moisture (11.14%), protein (2.3%), starch (13.35%), crude fiber (31.46%), fatty oils (14.5%), volatile oil (0.2–0.6%), and resin (5%). The volatile oil extracted from crushed seeds is called as crude oil or concrete. The main constituent of the seed oil is a sesquiterpene alcohol, farnesol (0.12% in the seeds). The characteristic musk-like odor of oil is due to the presence of a ketone, ambrettolide (0.3% in the crude oil) which is lactone of ambrettolic acid (16-hydroxy-7-hexadecenoic acid). The presence of acetic and ambrettolic acids in the ester forms has also been reported. Furfural is present in the water condensate of seed oil. The seed concrete contains large amount of higher fatty acids, chiefly palmitic acid.[9] Other fatty acids present in crude volatile oil of seeds are octanoic acid, nonanoic acid, hexadecanoic acid, octadec-9-enoic acid, octadeca-9,12-dienoic acid, decanol, dodecanol, (E)-nerolidol, (ZE)-farnesol, (EE)-farnesol, decyl acetate, dodecyl acetate,

(ZE)-farnesyl acetate, (EE)-farnesyl acetate, (EE)-farnesyl myristate, (EE)-farnesyl palmitate, (EE)-farnesyl stearate, (EE)-farnesyl oleate, (EE)-farnesyl linoleate, and (EE)-farnesyl-16-hydroxy-hexadec-7-enoate. The fatty oil extracted from the seeds is rich in linoleic acid and contains phospholipids-α-cephalin, phosphatidylserine, and its plasmalogen and phosphatidylcholine plasmalogen. The seeds also contain 2-trans-6-trans-farnesyl acetate, 2-cis-6-trans-farnesyl acetate, 1-(-acetoxyethyl)-1-hexylcyclopropane, and 1-(4-acetoxybutyl)-2-hexacyclopropane.[10] The volatile compounds were also identified in the seed coats of the plant, out of which 2-methylbutyl-2-methylbutanoate was most abundant compound.[11]

The yellow portion of the petals of the plant contains the flavonoids, myricetin, and cannabiscitrin. The flowers are reported to contain cyanidin-3-sambubioside and cyanidin-3-glucoside.[6] The leaves contain beta-sitosterol and its beta-D-glucoside, myricetin and its glucoside [Figure 2].[2]

PHARMACOLOGY

Diuretic Activity

The diuretic activity of methanolic extract of *A. moschatus* seeds was evaluated at the dose of 50 and 100 mg/kg in rats. The plant extract administration resulted in significant increase in urine volume in dose-dependent manner. The percent increase in urine volume kg was 22 and 44 % by the dose of 50 and 100 mg/kg, respectively, as compared to the control group. There was also significant increase in the sodium excretion but only at the higher dose (100 mg/kg) of plant extract. The plant extract showed the additional advantage of potassium-conserving effect.[12]

The petroleum ether, chloroform, and alcoholic extracts of leaves of the plant were also studied for diuretic potential at the dose of 200 mg/kg in rats. The alcoholic extract was found most effective in increasing urine output and urinary electrolyte excretion followed by chloroform and petroleum ether extracts.[13]

Antioxidant Activity and Free-radical Scavenging Activity

The antioxidant and free-radical scavenging activity of the seed and leaf extract of *A. moschatus* were studied by total antioxidant, DPPH, and ferrous reducing antioxidant property methods. The extract of seed and leaf showed significant antioxidant activity with highest activity of 21.52 mgAAE/dw (milligram of ascorbic acid equivalents per gram of dry weight) by hydroalcoholic leaf extract of the plant. Both leaf and seed extracts showed DPPH radical scavenging activity. Hydroalcoholic seed extracts exhibited higher DPPH radical scavenging activity with IC50 value of 38.1 µg GAE/ml (microgram of gallic acid equivalents per gram of dry weight). Leaf extract of the plant showed considerably higher ferrous reducing power (6.28 mg AAE/gdw by hydroalcoholic extract) than the seed extract. The seed and leaf extract of the plant also showed significant lipid peroxidation inhibiting effect as well as hydrogen peroxide, hydroxyl radical, and superoxide radicals scavenging activity.[14]

Antiproliferative Activity

The antiproliferative activity of the seed and leaf extracts of *A. moschatus* was evaluated using colorectal adenocarcinoma (COLO-205) and retinoblastoma human cancer (Y79) cell lines. The result indicated that hydroalcoholic seed extract showed 73.33 and 74.40% inhibitory activities, at the concentration of 200 µg/ml, against COLO-205 and Y79 cell lines, respectively. The hydroalcoholic leaf extract showed 78.25 and 78.8% inhibitory activities, at the concentration of 200 µg/ml, against cell lines COLO-205 and Y79, respectively.[14]

Antimicrobial Activity

Hexane, ethyl acetate, methanol, and aqueous extracts of leaves of *A. moschatus* were evaluated for their antimicrobial activity against a number of pathogens using disc diffusion assay method. Results showed that the plant has significant antimicrobial activity against *Staphylococcus aureus*, *Bacillus megaterium*, *Shigella flexneri*, *Proteus mirabilis*, *Proteus vulgaris,* and *Corynebacterium diphtheriae*. The hexane fraction containing essential oil showed strong antibacterial activity against *C. diphtheriae.* Aqueous extract of *A. Moschatus* seeds exhibited antimicrobial activity against *Bacillus subtilis, S. aureus, Escherichia coli, Pseudomonas aeruginosa, P. vulgaris,* and *Salmonella enterica paratyphi*. Hydroalcoholic extract of leaves of plant also showed antimicrobial effect against *Candida albicans*.[15]

A novel trypsin inhibitor (AMTI-II) with both antibacterial and antifungal activities was purified from the seeds of the plant. AMTI-II exhibited potent antibacterial activity toward *S. aureus, E. coli, P. vulgaris, B. subtilis, Streptococcus pneumoniae,* and *Bacillus cereus,* and it was moderately active against *Klebsiella pneumoniae, P. aeruginosa, Pseudomonas syringae,* and *Streptococcus pyogenes.* AMTI-II also found to moderately affects the growth of fungal species, *C. albicans, Candida tropicalis, Aspergillus flavus, Saccharomyces cerevisiae, Candida glabrata* and *Aspergillus niger*.[16]

Antilithiatic Activity

The hydroalcoholic extract of whole plant of *A. moschatus* was studied at the dose of 200 and 400 mg/kg against

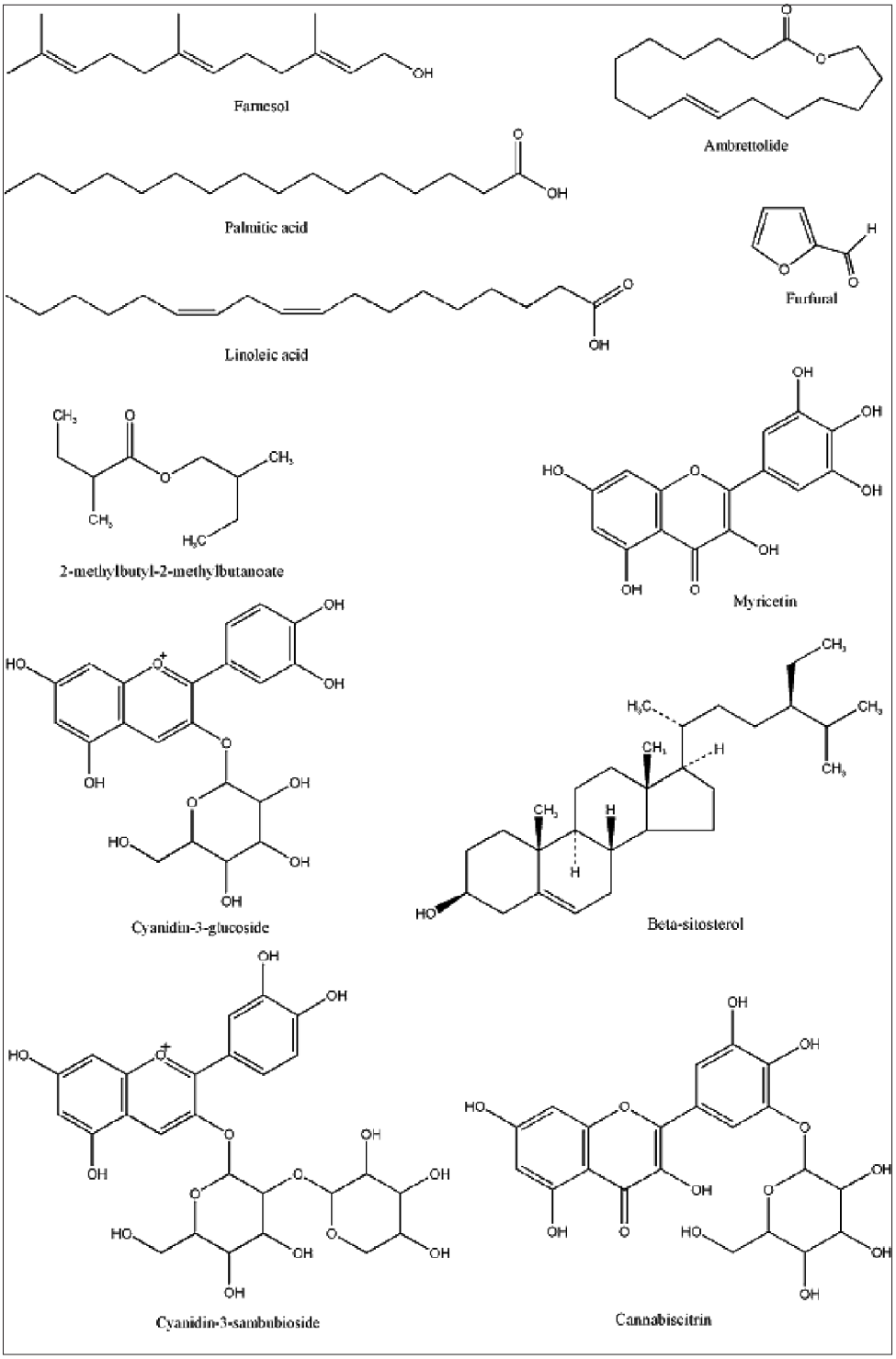

Figure 2: Structure of chemical constituents of *Abelmoschus moschatus* L.

ethylene glycol-induced urolithiasis in rats. The plant extract caused significant decrease in urinary calcium, oxalate, and phosphate levels, and increase in the urinary magnesium level as compared to lithiatic control animals. It is concluded that the plant extract reduced and prevented the growth of urinary stones against ethylene glycol-induced lithiasis possibly through an antioxidant, nephroprotection, and its effect on the urinary concentration of stone-forming constituents and risk factors.[8]

Hepatoprotective Activity

The hepatoprotective activity of ethanolic and aqueous extracts of seeds of *A. moschatus* was studied at the dose of 300 mg/kg against paracetamol and ethanol-induced hepatotoxicity in rats. Administration of ethanolic as well as aqueous extract prevented paracetamol-induced lipid peroxidation of liver tissue and restored altered serum marker enzymes such as serum glutamic oxaloacetic transaminase, serum glutamate

pyruvate transaminase, and alkaline phosphatase and total bilirubin levels toward normal. Hepatoprotective activity of ethanolic extract was found more significant than the aqueous extract. It is concluded that the *A. moschatus* seed has significant protective effect against paracetamol and ethanol-induced hepatotoxicity in rats.[17]

Memory Strengthening Effect

The ethanolic extract of *A. moschatus* seeds was evaluated for memory strengthening activity at the dose of 100 and 200 mg/kg in mice. Pre-treatment of plant extracts for seven successive days significantly improved learning-memory and reversed the diazepam-induced amnesia in mice. It also decreased whole brain acetylcholinesterase and malondialdehyde content and increases the brain glutathione. These results indicate that ethanolic seed extract of *A. moschatus* has memory strengthening, anticholinesterase activity, and antioxidant activity.[18]

Antidiabetic Activity

The hypoglycemic activity of myricetin isolated from *A. moschatus* was investigated in streptozotocin-induced diabetic rats. Results indicated that intravenous injection of myricetin causes significant decrease of the plasma glucose concentration in a dose-dependent manner.[19] It is concluded that hypoglycemic effect of myricetin is due to the enhancement of glucose utilization by activation of opioid μ-receptors of peripheral tissues in response to increased β-endorphin secretion.[20] Moreover, myricetin improved insulin sensitivity through the enhancement of insulin action on IRS-1-associated PI3-kinase and GLUT4 activity in soleus muscles of obese Zucker rats.[21]

Effects on Central Nervous System

Effect of oral administration of hydroalcoholic extract of *A. moschatus* seeds was evaluated at doses of 200 and 0 on various behavioral models such as forced swim test, tail suspension test, light-dark box test, elevated-plus-maze test, locomotor test, hole-board test, pentylenetetrazole-induced convulsions, strychnine-induced convulsions, maximal electroshock-induced seizure, pentobarbitone-induced sleeping time test, rotarod method, climbing test, and inclined screen test in laboratory animals. Results indicated that the both doses of *A. moschatus* seed extract (200 and 400 mg/kg) possesses antidepressant, anxiolytic, anticonvulsant, hypnotic, and muscle relaxant activity.[22]

Hemagglutinating Activity

AMTI-I and AMTI-II isolated from the seeds of *A. moschatus* was evaluated for hemagglutinating activity against both normal and trypsin-treated erythrocytes of rabbit, rat, human, and sheep. Results showed that both the inhibitors, AMTI-I and AMTI-II, agglutinated trypsin-treated rabbit and rat erythrocytes at a much lower concentration compared to those of human and sheep. As low as 12.5 μg, AMTI-I and AMTI-II was sufficient to cause the visible agglutination reaction with trypsin-treated rabbit erythrocytes. The inhibitors agglutinated trypsin-treated rabbit and rat erythrocytes equally but the titer value obtained with native rabbit erythrocytes was 2 times higher than that obtained with untreated rat erythrocytes. Both AMTI-I and AMTI-II also agglutinated trypsin-treated human erythrocytes irrespective of the blood groups. It is concluded that the AMTI-I and AMTI-II exhibit stable and potent hemagglutinating property against human and animal erythrocytes and may be useful in agricultural field for the development of insect-resistant transgenic crops.[23]

Anti-ageing Property

A cosmetic preparation containing *A. moschatus* seed extract was developed and studied for its effect on skin fibroblast *in vitro* and *in vivo*. Results of *in vitro* experiment showed that *A. moschatus* seed extract exhibits heparan sulfate-like properties and dose-dependently protects FGF-2 from thermal degradation. *In vivo* experiment also confirmed anti-ageing properties of *A. moschatus* seed extract and found to cause significant improvements in wrinkles, skin texture, skin elasticity, and skin density by preserving FGF-2 content of human skin.[24]

SAFETY AND TOXIC PROFILE

Acute and 28 days subacute oral toxicity studies of hydroalcoholic seed extracts of *A. moschatus* were conducted in Swiss albino mice and Wistar albino rats.[25] Results indicated that a dose of 2000 mg/kg body weight of hydroalcoholic seed extracts of *A. moschatus* given orally appeared to be non-toxic. Acute oral toxicity and safety evaluation of seed oil in albino rats showed the oil is safe to use for edible purposes.[1] An airborne photoallergic contact dermatitis with brownish pigmentation is reported by musk ambrette in incense.[26]

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