ALHAGI MAURORUM AS A POTENTIAL MEDICINAL HERB: AN OVERVIEW

Ali Esmail Al-Snafi

Department of Pharmacology, College of Medicine, Thi qar University, Nasiriyah, P O Box 42, Iraq.

ABSTRACT

The previous studies showed that *Alhagi maurorum* contained many secondary metabolites including flavonoids, fatty acids, coumarins, glycosides, sterols, resins, vitamins, alkaloids, carbohydrates, tannins, unsaturated sterols and triterpenes. It exerted antibacterial, anti-inflammatory, antipyretic, analgesic, antioxidant, gastrointestinal, cardiovascular, diuretic, and dermatological and many other effects. The present review will highlight the chemical constituents and the pharmacological and therapeutic effects of *Alhagi maurorum*.

Key words: *Alhagi maurorum*, pharmacology, chemical constituents.

INTRODUCTION

Herbal Medicine is the oldest form of medicine known to mankind. It was the mainstay of many early civilizations and still the most widely practiced form of medicine in the world today. The previous studies showed that *Alhagi maurorum* contained many secondary metabolites including flavonoids, fatty acids, coumarins, glycosides, sterols, resins, vitamins, alkaloids, carbohydrates, tannins, unsaturated sterols and triterpenes. It exerted antibacterial, anti-inflammatory, antipyretic, analgesic, antioxidant, gastrointestinal, cardiovascular, diuretic, and dermatological and many other effects. The present review will highlight the chemical constituents and the pharmacological and therapeutic effects of *Alhagi maurorum*.

Synonym


Common names

Arabic: Shook, Aquool, Shook El Jamal, Shprim, Lehlah;
English: Camel thorn bush, Caspian manna, Persian manna;
French: alhagi des Maures;

Taxonomic classification

Kingdom: Plantae; Phylum: Spermatophyta; Subphylum: Angiospermae; Class: Dicotyledonae; Order: Fabales, Family: Fabaceae, Subfamily: Faboideae; Genus: Alhagi, Species: *Alhagi maurorum* [5].

Description

It is a deep rooted, rhizomatous, perennial shrub, with roots that can extend six to seven feet into the ground. The spiny, intricately-branched shrub reaches 1.5 to 4 feet in height. The plant, which is grayish green and hairless, has simple, entire leaves that are alternately arranged. The leaf shape is oval to lance-shaped. The small pea-like flowers are pinkish purple to maroon and are borne on short, spine-tipped branches that arise from the leaf axials. The reddish-brown to tan fruits are found between the seeds, with a short narrow beak at the end [5-6].

Distribution

It was native to North Africa, Middle East and South East Europe. It was also found in wide areas including Asia ( Afghanistan, Armenia, Azerbaijan, Bahrain, China, India, Iran, Iraq, Palestine, Jordan, Kazakhstan, Kuwait, Lebanon, Mongolia, Pakistan, Saudi
Traditional uses

*Alhagi maurorum* plant is grazed by livestock. It is cut in late spring and used for making hay for small livestock and camels (9-10). Manna, a sugar exudate, is formed on stems and leaves and shaken from the bushes at flowering. In Indian markets it is sold under the name (torajabin) and is imported from Afghanistan and Iran. Today, manna is used for extracting mannitol, made into tablets and used in the cosmetic and pharmaceutical industries to produce laxatives, diuretics and sweeteners [11-14]. It composed from monomeric units mainly consisting of galactose and uronic acids [15]. *Alhagi maurorum* is customarily used in folk medicine as a remedy for rheumatic pains, bilharziasis, liver disorders, various types of gastrointestinal discomfort, general tonic, anthelmintic, to treat constipation, jaundice, and arthritis. It also used as diuretic, blood purifier, antimicrobial, for treatment of dysentery, upper respiratory system problems, wounds, hemorrhoids and uterine problems. The roots were used as aphrodisiac [7-8, 16]. The plant is used as laxative, diuretic and expectorant in India. The oil extracted from leaves is used for curing rheumatism [17]. A decoction made from seeds of *Alhagi maurorum* is used for curing kidney stones [18].

**Part used:** All plant parts including the roots were used medicinally

**Physicochemical constants**

Moisture 8.76%, loss in weight on drying at 105°C (%): 9.2-9.5, solubility (%): (alcohol solubility 14.00-15.00, water solubility: 23.00-24.00, 10% ethanolic extractive : 34.00-35.50 ), ash values (%): ( total ash: 11.20-12.66, water soluble ash: 6.4-6.6, acid-insoluble ash: Nii), and successive extractive value (%): (petroleum ether (60-800): 4.6-6.8, chloroform: 1.00-1.10%, absolute alcohol: 8.1-8.2, distilled water: 26.8 – 27.00) [7, 19].

**Chemical constituents**

Nutrient analysis of the plant showed that it contained protein (6.56±0.02%), fat (4.88±0.01%), fiber (3.33±0.01%), carbohydrate (56.52±0.12%), energy values (330.51±0.01Kcal/100g) and trace elements Ca: 2234, Mg: 1292, K: 14991, Na: 650, Fe: 105.4, Cu: 14.3, Zn: 8.5, Cr: 2.5, Cd: 0.2, Pb: 0.7, and Ni: 2.5 PPM [19].

The plant contained many bioactive metabolites including flavonoids, fatty acids, coumarins, glycosides, sterols, steroids, resins, vitamins, alkaloids, carbohydrates, tannins, unsaturated sterols and triterpenes [20-23]. Many flavonoids were isolated from *Alhagi maurorum* included, tamarixin 3-O-dihrominoside, isorhamnetin 3-O-glucoolsoylne-hesperidose, isorhamnetine 3-O-robinoside, isorhamnetin 3-O-robinoside, quercetin 3-O-rhamnoside, kamperol 3-O-
galactoside, quercetin 3, 7-diglycoside, isorhamnetin 3-
rutinoside, daidzein 7, 4 -dihydroxysoflavone, calycsin 3-
hydroxymoronometin, and isorhamnetin, tamarixin aglycones, isorhamnetin-3-O-[alpha-L-rhamnopyranosyl-
(1→3)]-beta-D-gluco-pyranoside, 3′O-methylorobol and quercetin 3-O-beta-D-glucopyranoside [20,24-26]. The total phenolic and flavonoid compounds concentration were 23.83 mg gallic acid equivalent/g dried-weight and 11.53 mg rutin equivalent/g dried-weight respectively [27]. However, the highest total content for phenolics (mg/g) and flavonoids (mg/g) were observed in leaves extract (50.39±2.67; 39.24±1.54, respectively), followed by flowers extract (32.00±1.62; 18.50±0.80, respectively) [28].

Triglyceride, aliphatic ester, aliphatic ketone, thiophene derivative (29-32), and oleanene-type triterpene glycosides were isolated from the roots of *Alhagi maurorum* (33). Lupeol, a bioactive triterpenoid, was isolated from the root barks of *Alhagi maurorum*, and due to wild nature of the plant and ability to grow throughout the year, *Alhagi maurorum* was considered as a cheaper and ever available source for the lupeol [34].

The composition of the polysaccharide fractions of the manna, sugar exudates of the plant showed the presence of different types of monomeric units mainly consisting of galactose and uronic acids [15].

The volatile fractions of *Alhagi maurorum* consisted of complex mixture of different substances, with ketones (leaf: 4.4%, stem: 5.2%), acid derivatives (leaf: 1.5%, stem: 1.8%), terpenoids (leaf: 26.8%, stem: 18.7%), and hydrocarbons (leaf: 19.3%, stem: 50.6%). Also, heterocyclics were present in the leaves (5.2%) and aldehydes in the stems (0.2%). The major constituents were oxygenated sesquiterpenes (24.6%) in the leaves and hydrocarbon (50.6%) in the stems. However, the compounds obtained from the leaves of *Alhagi maurorum* were included: 4-hexyl-2,5-dihydro-2,5-
dioxy-3-furanacetic acid; 2-nondecanene; 9-
-octy1heptadecane; drimenol; 13-tetradecen-1-ol acetate; E-

Nuciferol; octadecane; hexadecanoic acid methyl ester: eicosane; docosane; tricosane; tetrasane; 1,21-
docosadiene; pentacosane; squalene; octacosane; triterpene hydrocarbons; oxygenated sesquiterpenes; terpene-related compounds; acid derivatives and hydrocarbons. While, the oily compounds obtained from the stems of *Alhagi maurorum* were included: β-
damascenone; E-geranyl acetone; actinidiole; 2-(1,3-
butadienyl)-1,3,5-trimethylbenzene; isopropyl myristate: drimenol; octadecane; 6,10,14-trimethyl-2-
-pentadecanone; nonadecane; farnesyl acetate; isopropyl palmitate; E-15-heptadecenal; eicosane; docosane; neopentadiene; tricosane; tetracosane; squalene; nonacosane; hentriacontane; oxygenated monoterpenes; triterpene hydrocarbons; oxygenated sesquiterpenes; terpene-related compounds; acid derivatives and hydrocarbons [23].

**PHARMACOLOGICAL EFFECTS**

**Gastrointestinal effects**

Ethanolic extract of *Alhagi maurorum* exerted...
gastroprotective effects against ulcers induced by phenylbutazone, indomethacin and ethanol, increase locomotor activity, and induced sexual stimulation [7].

The anti-ulcerogenic effects of an aqueous extract of *Alhagi maurorum* (AME) (150, 300 and 450mg/kg, PO) was evaluated in two models of gastric ulcers induced by alcohol and water immersion restraint-stress in rats. The AME protected rats against water immersion restraint-stress and ethanol-induced ulcers in a dose-dependent manner. In water immersion restraint induced ulcer in rat, the AME increased pH and reduced gastric acid content [35].

*Alhagi maurorum* ethanolic extract (oral daily 100mg/kg bw) and ranitidine (oral daily 100mg/kg bw) were used in rats to protect against administration of aspirin ASP (oral 200mg/kg body weight) for two times through 10 days. Some rats were sacrificed after first and second aspirin administrations and the rest were sacrificed in the end of the experiment. Gastro fluid volume has been decreased in ASP group, and acid output was decreased for plant extract more than ranitidine. No ulcer patterns have been shown in the histopathological study, but some inflammation in the gastric wall and vascular change (dilatation of blood vessels) were detected [36].

Chrysoreol 7-O-xylosid and kaempferol-3-galactorrhannoside showed a promising antiulcergenic activity with curative ratios of 66.31%, 69.57%, 75.49% and 77.93%, respectively in ethanol 50% (V:V) induced gastric ulcer in rats when used in a dose of 100 mg/kg [24].

The anti diarrhoeal activity of *Alhagi maurorum* extract (200 and 400 mg/kg) and its effect on motility of isolated rabbit’s duodenum was investigated. *Alhagi maurorum* in a 200 mg/kg dose exhibits a significant anti- diarrhoeal effect against castor oil-induced diarrhea. *Alhagi maurorum* increased the contractile force in concentrations between 0.4 and 1.6 mg/ml, while higher concentrations (>3.2 mg/ml) caused a rapid depressant effect. The depressant effect appeared to be due to calcium channel blocking effect [37].

**Antibacterial activity**

Aqueous extract of *Alhagi maurorum* in different concentrations had no antibacterial activity against both Gram negative (*Escherichia coli* and *Pseudomonas aeruginosa*) and Gram positive (*Staphylococcus aureus* and *Streptococcus pyogenes*) bacteria [38].

Antimicrobial activity of the leaves and flowers extracts was tested against [*Staphylococcus aureus* (ATCC 25923), *Bacillus subtilis* (ATCC 6633), *Pseudomonas aeruginosa* (ATCC 15523), *Salmonella typhi-murium* (ATCC 13311) and *Candida albicans* (ATCC 10231)] using disc diffusion method. Both extracts showed antibacterial and antifungal activity. The minimum inhibitory concentrations of the leaves extract were 80.7±4.5, 68.8±4.6, 60.6±8.3 and 58.0±6.3, and that of flowers extract were 84.0±0.0, 65.0±2.7, 65.2±6.2, 62.4±5.0 and 60.4±5.6 µg/ml against the mentioned microorganisms, respectively [28].

The antibacterial activity of methanol extracts (6 mg/ml) of the fresh aerial parts of *Alhagi maurorum* were evaluated against gram positive microorganisms [*B cereus*, *C. perfringens* ATCC 13124, *L. innocua* ATCC 33090, *L. ivanovi* Li4 (pVS2), *L. monocytogenes* ATCC 19116, *S. aureus* 72, *S. aureus* 132, *S. aureus* 224 and *S. epidermidis*]. It showed antibacterial activity against only *B cereus*, *L. ivanovi* Li4 (pVS2), *S. aureus* 72, *S. aureus* 132 and *S. aureus* 224 with diameter of inhibition of 10, 7, 5, 12 and 20 mm respectively. The extract at the same concentration was also evaluated against gram negative microorganisms [*E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca*, *K. pneumonia*, *S. enterica* ATCC 25566]. It showed activity against only *K. pneumonia* with a diameter of inhibition of 7mm. Increase the concentration to 23 mg/ml gave antibacterial activity only against *K. oxytoca* and *K. pneumonia* with a diameter of inhibition of 18 and 7mm respectively.

The antibacterial activity of hexane extracts (6 mg/ml) of the fresh aerial parts of *Alhagi maurorum* were evaluated against gram positive microorganisms [*B cereus*, *C. perfringens* ATCC 13124, *L. innocua* ATCC 33090, *L. ivanovi* Li4 (pVS2), *L. monocytogenes* ATCC 19116, *S. aureus* 72, *S. aureus* 132 and *S. aureus* 224]. It showed antibacterial activity against only *B cereus*, *L. ivanovi* Li4 (pVS2), *L. monocytogenes* ATCC 19116, *S. aureus* 72 and *S. aureus* 132, with diameter of inhibition of 7, 7, 10, 10 and 15 mm respectively. The extract at the same concentration was also evaluated against gram negative microorganisms [*E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca*, *K. Pneumonia*, *S. enterica* ATCC 25566]. It showed activity against only *E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca* and *K. pneumonia* with a diameter of inhibition of 12, 13, 11 and 15 respectively [39].

The MIC of 90% methanic extract of the leaves of *Alhagi maurorum* Medic, against *Escherichia coli*, *Moraxella lacunata*, *Proteus merables*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmononla typhi*, *Micrococcus lutes*, *Sarcina ventricull*, *Streptococcus pyogenes* and *Saccharomyces cerevisiae* were 3.2,3.3,4,4.4,5, 5 and 5 mg/ml [40].

Antihelicobacter activity of 70% methanol extract of the whole *Alhagi maurorum* plant was carried out by cup diffusion techniques. It exerted anti H. pylori effect, the diameter of zone of inhibition was 38mm and the MIC was 0.79 mg/ml [41]. However, Neamah found that all doses of aqueous extract have no antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pyogenes*, using Cup-plate diffusion method [42].

The antifungal effects of *Alhagi maurorum* was examined against *Aspergillus flavus*, *Alternaria alternate*, *Fusarium oxysporum*, *Fusarium solani*, *Rhizoctnia solani*, *Pythium ultimum*, *Chetomium*, *Rhizopus and Mucor*. The result showed that the methanol extract of the plant (at 23 mg/ml concentration) exerted antifungal activity against *Aspergillus flavus*, *Alternaria alternate*, *Fusarium oxysporum*, *Fusarium solani*, *Bipolaris oryzae*, *Chetomium and Mucor*, with a
percentage of growth inhibition of 33.4, 89.4, 89.3, 94.6, 91.7, 59.0 and 94.1% [43].

Antioxidant activity

Antioxidant effect of the aqueous extract of *Alhagi maurorum* was evaluated by estimating the level of MDA and also by total antioxidant capacity (TAC) compared to acetylsalicylic acid antioxidant activity. The test extract seems to significantly reduce malondialdehyde level and potent antioxidant activity [38].

Antioxidant effect of the aqueous extract of *Alhagi maurorum* was evaluated by estimating the level of MDA and total antioxidant capacity (TAC) compared to acetylsalicylic acid antioxidant activity. The test extract seems to significantly reduce malondialdehyde level and exert potent antioxidant activity [42].

Antioxidant activity of the extract was measured by using free radical scavenging activity (DPPH) method and ferric reducing activity power (FRAP) method and then compared with ascorbic acid, α-tocopherol, and butylated hydroxytoluene/BHT. The results showed that the extract was able to inhibit 59.5±2.24% DPPH radical, while ascorbic acid, α-tocopherol, and BHT were able to inhibit 99.4±1.22%, 98.1±3.21%, and 46.8±1.16% at a concentration of 100 μg/ml respectively. Furthermore, the ability of extract as reducing power showed low inhibition compared to ascorbic acid, α-tocopherol, and BHT with values of 53.5±1.51, 93.3±1.13%, 83.7±1.65% and 93.1±3.46% at a concentration of 100 μg/ml respectively. The authors postulated that, even though the antioxidant activity of the methanolic extract was moderate as compared to the positive controls but still it can be applied as a source of natural antioxidant in food and in pharmaceutical and cosmetic industries [27].

The antioxidant properties and total phenolic contents of the leaves were higher than those of the flowers. In general, a concentration-dependent antioxidant effect was observed and 100 μg/ml was significantly better than the other two concentrations (10 and 50 μg/ml) for both leaves and flowers extracts [28].

Antiinflammatory analgesic and antipyretic effect

Pharmacological screening of extract of *Alhagi maurorum* has revealed that it possesses anti-inflammatory effect; the extract inhibited the release of pro-inflammatory mediators of acute inflammation such as histamine and prostaglandin [44]. The anti-inflammatory activity of an aqueous extract of *Alhagi maurorum* was examined in mice by formalin induced paw edema assay. The extract was also significantly reduce the thickness of paw edema induced by formalin at dose-dependent manner in both phase I and II. The analgesic effect of the aqueous extract of *Alhagi maurorum* at doses of 125, 250 and 500μg/animal and diclofenac sodium (1 μg/animal), on licking frequency was estimated in the phase 1 (0-5 min.) and in phase II (15-20 min) after formalin administration. The results induced analgesic effects and the 500μg/animal, showed the most potent effect [42]. The antinociceptive effect of methanolic extracts (200 and 400 mg/ kg) of *Alhagi maurorum* was studied using acetic acid-induced writhing and tail-flick test in mice. Oral administration of methanolic extracts of *Alhagi maurorum* significantly inhibited the nociception to acetic acid-induced writhes in low dose. In the tail-flick test, methanolic extracts of *Alhagi maurorum* in a dose of 400 mg/ kg produced significant increase in the latency to response of tail to thermal stimulation [46].

Administration of the ethanolic extract of *Alhagi maurorum* powdered roots in doses of 0.25 and 0.5 g/kg (IP) into mice did not induce any changes in the rectal temperature. However, administration of the extract in doses of 1 g/kg (IP) decreased the body temperature with a maximum of 3.3 °C 60 min after administration of the extract. Thereafter the temperature started to rise again [47].

Intraperitoneal administration of glyceryl-n-tetracosan-17-ol-oate (a new aliphatic ester isolated from the root of the plant) in mice at a dose of 200 mg/ kg of body weight reduced body temperature by 4.1 and 5.2 after one and two hours respectively [32].

Effect on skeletal muscles

Exposure of the frog’s rectus abdominis muscle to the extract in a concentration of 4 μg/ml bathing fluid for 5 min antagonize ACh (3 μg/ml)-induced contraction by 70 ± 2.1% (N = 4). When the dose of ACh was increased up to 8 μg/ml in presence of the extract blockade, it did not reverse completely the blockade. The maximum reversal of antagonism was 27.7%, suggesting that the extract blocked the action of ACh in a non-competitive manner. Intraperitoneal administration of the ethanolic extract of *Alhagi maurorum* powdered roots into conscious mice in doses of 1.6 g/kg produced mild sedation. The extract also decreased the locomotion activity of the animals and induced skeletal muscle relaxation suggesting an action at the skeletal muscles neuromuscular junctions [47].

Effect on the heart

In evaluation the effect of the ethanolic extract of *Alhagi maurorum* powdered roots in anaesthetized rats, the results revealed that the extract at a dose of 1 g/kg induced bradycardia only and not myocardial depressant. Glyceryl-n-tetracosan-17-ol-1-oate (a new aliphatic ester isolated from the root of the plant) possessed a heart rate stimulant action and a myocardial depressant action on rat isolated heart [47].
Diuretic effect

The diuretic effects of methanol extracts of *Alhagi maurorum* was evaluated in a single or repeated (1 x 5 days) oral dose of 500 or 1000 mg/kg orally in albino rats, compared to furosemide 20 mg/kg. Repeated oral administration of *Alhagi maurorum* in doses of 500 or 1000 mg/kg significantly (P<0.05) increased urine volume and the sodium and potassium excretion rate. The authors concluded that methanol extracts of *Alhagi maurorum* have a significant diuretic, kaluretic and saluretic effect [48].

The diuretic effects of a distilled product of *Alhagi maurorum* was investigated in goat. Results of oral distilled product of *Alhagi* showed that the level of urine specific gravity was decreased. In addition, urine pH was also decreased insignificantly. Concentrations of Na⁺ and Cl⁻ were increased in urine following consumption of distilled product of *Alhagi maurorum* at doses (8, 16 ml/kg) (P<.05). These effects were marked at 180 and 120 minutes. Concentrations of urine K⁺ and Ca²⁺ were decreased in urine following oral consumption of distilled product of *Alhagi maurorum* at doses 8, 16 ml/kg (P<.05). Concentration of urine creatinine was also decreased significantly (P<.05) [49].

**Effect on ureter**

Addition of histamine in doses of 3 μg/ml bathing fluid to the isolated guinea-pig ureter induced continuous contractions. Addition of the ethanolic extract (EE) of *Alhagi maurorum* powdered roots in doses of 5 mg/ml bathing fluid completely suppressed histamine induced contractions. Addition of another dose of histamine did not reverse the inhibition [47]. Glyceryl-n-tetracosan-17-ol-1-oate (a new aliphatic ester isolated from the root of the plant) induced relaxation of the guinea-pig ureter and suppressed histamine-induced spasms. It seemed to possess an anticolic action and a ureter relaxing action that can enhance getting rid of renal stones and relieve of the accompanying pain (contraction of the ureter). Treatment of the ureter with two doses of 20 and 40 micrograms/ml of solution surrounding the ureter for 5 min, reduced the ability of histamine to contract the ureter through 100s by a percentage equal to 75% and 100%, respectively [32].

**Hepatoprotective effect**

The hepatoprotective effect of *Alhagi maurorum* aerial parts ethanol extract was studied using Wistar albino rats. Liver injury induced in rats by carbon tetrachloride. The normal appearance of hepatocytes and the normal degree of the glutathione levels in the liver did not show any signs of toxicity and mortality up to 10 g/kg, orally in mice [35].

LD₅₀ of the glycosides constituents of shoot and seeds of *Alhagi maurorum* and their histopathological effects on the intestine, lungs, liver and kidney were studied in mice. The results exhibited acute toxicity, the LD₅₀ of shoot and seeds extract were 8333.333 and 7414.666 mg/kg bw respectively. Upon intraperitoneal administration in mice, the histopathological examination indicated that the tested extract induced several histopathological changes in the mice such as degeneration, desquamation of epithelial cells, atrophy, destruction of villi, hemorrhage and necrosis in intestine; pulmonary emphysema, necrosis of some hepatocytes, hydropic degeneration, edema and scattered bile canalici; necrosis of some of renal tubules and glomerulus with dilatation of Bowman’s capsule, sloughing of epithelium lining of collecting tubules, as well as presence of fibrotic glomerulus [53].
CONCLUSION
The paper reviewed *Alhagi maurorum* as a promising medicinal plant with wide range of pharmacological activities which could be utilized in several medical applications because of its effectiveness and safety.

REFERENCES


