Vol 5|Issue 2| 2015 |130-136.

International Journal
of
Pharmacy Review & Research
www.ijprr.com

e-ISSN: 2248 – 9207
Print ISSN: 2248 – 9193

ALHAGI MAURORUM AS A POTENTIAL MEDICINAL HERB: AN OVERVIEW

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ABSTRACT

The previous studies showed that *Alhagi maurorum* contained many secondary metabolites including flavonoids, fatty acids, coumarins, glycosides, sterols, steroids, resins, vitamins, alkaloids, carbohydrates, tannins, unsaturated sterols and triterpenes. It exerted antibacterial, anti-inflammatory, antipyretic, analgesic, antioxidant, gastro-intestinal, 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, steroids, 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

Alhagi graecorum, *Alhagi camelorum* Fisch., *Alhagi persarum* Boiss. & Buhse, *Alhagi pseudalhagi*, *Alhagi pseudalhagi* (M. Bieb.) Fisch., *Hedysarum alhagi L*., *Hedysarum pseudalhagi* M. Bieb., *Alhagi maurorum* Medik. *subsp. maurorum*, *Alhagi pseudalhagi subsp. persarum* (Boiss. & Buhse) Takht., *Alhagi camelorum var. spinis-elongatis* Boiss [1-4].

Common names

Arabic: Shook, Aqool, Shook El Jamal**,** Shprim, Lehlah**; English:** Camel thorn bush, Caspian manna, Persian manna**; French:** alhagi des Maures; **Germany:** Kameldorn, Manna-, Mannastrauch**; India:** Bharbhara, Jawasa**; Italy:** Lupinella alhagi, Manna di Persia**; South Africa:** Kameeldoringbos, Volstruisdoring [5].

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

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Arabia, Syria, Tajikistan, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan and Yemen); Africa (Egypt Algeria, Libya, Niger, Sudan and South Africa); North America (USA) ; Europe (Cyprus, Czech Republic and Russian Federation) and Australia [5,7-8].

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 105^0C (%): 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: Nil), 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, tamarixtin 3-O-dirhamnoside, isorhamnetin 3-O-glucosylneo-hesperidoside, isorhamnetine 3-O-robinoside, isorhamnetin 3-O-rotinoside, quercetin 3-O-rhamnoside, kampferol 3-O-galactoside, quercetin 3, 7-diglycoside, isorhamnetin 3-rutinoside, daidzein 7, 4 -dihydroxyisoflavone, calycisin 3 -hydroxyformononetin, and isorhamnetin, tamarxtin 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 oleanane-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-dioxo-3-furanacetic acid; 2-nonadecanone; 9-octylheptadecane; drimenol; 13-tetradecen-1-ol acetate; E-nuciferol; octadecane; hexadecanoic acid methyl ester; eicosane; docosane; tricosane; tetracosane; 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; actinidiolide; 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; neophytadiene; 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].

Chrysoeriol 7-O-xylosoid and kaempferol-3-galactorhamnoside showed a promising antiulcerogenic 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 antidiarrhoeal 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 *Stroptococcus 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. ivanovii* Li4 (pVS2), *L. monocytogensis* ATCC 19116, *S. aureus* 72, *S. aureus* 132, *S. aureus* 224 and *S. epidermis*]. It showed antibacterial activity against only *B cereus, L. ivanovii* 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. ivanovii* Li4 (pVS2), *L. monocytogensis* ATCC 19116, *S. aureus* 72, *S. aureus* 132 *and S. aureus* 224]. It showed antibacterial activity against only *B cereus, L. ivanovii* Li4 (pVS2), *L. monocytogensis* 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 diameter of inhibition of 12, 13, 11 and 15 respectively [39].

The MIC of 90% methanolic extract of the leaves of *Alhagi maurorum* Medic, *against Escherichia coli, Moraxella lacunata, Proteus merabiles, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Micrococcus luteus, Sarcina ventricull, Streptococcus byogenes* 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, Bipolaris oryzae, 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 phase II [38]. Zakaria *et al.* also found that *Alhagi maurorum* extract exerted significant anti-inflammatory activity in acute paw edema and significant anti-inflammatory activity in sub-acute cotton pellet model [45]. By using a spontaneous flinching of the formalin injected mice paw method. The aqueous extract at doses of 125, 250, 500 µg/animal caused significant decrease in frequency of licking of the formalin- injected paw [38]. The aqueous extract of *Alhagi maurorum* was evaluated in mice at doses of 125, 250 and 500µg/animal, for its anti-inflammatory and analgesic effects. The extract and the reference drug (Diclofenac sodium 1 µg/animal) were 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(1µg/animal), on licking frequency was estimated in the phase 1 (0-5 min.) and in phase II (15-20 min) after formalin administration. The extracts 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 writhe even 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- 1-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 Ca^{+2} 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].

Hepatroprotective 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 correction of serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP) and total bilirubin, indicated a good protection of the extract from carbon tetrachloride hepatotoxicity. The results were comparable with silymarin, the reference hepatoprotective drug [50]. Administration of 660 mg/kg of the ethanolic *Alhagi maurorum* extract to mice, showed a significant decrease in the level of transaminases in animals treated with a combination of ethanolic *Alhagi maurorum* extract plus carbon tetrachloride (CCl_4) or acetaminophen as compared to animals receiving CCl_4 or acetaminophen alone. Histopatological investigation also confirmed that, *Alhagi maurorum* extract protects liver against damage-induced either by carbon tetrachloride or acetaminophen [51-52]. *Alhagi maurorum* extract (oral daily 100mg/kg body weight) in rats protect liver enzymes, oxidation status (MDA and GSH), fucosidase tumor marker and risk lipid ratio [36].

Cytotoxic effects

Cytotoxicity test was carried out using methyl thiazolyl tetrazolium (MTT) on the human leukemia cell line (HL-60). Leaves and flowers extract induced inhibitory effect against the proliferation of HL-60 cells and the IC50 was 16.0 and 22.0 µg/ ml respectively [28].

OTHER EFFECTS

Effect on calcium oxalate solubility

When 1 g calcium oxalate was added to 5 ml of 20% solution of the ethanolic extract of *Alhagi maurorum* powdered roots and the mixture was mixed and left to stand for 3 days, there was no solubilization of the calcium oxalate crystal. The weight of undissolved calcium oxalate was not changed compared with the initial weight [47].

Xanthine oxidase inhibitory effect

The effect of *Alhagi maurorum* leaves and fllowers extracts on xanthine oxidase activity was studied. The addition of the leaves extract showed a dose-dependent inhibition of xanthine oxidase activity, but the addition of flowers extract exhibited a lower effect. Higher concentrations showed more efficient inhibitory action on xanthine oxidase activity than the lower concentration. The inhibition activities were (92.00 and 80.00%, for the leaves and flowers extracts, respectively) [28].

Toxicity and adverse effects

The methanolic extracts in doses up to 2 g/ kg bw did not cause any deaths or major signs of acute toxicity [47]. The aqueous extract of *Alhagi maurorum* did not show any signs of toxicity and mortality up to10g/kg, orally in mice [35].

LD_{50} 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 LD_{50} 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 canaliculi; 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 promising medicinal plant with wide range of Pharma cological activities which could be utilized in several medical applications because of its effectiveness and safety.

REFERENCES

1. EOL, Encyclopedia of the life, *Alhagi maurorum* 2014, http://eol.org/pages/703028/ names/synonyms
2. USDA, NRCS. The Plants Database. National Plant Data Center, Baton Rouge, LA, USA 2010.
3. The flora of Pakistan, *Alhagi maurorum*, Freshbiology, 2011.
4. EuroMed plant database, *Alhagi maurorum*, ww2.bgbm.org/EuroPlusMed/PTaxon Detail.asp?NameId=63693&PTRefFk=8500000 [January 2011]
5. A Guide to Medicinal Plants in North Africa. Asphodelus tenuifolius Cavan, 21-22.
6. *Alhagi maurorum*, http://www.cabi.org/isc/datasheet/4215 [21 September 2012]
7. Encyclopedia of medicinal plants in UAE. Health Authority Abu Dhabi. Zaied Center for Traditional Medicine and Herbs Researches 2005, 15-20 **.**
8. Bolus L. Medicinal Plants of North Africa. Cairo, Egypt, Reference Publications Inc. 1983:368.
9. Al-Snafi AE. Encyclopedia of the constituents and pharmacological effects of Iraqi medicinal plants. *Thi qar University*, 2013.
10. Bhandari MM. Flora of the Indian Desert. Jodhpur, India: Scientific Publishers, 1978, 51
11. Brandis D. The Forest-Flora of North-West and Central India. Dehradun, India, Bishen Singh Mahendra Pal Singh, 1972.
12. Bamber CJ. Plants of Punjab. Punjab, India, Superintendent Government Printing, 1916.
13. Maheshwari JK. The Flora of Delhi. New Delhi, India, CSIR, 1963.
14. Thalen DCP. Ecology and Utilization of Desert Shrub Rangelands in Iraq. The Hague, The Netherlands: Dr. W. Junk, BV Publishers, 1979.
15. Goncharov MY, Yakovlev GP and Vitovskaya GA. Composition of polysaccharides from above-ground part of *Alhagi maurorum* Medic. *Rastitel'nye Resursy*, 37, 2001, 60-63.
16. Chakravarty A. The Plant Wealth of Iraq (A Dictionary of Economic Plants). Botany Directorate, Ministry of Agriculture & Agrarian Reform, England, 1976.
17. Singh Y, Wadhwani AM and Johri BM. Dictionary of Economic Plants of India. New Delhi, India: Indian Council of Agricultural Research, 1990.
18. Fahmy IR. Drug plants of Egypt. *Planta Medica*, 11, 1963, 202-224.
19. Ullah Z, Baloch MK, Baloch IB and Bibi F. Proximate and Nutrient Analysis of Selected Medicinal Plants of Tank and South Waziristan Area of Pakistan. *Middle-East Journal of Scientific Research*, 13(10), 2013, 1345-1350.
20. Kamil M, Ahmad F, Jairaj AF, Gunasekar C, Thomas S, Chen K and Attas A. Pharmacognostic and Phytochemical studies on aerial parts of *Alhagi maurorum* Medik. *Hamdard Medicus*, XL1V(3), 2001, 57-71.
21. Kamil M, Ahmad F, Jairaj AF, Gunasekar C, Thomas S, Chen K and Attas A. Quality control protocols for *Alhagi maurorum* 48th Annual Meeting of Soc. For medicinal Plants Res. Natural Product Research in New Millenium. Zurich, Switzerland, 2000, 4-A/13.
22. Awaad Amani AS, Maitland DJ and Solim GA. Antiulcerogenic activity of *Alhagi maurorum*. *Pharmaceutical Biology*, 44(4), 2006, 292-296.
23. Samejo MQ, Memon S and Khan KM. Chemical composition of essential oils from *Alhagi maurorum*. *Chem Natural Comp*, 48(5), 2012, 898-900.
24. El-Sayed NH, Ishak MS, Kandil FI and Mabry TJ. Flavonoids of *Alhagi graecorum*. *Pharmazie*, 48(1), 1993, 68-69
25. Al-Yahya MA, Mossa JS, Al-Badr AA, Tariq MS and Al- Meshal IA. Phytochemical and biological studies on Saudi medicinal plants Part 12. A study on Saudi plants of family Leguminosae. *Int J Crud Drug Res*, 25, 1987, 65–71.
26. Ahmad S, Riaz N, Saleem M, Jabbar A, Nisar-Ur-Rehman and Ashraf M. Antioxidant flavonoids from *Alhagi maurorum*. *Journal of Asian Natural Products Research*, 12(2), 2010, 138-143.
27. Armina O, Ehsanb O, Rudib H, Faridac Z, Fatemehc S and Ehsand K. Antioxidant activity and bioactive compounds in *Alhagi maurorum*. *Clinical Biochemistry*, 44, 2011, S343-S344.
28. Sulaiman GM. Antimicrobial and cytotoxic activities of methanol extract of *Alhagi maurorum. Afr J Microbiol Res*, 7(16), 2013, 1548-1557.
29. Marashdah MS, Mudawi BM, Al-Hazimi HM and Abdallah MA. New triglyceride and new aliphatic ester from the roots of *Alhagi maurorum* medic. *J Saudi Chem Soc*, 10(2), 2006, 367-372.
30. Marashdah MS, Mudawi BM, Al-Hazimi HM and Abdallah MA. New aliphatic ketone and new aliphatic ester from the roots of *Alhagi maurorum* medic. *J Saudi Chem Soc*, 10(3), 2007, 509-514.
31. Mudawy BM, AL-Hazimi HM, Abdullah MA and Marashdah MS. New aliphatic ester and new thiophene derivative from the roots of *Alhagi maurorum* Medik. *JSCS*, 11(1), 2007, 87-92.
32. Marashdah S. New natural compound for the enlargement of the ureter. *Arabian Journal of Chemistry*, 7, 2014, 381–383.
33. Hameda A, Perronec A, Mahalela U, Oleszekb W, Stochmalb A and Piacentec S.Oleanane glycosides from the roots of *Alhagi maurorum*. *Phytochemistry Letters*, 5(4), 2012, 782-787.

34. Lagharia AH, Memona S, Nelofar A and Khanc KM. *Alhagi maurorum*: A convenient source of lupeol. *Industrial Crops and Products*, 34(1), 2011, 1141-1145.
35. Naseri MKG and Mard SA. Gastroprotective effect of *Alhagi maurorum* on experimental gastric ulcer in rats. *Pak J Med Sci*, 23(4), 2007, 570-573.
36. Shaker E, Mahmoud H and Mnaa S. Anti-inflammatory and anti-ulcer activity of the extract from *Alhagi maurorum* (camelthorn). *Biological Research Association*, 48(10), 2010, 2785-2790.
37. Atta AH and Mouneir SM. Antidiarrhoeal activity of some Egyptian medicinal plant extracts. *Journal of Ethnopharmacology*, 92(2-3), 2004, 303-309.
38. Neamah NF. A Pharmacological evaluation of aqueous extract of *Alhagi maurorum*. *International Journal of Current Pharmaceutical Research*, 4(3), 2012, 119-122.
39. Abdel Rahman SM, Abd-Ellatif SA, Deraz SF and Khalil AA. Antibacterial activity of some wild medicinal plants collected from western Mediterranean coast, Egypt: Natural alternatives for infectious disease treatment. *African Journal of Biotechnology*, 10(52), 2011, 10733-10743.
40. Zain ME, Awaad MS, Al-Outhman MR and El-Meligy RM. Antimicrobial activities of Saudi Arabian desert plants. *Phytopharmacology***,** 2(1), 2011, 106-113**.**
41. Ramadan MA and Safwat NA. Antihelicobacter activity of a flavonoid compound isolated from *Desmostachya Bipinnata*. *Australian Journal of Basic and Applied Sciences*, 3(3), 2009, 2270-2277.
42. Neamah NF. A Pharmacological evaluation of aqueous extract of *Alhagi maurorum*. *Global Journal of Pharmacology*, 6(1), 2012, 41-46.
43. Abd-Ellatif S, Abdel Rahman SM and Deraz SF. Promising antifungal effect of some folkloric medicinal plants collected from El-hammam habitat, Egypt against dangerous pathogenic and toxinogenic fungi. *ARPN Journal of Agricultural and Biological Science*, 6(9), 2011, 25-32.
44. Okoli CO, Akah BA and Ezugworie U. Anti -inflammatory activity of extracts of root bark of *Securidaca longipedunculata* Fres (Polygalaceae). *Afr J Trad Cam*, 2(3), 2005, 54-63.
45. Zakaria MNM, Islam MW, Radhakrishnan R, Chen HB, Ismail A, Chan K and Habibullah M. Pharmacological evaluation of anti-inflammatory activity of *Alhagi maurorum*. *J Pharm Pharmacol*, 51(Suppl), 1999, 118.
46. Atta AH and Abo EL-Sooud K. The antinociceptive effect of some Egyptian medicinal plant extracts. *Journal of Ethnopharmacology*, 95(2-3), 2004, 235-238.
47. Marashdah MS and AL-Hazimi HM. Pharmacological activity of ethanolic extract of *Alhagi maurorum* roots. *Arabian Journal of Chemistry*, 3(1), 2010, 39-42.
48. Atta AH, Nasr SM, Mouneir SM, Alwabel NA and Essawy SS. Evaluation of the diuretic effect of *Conyza dioscorides* and *Alhagi maurorum*. *Int J Pharmcy and Pharm Sci*, 2(3), 2012,162-165.
49. Ghane M, Badiei KH, Mohammadi AH and Mallah AR Diuretic effect of *Alhagi maurorum* in goat. *Iranian J Vet Med*, 2008, article 2.
50. Alqasoumi SI, Al-Rehaily AJ, AlSheikh AM and Abdel-Kader MS. Evaluation of the hepatoprotective effect of *Ephedra foliate, Alhagi maurorum, Capsella bursa-pastoris* and *Hibiscus sabdariffa* against experimentally induced liver injury in rats. *Natural Product Sciences*, 14 (2), 2008, 95-99.
51. Abdellatif AG, Gargoum HM, Debani AA, Bengleil M, Alshalmani S, El Zuki N and El Fitouri O. Camel thorn has hepatoprotective activity against carbon tetrachloride or acetaminophen induced hepatotoxicity, but enhances the cardiac toxicity of adriamycin in rodents. *International Journal of Medical, Health, Pharmaceutical and Biomedical Engineering*, 8(2), 2014, 118-122.
52. Gargoum HM, Muftah SS, Al Shalmani S, Mohammed HA, Alzoki A, Debani, Al Fituri AHO, El Shari F, El Barassi I, Meghil SE and Abdellatif AG. Phytochemical screening and investigation of the effect of *Alhagi maurorum* (camel thorn) on carbon tetrachloride, acetaminophen and adriamycin induced toxicity in experimental animals. *Journal of Scientific and Innovative Research*, 2 (6), 2013, 1023-1033.
53. AL-Jubory SY. Determination the lethal dose50 (LD_{50}) and study of acute toxicity and histopathological effects of glycosides extract of *Alhagi maurorum* (Aqual) in mice. *J Thi-Qar Sci*, 3(4), 2013, 26-33.