International Journal of Advanced Research in Botany
Volume 9, Issue 1, 2025, PP 5-25
ISSN 2455-4316 (Online)
https://doi.org/10.20431/2455-4316.0901002
www.arcjournals.org

Medicinal Weed: The Ecological, Biological and Pharmaceutical Potential of Alhagi Maurorum Medikus - A Review

Muhammad Shafiq[1*], Muhammad Zafar Iqbal [2], Mohammad Athar[3]

[1,2]*Department of Botany, University of Karachi, Karachi-75270, Pakistan*

[3]*California Department of Food and Agriculture, 3288 Meadowview Road, Sacramento, CA 95832, U.S.A*

Corresponding Author:** ***Muhammad Shafiq, *Department Of Botany, University Of Karachi, Karachi-75270, Pakistan.*

Abstract

Alhagi maurorum Medikus a medicinal weed is a member of family Fabaceae and commonly known as camel thorn. This weed as desert plant species grew well in the arid, semiarid environmental conditions of the world and played a promising phytoremediation role to lessening the burden toxic pollutants from the environment. The main purpose of this review was to explore the ecological, biological and pharmacological potential of this spiny branched shrub. A. maurorum is also an important weed which harms crop productivity in agricultural regions, limits the agricultural cultivable areas and also possesses an allelopathic potential. It competes with agricultural crops in many countries. The A. maurorum showed a good growth in salty and saline environment. Various plant species used for the treatment of human diseases and among them, A. maurorum is traditionally used as medicine for the treatment of discomfort and various types of illness such as piles, kidney stones, urinary tract inflammation, angina, constipation, jaundice, expectorant, antidiarrheal, prostate cancer, human cancer cell lines and breast cancer. A. maurorum plant species is also reported to be rich in many phytochemical compounds. Similarly, A. maurorum reported a good hyperaccumulator for toxic pollutants from the immediate environment. Therefore, there is a dire need to search for further details on this species growing in polluted environments and publish the findings for the awareness of policymakers, non-environmental organizations, and environmental managers working for a clean environment.

The information in this review was gathered from the published research articles available from the last more than sixty years (1959-2024) using on line electronically scholarly scientific search engine English databases which includes, Science Direct, Google, Google scholar, MBMG, PubMed, Taylor and Francis online, and Scopus data base. The published papers were searched using the keywords, Alhagi maurorum, bioremediation, diseases, ecology, natural compounds, pharmacology, soil, vegetation.

Keywords: *antimicrobial, bioremediation, bioactive compounds, ecology, heavy metals, pharmacology, phytochemical.*

1. Introduction

A. maurorum is an highly branched spiny shrub which, attain 1.5 to 4 feets height and roots may reach up to the depth of 15 meters (Ahmad *et al.*, 2015). This plant species or manna as weed prefers to grow in arid and semiarid region. Table 1 showed the botanical description of *A. maurorum*. Some of the antioxidant plants are growing in Arab world was reported earlier (Al-Jaber *et al.*, 2011). Camelthorn is known as weed plants and the use of camelthorn to produce an organic rainfed watermelon had been common for many years in some provinces including Khuzestan, Fars, Yazd, Isfahan and Khorasan from Iran (Moradgholi *et al.*, 2023). The roots of this perennial plant species, *A. maorurum* is native to Middle East, tropical Eurasia and has an extensive rhizome system that may extend over two metres into the soil (Molaei-Kordabad *et al.*, 2024). Taranjebin manna is a substance produced by *Poophilus nebulosus* Leth. (Aphrophoridae) larva that feed from host plant *A. maurorum* (Hamedi *et al.*, 2015). The availability of nutrient and mobility, soil salinity, water availability and disturbance are an important factor in distribution of plant species in any region. *Alhagi* Gagnebin (Fabaceae: Hedysareae) is a small genus of shrubs or subshrubs distributed in temperate and tropical regions of Asia, Europe, and Africa. As the populations *A. pseudalhagi* and *A. maurorum* jointly formed a group (*A. maurorum* complex) segregated from those of *Alhagi graecorum* (Amirkhosravi *et al.*, 2021). Further analyses of

A. maurorum complex showed a significant molecular difference among the studied populations (PhiPT value = 0.213, P = 0.001) as well as a high amount of variability within populations (79%) indicating frequent genetic exchanges. The antifungal effects of all concentrations of the phenolic extract of *A. maurorum* were significantly better than the effect of negative control, dimethyl sulfoxide ($p<0.0001$) against the tested fungi *Trichophyton mentagrophytes* which was l.5 µg/ml, while the highest MIC was recorded against *Cladosporium cladosporoides* which was 6.2 µg/ml. According to the results of the study, *A. maurorum* possessed strong antifungal activity (Al-Snafi *et al.*, 2019).

Natural compounds largely used in many applications in the fields of pharmacy, biology and industry and *A. maurorum*, a legume used as natural sweetener. The phytochemicals composition were recorded promising for their potential cytotoxicity against a panel of human cancer cell lines by sulforhodamine B (SRB) assay (Loizzo *et al.*, 2014). The phytochemical profile of the *A. maurorum* extract showed the presence of carbohydrates, alkaloids, saponins, tannins, phenolics, fatty acids, coumarins, glycosides, sterols, steroids, resins, vitamins, unsaturated sterols, triterpenes and flavonoids (Al-Snafi *et al.*, 2019; Khalifa *et al.*, 2019).

The importance of medicinal plant for diet, fuel, fodder and treatment of different types of diseases in use from since last many centuries. A. maurorum is commonly known as camel thorn and an important medicinal weed plant species. A. maurorum is a cheap source of many human health remedies which includes, stomach pain, piles, migraine, liver, kidney stone, urinary track inflammation, renal stone, ulcer, fever, angina, constipation, jaundice and tract infection, expectorant, antidiarrheal, prostate cancer, human cancer cell lines, cancer and prevention of urolithiasis *(Atta et al., 2004;* Heilberg and Schor, 2006; Amiri *et al.*, 2014; Muhammad *et al.*, 2014; *Ahmad et al., 2015;* Eliasvandi *et al.*, 2019; Ammar *et al.*, 2022; Zhao *et al.*, 2022; Mehrabi *et al.*, 2023; Molaei-Kordabad *et al.*, 2024*)*. The presence of bioactive compounds in plant materials globally play a promising role to treat infectious disease due to microbial activities.

The chemical-mineral composition, gas production parameters, ruminal fermentation parameters, buffering capacity, and silage characteristics of *A. maurorum* was investigated by standard laboratory methods (Kazemi and Valizadeh, 2023). The ash content as well as sodium, calcium, potassium, phosphorus and magnesium were highest in treatment no 2. Silages containing 10% molasses had the highest and lowest lactic ($p < 0.0001$) and butyric ($p < 0.0001$) acids, respectively. The highest amount of potential gas production was observed in treatments 1 × 104 CFU of *Saccharomyces cerevisiae*/g of fresh silage + 5% molasses and 1 × 104 CFU of *Saccharomyces cerevisiae* /g of fresh silage + 10% molasses, respectively ($p < 0.0001$). Also, the addition of molasses improved the internal fermentation characteristics of *A. maurorum* in the silo.

The forage quantity and quality of halophyte species grown in arid saline environments investigated by different researchers. Pirasteh-Anosheh *et al.*, (2023) identified 44 halophytic species in the region and considering the potential of quantitative and qualitative forage production reported differed significantly in terms of both forage quantity, measured in terms of fresh and dry weight, and forage quality assessed in terms of tissue water content, ash, nitrogen content, crude protein, acid detergent fiber, neutral detergent fiber, dry matter digestibility and metabolizable energy. However, based on forage quality characteristics, *A. maurorum* showed the best forage potential. he use of camelthorn to produce an organic rainfed watermelon had been common for many years in some provinces of the Iran, including Khuzestan, Fars, Yazd, Isfahan and Khorasan and the knowledge to increase productivity and create a sustainable environment for organic products with high nutritional and economical value and it can be used to improve the living conditions of local people (Khouzani, 2021).

The main purpose of this review was to report the ecological, biological and medicinal potential of this spiny branched shrub. The information was collected from different search engine.

Table 1. *Botanic identification of Alhagi maurorum Medik*

Domain	Eukaryota
Kingdom	Plantae
Phylum	Magnoliophyta (Spermatophyta)
Subphylum	Angiospermae
Class	Magnoliopsida (Dicotyledonae)
Subclass	Rosidae
Order	Fabales

Family	Fabaceae, Leguminosae
Subfamily	Faboideae
Genus	*Alhagi*
Scientific name	*Alhagi maurorum* Medik
Others scientific names	Alhagi camelorum Fischer; Alhagi canescens (Regel) Keller & Shap.; Alhagi graecorum Boiss.; Alhagi kirghisorum Schrenk; Alhagi mannifera Jaub & Spach; Alhagi persarum Boiss. & Buhse; Alhagi pseudalhagi Desv; Alhagi *tournefortii* Heldr; *Hedysarum alhagi* L.; *Hedysarum pseudalhagi* M. Bieb.
Common name	Persian manna or Camel Thorn; Camel-thorn; English **(**camel thorn bush,Caspian manna, Persian manna), French **(**alhagi des Maures), Germany (Kameldorn, Manna-Mannastrauch), Hungarian (tevetövis), India **(**bharbhara, jawasa), Iran (*Khar Shotor*), Israel **(**manna), Italy **(**lupinella alhagi,manna di Persia), South Africa **(**kameeldoringbos,volstruisdoring).
Appearance	Weed,
Foliage	Leaf simple, alternate arrangement, smooth margin,10-25 mm long, 3-8 mm broad, obovate or elliptic-oblong, glabrous or pubescent, entire, apiculate; petiole c. 2 mm; stipules minute.
Inflorescence	lateral axillary racemes 1-5 cm long, ending in spine. Pedicel 1-3 mm, with 1-2 minute bracteoles. Calyx 2-2.5 mm, glabrous, teeth almost obsolete to triangular. Corolla 6-9 mm long, pink or reddish - violet.
Flowers	Small, pea-like flowers extend from the spines located along the rigid branches. Flowers are brown to maroon in color.
Flowering period	April-September
Fruit	Fruit 19-34 mm long, 2-3mm dorab, glabrous, more or less constricted between the seeds, 1-9-seeded.Seed pods are constricted between the individual seeds and are tipped with a small beak.
Pollinators	Insects
Cultivation status	Cultivated, Wild.
Weeds	Class B noxious weeds
Weed potential	Yes. The vigorous root and rhizome system facilitates its spread in agriculture land and it has become a troublesome weed in other countries in cereal and horticultural crops where repeated cultivation aids its spread. In the United States it competes with, and eliminates, other vegetation including crop plants, preferred forage plants for stock and native species, and is itself grazed sparingly by stock.
Habitat types	Agricultural land, pastures, waste lands
Life span	Perennial shrub
Life form	Phanerophyte
Soil	Suitable for: light (sandy) and medium (loamy) soils and prefers well-drained soil. Suitable pH: mildly acid, neutral and basic (mildly alkaline) soils and can grow in saline soils.
Distribution	It is native to the Mediterranean region and western Asia. Afghanistan, Algerian Sahara, Australia, Cyprus, Egypt, Iran, Iraq, Middle East, N.Africa, North China, Pakistan, Palestine, Russia, Saudi Arabia desert, South East Europe, Syria, Turkey, U.S.A.
Ecological relevance	It favors arid agricultural areas, grasslands, meadows and desert riparian areas. One camelthorn plant can spread rapidly (about 10 m per year in all directions) by developing many new plants from its large creeping root system. Camelthorn seeds are also known to disperse over long distances.
Economic uses	Used medicinally and as fodder for camels.
Ref: Nasir and Ali, 1972; Kawase and Kanno, 1983; Awmack and Lock, 2002; Boulos, 2009; Hameed *et al.*, 2011; Hamed *et al.*, 2012; Muhammad *et al.*, 2014; Asghari *et al.*, 2016; Al-Saleem *et al.*, 2019; Khalil *et al.*, 2020; Bijani *et al.*, 2021; CABI, 2021; Chakou *et al.*, 2021; AZDA, 2024; IO, 2024; eflora, 2024; CALIPC, 2024; EGD, 2024; FU, 2024; NMSU, 2024; PFAF, 2024; UTP, 2024; WA, 2024;WF, 2024.	

2. Materials And Methods

This research work was conducted with the aim to review the potential of an important weed plant species namely, *A. maurorum* growing in the harsh climatic conditions of the desert areas and especially, in Arab world. The information was gathered from the published research articles available from the last more than forty years (1959-2024) on line electronically scholarly scientific search engine databases which includes, CABI Digital Library, Science Direct, Google, Google scholar, MBMG, PubMed, Scholars portal Journal, Taylor and Francis online, and Scopus data base. Three tables were used for information on camel thorn characteristics. There were 1150 published papers were analyzed and 151 were presented using the keywords, as *Alhagi maurorum*, carbohydrates, chlorophyll, ecology, flavonoids, medicinal plants, pharmacology, phytochemical compounds, proline and weed.

3. TRADITIONAL PROPERTIES

The importance of medicinal plants of the world described in many research articles and in books. Bolus, (1983) has reported many vascular plants species, indigenous, naturalized or cultivated in North Africa. Bijani *et al.,* (2021) reported Camelthorn, Alhagi maurorum Medik. (Fabaceae, Leguminosae), a native component of the Asian flora, is invasive in Australia, South Africa and the USA where it is considered a noxious weed in several states.

A. maurorum is well known traditionally also used in folk medicine application as a remedy for the treatment of discomfort and ailments. Aslam and Ahmad (2016) was carried out research work on an important weed *A. maurorum* were collected from Rajhanpur District, Punjab, Pakistan with the purpose to document the knowledge of its ethnomedicinal significance. The identification of indigenous medicinal plants, including the gathering of information regarding the uses of these plants can help find out their traditional pharmacological activities and their benefits for the community's healthcare system (Basati *et al.,* 2019). Anwar *et al.,* (2023) used common ethnobotanical analytical techniques viz. use value (UV), relative frequency of citation (RFC), informant consensus factor (ICF), fidelity level (FL), relative importance (RI), frequency index (FI), family use value (FUV), family importance value (FIV), popular therapeutic use value (POPUT), plant part value (PPV), preference ranking (PR), cultural significance index (CSI), rank order priority (ROP) and Jaccard index (JI) for the exploration of the wild edible plants by local people for basic health care from Bahawalpur and adjacent region, Pakistan. A. maurorum had the greatest Relative Frequency Citation (0.009). The ethnomedicinal data were collected between July and September 2012 through face-to-face interview with local herbalist and a total of 18 species belonging to 19 botanical families were recorded in study area and *A. maurorum* showed the highest frequency by 51.58%. (Bahmani *et al.,* 2016).

Cabbage large white butterfly, Pieris brassicae is one of the important insect pests of plant family Brassicacea which causes remarkable quantitative or qualitative crop losses and the efficacy of chlorantraniliprole and lambda cyhalothrin insecticides alone and in combination with *A. maurorum* extract and cabbage seed oil against *P. brassicae* under laboratory conditions was investigated (Jarchelou *et al.,* 2022). The methanolic extract of *A.* maurorum when combined with chlorantraniliprole and lambdacyhalothrin possessed additive and synergistic effect, respectively. It was suggested that the obtained results will guide future study and could be used as an effective tool for *P. brassicae* management strategies. The effects of replacing different levels of camels thorn on the performance and parameters of safety and health of 9-15-week-old ostriches from the ostriches of the Special Livestock Research Institute of Zabul University was investigated (Moradgholi *et al.,* 2023). The obtained results showed the food conversion ratio at the end of the sixth week was significant among all experimental treatments ($P \leq 0.05$). The authors recommended to use scurvy plant as an alternative in order to provide dietary fiber and improve the health of ostriches (Moradgholi *et al.,* 2023).

4. ECOLOGICAL RESPONSES OF ALHAGI MAURORUM

Habitat utilization by the dorcas gazelle (*Gazella dorcas*) was investigated from 1972 to 1975 in a saline desert area of the Arava Valley, Israel (Baharav, 1980). Four vegetation types with *A. maurorum* were found, distributed from west to east according to the depth of the water table: (a) Acacia spp.—*Nitraria retusa*, (b) *N. retusa—Alhagi maurorum,* (c) *N. retusa*—Tamarix spp. and (d) *Phoenix dactylifera—Juncus maritimus*. During 1972–3, the gazelles' principal food was young twigs and leaves of *A. maurorum* in the fall and winter, while in 1974–5 the gazelles relied on *A. maurorum* during the fall, winter and spring. The understory was open with a few *Nitraria retusa* stands between the trees and *Nitraria–Alhagi* association, the most extensive plant formation of the saline regions. Furthermore, Baharav (1981) studied the food eaten by the mountain gazelle (*Gazella gazella gazella*) by analysing 68 rumen contents collected during 1972–3 in the eastern Lower Galilee, Israel. Plant particles in the rumen were identified by comparing epidermal tissue with that of known plants on reference pictures. Its diet contained 73 per cent grasses, 23 per cent forbs and 4 per cent browse species (*Zizyphus lotus, Prosopis farcata* and *Alhagi maurorum*). Seeds of *Arthrocnemum indicum, Alhaji maurorum, Cressa cretica, Halopyrum mucronatum, Haloxylon stocksii* and *Suaeda fruticosa* were analyzed to determine their potential to be used as source of edible oil. The quantity of oil present varied from 22% to 25%. The lipids in the seeds were found to contain 12 unsaturated fatty acids and four saturated fatty acids. The ash content also ranged from 2%–39% (Webera *et al.,* 2007).

The plants likewise halophytes well adapted to the available salinity levels in their environment. Al-Adily *et al.,* (2016) studied the anatomical variation of some halophytes from different sites in Babylon Provinus, Iraq. The stem sections of *A. maurorum* showed well formation of distinguish cells within pith as salt collection cells in response to salinity. Camelthorn has a high tolerance to salt and water stresses, and there are few studies on evaluating agronomic factors and breaking the seed dormancy potential observed. The results of the experiment showed that the highest germination percentage was obtained in sulphuric acid priming (56.6%) as compared to control. It was concluded that the best method for improving germination of camel thorn was recorded priming with sulphuric acid 98% (internal) or 75% (imported) for 25 min (Pirasteh-Anosheh *et al.,* 2020).

4.1. Biotic and Abiotic Stress Responses

Plant growth and development under abiotic and biotic stresses are the major constraints (Agarwal *et al.,* 2018). The response of plant species to environmental pressures such as sand mobility, soil salinity, water availability, nutrient status and disturbance are more important for the occurrence and distribution of plant functional groups than regional belonging (Mahdavi and Bergmeier, 2016). Another studies reported the role of morpho-physiological and anatomical attributes of *A. maurorum* populations from five water deficit regions in Punjab province, Pakistan, namely, Cholistan desert (KHP), Rajanpur (DGK), Thal (LYH), Patisar Lake (LAS), and Salt Range (WSM), in their adaptability to arid and semi-arid regions was investigated (Iqbal *et al.*, 2023). Arid populations [Khanpur-KHP (D = 44.91, P = 97.1 mm), Dera Ghazi Khan-DGK (D = 41.41, P = 105.3 mm), Layyah-LYH (D = 37.11, P = 117.5 mm) and Ladamsar-LAS (D = 34.83, P = 125.2 mm)] relied on larger roots and leaves, enhanced biomass production, ion accumulation, and photosynthetic pigments. It was concluded that the modifications at both structural and functional levels guaranteed the survival and success of this species in the prevailing challenging environmental conditions.

4.2. Allelopathic Potential

A maurorum is an important weeds in wheat fields. The allelopathic effect of *A. maurorum* shoots on mineral nutrient concentrations in pot grown wheat plants and soil was observed (Mohammadkhani and Servati, 2018). The presence of dry powder of *A. maurorum* shoots showed reduction in concentrations of macronutrients (NO^{3-}, K^+, Ca^{2+} and P) and micronutrients (Fe^{2+} and Cu^{2+}) in roots and shoots of wheat plants. There was also a significantly positive correlation between wheat growth and ion concentration was recorded. El-Mergawi and Al-Humaid (2019) investigated the phytotoxic effects of methanol extracts at 0, 5, 10, 20, and 40 g/L obtained from *A. maurorum* on germination and growth of *Phalaris minor, Echinochloa crusgalli, Portulaca oleracea,* and *Lactuca sativa.* The inhibitory effect of tested extracts varied among the examined seeds. The concentration of 40 g/L, extracts of *A.* maurorum affected shoot growth.

The release of allelochemicals from the neighboring plants becomes an important reason of current soil nutrient status and any changes in the availability in soil also results in the plant nutrient status. The effect of aqueous extract of *A. maurorum* at different rates (1, 5, 10, 15%, w/v) on the growth as well as some physiological parameters of pea (*Pisum sativum* L.) was investigated in pot experiment (Khalil *et al.,* 2020). The results revealed that *A. maurorum* aqueous extract reduced all growth parameters of pea plant along with photosynthesis pigments, insoluble sugars, total carbohydrate, total protein and total phenolics. The reason of adverse effect on the growth of pea plants was especially due to high concentration of hydroquinone and sinapyl alcohol from the methanolic extract of *A. maurorum*. Weed infestation and salinity are considered both biotic and abiotic stresses that were highly present in the Basrah governorate in Iraq and widely influence on the crop growth (Neamah *et al.,* 2024). Furthermore, the effect of salinity at (0, 6, 12 dS/m) and aqueous extract of ***A.** maurorum* at (0, 3 g/L) on growth and biochemical parameters as well as phytocompo nents of *Anethum graveolens* L revealed that growth parameters and photopigment content increased with salinity at 12 dS/m and reduced with ***A.** maurorum* aqueous extract.

4.3. Metal toxicity and phytoremediation response:

The effect of the native vegetation on the successive development of the soil ecosystem at abandoned coal ash landfills of the Angren coal fired power plant in Uzbekistan was investigated (Pen-Mouratov *et al.,* 2014). The soil biotic structure, including soil microorganisms and soil free living nematode communities, was also investigated both at open plots and under different native plants at the coal ash landfill area. The results showed that the nematode trophic and species abundance and diversity increased from the newer toward the older coal ash landfills. All applied ecological indices confirmed that *A.* maurorum was found to be important environmental components for the natural remediation of a soil ecosystem in the coal ash landfill area (Pen-Mouratov *et al.,* 2014).

Cadmium is an extremely toxic metal commonly found in industrial and urban regions. The remediation strategy or to remove cadmium from contaminated resources through an economical and efficient method likewise using *Alhaji maurorum* seed adsorbent was investigated (Ebrahimi *et al.,* 2015). The concentrations of certain metals in the soil samples at Sorkheh and Mazraeh copper mining areas in northwestern Iran and the ability of *Alhaji maurorum* and *Stachys inflata* at Sorkheh mines, and *Cirsium vulgare* at Mazraeh mines was evaluated (Hoseinpour *et al.,* 2020). The results revealed that the soil samples at Sorkheh and Mazraeh mining areas were highly contaminated with As at CF values of 16.9 and 4.6, respectively. The soil samples from the two mining areas were moderately contaminated with Pb and Zn. The data also confirmed that *A. maurorum* and *S. inflata* showed the good ability to accumulate Cd, Mo and Sc from the soils in Sorkheh area.

The results of optimization tests showed that the optimum condition of cadmium adsorption (85.5% removal) occurs at pH of 6.5 with 20 g/L of adsorption dose for 45 min. It was concluded that *A. maurorum* seed is a good biological adsorbent for adsorbing cadmium from aqueous solution. Camelthorn is a dominant desert plant indigenous in various habitats especially prevalent in and around economic iron ore deposits. This plant species, *A. maurorum* serve as an indicator of heavy metal pollution. The substantial functional role of photosynthetic pigments, protein, proline, alkaloids, flavonoids, 2, 2-diphenyl-1-picrylhydrazylscavenging, reduced glutathione, malondialdehyde, antioxidant enzymes, and stress-related gene expression were assessed to determine in metal stress adaptation from three sites (Heikal *et al.,* 2022). Heavy metal accumulation also affected the expression of stress related genes. Therefore, *A.* maurorum proved and adaptive characteristics for heavy metal sequestration from mining site soils and is proposed as a strong candidate for phytoremediation.

Saber et al., (2022) investigated the probable protective effect of an *A.* maurorum ethanolic extract on the hepatotoxicity and neurotoxicity accompanied by neurobehavioral deficits caused by lead in rats. The results demonstrated that lead exposure resulted in elevated locomotor activities and sensorimotor deficits associated with a decrease in brain dopamine levels. The soil quality and phytoextraction of cadmium, chromium, and lead from saline soils using *A. maurorum* was examined by atomic absorption spectrometry (Waris *et al.,* 2022). Screening various plant species to act as hyperaccumulators and associated health risks could serve as a sustainable solution for the bioremediation heavy metals (Sabir *et al.,* 2022). The phytoremediation potential of native plants, soil enrichment, and human health risks associated with the contamination of HMs (Chromium (Cr), Lead (Pb), Nickel (Ni), Iron (Fe), and Zinc (Zn) in soil and plant samples was collected from a municipal solid waste open dump site. The analysis of *A. maurorum* on the basis of translocation factor and bioaccumulation values showed a promising species for both Ni and Cr. The bioconcentration factor (BCF) and translocation factor (TF) of also examined. The rhizospheric soil showed the improved quality of saline soil reflected the good phytoextraction of salts from saline soil. The high contents of Cd in roots and shoots (1.02 and 0.65 µg g-1) of *A. maurorum,* Cr in the roots and shoots (6.20, and 6.75 µg g-1) and based on BCF and TF values Cr and Pb have the efficiency to uptake toxic metals from saline soil. Thus, it was concluded that selected plant species may have ability for the phytoextraction the Cd, Cr and Pb from saline soil. Camelthorn can withstand a variety of abiotic challenges, including water stress and harsh weather, making it potentially useful for cleaning cadmium (Cd) from contaminated soils. The degree of plant tolerance to Cd toxicity and the possibility of using it in the phytoremediation of Cd-contaminated soils was cultivated in soil polluted with Cd at doses of 0, 25, 50, 100, and 200 mg kg^{-1} (Alotaibi *et al.,* 2023). The exposure of camelthorn plants to 200 mg kg^{-1} of Cd inhabited the synthesis of leaf chlorophyll by 49% compared to the control and reduced the concentrations of nitrogen, phosphorus, potassium, calcium, iron, and zinc by 43, 36, 43, 50, 67, and 36%, respectively. It was concluded that camelthorn plants can tolerate up to 11 mg kg^{-1} of available soil Cd, 65 mg kg^{-1} in the root, and 22 mg kg^{-1} in the shoot before experiencing Cd toxicity.

4.4. Nanoparticles relevance:

Many reports have documnted about the plant extract synthesized silver nanoparticles (Jayaseelan and Rahuman, 2012; Sukirtha *et al.,* 2012; Rajan *et al.,* 2015; Sur *et al.,* 2018; Kumar *et al.,* 2021). The nanoparticles ranged from 1-100 nanometer in size, different shapes and has brought up a significant changes with many advantages in research and human life activities. The synthesis of nanomaterial's from biological materials used for the treatment of many diseases. There were different techniques such as Ultraviolet–visible spectrophotometry (UV-Vis), fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM), and Energy Dispersive X-ray Spectrometry (EDS) used for the investigations of their structural and textural characteristics. The synthesis of nanoparticles from the plant extract used for the treatment of different diseases and decreasing the concentrations of toxic pollutants from the immediate environment is an environment friendly approach. Green synthesis of nanoparticles application in the field of agriculture, pharmaceutical sectors and environment pollution controlling issues are playing a promising role successfully in recent years.

4.5. Copper Nanoparticles [CuNPs]

Liyuan *et al.,* (2022) synthesised copper nanoparticles according to green chemistry rules using the aqueous extract of *A. maurorum* and its ability to amelioration of *Mycoplasma* pneumoniae infected pneumonia mice model. The results confirmed spherical morphology for the nanoparticles with a size of 42.68–68.87 nm. The results showed that CuNPs regulated the levels of the inflammatory mediators in the infected mice. At the antioxidant test, the CuNPs removed 50% of free radicals at the concentrations of 181 µg/ml. In conclusion, the results revealed the ameliorative property of CuNPs green formulated by *A. maurorum* aqueous extract on *M.* pneumoniae infected pneumonia mice model.

4.6. Gold Nanoparticles [AuNPs]

The properties of gold nanoparticles green medicated by *A. maurorum* leaf aqueous extract against common prostate cancer cell lines were investigated (Zhao *et al.,* 2022). In this study, the cooper nanoparticles were green synthesized using the aqueous extract of *A. maurorum.* The viability of malignant prostate cell lines reduced dose dependently in the presence of AuNPs. The IC50s of AuNPs were 229, 368, 298, and 222 µg/mL against DU 145, NCI-H660, 22Rv1, and LNCaP.

The nanoparticles have high cytotoxic activities against abnormal cancer cells and among them the gold nanoparticles are composed of silver surrounded by oxygen networks and nanoparticle shown the potential of the antioxidant behaviors including superoxidase dismutase, catalytic enzyme activity, nitric oxide and hydroxyl radical inhibition, as well as oxidant behaviors that determine several conditions such as the pH of the environment, the type of activity of this nanoparticle (Qu *et al.,* 2023). In this study, gold nanoparticles were green synthesized using the aqueous extract of *A. maurorum* leaf aqueous extract. The viability of gastric carcinoma cell lines was reduced dose dependently in the presence of AuNPs. The IC50 of AuNPs were 44, 125, 45, and 22 µg/mL against GC1415, GC1436, NCI-N87 and MKN45 cell lines, respectively.

4.7. Nickel Nanoparticles [NiNPs]

The nickel nanoparticles were synthesized according to green chemistry rules using the aqueous extract of *A. maurorum*. The FE-SEM results confirmed the spherical morphology for the nanoparticles with size of 20.56–36.63 nm (Yuan *et al.,* 2022). In the oncological part the treated cells with NiNPs were assessed by MTT assay for 48 h about the cytotoxicity and anti-human ovarian cancer properties on normal (HUVEC) and ovarian cancer cell lines i.e. OVCAR-3, ES-2, TOV-21G, OV-90 and UWB1.289. The viability of malignant ovarian cell lines reduced dose-dependently in the presence of NiNPs.

4.8. Silver Nanoparticles (AgNPs)

Green synthesis of silver nanoparticles using aqueous solution of different plant species, *Ficus benghalensis, Rauvolfia tetraphylla, Caesalpinia coriaria, Curvularia pallescens* and *Gracilaria corticata* leaf and characterization of their antibacterial and antifungal activity was investigated (Kumar *et al.,* 2012; Prabhu and Poulose, 2012; Saxena *et al.,* 2012; Kalaiarasi *et al.,* 2013; Jeeva *et al.,* 2014; Velmuruga *et al.,* 2014; Wu *et al.,* 2018).

Biologically synthesized silver nanoparticles (SNPs) from *A. maurorum* used as disinfectant, and in callogenesis and organogenesis. Green SNPs 125 and 150 mg/l were the best for explants sterilization. 2.0 mg/l â€“6.0 mg/l SNPs when added in MS medium [(BAP (3.0mg/l) + NAA (0.2mg/l) + Kin (1.0 mg/l) + ascorbic acid 50.0 mg/l and 25 mg/l each of citric acid, arginine and adenine sulphate)] showed better calologenesis and organogenesis. Higher concentrations of SNPs resulted in decline of survival percentage, callus initiation and growth of cultured tissues (Sehrawat *et al*., 2021). In an in vitro study, AgNPs were green synthesized using *A. graecorum*, and its antifungal and antitumor activities. The result indicated spherical shape of AgNPs with a size range of 22-36 nm. The functional groups indicated by Fourier-transform infrared spectroscopy (FTIR) represented the groups involved in the reduction of silver ion into nanoparticles. *A. graecorum* AgNPs inhibited MCF-7 breast cancer cell line growth in increased concentration depend manner, significant differences shown at 50, 100, and 150 μg/ml concentrations compared to the control. Strong antifungal activity against *Candida* species (*C.* albicans., *C.* glabrata, *C.* parapsilosis, *C.* tropicales, and *C.* krusei) was observed and the inhibition zone range from 14-22 mm at a concentration of 0.01 mmol/ml and from 17-27 mm at a concentration of 0.02 mmol/ml. It was concluded that synthesized silver nanoparticles from *A. graecorum* can be used as a potential antitumor and antifungal agent for various therapeutic applications (Sumaiya *et al.*, 2022). Al-Yousef *et al.*, (2022) synthesized the silver nanoparticles (AgNPs) using desert plant *A. maurorum* to examine their effects in improvement the antibiotics efficiency. The results find the UV-visible absorbance which showed a strong intense peaks at 375 nm. However, the silver-nanoparticles showed considerable synergistic effect with different antibiotics.

4.9. Titanium Nanoparticles (TiNPs)

In this study, titanium nanoparticles (TiNPs) were synthesized in an aqueous medium using *A. maurorum* extract as stabilizing and reducing agents. Ultraviolet–visible spectrophotometry (UV-Vis), fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM), and Energy Dispersive X-ray Spectrometry (EDS) were the techniques to characterize the biosynthetic of TiNPs. According to the XRD analysis. To survey the anti-human breast cancer effects of TiNPs, MTT assay was used on the common breast cancer cell lines i.e., breast cancer (Breast adenocarcinoma (MCF7), infiltrating ductal cell carcinoma (Hs 319.T), inflammatory carcinoma of the breast (UACC-732), and metastatic carcinoma (MDA-MB-453) cell lines. 16.08 nm was measured for TiNPs crystal size. SEM images exhibited a uniform spherical morphology in range size of 12.16 to 43.46 nm for the biosynthesized nanoparticles respectively. The cell viability of breast carcinoma cells decreased dose-dependently in the titanium nanoparticles presence. The IC50 of *A. maurorum* and titanium particles on MCF7 cell line were 680 and 359 µg/mL, on Hs 319.T cell line were 507 and 191 µg/mL, on UACC-732 cell line were 477 and 217 µg/mL, and on MDA-MB-453cell line were 507 and 191 µg/mL, respectively. TiNPs had high anti-breast cancer activities dose-dependently against MCF7, Hs 319.T, UACC-732, and MDA-MB-453 cell lines. The best result of anti-breast cancer effects was seen in the case of the Hs 319.T cell line (Ye *et al.*, 2021).

4.10. Zinc Oxide Nanoparticles (ZnONPs)

Chinnathambi and Alahmadi, (2021) synthesized the zinc oxide nanoparticles (ZnONPs) in an aqueous medium using the plant extract as stabilizing and reducing agents. The anti-osteosarcoma and cytotoxicity effects of ZnONPs, $Zn(NO_3)_2 \cdot 6H_2O$, and *A. maurorum* aqueous extract was used 3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyl-2H-tetrazolium bromide (MTT) assay. The result of this test showed the potent of anti-osteosarcoma features dose dependently against G-292, clone A141B1, MG-63, HOS, Hs 707(A).T, and Saos-2 cell lines. It was concluded that this is probably due to potent anti-human osteosarcoma activities of ZnONPs formulated with *A.* maurorum aqueous seed extract because of antioxidant properties.

4.11. Nanoemulsion Technology

Nanoemulsion technology is an alternative candidate to overcome antibiotic resistance in pathogenic bacteria. The nanoemulsion production from the essential oil of *A. maurorum* and the characterization of this nanostructure with the help of ionotropic gelation and chitosan as a nanocarrier was applied (Hassanshahian *et al.*, 2020). Therefore, the effect of nanoemulsion on the antibacterial, antibiofilm, and plasmid curing of six antibiotic resistant pathogenic bacteria (*P. aeruginosa, E. coli, S. aureus, K. pneumonia, A. baumannii, B. cereus*) was evaluated and the results of this study showed that nanoparticles had a spherical shape and smooth topology. The mean size were 172 ± 4 nm and Zeta potentials was +28.6 mv. Furthermore, the results of antibacterial activity confirmed that nanoemulsion of essential oil had higher inhibition against bacteria compared to free essential oil. Statistical analysis demonstrated that the inhibitory effect of nanoemulsion against bacterial biofilm was significant ($P < 0.05$). It was concluded that Nanoemulsion of *A.* maurorum had the potential to use as suitable antimicrobial agents against antibiotic resistant bacteria.

5. PHARMACOLOGICAL PROPERTIES OF A. MAURORUM

Health is always a prime importance in Islam and Islam has given guidelines to all Muslim world that would continue till modern world (Aslam and Ahmad, 2016). The plants are in use in diet, fuel, fodder and for the betterment of health. Plants are cheap source and control of different types of disease around the world. *A.* maurorum is a popular medicinal plant and used for the treatment of different health issues. The different parts of *A. maurorum* showed many medicinal properties for the treatment of different ailment such as, eye diseases, laxative, antinociceptive; skin eruption, ureteral stone, gastric cancer, piles, migraine, diuretic, expectorant, and antiprostate cancer (Uphof, 1959, Chakravarty, 1976; Bhatti *et al.*, 2001; Atta and El-Sooud, 2004; Marashdah *et al.*, 2006a, Marashdah *et al.*, 2006b; Mudawi *et al.*, 2007; Marashdah *et al.*, 2008; Tareen *et al.*, 2010; Aryaeefar *et al.*, 2022; Zhao *et al.*, 2022; Qu *et al.*, 2023). *A. maurorum* also used as a purgative, diaphoretic, expectorant to ureteral stone, renal stone, warts and rheumatism remedies (Marashdah and AL-Hazimi, 2009; Ahmad *et al.*, 2015; Aryaeefar *et al.*, 2022).

In earlier studies, Badshah and Hussain, (2010) reported the usage of camel thorn as a blood purifier and as an expectorant as people of District Tank dispense its dry roots for kidney trouble (2g/per day). Furthermore, the other uses are diaphoretic, diuretic, laxative treatment (Al-Marashdah and Al-Hazimi, 2010). The ethanolic extract of *A. maurorum* powdered roots treatment induced relaxations to the guinea pig ureter (Marashdah and AL-Hazimi, 2009). The biological activity test details for the treatment of different ailments are described below for further details.

5.1. Anticancer activity [breast, prostate]

Cancer is challenging disease and a major cause of death worldwide. The most common cancers types are colorectal, breast, lung, liver, intestine, brain, stomach, apoptosis, ovarian and prostate cancer and different role was studied (Gann *et al.*, 1999; Lowe and Lin, 2000; Koh *et al.*, 2010; Chen *et al.*, 2011; Jemal *et al.*, 2011; Cazzaniga and Bonanni, 2012; Lee *et al.*, 2012; Chen *et al.*, 2014; Lv *et al.*, 2014; Huang *et al.*, 2015; Koohpar *et al.*, 2015; Pons *et al.*, 2015; Wang *et al.*, 2015; Zhang *et al.*, 2015).

Ko and Moon (2015) suggested that the development of effective agents to slow, reduce, or reverse the incidence of breast cancer in women. There were an estimated 3.2 million new cases of cancer and 1.7 million deaths from cancer in 2008 in 40 European countries recorded (Ferlay *et al.*, 2010). The relationship between presence of cytotoxic compounds in *A. maurorum* and their parasite *Cuscuta campestris* against breast cancer cell lines (MCF-7 and MDA-MB-231) and normal breast cell line (MCF 10A) was evaluated (Behbahani, 2014). Three active fractions were detected by nuclear magnetic resonance as lutein, lupeol and eugenol. These compounds and their epoxidized forms were also detected in their parasite *C. campestris*. Breast cancer is a challenging disease and becoming a leading cause of death in women. *A. maurorum* has been reported to exhibit an anticancer effect on various types of cancer cells. Taken together, the findings of authors suggested that DTX combined with *A. maurorum* at an optimal dose of 500 mg/kg as the optimal dose can inhibit β-cat, FZD7, MMP2, and breast cancer growth via interrupting HIF-1α/VEGF signaling and might be used as a promising antiangiogenic agent for breast cancer treatment. The combined treatment with *A. maurorum* and docetaxel inhibited breast cancer progression via targeting HIF-1α/VEGF mediated tumor angiogenesis in vivo (Bahamin *et al.*, 2023).

5.2. Antidiarrheal Activity

The alcoholic total extract of *A.* maurorum exhibits anti-diarrheal activity in vivo at the oral dose of 200 and 400 mg/kg. One of the possible mechanisms of action was considered due to calcium channel blocking effect (Marashdah *et al.*, 2008).

5.3. Anti-inflammatory

The anti-inflammatory and antihyperglycemic effects of polysaccharides extracted from *Alhagi* maurorum Medik.seeds, from Southern of Algerian Sahara were investigated (Chakou *et al.*, 2021). Their water extraction followed by alcoholic precipitation was conducted to obtain two water soluble polysaccharides extracts (WSPAM1 and WSPAM2). The investigations highlighted the antinflammatory and antihyperglycemic effects in a dose-dependant manner of WSPAM1 and WSPAM2.

5.4. Anti-bacterial/Antifungal Activities

The aerial part of *A.* maurorum possesses anti-bacterial activity (Neamah, 2012). *A.* maurorum has been explored for their antioxidant potential and a wide array of pharmacologically active secondary metabolites such as flavonoids, alkaloids (alhacidin and alhacin), steroids, pseudalhagin A, phospholipids and polysaccharides have been reported from different parts of *Alhagi* species (Muhammad *et al.*, 2014). Traditional herbal also used for the treatment of a number of infectious and non-infectious diseases. The antipyretic effect of *A.* maurorum in animal model were used to reduce *E.*coli lysate induced pyrexia in rabbits (Alam *et al.*, 2016). A comprehensive review of the phytopharmacological effects and traditional uses of *Alhagi* species (*A.* maurorum, *A.* camelorum, *A.* persarum, *A.* pseudoalhagi, and *A.* kirgisorum.) and their active constituents with special attention to the responsible mechanisms, effective dosages and routes of administration. Among *Alhagi* species, *A.* maurorum possess the highest anti-microbial activity and were dose dependent (Asghari *et al.*, 2016).

A broad range of biological activities such as antioxidant, cardiovascular, anti-ulcer, hepatoprotective, antispasmodic, antidiarrheal, antinociceptive, antipyretic, anti-inflammatory, anti-rheumatic, antibacterial and antifungal have been ascribed to different parts of *Alhagi*. Natural bioactive molecules and essential oils and extracts from plants have been used globally to treat infectious disease. The antimicrobial activities of chloroformic and methanolic extracts of *A. maurorum* was evaluated against 8 bacteria (*S. aureus*, *B.* subtilis, *R. toxicus*, *P.* aeruginosa, *E. coli*, *P. syringae*, *X.* campestris, *P. viridiflava*) and 3 fungi (*Pyricularia* oryzae, Fusarium oxysporum and *Botrytis cinerea*), through disc diffusion method (Hadadi *et al.*, 2020).

5.5. Anti-Kidney Stone

Mehrabi *et al.*, (2023) reviewed the literature that showed the therapeutic effects of *A.* maurorum extract on urinary tract stones with kidney in the upper ureter having a size of 4–10 mm in patients over 18 years of age. After intervention, the size and number of stones diminished, up to 70% in treated groups. The study showed that *A. maurorum* is as effective as hydrochlorothiazide in treatment of kidney and ureteral stones with no significant complications and is promising.

5.6. Anti-Urolithiatic Activity

The potential of *A.* maurorum aqueous extract for treatment or prevention of urolithiasis, to dissolve calcium oxalate stones *in* vitro was evaluated ((Ammar *et al.*, 2022). The results showed a significant dissolution effect for the extract on the kidney calculi during the experimentation period. At the end of the experiment, the percentages of calculi weight were decreased by 41.23, 4.97 and 55.67% for the extract, NaCl solution and Rowanix, respectively. Gas Chromatography analysis revealed mainly the presence of the following phyto-compounds: Cyclopropenone, 2,3-diphenyl; 1-Nonadecanol; methyl-alpha-D-mannopyranoside; cis-9-Hexadecenal. These compounds unarguably play crucial roles in the health care system especially in cancer treatment and many other diseases including urolithiasis. The urinary stone dissolution, independent of medium pH, could be attributed to formation of complexes between the phytochemical compounds in the extract and the calculi.

5.7. Anti-Oxidantal Activity

The antioxidant activity and bioactive compounds in *A.* maurorum was investigated (Armin et *al.*, 2011). Leghari *et al.*, (2012) determined some phenolic acids from the leaves and flowers of *A.* maurorum by HPLC-DAD, confirmed by LC-MS-APCI. It was found that the leaf extract had higher antioxidant potential (83.5%) than the flower extract (72.3%). The antioxidant properties and total phenolic contents of the leaves were recorded higher than those of the flowers. *A. maurorum* possesses potent antioxidant activities and aqueous extract significantly ameliorated norfloxacin elevation in tissue malondialdehyde, and reduction in tissue antioxidant enzymes such as catalase, glutathione peroxidase, and superoxide dismutase activities as well as reduced glutathione concentration (Khalifa *et al.*, 2019).

The biological, chemical, and in silico properties of methanol and dichloromethane (DCM) extracts of *A.* maurorum roots with respect to the antioxidant, enzyme inhibition, and phytochemical composition were evaluated (Saleem *et al.*, 2020). The methanol extract was found to contain higher total phenolic (105.91 mg GAE/g extract) and flavonoid (2.27 mg RE/g extract) contents which can be correlated to its more substantial antioxidant potential as well as AChE, BChE, tyrosinase and α-glucosidase inhibition. The results of the study concluded that *A.* mauroram to be considered as a lead source of natural antioxidant and enzyme inhibitor compounds. Ghavipanje *et al.*, (2022) determined the effect of dietary inclusion of *A. maurorum* on the performance, blood metabolites, and antioxidant status of growth of Sindhi camel calves of 9-10 months of age and 115 ± 7 kg body weight with the assignment to three diets. The feeding camels with *A.* maurorum for up to 25% of their dry matter diet positively influenced the antioxidant status without severe deleterious effects on growth performance.

5.8. Antiulcerogenic Activity

Six main flavonoid glycosides were isolated from the ethanol extract of *A. maurorum* and identified as kaempferol, chrysoeriol, isorhamnetin, chrysoeriol-7-*O*.-xylosoid, kaempferol-3-galactorhamnoside, and isorhamnetin 3-*O*.-β-D-apio-furanosyl (1-2) β-D-galactopyranoside. Their identities were established by m.p., UV, EI-mass, Fab-mass, 600 MHz ^{1}H and ^{13}C NMR. Whereas, the total extract (300 and 400 mg/kg) and two of the isolated compounds (chrysoeriol 7-*O*.-xylosoid and kaempferol-3-galactorhamnoside, 100 mg/kg each) showed a very promising antiulcerogenic activity with curative ratios 66.31%, 69.57%, 75.49%, and 77.93%, respectively (Amani *et al.*, 2006).

5.9. Wound Healing Potential

In wound dressing alginate has been known to be a good and it does not have antimicrobial properties, has low availability, and is expensive. The herb extract of *A.* maurorum and Pseudomonas *aeruginosa* combination showed sound wound healing property. Nineteen *P.* aeruginosa strains were isolated and identified from burned skin, and the one isolated strain with the highest ability of alginate production was selected. The results showed that the high alginate production without any toxic effect was obtained from the *P. aeruginosa* strain K1. This type of research work introduced a new type of wound dressing with high wound healing properties (Pourali and Yahyaei, 2019).

5.10. Anti-Constipation

Chronic constipation is frequently observed in postmenopausal women and *A. maurorum* has been introduced in traditional books as an effective laxative (Eliasvandi *et al.*, 2019). Thus, the the effectiveness of the combined herbal capsule on chronic constipation in postmenopausal women. The mean frequency of bowel movements in the herbal capsule group was significantly higher than the placebo group (mean difference=4.2; 95% confidence interval: 0.3 to 4.5; $p<0.001$) and concluded that the conumption of herbal capsules improved chronic constipation in postmenopausal women.

Table 1.*Ethnomedicinal uses from A. maurorum*

Plant parts treatment	References
The renal stone formation and medical treatment by *A. maurorum.*	Heilberg & Schor 2006.
The ethanolic extract of *A. maurorum* powdered roots seemed to possess a spasmolytic action and a ureter relaxing action that can enhance getting rid of renal stones and relieve of the accompanying pain (contraction of the ureter) in mice.	Marashdah *et al.*, 2009.
Anti-inflammatory and anti-ulcer activity of the extract from *A. maurorum.*	Shaker, 2010.
A. maurorum were repeatedly mentioned by the traditional healers as the most widely used for the treatment of jaundice in the study area of Iran.	Amiri *et al.*, 2014.
The cytotoxic compounds in *A. maurorum* and their parasite *Cuscuta campestris* against breast cancer cell lines (MCF-7 and MDA-MB-231) and normal breast cell line.	Behbahani, 2014.
As a purgative, diaphoretic, expectorant and diuretic used to treat piles, migraine, warts and rheumatism.	Ahmad *et al.*, 2015.
The flowers are ground into sugar and powder is used for eyes diseases, which clean the eyes. One teaspoon of powdered is taken in the morning one in the evening which improves eyesight.	Aslam & Ahmad, 2016.
The powder of dry flowers is used for stomach pain.	Aslam & Ahmad, 2016.
The roots are soaked in water and extract is useful for liver complaints.	Aslam & Ahmad, 2016.
Used for the treatment of kidney injury and urinary stones.	Bahmani *et al.*, 2016.
Most frequent herb used by neonates and their feeding mother to treat jaundice. Manna was the most popular plant part and distillation and soaking were most frequent preparation methods in these patients from Qom (Iran).	Heydari *et al.*, 2016.
A. maurorum extracts decreased elevated blood glucose levels and hyperlipidemia and suppressed oxidative stress caused by diabetes mellitus in rats.	Sheweita *et al.*, 2016.
A. maurorum medicinal plant in Shahrekord (Iran) are used to relieve pain.	Basati *et al.*, 2019.
The herb extract of *A. maurorum* and *Pseudomonas aeruginosa* combination showed sound wound healing property.	Pourali & Yahyaei, 2019.
In herbal capsule form control chronic constipation among menopausal women and effective against laxative.	Eliasvandi *et al.*, 2019.

The treatment of *A. maurorum* improved renal function in patients with chronic kidney diseases through regulating glucose and anti-inflammatory, laxative, and immunostimulatory properties was suggested.	Hoseini *et al.*, 2020.
The *A. maurorum* aqueous extract showed a significant dissolution effect for the extract on the kidney calculi during the experimentation period.	Ammar *et al.*, 2022.
Camelthorn is popular with richness in pharmacologically active metabolites. *A. maurorum* exhibited a potent healing effect in acetic acid-induced oral ulcers in rats by mitigating the release of pro-inflammatory cytokines and improving PCNA expression.	El-Zahar *et al.*, 2022.
Dietary inclusion of *A. maurorum* affected the performance, blood metabolites, and antioxidant status of growing camels.	Ghavipanje *et al.*, 2022.
Effect of *A. maurorum* extract on urinary tract infections was assessed.	Mirzaei *et al.*, 2022.
The aerial parts of *A. maurorum* extract treatment on kidney and urinary tract stones with size of 4–10 mm over 18 years of age patient found the size and number of stones diminished, up to 70%.	Mehrabi *et al.*, 2023.
Cough and skin disorder	Anwar *et al.*, 2023.

6. PHYTOCHEMICAL CHARACTERIZATION

The plants are an important source of phytochemicals compounds and natural products from plants shows an interesting biological activities. The availability of phytochemicals are much better as compared to synthetic compounds. In a study, the plant extract of *A. maurorum* was isolated such as 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, daidzein7,4′-dihydroxyisoflavone, calycisin 3′-hydroxyformononetin, isorhamnetin, tamarxtin aglycones, coumarins and alkaloids (Behari and Gupt, 1980; Boulos, 1983; Atta and El-Sooud, 2004).

Plant extract have an impressive source of phytochemicals and used for different types of ailments successfully around the world since ancient time. Phytochemical screening of *A. maurorum* indicated the presence of unsaturated sterols, triterpenes, tannins, flavonoids and carbohydrates and/or glycosides as major constituents (Atta and El-Sooud, 2004). In another study, the phytochemical of the petroleum ether extract of the roots of *A. maurorum* (collected from a plane in Palestine) resulted in the isolation of a new triglyceride (tripalmitin), a new aliphatic ester (dipalmitoolein), a triglyceride (hexacosanoic acid) and a fatty acid (n-pentacosanyl-n-hexa-4-enoate). Their structures were elucidated based on spectral analysis and chemical reactions (Marashdah *et al.*, 2006a). The chloroform extract of the roots of *A. maurorum* yielded the isolation of new aliphatic ketone and new aliphatic ester in addition to two aliphatic esters and aliphatic alcohol and their structures was elucidated as docosanoic acid, 2, 3-dihydroxy propylester (1), octocosanoic acid, 28-hydroxy-2′, 3′-dihydroxy propylester (2), n-Ecos-7-ol-8-one (3), n-deconyl hexadecanoate (4) and tritriacontan-1-ol (5) on the basis of some chemical reactions and spectral analysis (Marashdah *et al.*, 2006b). The hepatroprotective effect of aerial parts of *A. maurorum* plant extract using Wistar albino rats was studied (Alqasoumi *et al.*, 2008). Furthermore, the biochemical parameters; serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, alkaline phosphatase and total bilirubin were also estimated as reflection of the liver condition. *A. maurorum* is a medicinal plant with its prospective potent flavonoids. GC-MS spectrum has found three flavone structures (2-phenyl-1,4-benzopyrone derivatives) with rate more than 50% in the ethanolic plant extract. More studies should be demonstrated potent natural plant extracts and their active components against gastro inflammation and ulcers (Shaker *et al.*, 2010).

The phytochemical profile of *Cistanche armena* - an endemic species from Armenia and evaluates the composition and biological activity in relation to specific organs of the parasite (flowers vs stem with tuber) and its interaction with host species, *A. maurorum* (Fabaceae) was investigated (Piwowarczyk *et al.*, 2020). The polyphenolic compounds was identified using the UPLC-PDA-MS/MS method and quantified the antioxidative effects; inhibitory activities; polyphenol, nitrate III and nitrate V contents; ABTS+, DPPH, and FRAP activities; and colour parameters. The nutritive value of camelthorn (*Alhagi maurorum*) at different growth stages (vegetative, flowering, and seeding) was evaluated in vitro and in vivo. The in vitro study revealed that the nutritive value of *A. maurorum* at the vegetative growth stage was found highest as compared to other growth stages. At the vegetative, flowering, and seeding stages the values for relative feed value were 112, 94.6 and 85.3, neutral detergent fiber were 449, 495 and 525 g/kg DM, and non-fiber carbohydrates were 351, 302 and 263 g/kg DM, respectively (Kazemi and

Ghasemi, 2021). The potential of *A. maurorum* aqueous using gas chromatography analysis revealed mainly the presence of the following phyto-compounds: Cyclopropenone, 2, 3-diphenyl; 1-Nonadecanol; methyl-alpha-D-mannopyranoside; cis-9-Hexadecenal (Ammar *et al.*, 2022). The polyphenols in the diet are an abundant antioxidant. The effects of dietary polyphenols on human health in the prevention of degenerative diseases, particularly cardiovascular diseases and cancers in scientific researchers communities widely studied (Scalbert *et al.*, 2004; Arts and Hollman, 2005; Cheynier, 2005).

Table 3. *Phytochemical screening of active compounds from different parts of A. maurorum.*

Plant parts	Compound	References
Leave extract	The presence of unsaturated sterols, triterpenes, tannins, flavonoids and carbohydrates and/or glycosides as major constituents.	Atta & El-Sooud, 2004.
Aqueous extract	flavonoids, fatty acids, coumarins, sterols, vitamins, and alkaloids.	Amani *et al.*, 2006.
Roots	New aliphatic ester and new thiophene.	Mudawi *et al.*, 2007.
Roots	5,5′′′′-dipropyl-2,2′:5′,2′′:5′′,2′′′:5′′′,2′′′′-pentathienyl, octacosanoic acid, 28- hydroxy-2′, 3′-dihydroxy propylysate.	Marashdah *et al.*, 2008.
Plant extract	A new flavonoid, isorhamnetin-3-O-[-alpha-l-rhamnopyranosyl-(1 --> 3)]-beta-D-glucopyranoside (1), along with two known flavonoids 3'-O-methylorobol (2) and quercetin 3-O-beta-d-glucopyranoside (3).	Ahmad *et al.*, 2010.
Roots	Three new oleanane-type triterpene glycosides (**1**–**3**), along with four known compounds (**4**–**7**) glycosides, were isolated. Most of saponins isolated from *A. maurorum* show as sugar chain β-fabatriose.	Hamed *et al.*, 2012.
Leaves/flowers	Contained some phenolic compounds.	Leghari *et al.*, 2012.
Plant material	*Alhagi* plants are also valued as a rich source of digestible protein and important minerals.	Muhammad *et al.*, 2014.
Aerial part extract	Presence of flavonoids and phenolic compounds.	Sheweita *et al.*, 2016.
Whole plant extract	The phytochemical profile of the extract showed the presence of carbohydrates, alkaloids, saponins, tannins, phenolics, flavonoids.	Khalifa *et al.*, 2019.
plant extracts	Natural bioactive molecules, the plant essential oils treat the infectious disease and he antimicrobial activities of chloroformic and methanolic extracts of *A. maurorum* was evaluated against 8 bacteria (*S. aureus*, *B. subtilis*, *R. toxicus*, *P. aeruginosa*, *E. coli*, *P. syringae*, *X. campestris*, *P. viridiflava*) and 3 fungi (*Pyricularia oryzae*, *Fusarium oxysporum* and *Botrytis cinerea*).	Hadadi *et al.*, 2020.
Methanol and dichloromethane extracts of *A. maurorum* roots.	the antioxidant, enzyme inhibition, and phytochemical composition was found to contain higher total phenolic (105.91 mg GAE/g extract) and flavonoid (2.27 mg RE/g extract). A more correlation to its more substantial antioxidant potential as well as AChE, BChE, tyrosinase and α-glucosidase inhibition. A lead source of natural antioxidant and enzyme inhibitor compounds.	Saleem *et al.*, 2020.
The potential of *A. maurorum* aqueous extract	Gas Chromatography analysis revealed mainly the presence of the following phyto-compounds: Cyclopropenone, 2,3-diphenyl; 1-Nonadecanol; methyl-alpha-D-mannopyranoside; cis-9-Hexa dece nal.	Ammar *et al.*, 2022.
Crude extract fraction of *A. maurorum* aerial parts.	The major phenolic compound was isolated from the polyphenol-rich EFAM fraction and identified by conventional and spectroscopic methods of analysis as isorhamnetin-3-*O*-rutinoside. Furthermore, standardization of EAFM using UPLC-PDA-UV quantified isorhamnetin-3-*O*-rutinoside as 262.91 0.57 g/mg of the fraction.	El-Zahar *et al.*, 2022.
A. maurorum extract	*Proteus mirabilis* is a frequent cause of catheter associated urinary tract infections. The most effective chemical compounds found in extract were tamarixetin, quercetin, and transanethole.	Mirzaei *et al.*, 2022.

Plant extract	Many bioactives like tannins, alkaloids, saponins, flavonoids are present and bioactivities include hepatoprotective, wound healing, antireheumatic, antiviral, antibacterial, antifungal, antidepressant and analgesic activities	Mulukuri &Kumar PP, 2023.

7. Conclusion

According to the information based on the survey of considerable amount of published research articles from various electronic English data base suggests that *A. maurorum* plant species has an enormous scope and potential for the use in the field of ecology, pharmacology and remedies for the different ailments. There is a further need of research required to find the literature on the use of this plant species as phytoremediation of polluted sites and guide lines to policy makers, ecofriendly organization, and environmental mangers working for the healthy and clean environment. The screening and role of this plant species as hyper accumulator for others heavy metals is required. *A. maurorum* showed a strong pharmacological for the cure of different types of diseases. This species also possesses many natural compounds such as alkaloid, minerals and phenols.

Author Contributions

All authors contributed to the manuscript. Conceptualization and original draft was checked by MZI and MA. The validation investigation, resources, data curation, and writing worked by MS. All the authors read and approved the final manuscript.

Funding

This research review received no external funding.

Acknowledgments

The critical comments on this review by anonymous referees is sincerely acknowledged.

Conflicts of Interest

The authors declare no conflict of interest exist among the all authors.

Additional information

Notes on Contributors

I am Muhammad Shafiq (Ph.D.) (the corresponding author), working as research scholar at the Department of Botany, University of Karachi, Pakistan. Our team is mainly engaged in Plant ecology and environmental pollution related issues. Although most of our reported works are on the impact of automobile pollution on street plants, disturbed vegetation due to automobile and industrial activities, biomonitoring of the heavy metals using plant and soil sample. We are still working on assessing the toxicity and tolerance to the selected plants species growing around the industrial units and to heavy metals. In this regard, we have published many research papers, book chapter, review articles and annotated bibliography with regional, national and international publishers.

References

[1] *Agarwal T, Gupta AK, Shekhawat NS. Effect of salt stress on in vitro propogation of Alhagi maurorum (Medik). Journal of Phytology Research, 2018: 31(1-2):55-62.*

[2] *Ahmad N, Bibi Y, Raza I, Zahara K, Idrees S, Khalid N, Bashir T, Tabassum S. Traditional uses and pharmacological properties of Alhagi maurorum: A review. Asian Pacific Journal of Tropical Disease, 2015:5(11):856-861. https://doi.org/10.1016/S2222-1808(15)60945-8*

[3] *Ahmad N, Shinwari ZK, Hussain J, et al. Phytochemicals, antibacterial and antioxidative investigations of Alhagi maurorum Medik. Pakistan Journal of Botany, 2015:47:121–124.*

[4] *Ahmad S, Riaz N, Saleem M, Jabbar A, Nisar-Ur-Rehman, Ashraf M. Antioxidant flavonoids from Alhagi maurorum. Journal Asian Natural Product Research, 2010:12(2):138-43. doi: 10. 1080/ 0286020 903451724. PMID: 20390757.*

[5] *Al-Adily BMH, Al-Ani HA, Al-Taee MMS. Anatomical variation of some halophytes from different sites in Babylon Provinus, Iraq. Mesopotamia Environmental Journal, 2016:2(2):19-26.*

[6] *Alam MK, Ahmed S, Anjum S, Akram M, Shah SM, Wariss HM, Usmanghani K. Evaluation of antipyretic activity of some medicinal plants from Cholistan desert Pakistan. Pakistan Journal of Pharmaceutical Sciences, 2016:29(2):529-33. PMID: 27087078.*

[7] *Al-Jaber NA, Awaad AS, Moses JE. Review on some antioxidant plants growing in Arab world. Journal of Saudi Chemical Society, 2011:15(4):293-307. https://doi.org/10.1016/ j.jscs. 2011.07.004*

[8] *Al-Marashdah MS, HM. Al-Hazimi. Pharmacological activity of ethanolic extract of Alhagi maurorum roots. Arab Journal of Chemistry, 2010: 3: 39-42. https://doi.org/ 10. 10 16 / j. arabjc. 2009.12.007*

[9] *AL-Nafea SI, Aljahdali MO. Protective effects of ethanolic extract of Alhagi maurorum roots on renal failure induced by acetaminophen in mice. Journal of Applied Biotechnology and Bioengineering, 2021:8(1):16-22.*

[10] *Alotaibi MO, Ghoneim AM, Eissa MA. Cd uptake and translocation by camelthorn (Alhagi maurorum Medik): a promising approach for phytoremediation of Cd-contaminated soils. Environmental Science and Pollution Research International, 2023:30(24):65892-65899. doi: 10.1007/s11356-023-27105-y. Epub 2023 Apr 24. PMID: 37093375.*

[11] *Alqasoumi SI, Al-Rehaily AJ, AlSheikh AM, Abdel-Kader MS. 2008. Evaluation of the hepatoprotective effect of Ephedra foliate, Alhagi maurorum, Capsella bursa-pastoris, Hibiscus-sabdariffa against experimentally induced injury in rats. Natural Product Sciences, 14(2): 95–99.*

[12] *Al-Saleem MSM, Al-Wahaib LH, Abdel-Mageed WM, et al. Antioxidant flavonoids from Alhagi mauroruzm with hepatoprotective effect. Pharmacognosy Magazine, 2019:15 (65): 592.*

[13] *Al-Snafi AE, Al-Kamel ML, Esmael ME. Antifungal effect of Alhagi maurorum phenolic extract. IOSR Journal of Pharmacy, 2019:9(8):7–14.*

[14] *Al-Snafi AE. Alhagi maurorum as a potential medicinal herb: An overview. International Journal of Pharmacy Review and Research, 2015:5(2): 130-136.*

[15] *Al-Yousef SA, Ali AM, Ali AM, AbdelRahim K. Biosynthesized silver nanoparticles induced potential antibacterial activity. Egyptian Journal of Medical Microbiology, 2022:31(2):49-55.*

[16] *Amani AAA, Maitland DJ, Soliman GA. Antiulcerogenic activity of Alhagi maurorum. Pharm Biol, 2006: 44(4):292-296.https://doi.org/10.1080/13880200600714160.*

[17] *Amiri MS, Joharchi MR, Taghavizadehyazdi ME. Ethno-medicinal plants used to cure jaundice by traditional healers of mashhad, Iran. Iranian Journal of Pharmaceutical Research, 2014:13(1):157-62. PMID: 24734067; PMCID: PMC3985247.*

[18] *Amirkhosravi A, Asri Y, Assadi M, Mehregan I. Genetic structure of Alhagi (Hedysareae, Fabaceae) populations using ISSR data in Iran. Molecular Biology Reports, 2021:48(6):5143-5150. doi: 10.1007/s11033-021-06511-w.*

[19] *Ammar RB, Khalifa A, Alamer SA, Hussain SG, Hafez AM, Rajendran P. Investigation of the potential anti-urolithiatic activity of Alhagi maurorum (Boiss.) grown wild in Al-Ahsa (Eastern Province), Saudi Arabia. Brazilian Journal of Biology, 2022: 84, Article ID e259100, 2022.*

[20] *Anwar T, Qureshi H, Naeem H, Shahzadi S, Sehar Z, Hassan R. Exploration of the wild edible plants used for basic health care by local people of Bahawalpur and adjacent regions, Pakistan. Foods, 2023:12(19):3557. doi: 10.3390/foods12193557.*

[21] *Armin O, Ehsan O, Rudi H, Farida Z, Fatemeh S, Ehsan K. Antioxidant activity and bioactive compounds in Alhagi maurorum. Clinical Biochemistry, 2011:44(13): S343-S344. https://doi. org /10. 1016/j.clinbiochem.2011.08.856*

[22] *Arts ICW, Hollman PCH. Polyphenols and disease risk in epidemiologic studies. American Journal of Clinical Nutrition, 81 (suppl) (2005):317S-325S.*

[23] *Aryaeefar MR, Khakbaz A, Akbari S, Movahedi A, Gazerani A, Bidkhori M, Moeini V. Effect of Alhagi maurorum distillate on ureteral stone expulsion: A single-blind randomized trial. Journal of Herbal Medicine, 2022:34:100567. https://doi.org/10.1016 /j. hermed. 2022.100567*

[24] *Asghari MH, Fallah M, Moloudizargari M, Mehdikhani F, Sepehrnia P, Moradi B. A systematic and mechanistic review on the phytopharmacological properties of Alhagi species. Ancient Science of Life, 2016:36(2):65-71. doi: 10.4103/asl.*

[25] *Aslam MS, Ahmad MS. Alhagi maurorum and Tamarix aphylla – two medicinal weeds mentioned in Holy Quran and Ahadith and their ethnomedicinal uses in district Rajhanpur of Pkistan. Universal Journal of Pharmaceutical Research, 2016: 1(1): doi:10.22270/ ujpr. v1i1.RW5.*

[26] *Atta A, EL-Sooud. The antinociceptive effect of some Egyptian medicinal plant extracts. Journal of Ethnopharmacology, 2004:95(2-3): 235-238. https://doi.org/10.1016/j.jep. 20 04.07.006*

[27] *Atta AH, Abo EL-Sooud K.Theantinociceptive effect of some Egyptian medicinal plant extracts. Journal of Ethnopharmacology, 2004: 95 (2-3):235-238.https://doi.org/10.1016/ j.jep. 2004.07.006*

[28] *Awmack CS, Lock JM. The genus Alhagi (Leguminosae: Papilionoideae) in the middle east. Kew Bulletin, 2002:57: 435-445.*

[29] *AZDA. 2024. Arizona Department of Agriculture (AZDA). https://agriculture. az. gov/ pestspest-control/agriculture-pests/noxious-weeds. Visited on 05-03-2024.*

[30] *Badshah L, Hussain F. People preference and use of local medicinal flora in District Tank, Pakistan, 2010.*

[31] *Bahamin N, Rafieian-Kopaei M, Ahmadian S, Karimi I, Doustimotlagh AH, Mobini G, Bijad E, Shafiezadeh M. Combined treatment with Alhagi maurorum and docetaxel inhibits breast cancer progression via targeting HIF-1α/VEGF mediated tumor angiogenesis in vivo. Heliyon, 2023:9(5), e16292. https://doi.org/10.1016/j.heliyon.2023.e16292*

[32] *Baharav D. Food habits of the mountain gazelle in semi-arid habitats of eastern lower Galilee, Israel. Journal of Arid Environments, 1981:4(1):63-69. https://doi.org/10.1016/ S0140-1963 (18)31594-5.*

[33] *Baharav D. Habitat utilization of the dorcas gazelle in a desert saline area. Journal of Arid Environments, 1980:3(2):161-167. https://doi.org/10.1016/S0140-1963(18)31664-1*

[34] *Bahmani M, Baharvand-Ahmadi B, Tajeddini P, Rafieian-Kopaei M, Naghdi N. Identification of medicinal plants for the treatment of kidney and urinary stones. Journal of Renal Injury Prevention, 2016:5(3):129-33. doi: 10.15171/jrip.2016.27.*

[35] *Basati G, Abbaszadeh S, Zebardast A, Teimouri H. Analgesic medicinal plants in Shahrekord, Southwest of Iran: An ethnobotanical study. Galen Medical Journal, 2019: 8: 8:e1593. doi: 10.31661/gmj.v8i0.1593.*

[36] *Behbahani M. Evaluation of in vitro anticancer activity of Ocimum basilicum, Alhagi maurorum, Calendula officinalis and their parasite Cuscuta campestris. PLoS One. 2014:9(12):e116049. doi: 10.1371/journal.pone.0116049.*

[37] *Bhatti GR, QureshiR, ShahM. Ethnobotany of Qadan Wari of Nara Desert. Pakistan Journal of Botany, 2001:33: 802-812.*

[38] *Bijani F, Naderi R, Akrami MA, Weyl PSR, Heidari B, Edalat M. Impact of Aceria alhagi (Acari: Eriophyidae) as a potential biological control agent on the invasive weed Alhagi maurorum (Fabaceae) in its native range. Experimental and Applied Acarology, 2021: 83(2):229-239. doi: 10.1007/s10493-020-00585-0.*

[39] *Bolus L. Medicinal Plants of North Africa. Vol. 45-48, Cairo, Egypt, Reference Publications Inc., 1983: p. 368.*

[40] *Boulos L. Flora of Egypt checklist, revised annotated edition. Al-Hadara Publication Cairo, 410 (2009), pp. 198-201*

[41] *Brown D. Encyclopaedia of Herbs and Their Uses. Dorling Kindersley, London. ISBN: 0-7513-020-31. 1995.*

[42] *CABI. Alhagi maurrorum (Camel thorn). 2021. https://www.cabidigitallibrary.org/doi/10. 1079/ cabicompendium.4215*

[43] *CALIPC. https://www.cal-ipc.org/plants/profile/alhagi-maurorum-profile/ visited on 26-02-2024.*

[44] *Cazzaniga M, Bonanni B. Breast cancer chemoprevention: old and new approaches. Journal of Biomedicine and Biotechnology, 2012:985620. doi: 10.1155/2012/9 85620.*

[45] *Chakou FZ, Boual Z, Hadj MDOE, Belkhalfa H, Bachari K, El Alaoui-Talibi Z, El Modafar C, Hadjkacem F, Fendri I, Abdelkafi S, Traïkia M, Cerf DL, Dubessay P, Delattre C, Pierre G, Michaud P. Pharmacological investigations in traditional utilization of Alhagi maurorum Medik. in Saharan Algeria: In vitro study of anti-Inflammatory and antihyper glycemic activities of water soluble polysaccharides extracted from the seeds. Plants (Basel). 2021:10(12):2658. doi: 10.3390/plants10122658.*

[46] *Chakravarty A. The Plant Wealth of Iraq (A Dictionary of Economic Plants). Botany Directorate, Ministry of Agriculture & Agrarian Reform, England. Vol. 1. (1976)*

[47] *Chen B, Zhang Y, Wang Y, Rao J, Jiang X, Xu Z. Curcumin inhibits proliferation of breast cancer cells through Nrf2-mediated down-regulation of Fen1 expression. Journal of Steroid Biochemistry and Molecular Biology,2014:143:11–8. doi: 10.1016/j. jsbmb. 2014. 01.009.*

[48] *Chen PH, Peng CY, Pai HC, Teng CM, Chen CC, Yang CR. Denbinobin suppresses breast cancer metastasis through the inhibition of Src-mediated signaling pathways. Journal of Nutritional Biochemistry, 2011:22:732–40. doi: 10.1016/j.jnutbio.2010.06.004.*

[49] *Cheynier V. Polyphenols in foods are more complex than often thought. American Journal of Clinical Nutrition, 2005:81 (suppl):223S-229S.*

[50] *Chinnathambi A, Alahmadi TA. Zinc nanoparticles green-synthesized by Alhagi maurorum leaf aqueous extract: Chemical characterization and cytotoxicity, antioxidant, and anti-osteosarcoma effects. Arabian Journal of Chemistry, 2021:14(4): 103083. https:// doi.org/10. 1016/ j.arabjc.2021.103083*

[51] *Ebrahimi A, Ehteshami M, Dahrazma B. Isotherm and kinetic studies for the biosorption of cadmium from aqueous solution by Alhaji maurorum seed. Process Safety and Environmental Protection, 2015:98: 374-382. https://doi.org/10.1016/j.psep.2015.09.013*

[52] *Eflora. Flora of Pakistan. http://www.efloras.org/florataxon.aspx? flora_id=5&taxon_ id= 242420262. 26-02-2024.*

[53] *EGD. 2024. EPPO Global Database (EGD). Alhagi maurorum (ALHPS). https://gd.eppo.int/taxon/ALHPS. Visited on 05-03-2024.*

[54] *Elgorban AM, El-Samawaty AEM, Abd-Elkader OH, et al. Bioengineered silver nanoparticles using Curvularia pallescens and its fungicidal activity against Cladosporium fulvum. Saudi Journal of Biological Sciences, 2017: 24(7):1522–1528.*

[55] *Eliasvandi P, Khodaie L, Charandabi MAS, Mirghafourvand M. Effect of an herbal capsule on chronic constipation among menopausal women: A randomized controlled clinical trial. Avicenna Journal of Phytomedicine, 2019:9(6):517-529. doi: 10.22038/AJP.2019.13109.*

[56] *El-Mergawi RA, Al-Humaid AI. Searching for natural herbicides in methanol extracts of eight plant species. Bulletin of the National Research Centre, 2019:43(1): 1-6. https://doi.org/10. 1186 /s42269-019-0063-4*

[57] *El-Zahar H, Menze ET, Handoussa H, Osman AK, El-Shazly M, Mostafa NM, Swilam N. UPLC-PDA-MS/MS Profiling and Healing Activity of Polyphenol-Rich Fraction of Alhagi maurorum against Oral Ulcer in Rats. Plants (Basel). 2022:11(3):455. doi: 10.3390/plants11030455. PMID: 35161436; PMCID: PMC8838639.*

[58] *Ferlay J, Parkin D, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. European Journal of Cancer, 2010:46 (4):765-781.*

[59] FV. 2024. *Flora Veg.* EU. (FV)*https://floraveg.eu/en/taxon/overview /Alhagi %20 mauro rum.* Visited on 05-03-*2024.*

[60] *Gann PH, Ma J, Giovannucci E, Willett W, Sacks FM, Hennekens CH, et al. Lower prostate cancer risk in men with elevated plasma lycopene levels: results of a prospective analysis. Cancer Research, 1999:59:1225–30.*

[61] *Ghavipanje N, Vargas-Bello-Pérez E, Afshin M, Hosseini SA, Aghashahi A, Vatankhah AM. The inclusion of Alhagi maurorum in growing camel diet: effect on performance, liver related blood metabolites, and antioxidant status. Frontiers in Veterinary Science, 2022: 9:863121. doi: 10.3389/fvets.2022.863121.*

[62] *Hadadi Z, Nematzadeh GA, Ghahari S. A study on the antioxidant and antimicrobial activities in the chloroformic and methanolic extracts of 6 important medicinal plants collected from North of Iran. BMC Chemistry, 2020:14(1):33. doi: 10.1186/s13065-020-00683-5.*

[63] *Hamed A, Perrone A, Mahalel U, et al. Oleanane glycosides from the roots of Alhagi maurorum. Phytochemistry Letter, 2012:5(4):782–787.*

[64] *Hamedi A, Farjadian S, Karami MR. Immunomodulatory properties of Taranjebin (Camel's Thorn) Manna and its isolated carbohydrate macromolecules. Journal Evidance Based Complementary Alternative Medicine, 2015:20(4):269-74. doi: 10.1177/21565872155804 90.*

[65] *Hameed M, Ashraf M, Al-Quriany F, Nawaz T, Ahmad MSA, Younis A, Naz N. Medicinal flora of the Cholistan desert: a review. Pakistan Journal of Botany, 2011:43: 39-50.*

[66] *Hassanshahian M, Saadatfar A, Masoumipour F. Formulation and characterization of nanoemulsion from Alhagi maurorum essential oil and study of its antimicrobial, antibiofilm, and plasmid curing activity against antibiotic resistant pathogenic bacteria. Journal of Environmental Health Science and Engineering, 2020 Aug 31;18(2):1015-1027. Doi:10.1007/s40201-020-00523-7.*

[67] *Heikal YM, El-Esawi MA, Naidu R, Elshamy MM. Eco-biochemical responses, phytoremediation potential and molecular genetic analysis of Alhagi maurorum grown in metal contaminated soils. BMC Plant Biology, 2022:22(1):383. doi: 10.1186/s12870-022-03768-6.*

[68] *Heilberg IP, Schor N. Renal stone disease: causes, evaluation and medical treatment. Arquivos Brasileiros de Endocrinologia and Metabologia, 2006:50(4):823–831.*

[69] *Heydari M, Heydari H, Saadati A, Gharehbeglou M, Tafaroji J, Akbari A. Ethnomedicine for neonatal jaundice: A cross-sectional survey in Qom, Iran. Journal of Ethnopharmaco logy, 2016: 193:637-642. doi: 10.1016/j.jep.2016.10.019.*

[70] *Hoseini SM, Anushiravani M, Mojahedi MJ, Hami M, Zibaee S, Rakhshandeh H, Taghipour A, Nikakhtar Z, Eshraghi H, Tavassoli AP. The efficacy of camel milk and Tarangabin (manna of Alhagi maurorum (combination therapy on glomerular filtration rate in patients with chronic kidney disease: A randomized controlled trial. Avicenna Journal of Phytomedicine, 2020: 10(2):170-180. PMID: 32257889; PMCID: PMC7103430.*

[71] *Hoseinpour F, Hosein-Nejad Mohtarami M, Alipour S, Torbati S. Heavy metal contaminations at two Iranian copper mining areas and the remediation by indigenous plants. Iranian Journal of Toxicology,2020:14 (2):81-92. URL: http://ijt.arakmu.ac.i r/ article -1- 785 -en. html*

[72] *Huang G, Li M. The role of EphB4 and IGF-IR expression in breast cancer cells. International Journal of Clinical and Experimental Pathology, 2015:8:5997–6004.*

[73] *IO. IO (Invasive.org.) center for invasive species and ecosystem health. Camel thorn. Alhagi maurorum Medik. https://www.invasive.org/browse/subinfo. cfm?sub=5061visited on 25-02-2024.*

[74] *Iqbal U, Ali A, Daad A, Aslam UM, Ur Rehman F, Farooq U, Gul FM. Unraveling the defensive strategies of camel thorn Alhagi maurorum medik. For thriving in arid and semi-arid environments. Journal of Arid Environments, 2023:219:105076. https://doi. org/ 10. 1016/ j.jaridenv. 2023.105076*

[75] *Jarchelou HS, Valizadegan O, Soleymanzade A. Laboratory assessment of cabbage seed oil and Alhagi maurorum extract in enhanced insecticidal activity of chlorantraniliprole and lambda yhalothrin against Pieris brassicae (Lepidoptera: Pieridae). Journal of Entomological Society of Iran, 2022:41(4):321-340. doi: 10.22117/jesi.2022.357933.1453*

[76] *Jayaseelan C and Rahuman AA. Acaricidal efficacy of synthesized silver nanoparticles using aqueous leaf extract of Ocimum canum against Hyalomma anatolicum anatolicum and Hyalomma marginatum isaaci (Acari: Ixodidae). Parasitology Research, 2012:111: 1369–1378.*

[77] *Jeeva K, Thiyagarajan M, Elangovan V, Geetha N and Venkatachalam P. Caesalpinia coriaria leaf extracts mediated biosynthesis of metallic silver nanoparticles and their antibacterial activity against clinically isolated pathogens. Industrial Crops and Products 2014: 52: 714-720.*

[78] *Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. CA Cancer Journal of Clincians, 2011:61:69–90. doi: 10.3322/caac.20107.*

[79] *Kalaiarasi R, Prasannaraj G and Venkatchalam P. A rapid biological synthesis of silver nanoparticles using leaf broth of Rauvolfia tetraphylla and their promising antibacterial activity. Indo American Journal of Pharmaceutical Research, 2013: 3: 8052–8062.*

[80] *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 2001; XL1V(3): 57-71.*

[81] *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.*

[82] *Kawase K and Kanno I**.** 1983**.** Soils of China: their use and improvement, nature of fertility and soil properties, and genesis, classification and distribution. Hakuyusha, Tokyo. 854888.*

[83] *Kazemi M, Ghasemi BK. An investigation of the nutritional value of camelthorn (Alhagi maurorum) at three growth stages and its substitution with part of the forage in Afshari ewes diets. Animal Feed Science and Technology, 2021: 271:114762. https://doi.org /10. 1016/j. anifeed sci. 2020.114762*

[84] *Kazemi M, Valizadeh R. Can Alhaji maurorum as a halophyte plant be ensiled with molasses and Saccharomyces cerevisiae well? AMB Express, 2023:13(1): 1-9. https://doi. org /10.1186/ s13568 -023-01529-8*

[85] *Khalifa HA, Shalaby SI, Abdelaziz AS. Alhagi maurorum aqueous extract protects against norfloxacin induced hepato nephrotoxicity in rats. Chinese Herbal Medicines, 12(2):156-162. https://doi.org/10.1016/j.chmed.2019.09.007*

[86] *Khalil R, Yusuf M, Bassuony F, Gamal A, Madany M. Phytotoxic effect of Alhagi maurorum on the growth and physiological activities of Pisum sativum L. South African Journal of Botany, 2020:131: 250-258. https://doi.org/10.1016/j.sajb.2020.02.037*

[87] *Khouzani ZMR. Utilization of camel thorn (Alhagi maurorum) to produce organic rainfed watermelon for sustainable development in the agricultural sector of arid and semi-arid regions. Central Asian Journal of Environmental Science and Technology Innovation, 2021:2(4):156-163.*

[88] *Ko Y, Moon A. Natural products for chemoprevention of breast cancer. Journal of Cancer Prevention, 2015:20(4): 223-231. https://doi.org/10.15430/JCP.2015.20.4.223*

[89] *Koh MS, Hwang JS, Moon AR. Lycopene inhibits proliferation, invasion and migration of human breast cancer cells. Biomolecule and Therapeutics, 2010:18:92–8. doi: 10.4062/ bio molther. 2010. 18.1.092.*

[90] *Koohpar KZ, Entezari M, Movafagh A, Hashemi M. Anticancer activity of curcumin on human breast adenocarcinoma: role of Mcl-1 gene. Iranian Journal of Cancer Prevention, 2015: 8:e2331.*

[91] *Kumar P, Senthamil Selvi S and Govindaraju M. Seaweed mediated biosynthesis of silver nanoparticles using Gracilaria corticata for its antifungal activity against Candida spp. Applied Nanoscience, 2012: 3: 495–500.*

[92] *Kumar S, Basumatary IP, Sudhani HP, Bajpai VK, Chen L, Shukla S, Mukherjee A. Plant extract mediated silver nanoparticles and their applications as antimicrobials and in sustainable food packaging: A state-of-the-art review. Trends in Food Science & Technology, 2021: 112: 651666.*

[93] *Laghari AH, Ali Memon A, Memon S, et al. Determination of free phenolic acids and antioxidant capacity of methanolic extracts obtained from leaves and flowers of camel thorn (Alhagi maurorum). Natural Product Research, 2012:26(2):173–176.*

[94] *Lee HR, Hwang KA, Park MA, Yi BR, Jeung EB, Choi KC. Treatment with bisphenol A and methoxychlor results in the growth of human breast cancer cells and alteration of the expression of cell cycle-related genes, cyclin D1 and p21, via an estrogen receptor-dependent signaling pathway. International Journal of Molecular Medicine, 2012:29:883–90.*

[95] Liyuan T, Lijun Z, Wei H, Meixuan J, Man Z, Zhihui Y, Qingtao L, Xiaona Q, Qian W, Jiangling T, Dianping Y, Yakun W. Green synthesised CuNPs using Alhagi maurorum extract and its ability to amelioration of Mycoplasma pneumoniae infected pneumonia mice model. Journal of Experimental Nanoscience, 2022:17:1: 585-598, DOI: 10.1080/17458080.2022.2104451

[96] Loizzo MR, Rashed K, Said A, Bonesi M, Menichini F, Tundis R. Antiproliferative and antioxidant properties of Alhagi maurorum Boiss (Leguminosae) aerial parts. Industrial Crops and Products, 2014:53: 289-295. https://doi.org/10.1016/j.indcrop.2013.12.049

[97] Lowe SW, Lin AW. Apoptosis in cancer. Carcinogenesis, 2000:21:485–95. Doi : 10.1093/ carcin/21.3.485.

[98] Lv ZD, Liu XP, Zhao WJ, Dong Q, Li FN, Wang HB, et al. Curcumin induces apoptosis in breast cancer cells and inhibits tumor growth in vitro and in vivo. International Journal of Clinical and Experimental Pathology, 2014:7:2818–24.

[99] Mahdavi P, Bergmeier E. Plant functional traits and diversity in sand dune ecosystems across different biogeographic regions. Acta Oecologica, 2016:74: 37-45. https://doi.org /10.1016 /j.actao. 2016.06.003

[100] Marashdah M, AL-Hazimi H. Pharmacological activity of ethanolic extract of Alhagi maurorum roots. Arabian Journal of Chemistry, 2009:3(1):39-42. https:// doi.org /10.10 16/j.arabjc.2009.12.007

[101] Marashdah MS, Al-Hazimi HM, Abdallah MA, Mudawi BM. Pharmacological activity of the new compound 5, 500 00-dipropyl-2,20:50,200:500,200 0:500 0,200 00-pentathienyl and octocosanoic acid,28-hydroxy-20, 30-dihydroxy propyleste isolated from Alhgi maurorum roots. Arabian Journal of Chemistry, 2008:1(1): 61-6.

[102] Marashdah MS, Mudawi MB, Al-Hazimi HM, Abdallah MA. New aliphatic ketone and new aliphatic ester from the roots of Alhagi maurorum medik. Journal of Saudi Chemical Society, 2006b:10(3):509-513.

[103] Marashdah MS, Mudawi MB, Al-Hazimi HM, Abdallah MA. New triglyceride and new aliphatic ester from the roots of Alhagi maurorum medik. Journal of Saudi Chemical Society, 2006a:10 (2): 367-371.

[104] Mehrabi S, Beigi P, Salehpour Z. Comparison of the effect of hydroalcholic extract of Alhagi maurorum and Hydrochlorothiazide on excretion of 4–10 mm kidney and ureteral stones in adults: A Randomized Prospective Study. Advances in Pharmacological and Pharmaceutical Sciences, vol. 2023, Article ID 6624981, 5 pages, 2023. https://doi.org /10. 1155/2023/6624981

[105] Mirzaei A, Esfahani NB, Ghanadian M, Moghim S. Alhagi maurorum extract modulates quorum sensing genes and biofilm formation in Proteus mirabilis. Scientific Reports, 2022:12(1):1-13. https://doi.org/10.1038/s41598-022-18362-x

[106] Mohammadkhani N, Servati M. Nutrient concentration in wheat and soil under allelopathy treatments. Journal of Plant Research, 2018:131(1):143-155. doi: 10.1007/s10265-017-09 81-x.

[107] Molaei-Kordabad N, Alizadeh-Salteh S, Ghanbari-Jahromi M, Saber M. In vitro study on anticancer effect of Dodder grown on fennel (Foeniculum vulgare) and camelthorn (Alhagi maorurum) against human cancer cells lines. Journal of Herbal Medicine, 2024:43: 100819. https://doi.org/10.1016/j.hermed.2023.100819

[108] Moradgholi H, Shojaeian K, Jalilvand G, Kasmani BF, Ghazaghi M. The effects of replacing different levels of scabies (Alhaghi maurorum L) on performance and parameters of safety and health of 9- to 15-week-old Ostriches. Animal Sciences Journal, 2023:36 (140):111-126. doi: 10.22092/asj.2023.359757.2253

[109] Mudawi MB, AL-Hazimi HM, Abdallah MA, Marashdah MS. New aliphatic ester and new thiophene derivative from the roots of Alhagi maurorum medik. Journal of Saudi Chemical Society, 2007:11(1):87-92.

[110] Muhammad G, Hussain MA, Anwar F, Ashraf M, Gilani H. Alhagi: A plant genus rich in bioactives for pharmaceuticals. Phytotherapy Research, 2014:29(1):1-13. https://doi.org/ 10.1002/ptr.5222.

[111] Mulukuri NVL and Kumar PP. Biomolecules and pharmacology of Alhagi maurorum Medik (Family: Fabaceae). Book Chapter. Bioactives and Pharmacology of Legumes. Edition1st Edition, First Published 2023, Imprint Apple Academic Press, Pages11, eBook ISBN9781003304555

[112] Nasir E, Ali SI. Flora of Pakistan, National Herbarium, NARC, Islamabad, Department of Botany, University of Karachi, Karachi, Pakistan, (Fascicles), 1972.

[113] Neamah NF. A pharmacological evaluation of aqueous extract of Alhagi maurorum. Global Journal of Pharmacy, 2012: 6(1):41-46.

[114] Neamah W, Hasan F, Jasim F, Hachim A. Studying the response of Anethum graveolens L. to the stress of salinity and foliar spray with Alhagi maurorum aqueous extract. Open Agriculture Journal 2024: 18: e18743315277673. http://dx.doi.org/10.2174/01187433152 776732312 08101854

[115] NMSU. 2024. New Mexico State University (NMSU) https://weeds.nmsu.edu/ factsheet.php?weed_id=73 visited on 05-03-2024.

[116] Olas B, Hamed AI, Oleszek W, et al. Comparison of biological activity of phenolic fraction from roots of Alhagi maurorum with properties of commercial phenolic extracts and resveratrol. Platelets, 2015:26(8):788–794.

[117] Pen-Mouratov S, Shukurov N, Yu J, Rakhmonkulova S, Kodirov O, Barness G, Kersten M, Steinberger Y. Successive development of soil ecosystems at abandoned coal ash landfills. Ecotoxicology, 2014:23(5):880-97. doi: 10.1007/s10646-014-1227-5.

[118] PFAF. 2024. PFAF (Plants for a Future). https://pfaf.org/user/Plant.aspx?LatinName= Alhagi+ maurorum visited on 05-03-2024.

[119] Pirasteh-Anosheh H, Ranjbar G, Akram NA, Ghafar MA, Panico A. Forage potential of several halophytic species grown on saline soil in arid environments. Environmental Research, 2023: 219:114954. doi: 10.1016/j.envres.2022.114954.

[120] Pirasteh-Anosheh H. Breaking seed dormancy of Camelthorn (Alhagi maurorum) using different treatments and salinity tolerance threshold level evaluation at germination stage. Iranian Journal of SeedResearch,2020:7(1):12doi:10.29252/yujs.7.1.181URL: http:// yujs.yu.ac.ir/jisr/article-1-402-en.html

[121] Piwowarczyk R, Ochmian I, Lachowicz S, Kapusta I, Sotek Z, Błaszak M. Phytochemical parasite host relations and interactions: A Cistanche armena case study. Science of the Total Environment, 2020:716:137071. doi: 10.1016/j.scitotenv.2020.137071.

[122] Pons DG, Nadal-Serrano M, Torrens-Mas M, Valle A, Oliver J, Roca P. UCP2 inhibition sensitizes breast cancer cells to therapeutic agents by increasing oxidative stress. Free Radical Biology and Medicine, 2015:86:67–77. doi: 10.1016/j.freeradbiomed.2015.04.032.

[123] Pourali P, Yahyaei B. Wound healing property of a gel prepared by the combination of Pseudomonas aeruginosa alginate and Alhagi maurorum aqueous extract in rats. Dermatologic Therapy, 2019:32(1):e12779. doi: 10.1111/dth.12779.

[124] Prabhu S, Poulose E. Silver nanoparticles: mechanism of antimicrobial action, synthesis, medical applications, and toxicity effects. International Nano Letters 2012: 2: 32.

[125] Qu J, Yang J, Chen M, Zhai A. Anti-human gastric cancer study of gold nanoparticles synthesized using Alhagi maurorum. Inorganic Chemistry Communications, 2023:151: 109859. https://doi.org/10.1016/ j.inoche.2022.109859

[126]Rajan R, Chandran K, Harper S, IlYun S, Kalaichelvan P. Plant extract synthesized silver nanoparticles: An ongoing source of novel biocompatible materials. Industrial Crops and Products, 2015:70: 356-373.

[127] Sabir M, Baltrėnaitė-Gedienė E, Ditta A, Ullah H, Kanwal A, Ullah S, Faraj TK. Bioaccumulation of heavy metals in a soil–plant system from an open dumpsite and the associated health risks through multipleroutes.Sustainability(Switzerland),2022:14(20), [13223]. https://doi.org/10.3390/su142013223

[128] Saleem H, Sarfraz M, Khan KM, Anwar MA, Zengin G, Ahmad I, Khan SU, Mahomoodally MF, Ahemad N. UHPLC-MS phytochemical profiling, biological propensities and in-silico studies of Alhagi maurorum roots: a medicinal herb with multifunctional properties. Drug Development and Industrial Pharmacy, 2020:46(5):861-868. doi: 10.1080/03639045. 20 20.1762199. Epub 2020 May 13. PMID: 32352878.

[129] Samejo MQ, Memon S and Khan KM. Chemical composition of essential oils from Alhagi maurorum. Chem Natural Comp 2012: 48(5): 898-900.

[130] Saxena A, Tripathi RM, Zafar F and Singh P. Green synthesis of silver nanoparticles using aqueous solution of Ficus benghalensis leaf extract and characterization of their antibacterial activity. Materials Letters, 2012: 67: 91–94.

[131] Scalbert A, Johnson IT, Saltmarsh M. Polyphenols: Antioxidants and beyond. The American Journal of Clinical Nutrition, 2004:81(1): 215S-217S. https://doi.org/10.1093/ ajcn/81.1.215S

[132] Sehrawat AR, Malik A, Sehrawat KD, Singh A, Kumar D. Antimicrobial and in vitro efficacy of green silver nanoparticles in tissue culture of Alhagi maurorum. NELUMBO, 2021:63(1) 243–253. https://doi.org/10.20324/ nelumbo/v63 /2021/165155

[133] Shaker E, Mahmoud H, Mnaa S. Anti-inflammatory and anti-ulcer activity of the extract from Alhagi maurorum (camelthorn). Food and Chemical Toxicology, 2010:48(10):2785-90. doi: 10.1016/j.fct. 2010.07.007.

[134] Sheweita SA, Mashaly S, Newairy AA, Abdou HM, Eweda SM. Changes in oxidative stress and antioxidant enzyme activities in streptozotocin induced diabetes mellitus in rats: Role of Alhagi maurorum extracts. Oxidative Medicine and Cellular Longevity, 2016:2016:5264064. doi: 10.1155/2016/5264064.

[135] Sukirtha R, Priyanka KM, Antony JJ, Kamalakkannan S, Thangam R, Gunasekaran P, Krishnan M and Achiraman S. Cytotoxic effect of green synthesized silver nanoparticles using Melia azedarach against in vitro HeLa cell lines and lymphoma mice model. Process Biochemistry, 2012: 47: 273–279.

[136] Sumaiya NH, Hanady SA, Zainb AA, Ghassan MS, Yaser HD, Jesamine JR. Green synthesis of silver nanoparticles from Alhagi graecorum leaf extract and evaluation of their cytotoxicity and antifungal activity. Journal of Nanomaterials, 2022, Article ID 1058119, 8 pages, 2022. https://doi.org/10.1155/2022/1058119

[137] Sur U, Ankamwar B, Karmakar S, Halder A, Das P. Green synthesis of silver nanoparticles using the plant extract of Shikakai and Reetha. Materials Today Proceedings, 2018: 5: 2321-2329.

[138]Tareen RB, Bibi T, Khan MA, Mustaq A, Zafar M. Indigenous knowledge of folk medicine by the women of Kalat and Khuzdar regions of Balochistan, Pakistan. Pakistan Journal of Botany, 2010: 42(3):1465-1485.

[139] Uphof JCT. Dictionary of Economic Plants, Weinheim. 1959. p.404.

[140] UTP. 2024. Useful Temperate Plants (UTP). Alhagi maurorum. https://temperate.theferns.info/plant/Alhagi+maurorum. Visited on 05-03-2024.

[141] Velmuruga PN, Krishnan A, Manoharan M, KuiJae L, Min C, Sang-Myeong L, Jung-Hee P, Oh SG, Bang KS and Oh BT. Green synthesis of silver and gold nanoparticles using Zingiber officinale root extract and antibacterial activity of silver nanoparticles against food pathogens. Bioprocess and Biosystem Engineering, 2014: 37: 1935-1943.

[142] WA. 2024. Weeds Australia (WA). What is weed. https://weeds.org.au/profiles /camel -thorn- camelthorn/ visited on 05-03-2024.

[143]Wang Y, Cui R, Xiao Y, Fang J, Xu Q. Effect of carotene and lycopene on the risk of prostate cancer: a systematic review and dose response meta-analysis of observational studies. PLoS One. 2015; 10:e0137427. doi: 10.1371/journal.pone.0137427.

[144] Waris M, Baig JA, Talpur FN, Kazi TG, Afridi HI. An environmental field assessment of soil quality and phytoremediation of toxic metals from saline soil by selected halophytes. Journal of Environmental Health Science and Engineering, 2022:20(1):535-544. doi: 10.1007/s40201-022-00800-7.

[145] Webera DJ, Ansarib R, Gulb B, Khan MA. Potential of halophytes as source of edible oil. Journal of Arid Environments, 2007:68:315–321.

[146] WF. 2024. (Weed Futures). Determining current and future weed threats in Australia. Alhagi mauroum Family, Fabaceae. https://weedfutures.net/species.php?id=1005. Visited on 05-03-2024.

[147] Wu X, Li H, Xiao N. Advancement of near-infrared (NIR) laser interceded surface enactment of proline functionalized graphene oxide with silver nanoparticles for proficient antibacterial, antifungal and wound recuperating therapy in nursing care in hospitals. Journal of Photochemistry and Photobiology B. 2018:187: 8995.

[148] Ye J, Shi J, Zhang M, et al. Novel Alhagi maurorum leaves mediated synthesis of titanium nanoparticles for human breast carcinoma applications: a preclinical trial. Archives of Medical Science, 2021. doi:10.5114/aoms/143345.

[149]Yuan C, Jiang B, Xu X, Wan Y, Wang L, Chen J. Anti-human ovarian cancer and cytotoxicity effects of nickel nanoparticles green-synthesized by Alhagi maurorum leaf aqueous extract. Journal of Experimental Nanoscience, 2022: 17:1: 113-125, DOI: 10.1080 /17458 080. 2021.2011860

[150]Zhang J, Wang W, Qian L, Zhang Q, Lai D, Qi C. Ursolic acid inhibits the proliferation of human ovarian cancer stem-like cells through epithelial mesenchymal transition. Oncology Reports, 2015:34:2375–84.

[151]Zhao W, Wang L, Chen H, Qi L, Yang R, Ouyang T, Ning L. Green synthesis, characterization and determination of anti-prostate cancer, cytotoxicity and antioxidant effects of gold nanoparticles synthesized using Alhagi maurorum. Inorganic Chemistry Communications, 2022:141: 109525. https://doi.org/10.1016/j.inoche.2022.109525

Citation: *Muhammad Shafiq. Medicinal Weed: The Ecological, Biological and Pharmaceutical Potential of Alhagi Maurorum Medikus - A Review. International Journal of Advanced Research in Botany. 2025; 9(1):5-25. DOI: https://doi.org/10.20431/2455-4316.0901002.*