

Review Article

A review on Kaff Maryam (*Anastatica hierochuntica* L.): chemical constituents, pharmacological activities and role on fertility

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ABSTRACT

Anastatica hierochuntica L., a plant widely used in folkloric medicine in Arab countries, has gained attention for its therapeutic properties. The plant is employed as an herbal remedy to address various diseases, including gynecological health issues. Its pharmacological effects are attributed to a diverse array of phytoconstituents, including steroids, triterpenoids, flavonoids, tannins, fatty acids, coumarins, alkaloids and more. According to research, *A. hierochuntica* has a variety of useful properties, including anti-cancer, antioxidant, anti-diabetic, anti-inflammatory, gastroprotective, immunostimulant, hepatoprotective and antibacterial properties. Notably, the plant has been recognized for its role in infertility treatment, with several scientific studies supporting its therapeutic value in this regard. This review aims to provide a comprehensive overview of *A. hierochuntica*, covering aspects such as plant description, traditional uses, chemical constituents and pharmacological activities. Emphasis is placed on the plant's potential in infertility treatment and this review work explores possible mechanisms behind this role. The article underscores the multifaceted potential of *A. hierochuntica* in offering a variety of health benefits and encourages further exploration for its application in the development of novel treatments.

Keywords: *Anastatica hierochuntica*, Kaff Maryam, Phytochemical analysis, Pharmacological activities, Phytoestrogen and infertility

INTRODUCTION

Components derived from natural source have always been the choice of medicaments for most of the people, especially for the people of developing countries. Though recent advanced world is more inclined to synthetic components still the acceptability of medicinal plants in therapeutic application is very much notable. As they have greater acceptance in society, work better with the human body, and have fewer adverse effects, herbal medicines are preferred. The medicinal properties of plants are due to their phytochemical components, which have specific effects on the human body. Alkaloids, flavonoids, tannins and phenolic compounds are some of the significant components.¹⁻³

A. hierochuntica is a wonder plant which is commonly called Kaff Maryam (Mary's hand), Gurgaon Fatimah or Rose of Jericho in Arab countries. It is referred to as the "hand of Maria" or the "hand of Fatma" throughout Europe. In Malaysia, it is called 'Kembang Fatimah'. In Indonesia, it is called 'Rumput Fatimah'. It can be found in desert areas of the United Arab Emirates, Jordan, Saudi Arabia, Iraq, Egypt, Kuwait, Libya, Iran, Israel, North Africa and Oman. It is an annual plant native to the Sahara and Arabian deserts that blooms in the winter. It is utilised in Egyptian folk medicine and drunk as tea in Arabic countries. It can survive without water for long periods and arises from a latent phase when water is available. The soaking water of *A. hierochuntica* is

consumed by pregnant women in Indonesia to increase uterine contractions.¹⁻⁴

It is a tiny, grey herb that is a member of the *Brassicaceae* family. It is the lone specimen in the *Anastatica* genus. The plant produces little white flowers and can grow up to 15 cm in height. During extreme temperatures, it branches from the base, and in unfavorable conditions, it curls inward, resembling a greying-white dry ball. When conditions improve, the plant reverts to its stable structure. When dry, the minute white flowers roll up, expanding again when moist. Overall, *A. hierochuntica* is a unique, monotypic species with distinctive characteristics and adaptability to arid environments.^{2,4-6}

A. hierochuntica L. is a plant rich in secondary constituents, including anastatin A and B, naringenin, aromadendrin, eriodictyol, (+)-taxifolin, 3'-O-methylaxifolin, (+)-epitaxifolin, silybin, and hierochins A, B, and C. Flavonoids such as luteolin-7-glucoside, isovitexin, kaempferol 7-glucoside, kaempferol 3-rhamnoglucoside, quercetin and lucitin are found throughout the plant. Glucosinolates, specifically glucoiberin and glucocheirolin are present. The fruits contain various sugars, including glucose, fructose, galactose, sucrose, stachyose and raffinose. *A. hierochuntica* is a source of phenolic substances, flavonoids, sterols and essential minerals such as Mg, Mn, Ca, Co, Cr, Cu, Fe and Zn. Because of its flavonoids and other chemicals, the plant is known for having phytoestrogenic properties, which are similar to those of estrogen in the reproductive system of humans. All parts of the plant are rich in essential minerals, highlighting its potential nutritional and medicinal value.^{2,3,6,7}

A. hierochuntica is a versatile herb with a rich history of traditional medicinal use across a wide range of health concerns and holds significant medicinal value in Egyptian folk medicine. The methanolic extract from the whole plant exhibits potent hepatoprotective effects. The plant is used to treat depressive conditions, painful periods, uterine hemorrhage and exhaustion. It also acts as an antispasmodic and eases stomach discomfort. Asthma, diabetes, inflammation, infections and arthritis are said to be relieved by it. The plant is also employed for pain relief after surgery and has applications as a local disinfectant, childbirth aid, liver tonic and anti-vomiting agent. The methanolic and aqueous extracts demonstrate antioxidant, antifungal and antimicrobial properties. *A. hierochuntica* is considered cardio-tonic, with hypoglycemic and hypolipidemic effects.^{1,4,8,9}

A. hierochuntica L. is traditionally consumed by pregnant women, especially nearing delivery, for its believed ability to ease childbirth and address reproductive system disorders like menstrual cramps and uterine hemorrhage. Some scientific findings support its traditional use as a facilitator of labor, demonstrating its potential to stimulate myometrial contractions and increase

prostaglandin levels, crucial for childbirth. The dose of *A. hierochuntica* L. extract at 100 mg/kg bw/day exhibited a significant impact on myometrial hypertrophy and yielded a substantial elevation in prostaglandin E2 (PGE2) and prostaglandin F2 α (PGF2 α) levels in pregnant mice.³ However, caution is advised due to potential risks associated with concurrent use of modern labor-inducing drugs, leading to excessive induction and hyperstimulation of the uterus. Additionally, women taking insulin injections for gestational type 2 diabetes may be at risk from the herb, as it could contribute to hypoglycemia. Mutagenic effects of *A. hierochuntica* at 0.04 and 0.2 mg/mL were observed *in vivo* and *in vitro* modified Ames test, and a study on fetal toxicity in mice indicated increased rates of fetal resorption (11/105 or 10.5%) and incidences of anencephaly (a congenital disorder) with high doses (0.25, 1 and 4 g/kg) of *A. hierochuntica* extract.⁵ As a result, the consumption of this herb during pregnancy is advised against until proven safe, highlighting the need for caution and further research regarding its potential risks and benefits.⁷

LITERATURE REVIEW

In this literature review, a comprehensive approach was taken to examine the medicinal plant *A. hierochuntica*. The methodology involved an exhaustive search of peer-reviewed journals using various keywords related to the plant, such as “medicinal plant”, “*A. hierochuntica*”, “phytochemical analysis”, and “pharmacological activities of *A. hierochuntica*”. Conference papers and reports were excluded from the search. After carefully examining the abstracts and titles in order to find relevant references, important information was retrieved, including the types of extracts, study designs, sample sizes, dosages, and results. The search utilized reputable sources such as Google Scholar, PubMed, Web of Science, Science Direct, Scopus and others. Additionally, the reference sections of identified articles were explored to uncover additional relevant literature. This literature review also incorporated visual elements, with pictures of the *A. hierochuntica* plant sourced from websites. The review was composed using Word 2016 on an HP Probook 450 G5 device. ChemDraw pro 12.0 was used to draw the structures of phytochemical constituents like our previous works.¹⁰⁻¹² The paper primarily focused on valuable information, notably the pharmacological activity, therapeutic role and medicinal uses of *A. hierochuntica*. By employing a rigorous methodology and utilizing a variety of reputable sources, the review provides a thorough and reliable exploration of the medicinal aspects of this plant as we have observed in our previous review articles.^{10,13}

TAXONOMICAL CLASSIFICATION

Kingdom: plantae, phylum: Tracheophyta, division: magnoliophyta, class: Magnoliopsida, family: *Brassicaceae*, genus: *anastatica*, species: *A. hierochuntica* L.¹⁴

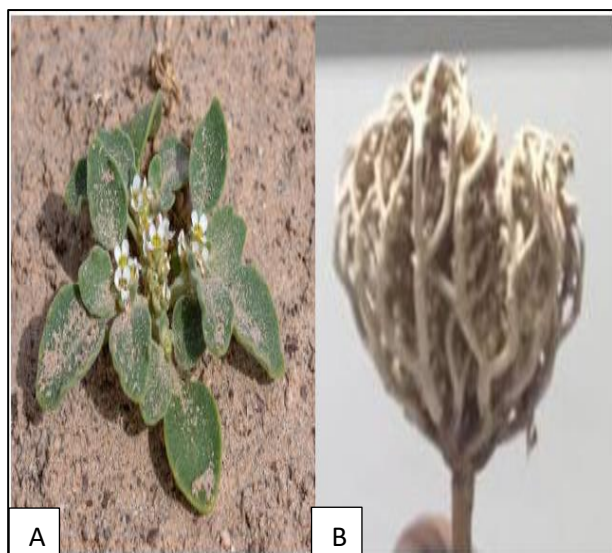


Figure 1 (A and B): Moist (left) and dry (right) state of Kaff Maryam (*A. hierochuntica*) plant.

Pictures taken from <https://www.monaconatureencyclopedia.com/anastatica-hierochuntica/?lang=en> and Molecular Pharmacology and Herbal Drug Research Laboratory, Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Dhaka, Dhaka-1000, Bangladesh.

CHEMICAL CONSTITUENTS OF *A. HIEROCHUNTICA*

The abundance of a variety of chemical groups was found during the phytochemical screening of the plant's different parts, indicating a rich chemical composition as shown in Figure 2. The major chemical groups identified include steroids, triterpenoids, flavonoids, tannins, fatty acids, coumarins, reducing compounds, alkaloids and salts. It is important to note that the composition may vary due to factors such as environmental conditions, location, temperature, drying period, time of harvest, genotype and place of origin. These variations in chemical composition can influence the plant's bioactivity and potential medicinal properties. The presence of these diverse phytochemicals suggests the plant may have various biological activities and could be valuable for different applications in traditional medicine or as a source of bioactive compounds.^{7,15,16}

The elemental analysis of *A. hierochuntica* plant parts indicates that leaves contain the highest concentrations of both micro and macro elements. Specifically, the leaves show elevated levels of calcium (Ca), potassium (K) and sodium (Na). This abundance of minerals, particularly Ca, K and Na, suggests a potential role in supporting action potential generation and excitation-contraction coupling in uterine smooth muscle cells. This phenomenon could contribute to the stimulation of uterine contractions during labor. Furthermore, the mineral analysis reveals notable concentrations of copper (Cu-8.65±0.30ppm), zinc (Zn-47.51±1.31ppm), and iron (Fe-169.48±7.11 ppm) in *A. hierochuntica* leaves. The

high levels of iron and manganese (Mn) suggest a potential benefit in reducing postpartum hemorrhage, given their involvement in blood vessel functions, hemostasis and blood clotting. Overall, the mineral composition of *A. hierochuntica*, especially in its leaves, may hold significance for maternal health during labor and postpartum periods.^{16,17}

Phenolic compounds

Various phenolic compounds, including dihydroxybenzoic acid hexoside, 5-O-caffeoylquinic acid, 3,4-dihydroxybenzoic acid, 3,4-O-dicaffeoylquinic acid and 4,5-O-dicaffeoylquinic acid have been detected in aqueous extracts derived from plant seeds. These compounds were observed to possess antioxidative properties. Also, larciresinol, balanophonin, dehydroniciferyl alcohol, evofolin B, silybin A, silybin B, isosilybin A, isosilybin B, p-hydroxybenzoic acid, vanillin, acetovanillone, coniferaldehyde etc. were found in the whole plant. *A. hierochuntica* whole plant methanolic extracts have yielded three distinct neolignans, called hierochins A, B and C.^{9,17,18}

Flavonoids

A. hierochuntica is found to possess a high concentration of flavonoids, encompassing a diverse range of groups such as flavones, flavonols, flavanones and flavonolignans. These flavonoids exhibit various beneficial properties, including antioxidant, anti-melanogenic and hepatoprotective effects. Additionally, research suggests that the flavonoids in *A. hierochuntica* play a crucial role in immune modulation, contributing to the activation of immune responses.

Previous studies on *A. hierochuntica* have specifically highlighted flavone glycosidic components, attributing them to the stimulation of lipolysis and their involvement in nucleic acids and protein metabolism. Notably, these flavonoids have shown regenerative effects on pancreatic cells in diabetic rats induced by substances like alloxan and streptozotocin (STZ). The comprehensive findings underscore the diverse therapeutic potential of *A. hierochuntica* flavonoids, making it a valuable plant with potential applications in antioxidant, hepatoprotective and immune-modulating interventions.¹⁷

Naringenin, eriodictyol, aromadendrin, anastatin A, taxifolin, 3-O-methyl taxifolin, anastatin B, epitaxifolin, kaempferol, luteolin, rutin (citrus flavonoid glycoside), silychristin (flavonolignan) etc. have been identified in the whole plant. Also seeds contain different flavonoids like luteolin-6-C-hexosyl-8-C-pentoside, isovitexin-7-O-glucoside, luteolin-6-C-pentosyl-8-C-hexoside, luteolin-O-glucoside (flavonoid glycoside), orientin, isoorientin, isovitexin, diosmetin-8-C-glucoside, luteolin-O-glucuronide, isoorientin-2''-O-glucoside, taxifolin-O-hexose, kaempferol-3-O-glucoside.^{9,18,19}

Steroidal compounds

Various steroidal compounds including β -sitosterol, γ -sitosterol, campesterol, stigmasterol, 7-dehydrodiosgenin (steroidal sapogenin), stigmastan-3,5-diene etc. were isolated from stem, leaf, seed and whole plant of *A. hierochuntica*.^{18,20}

Tannins

Aqueous extracts of *A. hierochuntica* stems and methanol extracts of seeds and leaves exhibit a high concentration of tannins. Tannins, known for their presence in plants used traditionally for treating intestinal disorders, contribute to the ethnomedical application of *A. hierochuntica*. Tannins exist in hydrolysable and condensed forms, demonstrating their capacity to stop lipid peroxidation, bind transition metals, inhibit pro-oxidative enzymes, and neutralize free radicals. These

properties suggest the potential of *A. hierochuntica* in providing therapeutic benefits related to antioxidant and anti-inflammatory effects, supporting its traditional use in ethnomedicine for addressing gastrointestinal issues.¹⁷

Fatty acids

The seeds of *A. hierochuntica* exhibit a high energy value, likely attributed to their elevated fat content. Numerous studies emphasize the medicinal significance of the seeds. The substantial lipid content in *A. hierochuntica* seeds plays a crucial role in mechanisms associated with desiccation tolerance and resurrection properties. These properties are noteworthy and contribute to the plant's ability to endure periods of dehydration and subsequently recover upon rehydration.¹⁷ Palmitic acid, stearic acid, oleic acid, cis-vaccenic acid, pentadecanoic acid etc. fatty acids are present in the stem, seed and leaf of the plant.¹⁸

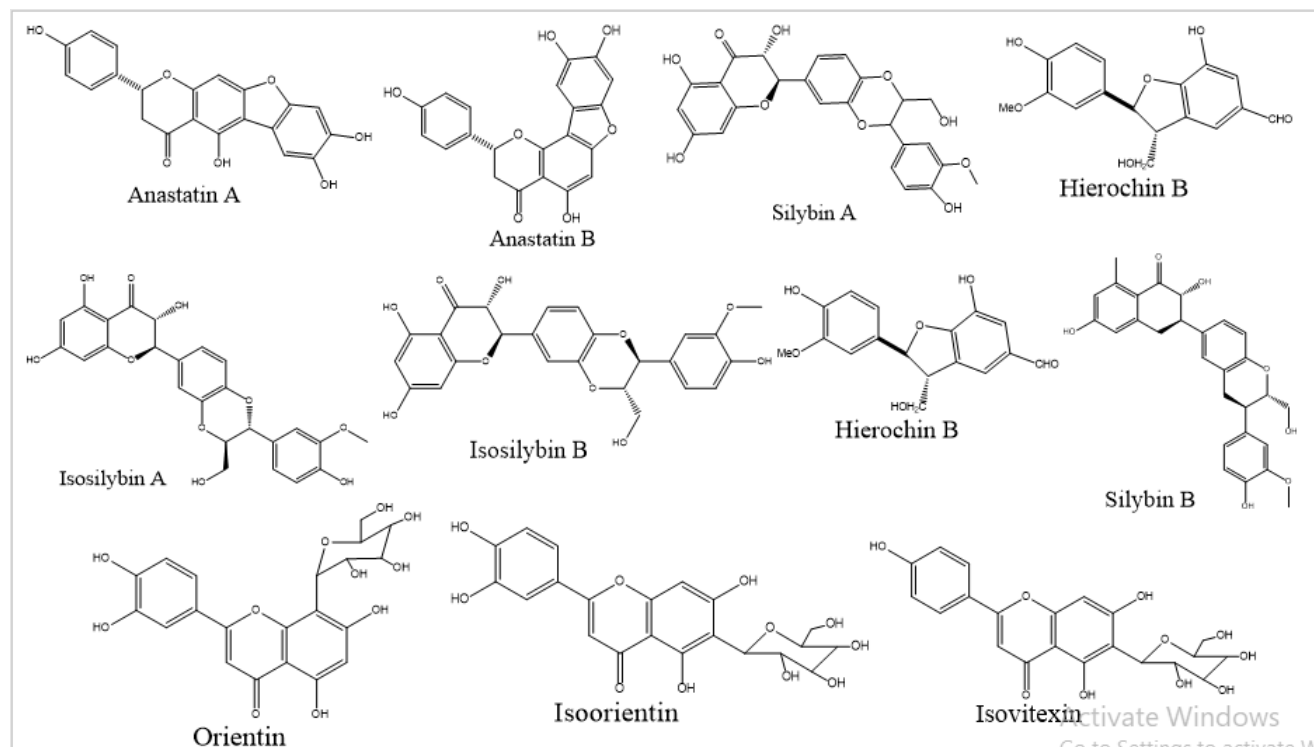


Figure 2: Important phytochemicals isolated from *A. hierochuntica*.

PHARMACOLOGICAL ACTIONS OF *A. HIEROCHUNTICA*

A. hierochuntica, known for its wide range of pharmacological actions, has been utilized for medicinal purposes with some scientific support. Extracts from the plant exhibit antioxidant, antimicrobial, antifungal, hypolipidemic and hypoglycemic properties. Additionally, the plant displays hepatoprotective, anti-inflammatory and gastroprotective activities. The entire *A. hierochuntica* plant is rich in essential minerals and phenolic compounds, which may contribute to its therapeutic potential as an herbal medicine.^{4,9} The plant's

primary pharmacological properties, which have been ascertained through thorough scientific research are summarized below:

Antioxidant activity

The methanolic extract of *A. hierochuntica* has demonstrated antioxidant activity, as indicated by various assays. In a 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay at a dose of 150 mg/mL, the methanolic extract exhibited antioxidant properties, suggesting its ability to neutralize free radicals and protect against oxidative reactions. Additionally, another

study investigated the antioxidant potential of the ethanolic extract of *A. hierochuntica* using the 2,2-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assay. In this assay, the whole extract displayed significant antioxidant activity, as evidenced by lower IC₅₀ values (specific concentrations at which 50% of radicals are inhibited) compared to one of the positive controls, butylated hydroxytoluene (BHT) at doses of 100, 200 and 400 µg/mL. The IC₅₀ values for the *A. hierochuntica* extract were notably low at 3×10^{-13} , indicating its efficient scavenging of free radicals.^{9,21}

Antimicrobial activity

A. hierochuntica exhibits notable antimicrobial activity against both gram-positive and gram-negative bacteria, indicating the existence of broad-spectrum antibacterial chemicals in the plant extract. In disc diffusion assays, aqueous extracts of *A. hierochuntica* at a dose of 40 mg/mL demonstrated strong inhibition against various bacteria, including *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens* and *Staphylococcus aureus*. Additionally, a 10 µL ethanolic extract of the plant exhibited inhibition against *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus*.⁹

The antimicrobial activity extends to antifungal properties, as evidenced by positive results in paper disc diffusion assays. Aqueous, acetone and methanol extracts of *A. hierochuntica*, at a dose of 250 mg/mL, displayed antifungal activity against *Candida albicans*, *Aspergillus niger*, *Penicillium digitatum*, *Fusarium oxysporum* and *Cryptococcus neoformans*. Furthermore, in the well diffusion method, the aqueous extract at a dose of 150 mg/mL exhibited dose-dependent inhibitory activity against *Microsporum audouinii*, *Candida albicans*, *Cladosporium sp.* and *Aspergillus flavus*.^{9,22}

Hypolipidemic activity

Studies investigating the hypolipidemic activity of the methanolic extract of *A. hierochuntica* whole plant demonstrated positive effects on the lipid profiles of alloxan-induced diabetic rats. In these studies, the daily oral administration of 100 mg/kg of the methanolic extract for a duration of 4 weeks resulted in significant improvements in lipid parameters. Specifically, the administration of the methanolic extract led to a substantial reduction in the levels of triglycerides (TG), low-density lipoprotein (LDL), very low-density lipoprotein (VLDL) and total cholesterol (TC) in alloxan-induced diabetic male Swiss albino rats. Moreover, the treatment significantly increased the levels of high-density lipoprotein (HDL) cholesterol, which is considered beneficial for heart health. The elevation of HDL cholesterol further contributes to the overall improvement in the lipid profile.⁹

Antidiabetic activity

A. hierochuntica has shown regenerative properties on pancreatic β-cells, making it a notable medicinal plant with potential therapeutic benefits for diabetes management. In studies involving alloxan-induced diabetic rats, the methanolic extract of *A. hierochuntica* exhibited hypoglycemic activity. The administration of this extract at a dose of 100 mg/kg bw resulted in a significant reduction of glucose levels by 74%, compared to the baseline levels in the control group. This hypoglycemic effect was attributed to the restoration of pancreatic β-cells.^{9,23} Additionally, the aqueous extract of *A. hierochuntica*, administered at a dose of 12.5 mg per rat, demonstrated an increase in serum insulin levels. This effect was associated with the regeneration of pancreatic cells in male albino Wistar rats.

The regenerative properties of *A. hierochuntica* on pancreatic cells contribute to its potential as a natural agent for promoting insulin production and improving glucose metabolism.⁹

Gastroprotective activity

Decoctions of *A. hierochuntica* are traditionally consumed to address gastric disorders. In a study, the ethanolic extract of *A. hierochuntica* demonstrated significant protective effects on the stomach wall against the damage caused by necrotizing agents in Wistar albino rats. The protective activity was observed at varying doses ranging from 125 to 500 mg/kg body weight. The results of the study indicate that the ethanolic extract of *A. hierochuntica* has a statistically substantial gastroprotective effect.⁹

Immunostimulatory activity

The methanolic extract of *A. hierochuntica*, administered to male Swiss albino mice at a dose of 50 mg/kg for a duration of 2 weeks, resulted in notable immunomodulatory effects. Specifically, the treatment led to a significant increase in the levels of immunoglobulin G (IgG), a key component of the immune system responsible for antibody-mediated responses. Additionally, the percentage of phagocytosis was also significantly elevated. It was suggested that the observed increase in circulating IgG levels could be attributed to the presence of flavone glycosidic components in the *A. hierochuntica* extract.

Moreover, when the plant extract was administered at a higher dose (100 mg/kg), it resulted in a significant decrease in the activity of adenosine deaminase (ADA), another immunological parameter.^{2,9}

Anticancer activity

A study investigating the anti-proliferative properties of *A. hierochuntica* found that both methanolic and aqueous

extracts from various parts of the plant, including seeds, stems, and leaves, exhibited significant inhibitory effects on MCF-7 breast cancer cells.

The anti-proliferative activity was observed in a dose-dependent manner, indicating that higher concentrations of the extracts led to more pronounced effects on reducing the viability of the cancer cells.²⁴

Antimalarial activity

The study on *A. hierochuntica* revealed antimalarial activity in adult male institute of cancer research (ICR) through the administration of ethanol, chloroform and aqueous extracts at various doses (50, 100, 200, and 400 UL kg⁻¹). The extracts demonstrated positive effects, including an extension of the survival periods of the mice infected with malaria and a significant reduction in parasitemia levels.²⁵

Anti-inflammatory and antinociceptive activity

A. hierochuntica's aqueous extract and chloroform fraction shown both anti-inflammatory and antinociceptive properties. In the carrageenan-induced paw edema assay, the extracts demonstrated the ability to inhibit edema formation at doses of 6.5 and 29.1 mg/kg. Moreover, in various nociception assays, including the hot-plate test, tail-immersion test, acetic acid-induced writhing test and formalin-induced paw licking test, doses ranging from 8.7 to 31.0 mg/kg of the extracts demonstrated both central and peripheral antinociceptive effects. This indicates the potential of *A. hierochuntica* as a source of compounds with anti-inflammatory and pain-relieving properties.²⁶

Antibacterial activity

In studies evaluating the antibacterial activity of *A. hierochuntica*, both methanolic and aqueous macerates of the seeds showed higher efficacy against Gram-positive bacteria compared to Gram-negative bacteria. The assessment was conducted using disk diffusion and well diffusion methods.²⁷

Nephroprotective activity

The ethanolic and aqueous extracts of *A. hierochuntica* exhibited nephroprotective activity in rats with carbon tetrachloride (CCl₄)-induced nephrotoxicity. The administration of 250 mg/kg body weight of these extracts demonstrated significant positive effects on kidney function. The nephroprotective effects were evident in the restoration of various parameters related to kidney function, including serum creatinine, urea, potassium (K), total protein and albumin levels.²⁸

EFFECT OF *A. HIEROCHUNTICA* ON FERTILITY

Herbal remedies, which include substances from natural sources including tea, syrup and plant extracts, have been used extensively for ages to address infertility issues. Both men and women are said to be affected personally, socially and psychologically by infertility. Natural sources of healing are still widely used to treat ailments like low sperm count and poor libido. The medicinal use of *A. hierochuntica* L has historically been associated with enhancing fertility, particularly in women. The plant has been traditionally utilized to aid couples in conceiving, addressing issues related to infertility and promoting reproductive health. Fertility hormones play a crucial role in various reproductive processes, including development, puberty, gametogenesis and overall sexual function.²⁹

Research on the effects of *A. hierochuntica* extract on albino male mice revealed that oral administration of different doses (100, 200, and 300 mg/kg) caused an elevation in testosterone levels, increased sperm count and a slight rise in body mass index without inducing toxic effects on the liver and kidneys. In female mice, the aqueous extract of *A. hierochuntica* demonstrated significant effects on hormone levels. At a specific dose, the extract led to a notable increase in Luteinizing hormone, Follicle-stimulating hormone, prolactin and progesterone levels. It can be inferred that the findings provide valuable insights into the potential benefits of *A. hierochuntica* in enhancing fertility, with observed effects on both male and female reproductive hormones in mice.^{10,29}

ETHNOMEDICINAL USES OF *A. HIEROCHUNTICA*

A. hierochuntica is renowned for its extensive traditional medicinal uses. Consumed in powdered form with honey, it is employed for treating various conditions, including difficult childbirth, uterine hemorrhage, stomach issues, infertility, depression, hypertension, indigestion, headaches, fever, colds and malaria. The plant is widely used in Arabian folk medicine, particularly for respiratory conditions, often consumed as a tea. In Malaysia, pregnant women commonly use *A. hierochuntica* due to its mineral content, believed to promote health and facilitate smooth delivery. Other ethnomedicinal applications include epilepsy, hyperglycemia, cardiac issues and infertility.^{8,9,30}

A. hierochuntica exhibits diverse medicinal properties, such as antioxidant, antibacterial, antifungal, hypolipidemic, anti-inflammatory, hepatoprotective and immunomodulatory characteristics. Specific compounds found in the plant, including anastatins A and B, silybin, luteolin, quercetin, and (+)-balanophonin, contribute to its pharmacological activities. The plant is used near childbirth to alleviate birthing pain, serving as an analgesic and emmenagogue. Overall, *A. hierochuntica*

has a rich history of traditional uses, reflecting its versatility in addressing a wide array of health concerns across different cultures.³¹⁻³³

TOXICITY OF *A. hierochuntica*

The plant *A. hierochuntica* has long been used in folk medicine to treat metabolic disorders and issues regarding to the reproductive system. It is concerning that, in spite of the lack of clinical research, pregnant women frequently take this herb towards the end of their pregnancy to speed up labor. Although there haven't been any documented adverse effects from pregnant women consuming *A. hierochuntica*, there are still some risks to be aware of. Prenatal toxicity effects were observed for both the highest and lowest doses of *A. hierochuntica* ethanol extract in studies on the toxicity effects of *A. hierochuntica* in pregnant Sprague-Dawley rats and their developing fetuses. According to the study, there could be harm to developing fetuses, especially during the organogenesis and implantation phases. Another study that used an *in vitro* modified Ames test showed that *A. hierochuntica* was mutagenic at concentrations of 0.04 and 0.2 mg/ml. Furthermore, a teratogenic potential was indicated by an increased incidence of fetal resorption rate and instances of anencephaly at higher doses in a study on the fetal toxicity effects of lyophilized *A. hierochuntica* extract in mice.^{5,34}

Preliminary toxicity studies using the Brine shrimp lethality test and observations on mitotic index depression in *Allium cepa* meristems suggested cytotoxicity, emphasizing the need for further investigations using different experimental models.⁸

To summarize, the results highlight *A. hierochuntica*'s possible teratogenic and mutagenic effects and its possible toxicity to fetuses. In order to have a complete understanding the safety profile and possible risks connected to consuming *A. hierochuntica*, more research is necessary, particularly during pregnancy.^{5,8,34}

CONCLUSION

A. hierochuntica is a well-known medicinal herb that has been used for centuries to treat a variety of illnesses with no known side effects, most notably infertility. It is an economically attractive option for the pharmaceutical industry due to its extensive distribution and capacity to flourish in low-demand soils. Although there is a substantial amount of information available about the biological activities of *A. hierochuntica*, there are significant gaps in knowledge, resulting in inconclusive findings. This review acknowledges the available data while emphasizing the necessity for additional scientific investigation to verify the purported therapeutic advantages of the plant. The review underscores the significance of conducting more thorough investigations and urges further research to clarify the underlying mechanisms responsible for the plant's biological

activities. Increasing our knowledge of its possible advantages and opening the door for more scientifically supported medical uses are the ultimate objectives. To summarize, this review presents an overview of the historical use of *A. hierochuntica*, the results of recent research, and the need for more scientific investigation to fully realize the potential of this herb for medical purposes.

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