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A SYSTEMATIC REVIEW OF PHYTOCHEMICAL ANALYSIS EXTRACTION METHODS AND PHARMACOLOGICAL ACTIVITIES OF ANASTATICA HIEROCHUNTICA

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ABSTRACT

People all across the world use the desert plant Anastatica hierochuntica L. (A. hierochuntica) to treat a variety of illnesses. The purpose of this study is to give an overview of the scientific studies on the biological activities of A. hierochuntica and to identify areas that require more investigation. The literature gathered from the following databases was combined to create this systematic review: According to earlier research, this plant's methanolic and aqueous extracts exhibit antibacterial, antifungal, and antioxidant properties. It was demonstrated to have microbicidal action and the capacity to activate phagocytes, increasing resistance to infection. This plant's methanolic and aqueous extracts were shown to have hypoglycemic properties as well, with the methanolic extract showing notable hypolipidemic effects in diabetic rats. Furthermore, it has been proposed that the methanolic extract of A. hierochuntica possesses hepatoprotective qualities. Its capacity to markedly reduce transaminase and alkaline phosphatase activity in rats with diabetes caused by alloxan lends credence to this. Additionally, this desert plant demonstrated gastroprotective, anti-inflammatory, Hypoglycemic activity,Hepatoprotective activity,Gastroprotective activity,Antibacterial activity and Antibacterial activity. thus reported biological activity and therapeutic advantages are mentioned in this article More research is required to better understand the effects of A. hierochuntica, its components, and potential modes of action before it may be utilized therapeutically.

Keywords: Anastatica Hierochuntica**,** Antibacterial, Antifungal, Antioxidant, Hypoglycemic, Hepatoprotective.

I. INTRODUCTION

Saudi Arabia, Egypt, Jordan, Oman, Libya, Iraq, the United Arab Emirates, Iran, Kuwait, and North Africa are all home to the well-known medicinal plant Anastatica hierochuntica L. (A. hierochuntica) [1,2]. The brief rainy season is when the plant grows from a seed. It seldom reaches a height of more than 15 cm and has small white blooms [1,3]. The stems of the plant coil inward into a tight, woody ball that is 4–10 cm in diameter when it dries out after the wet season. The seeds can remain dormant for many years since they are hard. This well-known plant is the sole member of the genus Anastatica and a member of the Brassicaceae family [3]. A. hierochuntica is consumed by people in Asia and other regions of the world in addition to its native countries. A. hierochuntica is known as Kaff Maryam in Arabic-speaking nations. It is referred to as the Hand of Fatima, the Hand of Maria, or the Rose of Jericho in Europe [1, 2, 4, 5]. Sanggul Fatimah, Genggam Fatimah, Kembang Fatimah, or Akar Kayu Bunga Fatimah are the names of the plant in Malaysia [2,3,6]. This plant is used internally as a fine powder or extract [1]. In order to create the extract, the dried plant is soaked in water, which causes the branches that were previously shriveled to stretch and straighten. The entire plant's water decoction is then ingested [3]. Numerous health advantages are thought to be associated with this plant. It is mostly used to treat conditions connected to the reproductive system, such as uterine hemorrhage and monthly cramps, and to facilitate the delivery process [1,7–13]. Additionally, it is used as a complementary therapy for metabolic diseases, primarily diabetes mellitus [11]. This plant is used by some as an analgesic and as a treatment for mental depression, bronchial asthma, mouth ulcers, arthritis, epilepsy, stomach disorders, and malaria [1,11,13–16]. Despite the paucity of scientific data and proof, people all over the world are aware of the supposed advantages of A. hierochuntica. Consequently, a careful scientific assessment of its seeming medicinal qualities is necessary. The purpose of this systematic review is to provide researchers who are interested in learning more about the characteristics, doses, and results of A. hierochuntica with relevant information. Every piece of chosen literature was examined for pertinent, important details and constraints.

Plant profile[1]

Kingdom: Plantae

Clade: Tracheophytes

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Brassicales

Family: Brassicaceae

Genus: Anastatica L.

Species:A. hierochuntica

Binomial name: Anastatica hierochuntica L.

Anastatica is a monotypic genus of plants in the family Brassicaceae containing the single species Anastatica hierochuntica. The plant is a small gray annual herb that rarely grows above 15 centimetres (6 in) high, and bears minute white flowers. It is a tumbleweed capable of hygroscopic expansion and retraction. However, it is not a true resurrection plant; because the plant's dead tissues do not revive and turn green.

This species is not to be confused with Selaginella lepidophylla, also sometimes referred to as "rose of Jericho", or "false rose of Jericho", which is a true resurrection plant that can revive from a dried state and regain the processes of respiration and photosynthesis.[17-20]

Names

Common names include Maryam's flower, flower of St Mary, St. Mary's flower, Mary's flower, white mustard flower and rose of Jericho [18].

Range

Anastatica is found in arid areas in the Middle East and the Sahara Desert, including parts of North Africa and regions of Iran, Egypt, Israel, Saudi Arabia, Iraq, Jordan and Pakistan [21].

Description

The branches of this plant, which has a high resistance to desiccation, have the ability to constrict when dry and stay closed and dry for many years until reopening when damp or in contact with water, restoring all of its beauty and freshness. The plant dries up after the wet season, folding its branches into a tight ball and shedding its leaves before aestivating. The fruits stay closed and linked inside the ball, shielding the seeds and avoiding their premature dispersal. Because of their extreme hardiness, the seeds can lie dormant for many years. When the ball is moistened once more during a subsequent rainy season, it uncurls and the plant awakens from its slumber, causing the capsular fruits to open and release the seeds. The scattered seeds sprout in a matter of hours if there is enough water. They are required travelers through steppes and deserts, crossing the boundaries of many Asian countries and spreading their seeds for everyone since, once they curl, it is simple for the wind to lift and drag them over great distances. Raindrops striking a spoon-shaped appendix on the seeds spread some of the seeds across the parent plant. Although the seeds' sticky coating aids in their adherence to the soil, surface wash may also carry them downstream. [22] But seeds that are swept downstream don't make it. [23]

Curling and uncurling is a fully reversible operation that can be done again. Trehalose, [24], a disaccharide sugar implicated in multiple cryptobiosis pathways, is thought to be responsible for the plant's capacity to accomplish this. It is frequently questioned that the rehydrated plant produces new leaves, flowers, and fruits [25]; rather, the seeds may occasionally sprout and produce new plants while still seated in the fruit on the deceased parent plant. It has been said that Anastatica is the most well-known tumbleweed. [26] After drying, the ball is reported to separate and disperse due to wind. It has been suggested that tumbleweeds use this behavior as a defense against being buried in dunes. [26] Anastatica might just have this behavior in the literature, albeit [27]. may tumble infrequently, if accidentally uprooted

Extraction methods

The bark, leaves, and flowers of the aerial plant parts of Anastatica hierochuntica and Aerva javanica were ground into a fine powder, sieved (to remove particles smaller than 0.2 mm), and stored in airtight plastic bags in a dry, clean cabinet. The Soxhlet solvent extraction method was used to extract about 50 g of this substance using several organic solvents. The plant material was placed into the Soxhlet column after being wrapped in Whatman #1 filter paper for the Soxhlet solvent extraction. After setting the heating mantle's temperature just over the solvent's boiling point, 100 milliliters of the solvent were permitted to percolate through the Soxhlet for a minimum of ten cycles. Ten to twelve hours was the average extraction time. Acetone, butanol, ethanol, ethyl acetate, methanol, dichloromethane, and hexane were the solvents that were utilized. Using a Rotovap (Rota vapor R210, Buchi, Flawil, Switzerland), the extracts were concentrated to about 10 mg/mL and kept at -20 °C until they were needed [28].

Phytochemical contents

According to energy-dispersive X-ray microanalysis, hierochuntica has notable concentrations of carbon, oxygen, silica, calcium (Ca), magnesium (Mg), aluminum, potassium, zinc (Zn), and iron (Fe) [1,3]. In addition, it contains copper (Cu), cobalt, manganese (Mn), and chromium [1]. A. hierochuntica has higher quantities of magnesium, calcium, and magnesium than other therapeutic herbs including mint, thyme, and rosemary [1], according to Daur (2012) [29]. Additionally, compared to other plants, such as cinnamon, Withaniasomnifera, and Vetiveriazizanioides, the concentrations of Fe, Cu, and Zn are either equal to or higher [29–31]. Three new (7R, 8S) and (7S, 8R) 8- 5' linked neolignans, called hierochins A, B, and C, were isolated from the methanolic extracts of the entire plants of A. hierochuntica in 2003, after Yoshikawa and colleagues [32] reported the isolation of new skeletal flavonoids, anastatin A and B. Additionally, evofolin B, b-sitosterol-3-O-b-D-glucopyranoside, kaempferol, luteolin, rutin, (+)-lariciresinol, (+)-dehydroxydiconiferyl alcohol, and (+)-balanophonin have been isolated [33]. An aqueous preparation of the seeds of this plant also yielded a number of different chemicals [34]. Al-Gamdi et al. (2011) used tandem mass spectrometric (MS2) detection and high-performance liquid chromatography (HPLC) with photodiode array (PDA) to accomplish the isolation [23]. Flavones were the most prevalent compounds, according to the assay. These included luteolin-6-C-hexosyl-8-C-pentoside, luteolin-6-C-pentosyl-8-C-hexoside, api-genin-6,7-C-diglucoside (isovitexin-7-O-glucoside) (1), apigenin-6-C-arabinosyl-8-C-hexoside, luteolin-8-C-glucoside (orientin) (2), luteolin-6-C-glucoside (isoorientin) (3), luteolin-6-C-glucoside (isovitexin) (4), luteolin-O-glucuronide, luteolin-6-C-glucosyl-2"-O-glucoside (isoorientin-2"-O-glucoside) (5), and luteolin-O-glucu-ronide. Flavone levels varied from 0.5 _ 0.0 mM to 542 _ 35 mM, with the greatest concentration of diosmetin-8-C-glucoside. There were also significant levels of phenolic acids and hydroxycinnamates. Dihydroxybenzoic acid hexoside, 3, 4-dihydroxybenzoic acid (7), 5-O-caffeoylquinic acid (8), 3, 4-O-dicaffeoylquinic acid (9) and 4, 5-O-dicaffeoylquinic acid (10), were among them. Each compound's concentration varied between 17 _ 0 mM and 210 _ 1 mM. Additionally, the aqueous extract had modest levels of flavonols including kaempferol-3-O-glucoside (11) and taxifolin-O-hexose (11) (Fig. 2) [34]. However, Nakashima et al. (2010) [26] used HPLC and ordinary- and reversed-phase silica gel column chromatography to separate a large number of additional chemicals from the ethyl acetate (EtOAc)-soluble fraction of the methanolic extract of the entire plant of A. hierochuntica. The known compounds were anastatin A (12), anastatin B (13), (+)-silychristin (14), (_)-silychristin (15), silybin A (16), silybin B (17), isosilybin A

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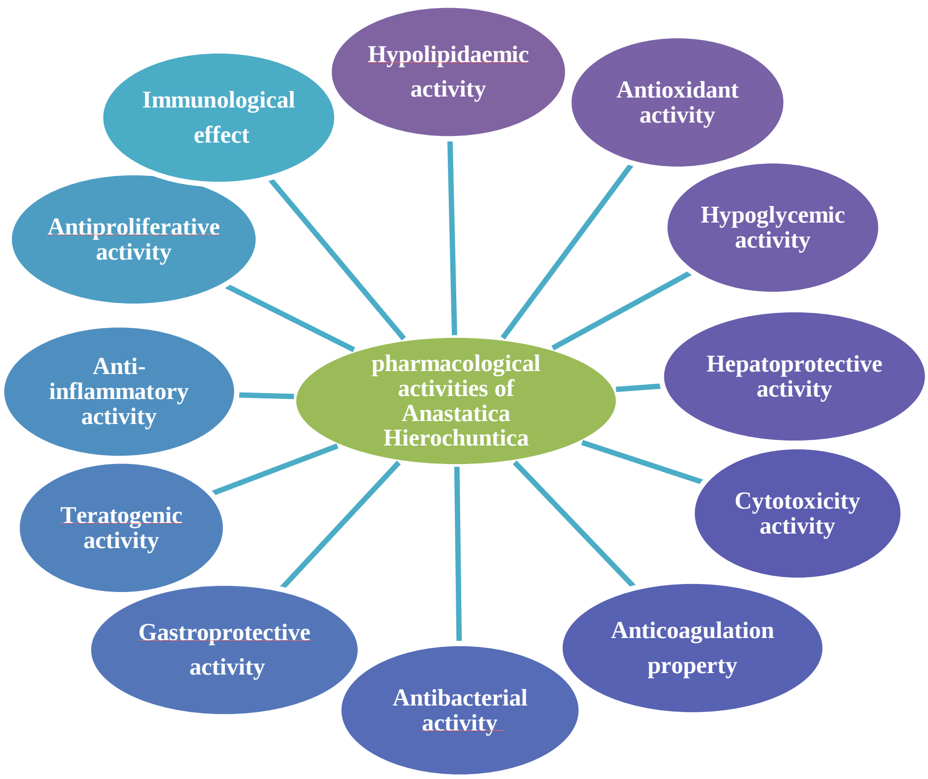
(18), isosilybin B (19), naringenin (20), eriodictyol (21), aromadendrin (22), (+)-taxifolin (23), (+)-30-O-methyl taxifolin (24), (+)-epitaxifolin (25), luteolin (26), kaempferol (27), quercetin (28), rutin (29), hierochin A (30), hierochin C (31), (+)-dehydrodiconiferyl alcohol (32), (+)-balano-phonin (33), hierochin B (34), (+)-lariciresinol (35), (_)-evofolin B (36), p-hydroxybenzoic acid (37), p-methoxybenzoic acid (38), 3,4-dihydroxybenzoic acid (39), 3-methoxy-4-hydroxybenzoic acid (40), p-hydroxybenzaldehyde (41), 3,4-dihydroxybenzaldehyde (42), vanillin (43), acetovanillone (44), 2,40-dihydroxy-30-methox- yacetophenone (45), hydroxypropioguaiacone (46), (+)-2,3-dihy- droxy-1-(4-hydroxy-3-methoxyphenyl-1-propanone) (47), trans-cinnamic acid (48), trans-ferulic acid (49) and coniferaldehyde (50) (Figs. 3 and 4) [2,35]. Furthermore, glucose, galactose, fructose, sucrose, raffinose, and stachyose were discovered to be present in the methanolic extract of the fruit portion of A. hierochuntica [2,35]. In the same year, Marzouk et al. (2010) published another report listing all the flavonoids that were isolated from the methanolic extract of the whole plant of A. hierochuntica [25]. These compounds included kaempferol 3-O-(6"-a-L-rhamnopyranosyl)-b-D-glucopyranoside, quercetin, quercetin 3-O-6"-a-L-rhamnopyrano-syl)-b-D-glucopyranoside, apigenin 6-C-b-D-glucopyranoside [iso-vitexin], naringenin (5,7,40-trihydroxydihydroflavone), and (+)-taxifolin (3,5,7,30,40-pentahydroxydihydroflavone) [37].

Phytochemical Analysis

The phytochemical analysis of the extracts for the identification of alkaloids, glycosides, tannins, flavonoids, terpenoids, saponins, etc., were carried out using previously reported procedures [38,39]. The extracts that contained the highest levels of phytochemicals were then analyzed for isolation of the biologically active compounds.

Pharmacological activities

For many years, A. hierochuntica has been utilized for a variety of medical applications because of its alleged wide range of pharmacological properties. However, scientific research have only shown evidence for a few of its apparent functions. According to reports, A. hierochuntica extracts contain antioxidant, antibacterial, antifungal, and hypolipidemic and hypoglycemic qualities. Additionally, the extracts' hepatoprotective, anti-inflammatory, gastroprotective, and anti-melanogenic properties have been demonstrated.



Hypolipidaemic

Only two studies pertaining to hypolipidemic activity were found by Shaban et al. (2011) and Salah et al. (2011), as far as our literature review could determine [39, 40]. The former demonstrated that after four weeks of treatment, triglyceride (TG), low-density lipoprotein (LDL), very low-density lipoprotein (VLDL), and total cholesterol (TC) levels in male Swiss albino rats with alloxan-induced diabetes were significantly decreased by daily oral administration of 100 mg/kg methanolic extract of the entire plant of A. hierochuntica. High-density lipoprotein (HDL) cholesterol levels, which are linked to a lower risk of coronary heart disease, also significantly improved as a result of it [41]. They observed that rats with alloxan-induced diabetes that received 150 mg/kg of A. hierochuntica methanolic extract for 15 days showed a considerable improvement in their lipid profiles (TG, TC, LDL, and HDL). The lipid profiles of rats with diabetes caused by alloxan improved in both investigations. These animals' aberrant lipoprotein levels may be the result of altered lipoprotein metabolism or, as a result of a lower serum insulin level, suppression of adiponectin release from adipose tissue. One significant protein that has a role in controlling lipid metabolism is adiponectin. A. hierochuntica flavonoids may increase the secretion of adiponectin, which may therefore increase the role of insulin in lipid metabolism. It is anticipated that a higher insulin level after flavonoid treatment may decrease hepatic lipolysis and triglyceride formation. The mechanism of this herb's hyperlipidaemic action may be further discussed as a result of in vivo studies on how it affects animals given a high-fat diet.

Antioxidant activity

Any substance's capacity to prevent oxidative damage to a target molecule is known as antioxidant activity. Numerous methods have been employed to assess antioxidant activity, including metal ion chelating activity, 2,2'-azino-bis (3- ethylbenzothiazoline-6-sulfonic acid)-diammonium salt (ABTS) assay, and reaction with 2,2-diphenyl-1-picrylhydrazyl (DPPH). At a concentration of 150 μg/mL, Anastatica hierochuntica methanol extract had a scavenging effect of 55.87% in the DPPH assay, demonstrating the clear impact of A. hierochuntica on free radicals [25]. The ability of A. hierochuntica to chelate iron ions is another way to measure its antioxidant activity. The oxidized metal ions, which have been linked to oxidative damage and peroxidative process blockage, are stabilized by the metal chelating effect, which lowers the redox potential. The iron chelating action was reported to be 16.72% metal scavenging capability at 200 μg/mL methanol extract of A. hierochuntica [25]. For iron chelating, the typical IC50 value of antioxidant activity was 1.27±0.05 μg/mL. In comparison to the conventional value, the antioxidant in this investigation was deemed low. In a different investigation, the response of five distinct extracts of A. hierochuntica with DPPH demonstrated the antioxidant activity. The highest inhibitory concentration (IC50) values for Anastatica hierochuntica ethanol, butanol, ethyl acetate extract, petroleum ether, and water extract were, respectively, 150.85, 13448.6, 278.3, 419.18, and 459.72 μg/mL [26]. Ascorbic acid was the reference chemical for antioxidant activity, with an IC50 of 5.29 ± 0.28 μg/mL. At 150.85 μg/mL, the ethanol extract had the lowest IC50 value and was much below the standard value. Therefore, A. hierochuntica's antioxidant activity in this investigation was not noteworthy. The antioxidant activity of petroleum ether, ethyl acetate, butanol extract, water extract, and A. hierochuntica ethanol was evaluated using an ABTS assay. The absorbance was measured at 734 nm using a spectrophotometer after the samples (0.2 mL) from the five distinct extracts were combined with 3.0 mL of diluted ABTS cation radical solution. All the extracts showed activity which enhanced with an increase in the concentration of the extracts, giving average IC50 values of 150 to 460 μg/mL, except for pet ether extract only showed activity at 400 μg/mL, and a staggering IC50 of 13448.6 μg/mL. With an IC50 of 150.85 μg/mL, the entire extract showed the highest antioxidant activity [42].

Hypoglycemic activity

Damage to the pancreatic islet beta cells causes diabetes mellitus, a common metabolic disease. In male Swiss albino rats with diabetes, the methanol extract of A. hierochuntica decreased blood glucose levels [43]. It was given orally to rats with diabetes and healthy rats at escalating doses of 50g, 100, and 200 mg/kg basal weight. After 28 days of recording and comparison, the blood glucose levels of diabetic rats treated with the extracts decreased from 300 ± 14 mg/dL to 163 ± 15 mg/dL. In contrast, when the extracts were administered to healthy rats, their blood glucose levels increased slightly from 100 ± 18 mg/dL to 109±14 mg/dL. This indicates that in diabetic rats, A. hierochuntica would function similarly to metformin. Additionally, histological investigations revealed that diabetic rats given extracts from A. hierochuntica had their βcells restored. Normal histology revealed an islet of Langerhans encircled by an exocrine part of pancreatic tissue in the pancreas of normal rats. The histological structure of Langerhans improved in diabetic rats given methanol extract from Anastatica hierochuntica [43]. After being administered 150 mg/kg of A. hierochuntica methanol extract for 15 days, the rats with alloxan-induced diabetes had a glucose level of 81.40 ± 1.61 mg/dL. A. hierochuntica was found to be useful in lowering oxidative stress, which causes the hypoglycemic effect [44]. Additionally, Anastatica hierochuntica demonstrated improvement in the recovery of the pancreatic tissue damage in rats with diabetes caused by streptozotocin (STZ). For two weeks, the aqueous extract of A. hierochuntica (12.5 mg/kg) was taken orally every day. Next, the hypoglycemia effects were noted in rats that were not diabetic and rats that were diabetic due to STZ. According to the results, the extract-treated diabetic rats had a blood glucose level of 318 mg/dL, which was lower than that of the untreated diabetic rat, which had a blood glucose level of 488 mg/dL. The improvement in the appearance of immunoreactive insulin-secreting cells in pancreatic islets has been depicted using the findings of an immunohistochemistry investigation [45]. In diabetic rats, A. hierochuntica methanol and aqueous extract have been shown to exhibit hypoglycemic effects. However, before they may be utilized clinically in diabetic patients, more research is needed to determine their potential mode of action and toxicological effect. In primary cultured mouse hepatocytes, the methanol and ethanol extracts from the entire plant of A. hierochuntica demonstrated notable hepatoprotective benefits against cytotoxicity caused by Dgalactosamine [46]. Hepatoprotective qualities were also demonstrated by the ethanol extract of A. hierochuntica. Anastatin A, anastatin B, naringenin, eriodictyol, aromadendrin, (+)-taxifolin, 3-O-methyl taxifolin, and (+)-epitaxifolin were found to have inhibitory effects on D-galactosamine-induced cytotoxicity in primary cultured mouse hepatocytes [47]. Out of all the drugs, anastatin B exhibited the greatest inhibition on hepatocytes.

Hepatoprotective activity

After administering 100 mg/kg of the extract to alloxan-induced diabetic rats for four weeks, the methanol extracts from A. hierochuntica demonstrated a hepatoprotective effect. Alloxan exposure raises serum levels of alkaline phosphate (ALP), glutamic pyruvic transaminase (GPT), and glutamic oxaloacetic transaminase (GOT), and can cause hepatocellular necrosis. The extract's administration considerably improved the histomorphological alterations in the diabetic rats' livers and returned the enzymes to normal levels [43]. In primary cultured mouse hepatocytes, the methanol and ethanol extracts from the entire plant of A. hierochuntica demonstrated notable hepatoprotective benefits against cytotoxicity caused by Dgalactosamine [46]. Hepatoprotective qualities were also demonstrated by the ethanol extract of A. hierochuntica. Anastatin A, anastatin B, naringenin, eriodictyol, aromadendrin, (+)-taxifolin, 3-O-methyl taxifolin, and (+)-epitaxifolin were found to have inhibitory effects on D-galactosamine-induced cytotoxicity in primary cultured mouse hepatocytes [47]. Out of all the drugs, anastatin B exhibited the greatest inhibition on hepatocytes.

Gastroprotective activity

The ethanol extract from Anastatica hierochuntica shown a protective effect against necrotizing agents, which were ethanol and indomethacin combinations that caused damage to the stomach wall. Necrotizing agents consisting of 80% ethanol, 0.6 M hydrochloric acid (HCl), 0.2 M sodium hydroxide (NaOH), 25% sodium chloride (NaCl), and indomethacin were given to the albino rats during the investigation. Significant protection against the harm caused by necrotizing chemicals was achieved by pre-treating with an oral gavage tube containing an ethanol extract of the entire A. hierochuntica plant at dose levels ranging from 125 to 500 mg/kg [48]. A. hierochuntica's ethanol extract prevented the ethanol from depleting the mucus in the stomach wall. Against the harmful effects of ethanol on stomach protein nucleic acid and gastric mucosal non-protein sulfhydryl (NP-SH), Anastatica hierochuntica demonstrated gastroprotective action [46]. According to histopathological investigations, rats' stomach walls' ethanol-induced necrosis, congestion, bleeding, and edema might be inhibited by pre-treating them with A. hierochuntica extract [48].

Antibacterial activity

The antibacterial properties of the ethanol and aqueous extracts of A. hierochuntica against bacterial strains were assessed using the paper disc diffusion method. In the investigation, 10 mL of extract was added to each plate after sterile paper discs had been placed on the surface of inoculated nutrient agar plates. After the plates were incubated for 24 hours at 37 °C, the inhibition zones were assessed. The findings demonstrated the aqueous extract's antibacterial capabilities against Staphylococcus aureus, Pseudomonas fluorescens, Bacillus subtilis, Escherichia coli, and Pseudomonas aeruginosa. The same bacteria, with the exception of P. fluorescens and E. coli, were active against the ethanol extract [47]. A. hierochuntica's antibacterial efficacy against a few Gram-positive and Gram-negative bacteria was examined in a different investigation. The paper disc diffusion method was employed in the investigation. The plant extract at a concentration of 40 mg/mL was applied to the discs. Gram-positive bacteria (B. subtilis) were shown to be susceptible to the antibacterial effects of methanol and aqueous extracts of the entire plant of A. hierochuntica, while Gram-negative bacteria (E. coli, P. aeruginosa, and Salmonella typhi) were not [49]. At 100 mg/mL, the methanol extract of A. hierochuntica was found to have antibacterial properties against Proteus mirabilis, B. subtilis, Enterococcus faecalis, S. typhi, Streptococcus faecalis, Streptococcus pyogenes, Shigella sonnei, and Listeria monocytogenes in addition to Klebsiella pneumonia. With no effect on L. monocytogenes, the results demonstrated antibacterial activity against P. mirabilis, S. typhi, Salmonella paratyphi, K. pneumonia, S. faecalis, S. pyogenes, S. sonnei, and E. faecalis [50].

Anticoagulation property

Prothrombin time (PT) and activated partial thromboplastin time (APTT) were estimated using normal human plasma to assess the anticoagulant activity of A. hierochuntica methanol and ethyl acetate extracts. The findings demonstrated that the kind of extracts and concentration had a significant impact on the ratio of clotting time in the PT and APTT assays. In the PT test, the methanol and ethyl acetate extracts considerably increased the plasma's clotting time to 68 and 59 seconds, respectively, at concentrations of 100 µg/mL, as opposed to 19 and 21 seconds, respectively, in the control. Additionally, they extended the APTT time from 2.12 and 2.56 seconds for the control to 9.58 and 11.12 minutes, respectively, at the same concentration of 100 µg/mL [51].

Cytotoxic activity

A. hierochuntica seed, stem, and leaf extracts in methanol and water demonstrated dose-dependent antiproliferative activities. By causing MCF-7 breast cancer cells to undergo apoptosis, the extracts had antiproliferative effects [52]. A. hierochuntica methanol extract's in vitro cytotoxic efficacy against acute myeloid leukemia (AML) blasts was assessed. A. hierochuntica has an IC50 of 0.38 ± 0.02 µg/mL on AML. The extract did not cause any cytotoxicity to normal human peripheral leucocytes in vitro, but it caused AML cell death through the p53-independent mitochondrial intrinsic route [53].

Anti-inflammatory activity

The anti-inflammatory properties and potential anti-inflammatory mechanisms of A. hierochuntica's essential oil were investigated. The plant's aerial portions were hydrodistilled to extract the essential oil, which was then subjected to gas chromatography and mass spectrometry (GC/MS) analysis. The carrageenan-induced paw edema and peritonitis model of inflammation was used to assess the anti-inflammatory efficacy. Carrageenan-induced NOx-peritoneal lavage concentration, myeloperoxidase activity, edema, and peritonitis were all decreased by the essential oil. Additionally, the essential oil reduced the nitric oxide radical produced by sodium nitroprusside [54].

Teratogenic activity

Sprague Dawley rats were used to examine the effects of an aqueous extract of A. hierochuntica on the skeletal development of fetuses. From the sixth day of pregnancy until the twentieth, the extract was given. In the 250 and 1000 mg/kg groups, respectively, skeletal abnormalities like maxillary defect (cleft lip) and sacrocaudal agenesis were noted. These results suggest that the extract may have harmful effects on the growing fetus [55]. When A. hierochuntica aqueous extract was administered to pregnant Sprague-Dawley rats, the fetus's body weight and the mother's weight gain were significantly lower than in the control group. Several congenital abnormalities that were seen in some of the offspring were linked to the findings [56]. The results demonstrated the toxicity of A. hierochuntica extract on Sprague Dawley rats during pregnancy. Consequently, the plant may be hazardous to the growing fetus, particularly if it is ingested during the organogenesis and implantation stages.

Immunological effect

Using hydrocortisone immunosuppressant medications as the positive control, the methanol extract of A. hierochuntica was examined for phagocytosis, immunoglobulin (IgG), and adenosine deaminase (ADA) activities. After 30 minutes, the extract at a dose of 50 mg/kg raised phagocytosis and IgG levels ($p \leq 0.05$). After two weeks of therapy, ADA activity was suppressed at a level of 100 mg/kg [57].

Antiproliferative activity

Extracts from A. hierochuntica were tested for their ability to inhibit the growth of a panel of cancer cells and healthy primary dermal fibroblasts. The extracts of water, ethanol, methanol, ethyl acetate, and chloroform shown antiproliferative action against melanoma (A-375) and leukemia (K-562) cells. When applied to human normal skin fibroblasts, the chloroform extract had no effect. It was discovered that the ethyl acetate extract only had mild genotoxic effects at very high dosages [58].

II. CONCLUSION

Traditional medicine has long utilized A. Hierochuntica, mostly for reproductive health and pregnancy/ childbirth-related conditions. In many cultures and practices, the plant is utilized as an alternative treatment for a wide range of illnesses, from simple conditions like sore throats and mouth ulcers to more serious conditions like depression, asthma, and malaria. Despite the scientific data and proof, people all over the world are aware of the purported advantages of A. Hierochuntica. Consequently, a scientific assessment of its therapeutic qualities is necessary.

The literature has some information about studies pertaining to the many biological activities Thus the phytochemical and biological activity of A. Hierochuntica are studied in this review. Which can be further used for the research purpose.

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