Xanthium strumarium: A Comprehensive Review of Morphology, Ecology, and Medicinal Potential

[1]Sumit S. Shirsath, [2]Ms. Sushma Ahire, [3]Mrs. Neha Patil, [4]Dr. D. A. Patil

[1,2]Assistant Professor K.K. Wagh institute of Pharmacy, Pimplas, Nashik,
[3]Assistant Professor Ahinsa Institute of Pharmacy Dondaicha,
[4]Principle Ahinsa Institute of Pharmacy Dondaicha

Abstract-

A popular medicinal plant with a long history of traditional usage in many different cultures is Xanthium strumarium, better known by its common name, cocklebur. The phytochemical makeup, pharmacological properties, and possible medical uses of X. strumarium are summarized in this article. A wide variety of bioactive substances, including as flavonoids, alkaloids, terpenoids, and polysaccharides, define X. strumarium's phytochemistry. Its many pharmacological characteristics, including anti-inflammatory, antioxidant, antibacterial, antiviral, anticancer, and immunomodulatory activities, are attributed to these phytoconstituents.

Many preclinical investigations have shown how well X. strumarium extracts and isolated chemicals work to treat a range of illnesses, such as skin cancers, gastrointestinal issues, metabolic abnormalities, and respiratory problems. Furthermore, studies have looked into the possibility of X. strumarium having neuroprotective benefits and helping to treat neurological conditions.

Furthermore, X. strumarium has potential in conventional medical systems for the treatment of pain, fever, diabetes, and immune-related illnesses. Additionally, new studies demonstrate its usefulness in fighting bacteria resistant to many drugs and its promise as an adjuvant therapy in the treatment of cancer.

Although X. strumarium has a great therapeutic potential, further study is necessary to understand its mechanisms of action, determine the best dose combinations, and assess its safety profile in clinical settings. All things considered, X. strumarium is a great source of bioactive chemicals with a wide range of pharmacological actions, and it has a lot of potential for the creation of novel therapeutic agents and nutraceuticals.

Keywords: Xanthium strumarium, immunomodulatory activities, alkaloid, flavonoids

INTRODUCTION: -

Cocklebur, or Xanthium strumarium, is a type of flowering plant belonging to the Asteraceae family. It grows throughout the world and is well-known for its prickly seeds. Its capacity to outcompete other plants and develop quickly has made it a weed in some areas [1].

Research has been done on the possible anti-inflammatory properties of xanthium strumarium. According to some research, this plant's extracts may have anti-inflammatory qualities that make them useful for several ailments. To completely comprehend its methods of action and possible therapeutic applications, more research is necessary [2].

Research on Xanthium strumarium has revealed encouraging anti-inflammatory properties, which are ascribed to flavonoids, phenolic acids, and polysaccharides, among other phytochemical elements. It has been discovered that these substances block the activity of pro-inflammatory mediators, including cytokines and enzymes like lipoxygenase (LOX) and cyclooxygenase (COX). Furthermore, Xanthium strumarium extracts have shown antioxidant qualities, which may lessen oxidative stress and scavenge free radicals, thereby contributing to their anti-inflammatory effects [3]. Xanthium strumarium extracts may be able to lessen inflammation in illnesses like dermatitis, arthritis, and gastrointestinal inflammation, according to research conducted on animal models and in vitro investigations. Nevertheless, there aren't many human clinical trials, therefore additional investigation is required to evaluate the safety and effectiveness of Xanthium strumarium

as an anti-inflammatory treatment for a range of illnesses [4]. Before utilizing Xanthium strumarium or any herbal treatment for therapeutic purposes, it is imperative to speak with a healthcare provider. This is especially true if you are taking medication or have underlying medical conditions, since there may be interactions and negative effects [5]. Aromatic and medicinal plants have long been used as valuable (phyto) therapeutic substances with pharmacological and commercial value. Owing to financial limitations, around 80% of people in developing nations still rely on plant extracts as a natural medicine source. Notably, the overuse and recurrent application of pharmaceuticals in contemporary medicine has led to the selection of microbial strains resistant to antibiotics, thereby decreasing the quantity of antibiotics available for treating clinical infections. For this reason, the utilization of aromatic and medicinal plants as a source of novel therapeutic agents remains essential to conventional healthcare systems. Furthermore, these plants' phytochemicals may act as lead compounds or precursors for the creation of new Animals that eat immature, hazardous plants and run the risk of becoming poisoned if they eat enough of them and perish as a result. Although xanthium is a well-known toxic herb (ranked as extremely toxic) for grazing animals (e.g., cattle, pigs, horses, and poultry), it is not mentioned as a medicinal herb in Western literature [12]. It has been shown to result in losses in sheep, goats, horses, pigs, cattle, and swine as well as decreased weight increase in poultry. In vulnerable individuals, the plant causes allergic contact dermatitis. In China, cockspur was grown as a green vegetable. In Assam, the young flowering tops and the two leaves below are boiled in water and consumed as a pot herb. Although the herb itself may be hazardous, the harmful components have been eliminated through cooking and cleaning. Cocklebur seeds and seedlings contain carboxyatractyloside, an extremely poisonous glycoside. At the two-leaf stage, the chemical content was found to be 0.12% in the seedlings and 0.457% in the seeds. Only the seed leaves or cotyledons of the seedlings have the toxin. The poison quickly vanishes during germination.

BIOLOGICAL ACTIVITY: -

In addition to its possible anti-inflammatory properties, Xanthium strumarium has been studied for several other biological properties, including:

1. Antioxidant: Xanthium strumarium contains compounds with antioxidant qualities that assist the body fight off dangerous free radicals and lessen oxidative stress.
2. Antimicrobial: According to certain research, Xanthium strumarium extracts can stop the growth of bacteria, fungi, and other microorganisms. Treatment for infections may be affected by this.
3. Antidiabetic: Studies suggest that extracts from Xanthium strumarium may have hypoglycaemic properties, which could lower blood sugar levels. This may help with diabetic management.
4. Anticancer: In lab tests, some Xanthium strumarium constituents have demonstrated possible anticancer action; nevertheless, additional investigation is required to determine their efficacy and safety in the treatment of cancer.
5. Anti-allergic: By regulating the immune system and lowering inflammation linked to allergies, Xanthium strumarium extracts have been studied for their potential to lessen allergic reactions.
6. Hepatoprotective: According to some research, xanthium strumarium may have hepatoprotective properties that help shield the liver from injury from toxins and other dangerous chemicals.
7. Diuretic: Xanthium strumarium has historically been used as a diuretic, encouraging the production of urine and maybe helping the body eliminate extra fluid and waste.
8. Analgesic: Xanthium strumarium extracts may have analgesic effects, assisting in the relief of pain, according to some research. This may have effects on how diseases like arthritis or other inflammatory disorders are treated.

Even though these possible uses are intriguing, more investigation—including clinical trials—is required to completely comprehend the security and effectiveness of Xanthium strumarium in these contexts. Before using Xanthium strumarium or any other herbal supplement for therapeutic purposes, it is vital to speak with a healthcare provider, particularly if you have underlying medical conditions or are taking medication [6].

EXTRACTION PROCESS: -

To extract chemicals from Xanthium strumarium, the following processes are usually involved:

1. Preparation: To extract moisture and retain the phytochemical components, the plant material—typically the leaves, stems, or seeds of Xanthium strumarium is gathered and dried.

2. Size Reduction: To improve the surface area and speed up the extraction process, the dried plant material is frequently ground or chopped into smaller pieces.
3. Solvent Selection: The polarity of the target compounds is taken into consideration when selecting an appropriate solvent. Water, ethanol, methanol, or a combination of solvents to extract a wider spectrum of chemicals are common solvents.
4. Extraction: After the plant material has been chopped or crushed, it is soaked or macerated in the chosen solvent for a predetermined amount of time to allow the solvent to dissolve the desired chemicals. For a more effective extraction, additional methods like Soxhlet extraction, ultrasound-assisted extraction, or supercritical fluid extraction may be used.
5. Filtration: To separate the liquid extract from the solid plant leftovers, the mixture of solvent and plant material is filtered after extraction.
6. Concentration: The liquid extract's solvent is then extracted using evaporation or other concentration methods, leaving behind a concentrated extract that contains the necessary Xanthium strumarium components.

Fig.1. Soxhlet Extraction Process.

7. Purification (Optional): In certain circumstances, additional purification procedures like chromatography or crystallization may be used to separate particular substances or eliminate impurities from the extract.
8. Drying: To create a solid or powdered form appropriate for storage, additional analysis, or application, the concentrated or purified extract is dried to eliminate any remaining moisture.
To maximize the yield and caliber of the chemicals recovered from Xanthium stromatolum, meticulous management of variables like temperature, duration, solvent-to-sample ratio, and extraction technique is necessary throughout the extraction process [7,8].

ETHNOPHARMACOLOGICAL ACTIVITY:-

Europe, China, Indo-China, Malaysia, and America all employ the herb as a recognized medication. The entire plant is utilized medicinally, with the fruit and roots being particularly useful. By Ayurveda, the plant enhances appetite, voice, complexion, and memory, and possesses cooling, laxative, fattening, anthelmintic, alexiteric, tonic, and antipyretic properties. Epilepsy, biliousness, leukoderma, insect venom, salivation, and fever can all be cured by it. Cattle and piglets have been known to die from this plant. Several native American groups utilize it to treat vomiting, diarrhea, and constipation. Uses for headaches, limb cramps and numbness, ulcers, and sinus issues are among the traditional Chinese uses. The herb is utilized as an adjuvant and is thought to be beneficial in treating chronic instances of malaria adulterant for Datura stramonium [5].

The use of the leaves and roots includes anodyne, antirheumatic, anti-syphilitic, appetizer, diaphoretic, diuretic, emollient, laxative, and sedative properties. [15] The therapy of tuberculosis, rheumatism, and sick kidneys has all involved the infusion of this herb. To lessen sweat, it has also been applied as a liniment under the arms. Numerous physiologically significant substances, including as glycosides and phytosterols, are found in the fruits. They have antispasmodic, antitussive, cytotoxic, hypoglycaemic, anodyne, antibacterial, antifungal, antimalarial, antirheumatic, and stomachic properties. Internally, they are used to treat a variety of conditions including leprosy, pruritis, constipation, diarrhea, lumbago, rheumatism, urticaria, catarrh, and allergic rhinitis. Additionally, they are applied externally to treat smallpox and pruritis. Clots on the lips and mucous membranes of the mouth are treated with the ashes. Febrifuge and bitter tonic are the root. It's been used traditionally to treat scrofulous tumors as well as localized boils, abscesses, and ulcers. It is said

Fig.2. Cocklebur (Xanthium strumarium)

The juice of the fruits and leaves can help treat smallpox, while the roots can treat cancer. The paste made from green, spiny fruits is used to treat migraines. Chinese people utilize the burs as a sedative, diuretic, and tonic. One remedy for high fevers, leukorrhea, and aiding a lady in ejecting her afterbirth is a root decoction. Treatment for bladder issues has involved the use of a decoction of the seeds. Applying a poultice of the ground seed as a salve to open wounds has been done. Herpes, erysipelas, and bladder infections are all treated with the semi-drying edible oil found in seeds (30–35%), which is similar to sunflower oil.

A source of tannin is the dried leaves. Leaf extract is used to make a yellow color. There have been blue body paint applications for the seed powder. In stored wheat grain, the dried herb deters weevils. The seed has an essential oil in it. As a leafy vegetable, Cocklebur was grown in China. Assamese people boil the young flower tops and the two leaves below in water and use them as pot herbs. While washing and cooking eliminate the potentially harmful compounds, the herb itself is thought to be dangerous. In Chinese Pharmacopoeia, xanthium is classified as a toxic plant. Individuals who consume more than 100 grams of the fruit during 12 hours may experience symptoms such as headaches, nausea, and fatigue. In humans, further toxic symptoms include jaundice, hepatomegaly, coma, dizziness, sleepiness, proteinuria, cystinuria, and haematuria, as well as coma and generalized tonic seizures. It is common practice to treat sinus congestion with a poisonous chemical soluble in water. No country's health authorities have prohibited it, and it hasn't been held accountable for any negative effects on Western customers. But, as will be done here, it is an herb that has to be researched. Many people are interested in the herb because of its many uses, including its antitumor and anticancer properties. Asthma, rhinitis, and dermatitis have been linked to pollens in those who are sensitive. Only in the fall, when the plant is in the pre-fruiting stage, is it thought to cause allergies. According to contemporary Materia Medicos, xanthium is categorized as an herb that can effectively ward off wind cold or

wind damp. The main conditions for which it is used nowadays are allergy-related ones, including allergic rhinitis, atopic dermatitis (urticaria), chronic paranasal sinusitis, and chronic eczema.

CHEMICAL CONSTITUENTS: -

A variety of unknown alkaloids that are supposedly poisonous can be found in the plant's aerial portions [9]. Besides alkaloids, the aerial parts of the plant contain sesquiterpene lactones, viz. xanthinin; its stereoisomer, xanthumin, xanthatin (deacetyl xanthinin); a toxic principle, a sulfated glycoside: xanthostrumarin, atractyloside, carboxyatractyloside; phytosterols, xanthanol, isoxanthanol, xanthinosin, 4-oxo-bedfordia acid, hydroquinone; xanthanolides; caffeoylquinic acids; α and γ-tocopherol; thiazine Dione, 4-oxo-1(5),2,11,(13)-xanthatriene-12,8-olide, known as "deacetyl xanthumin" an antifungal compound; linoleic acid. KARACENE glycoside carboxyatractyloside, formerly known as xanthostrumarium, is the primary poisonous component isolated from the plant. Possibly hazardous substances include carboxyatractyloside CAT as well as several sesquiterpene lactones (such as guaianolides, germmacranolides, and elemanolides).

The three xanthanolide and xanthane type sesquiterpenoids found in the aerial parts are 11α,13-dihydroxanthatin, 4β,5β epoxyxanthatin-1α,4α-endoperoxide, 1β,4β,4α,5α–diepoxy xanth-11(13)-en-12-oic acid, a dimeric xanthanolide, sesquiterpene lactones, 8-epixanthatin, 2-epixanthumin, and 8-epi-xanthatin-5β-epoxide. Coffee is acid, potassium 3-O-caffeoylquinate, 1-O-caffeoylquinic acid, chlorogenic acid, 4-O-caffeoylquinic acid, 1,4-di-O-caffeoylquinic acid, 1,5-di-O-caffeoylquinic acid, 3,5-di-O-caffeoylquinic acid, 4,5-di-O-caffeoylquinic acid, 1,3,5-tri-O-caffeoylquinic acid, 3,4,5-tri-O-caffeoylquinic acid, and caring are the phenols that have been isolated. Choline, hydroquinone, and an additional poisonous substance that is still unknown make up the seeds' harmful principles. Not only that, but the seeds have a significant iodine content. High in vitamin C are the fruits. The fruits include 7-hydroxy methyl-8,8-dimethyl 4,8-dihydrobenzol and other thiazinediones. Nitrazine-3,5-dione-11-O-β-d glucopyranoside,35] 2-hydroxy-7-hydroxymethyl-8,8-dimethyl-4,8-dihydrobenzol • thiazine-3,5-dione-11-O β-d-glucopyranoside Dimethyl-4,8-dihydroxymethyl-7-hydroxymethyl Seven-hydroxymethyl-8,8 dimethyl-4,8-dihydrobenzol, and thiazine-3,5-dione [1,4] Formononetin, ononin, ferulic acid, thiazine-3,5-dione, 2-O caffeoyl, and β-d-glucopyranoside. You may make activated carbon from fruit shell powder. Furfural can be synthesized from the shells, which have a 15.9% pentosan content, as an input. The number 36 Stramaroside, also known as β-d-glucoside of β-sitosterol, is present in the immature fruit along with glucose, fructose, sucrose, organic acids, phosphatides, and potassium nitrate. It contains 1.65% free amino acids in total. It contains micromoles of amino-n-butyric acid, proline, cystine, glutamic acid, aspartic acid, methionine, and tryptophan per milligram dry weight. Both monoterpenes (49.4%) and sesquiterpenes (29.1%) are present in significant proportions in the stem oil, whereas monoterpenes (55.8%) are more prevalent in the leaf oil than sesquiterpenes (26.4%). It has the same taste as other vegetable oils, light yellow, and odorless. Terpinolene (7.0%), β-caryophyllene (6.0%), d-limonene (35.0%), d-carveol (25.0%), α-ionone (11.5%), and p-cymene (5.0%) are the constituents of oil.42, 43] Utilizing gas chromatography (GC) and GC/mass spectrometry (MS), the essential oil extracted from the stems and leaves through hydrodistillation was examined.

Among the 22 chemicals that were identified, bornyl acetate (19.5%), limonene (15.0%), and β-selinene (10.1%) were found to be the main ones, accounting for 86.4% of the stem oil. Two of the 28 components that make up 85.2% of the total oil discovered in the plant's leaf oil, limonene (24.7%) and borneol (10.6%), are found in higher concentrations. The following compounds were obtained in decreasing proportions using pressure-steam distillation of X. strumarium's essential oil: limonene, carveol, terpineolene, β-caryophyllene, p-cymene, sabinene, bornyl acetate, β-cubebene, and a small amount of α-pinene. The majority of volatile substances in Iran were composed of sesquiterpenes, specifically germacrene D. Oil's fatty acid makeup is made up of saturated fatty acids like capric, lauric, myristic, and palmitic acid and unsaturated fatty acids like oleic, linoleic, palmitic, stearic, and behenic acid. The plant's lipid fraction is made up of C27–C33 n-alkanes and C28–C32 n-alkanols. The unsaponifiable fraction includes C23–C35 n-alkanes and C22–C30 n-alkanols in addition to a mixture of β-sitosterol, stigmasterol, campesterol, isohexacosane, chlorobutanol, stearyl alcohol, stigmasterol, oleic acid, 3,4-hydroxycinnamic acid, octacosanol, oxalic acid, KCl, KNO3, and K2 SO4 in the roots and stems. Additional compounds found include phytol, xanthanodiene, isoalantolactone, 2-hydroxytomentosin, tomentosin, ibogaine, and β-selinene. [9,10,11]

No.	Name of Compound	RI	Relative % in Essential Oil
1.	α-Pinene	939	1.8
2.	Camphene	953	2.2
3.	Sabinene	976	3.6
4.	Myrcene	991	0.5
5.	p-Cymene	1026	T
6.	Limonene	1032	20.3
7.	Linalool	1099	0.9
8.	trans-Verbenol	1135	0.4
9.	Borneol	1166	11.6
10.	trans-Carveol	1217	0.9
11.	Bornyl acetate	1286	4.5
12.	Tridecane	1299	0.2
13.	α-Cubebene	1251	2.4
14.	Eugenol	1356	t
15.	α-Ylangene	1273	t
16.	α-Copaene	1376	0.2
17.	β-Cubebene	1390	3.8
18.	β-Element	1391	0.2
19.	β-Caryophyllene	1418	1.9
20.	β-Gurjunene	1432	0.4
21.	α -Humulene	1454	0.6
22.	Germacrene D	1480	t
23.	β-Selinene	1485	2.8
24.	cis-β-Guaiene	1490	34.2
25.	Valencene	1491	0.4
26.	α-Muurolene	1499	t
27.	γ-Cadinene	1513	0.1
28.	Cubebol	1514	0.2
29.	δ-Cadinene	1525	0.2
30.	Xanthatin	1575	t
31.	α-Cadinol	1613	T
32.	epi-α-Cadinol	1654	0.4
33.	Phytol	1821	3.1
34.	Xanthinin	2341	1.0
35.	Monoterpene hydrocarbons	-	28.8
36.	Oxygenated monoterpenes	-	17.9
37.	Sesquiterpene hydrocarbons	-	47.2
38.	Oxygenated sesquiterpenes	-	0.6
39.	Others	-	4.3
40.	Total identified	-	98.9

Cis-β-guanine (34.2%), limonene (20.3%), borneol (11.6%), bornyl acetate (4.5%), β-cubebene (3.8%), sabinene (3.6%), phytol (3.1%), β-selinene (2.8%), camphene (2.2%), α-cubebene (2.4%), β-caryophyllene (1.9%), α-pinene (1.8%), and xanthinin (1.04%) were the principal constituents of the essential oil, according to GC-MS analysis. According to Scherer et al.'s analysis of the essential oil extracted from X. strumarium leaves in São Paulo, Brazil, β-guanine was the most prevalent of the 24 components found in that study (79.6%). The essential oil for X. strumarium was extracted from the stems and leaves of plants that were fully blossoming when they were gathered by Esmaeili et al. from Khorramabad, Lurestan Province, Iran. In the stem essential oil, they found 22 chemicals (86.4%), the most common of which were bornyl acetate (19.5%),

limonene (15.0%), and β-selinene (10.1%). After 28 components (85.2%) were found in the leaf essential oil, limonene (24.7%) and borneol (10.6%) were found in higher concentrations. The essential oil composition did not differ significantly in quality from prior research, and any quantitative differences that were found may be attributed to ecological, environmental, or genetic variables.**tructures of chemicals present in Cocklebur (x.strumarium)**

TOXICITY:-

Mammals cannot handle X. strumarium. Allergic reactions ranging from moderate to severe have been recorded. During the two-leaf seedling stage and in the seeds, carboxyatractyloside, a sulfated glycoside, is the key poisonous ingredient. Although it's generally believed that burs should only be taken when a person is mechanically injured during mastication, mature plants with burs have been observed to cause toxicosis in cattle that have consumed them. Plant growth inhibition is what CAT is. The second seed in the fruit capsule is thought to serve the purpose of keeping the first seed latent, delaying its development until the following year, in a hybridizing seed. A high carboxyatractyloside content is possible in cocklebur fruits, especially in the sections employed in Chinese herbal medicine. Water does not destroy CAT, nor is it likely to be eliminated by a simple rinse. CAT is water soluble. The ideal method, it seems, is to remove the prickles, which stir-frying by itself only partially manages to do.[12] It causes hypoglycemia and liver damage when consumed in large enough doses by animals; the latter effect may result from increased vascular permeability in reaction to extreme hypoglycemic states. A disturbance of oxidative phosphorylation, a process necessary for the cell's energy transfer and metabolism, has been suggested as the mechanism of action. It also includes potentially harmful substances, such as several sesquiterpene lactones, which, in large dosages, can result in nausea, vomiting, tremors, weakness, a weak pulse, and convulsions. Pigs with acute hepatic necrosis that had been given either ground bur, carboxyatractyloside xanthatin, or cough seedlings showed significant hypoglycemia, as well as increased levels of serum glutamate oxaloacetate transaminase and serum isocitric dehydrogenase. Six healthy Mukota breed porkers were fed crushed burs (fruits) or the two-leaf seedling stage of X. strumarium at 2% of body weight as part of an investigation that found the plant to be a potential cause of sudden death in pigs raised extensively in Zimbabwe. Prominent symptoms included sadness, vomiting, weakness, abdominal discomfort, recumbency, and convulsions that ended in death between six and ninety-six hours after intake. Acute liver congestion and hemorrhage, centrilobular hepatocyte necrosis, discoid lysis of the skeletal and cardiac muscle fibers, and sporadic binucleation were all notable microstructural abnormalities.

A different toxicological investigation conducted on male rats suggested that the cytotoxic and deadly effects of CAT might be related to its metabolism. Recorded were the toxicosis's clinical manifestations, length of sickness, mortality, gross lesions, and histological lesions of the liver and kidneys. There are separate lethal and cytotoxic components to CAT toxicosis, which may be partially caused by an active metabolite produced by de novo synthesized P450–P448-independent hemoprotein. Meanwhile, CAT detoxification may happen partially via a P448-dependent (BNF-inducible) enzyme and partially through a hemoprotein-independent, PBZ-inducible enzyme. It appears that CAT detoxification is not P450- or GSH-dependent. The rare but frequently deadly herbal poisoning known as atractyloside poisoning is found throughout the world but is most common in Africa and the Mediterranean. Inhibition of the mitochondrial ADP transporter is recognized as the main mechanism of atractyloside poisoning. In vitro research has demonstrated that at lesser concentrations, atractyloside causes cells to undergo apoptosis instead of the widespread necrosis that occurs at higher doses. Poisoning symptoms show up a few hours later. Walking, depression, tenseness in the muscles, spasms, lying down, elevated heart rate, and breathing—for instance, crucial deaths within the hour range—all contribute to this. [12,13]

EXPERIMENTAL SECTION: -

Plant Material

In the Sistan and Baluchistan Province of Iran, near Hamun Lake (31°1'43" N, 61°30'4" E), leaves of Xanthium strumarium L. were harvested in August and September of 2013. At Tehran, Iran's Shahid Beheshti University of Medical Sciences' Department of Botany, where a voucher specimen was preserved, the plant was taxonomically assessed.

Essential Oils Extraction

One kg of fresh leaves was separated from the stem and allowed to dry for ninety-six hours in the shade. Subsequently, they underwent chopping and three hours of hydro-distilled using a glass-only Clevenger configuration. Dichloromethane and n-hexane (Merck) were used to extract the oil from the distillate after it had been saturated with sodium chloride (NaCl) (Merck, Darmstadt, Germany). The produced essential oil was dried over anhydrous sodium sulfate (Sigma-Aldrich, St. Louis, MO, USA) and kept cold until gas chromatography coupled to mass spectrometry (GC-MS) analysis and bioassays were performed.

Identification of Essential Oil Constituents

We used GC-MS to investigate the leaf essential oil. There was a Shimadzu 17A gas chromatograph used in conjunction with a Shimadzu QP-5000 quadrupole mass spectrometer and a Varian 3800 gas chromatograph with an FID detector. With a 30 m × 0.25 mm × 0.25 µm film thickness, the extracted chemicals were separated using a DB-5 fused silica capillary column. A 1.0 mL/min flow rate of helium was employed as the carrier gas. 1 µL of spitless injections with an injector temperature of 230 °C were used for the analyses. The oven was set to a temperature range of 60–240 °C at a rate of 3 °C per minute, with an 8-minute hold on the desired temperature. At 240 °C and 250 °C, respectively, the FID detector and the GC/MS interface were kept operating comfortably. Based on the procedure and using n-alkanes as the benchmark, retention indices for each element were calculated. With the same chromatographic conditions, retention indices were calculated using the retention durations of n-alkanes injected after the essential oil. Within the scan range of 50–550 amu, full-scan mass spectra were collected to obtain all of the data. The Wiley GC-MS Library and the Adams Library were consulted to identify compounds using mass spectra comparison.

Microbial Isolates, Antibacterial, and Antifungal Activities

The Persian Type Culture Collection (PTCC) in Tehran, Iran, is where all of the microbes were collected. Three gram-negative bacteria—Klebsiella pneumoniae PTCC 1053 (American Type Culture Collection ATCC 10031), Escherichia coli PTCC 1330 (ATCC 8739), and Pseudomonas aeruginosa PTCC 1074 (ATCC 9027)—three gram-positive bacteria—Staph aureus PTCC 1112 (ATCC 6538), Staphylococcus epidermis PTCC 1114 (ATCC 12228) and Bacillus subtilis PTCC 1023 (ATCC 6633)—and two fungi—Aspergillus niger PTCC 5010 (ATCC 9142) and Candida albicans PTCC 5027 (ATCC 10231).

A disc diffusion method was used to assess the antibacterial and antifungal effects of various essential oil concentrations. The microorganisms were cultivated at 37°C for 14–24 hours, and their densities were adjusted to 108 CFU/mL, or 0.5 McFarland standards, at A530 nm. Next, nutritional agar (Merck) plates measuring 100 mm by 15 mm were covered with 100 µL of the microbial suspensions (containing 108 CFU/mL). Using 10 µL of various essential oil concentrations (10, 20, 40, 60, 80, and 100 µg/mL), the discs (6 mm in diameter) were individually impregnated before being placed on the inoculated agar. A 24-hour incubation period was conducted on all the inoculation plates at 37 °C. Three positive controls were employed for fungi, gram-positive and gram-negative bacteria: ketoconazole (10 mg/disc), ampicillin (10 mg/disc), and gentamicin (10 mg/disc).

Negative control, or dimethyl sulfoxide (DMSO), was employed. Zone of inhibition (mm) measurement was used to assess the antibacterial and antifungal properties. By using the microdilution test in 96 multi-well microtiter plates, the Clinical and Laboratory Standards Institute's standard technique [68] was followed to obtain the minimal inhibitory concentration (MIC) values of the essential oil versus each studied microbial strain." A density adjustment to the 0.5 McFarland standard at 570 nm (108 CFU/mL) was made for the bacterial and fungal strains suspended in the Luria-Bertani medium. 10 milliliters of 50% DMSO were used to dissolve the essential oil. To acquire concentrations ranging from 512.0 to 0.06 µg/mL, samples for each strain were serially diluted in broth. The ultimate microbe concentration in every well was adjusted to 106 CFU/mL by preparing broth cultures of each strain overnight. For 24 hours, 37 °C was the ideal incubation temperature. The growth control was medium containing bacteria and fungi but lacking essential oil, while the sterility control was medium without these microorganisms. It was compared to the growth of the controls for bacteria and fungi. The lowest essential oil concentrations that showed more than 95% growth inhibitory

effect against the evaluated microorganisms were identified as having MIC values, which were seen visually.[17,18]

SCOLICIDAL BEHAVIOR: -

From the infected livers of calves murdered in an abattoir, Echinococcus granulosus protoscolices were isolated to examine suicidal activity. The Helsinki Declaration stipulated that animals were treated ethically. Through the use of the Smyth and Barrett method, hydatid fluid and protoscolices were obtained for this experiment. A glass cylinder was briefly filled with hydatid fluid. Protoscolices were rinsed three times with normal saline after they had settled at the bottom of the cylinder after forty minutes. Their motility was examined under a light microscope (Nikon Eclipse E200, Tokyo, Japan) to establish their vitality. In a dark container filled with regular saline, protoscolices were moved and kept at 4 °C. It was tested for 10, 20, 30, and 60 minutes at four different essential oil concentrations: 2.5, 5, 10, and 20 mg/mL. Test tubes containing 25, 50, 100, and 200 µL of essential oil were filled with 9.7 mL of regular saline that had been enhanced with 0.5 mL of Tween-80 (Merck) and continuously stirred to create these concentrations. Three milliliters of essential oil solution were combined with one drop of a protoscolices-rich solution for each test, gently stirred, and allowed to incubate at 37 °C. One milliliter of 0.1% eosin stain was added to the remaining colonized protoscolices and slowly mixed after the top phase was carefully removed to avoid disturbing the protoscolices after each incubation period (10, 20, 30, and 60 minutes). Following a 20-minute incubation period at 25 °C, the supernatant was discarded. A cover glass was placed over the leftover protocolizes pellet (no centrifugation was done), and the sample was examined under a light microscope after being spread out on a glass slide that had been scaled by hand. After at least 600 protocolizes were counted, the percentage of dead protocolizes was ascertained. Only regular saline plus Tween-80 was used to treat protocolizes in the control group. [14]

Evaluation of Statistics

To conduct chemical analysis and bioassays, essential oil was extracted and examined three times. Statistical software (SPSS v. 11.5, IBM Corporation, Armonk, NY, USA) was used to analyze the data using a randomized design and analysis of variance (ANOVA) to find the least significant difference (LSD) at $p < 0.05$. Every outcome is given as mean ± SD.

MISCELLANEOUS: -

The PSI and PSII activities, as well as the chlorophyll and carotenoid content of MSMA-treated and untreated R and S biotypes, were investigated using standard cocklebur biotypes that are resistant (R) and susceptible (S). Neither the PSI nor PSII activities were inhibited by MSMA at 1, 10, or 100 mg/l. When MSMA treatments were administered or not, the R biotype exhibited greater PSI and PSII activity than the S biotype. After being treated with MSMA, R biotype leaf discs had higher levels of carotenoid and chlorophyll than S biotype leaf discs; S biotype cotyledons had higher amounts of both pigments than R biotype cotyledons. S biotype cotyledons as well as immature and mature leaf discs experienced a loss in pigmentation due to MSMA. According to the results, carotenoids may protect against MSMA toxicity, which may be brought on by an induced free radical mechanism, and photosynthetic ability may play a secondary role in the resistance process. [16] On a few crops and weeds, the potential allelopathic and herbicidal effects of the heartleaf of cocklebur's leaves, flowers, and seed extracts were investigated. According to the results, heartleaf cocklebur did not have any allelopathic effects on the seeds of Lepidium sativum L., Abutilon theophrastii Medik., Descurania Sophia L. Webb. Ex Prat, and Daucus carota L. Nevertheless, it significantly impeded the germination process in Avena sterilis L., Lolium perenne L., and Triticum vulgare L. There was a range of 0.00 to 86.66% in the effect of heartleaf cocklebur on the plants' post-emergence growth under pots. A. retroflexus, A. sterilis, and Conium maculatum L. were more susceptible to the herbicidal effects of hearleaf cocklebur than were the other plant species in this investigation.

As per the PRC's Pharmacopoeia, stir-frying xanthium is recommended to ensure its safe usage by removing the majority of its prickles. Removing the fruit spikes before stir-frying does not have the same poisonous effect as removing them. Therefore, washing the fruits in water or decocting them is not a good detoxification approach. Nothing suggests that the health of people is at risk from the remaining levels of CAT or other

chemicals. However, if xanthium is used for an extended period, the recommended dosage should be kept within the range of 3–10 g/day as per the Materia Medica guidelines. This will allow for a 10-fold margin of safety in comparison to the dose of 100 g that has been known to cause a significant reaction in a human. The risk ought to vanish with the combination of appropriate processing and dosage limitation. The xanthium pods can be examined by practitioners who utilize raw herbs to determine the state of the prickles. Before processing the finished product, manufacturers who make extracts or powders must inspect the pods. The herbicide Scepter caused cockleburs in the field to become resistant after three years of use. During that time, acetolactate synthase (ALS) was identified in this population. More than 300 times more inhibitors were needed for the resistant enzyme than for the wild-type cocklebur ALS when imazaquin, the active component of Scepter, was used to generate a 50% suppression of the enzyme activity.

CONCLUSION: -

Pharmacological studies have generally confirmed the traditional use of whole plant, root, leaf, and fruit extract as a treatment for leukoderma, salivation, rheumatism, tuberculosis, leprosy, lumbago, pruritis, allergic rhinitis, sinusitis, urticaria, rheumatoid arthritis, salivation, and long-standing cases of malaria. The majority of the biological effects can be attributed to the high concentration of sesquiterpene lactones (antibacterial, anticancer, and antitumor), xanthatin, xanthanolide, desacetyl xanthumin, xanthanol, xanthumin (CNS depressant), thiazinedione, desacetyl xanthumin, carboxyatractyloside, terpenes (antioxidant), and its quinic acid derivatives (hypoglycaemic, anti-inflammatory, and analgesic), which are present in all plant parts. Up until now, the majority of pharmacological research has been done on animals both in vitro and in vivo. To validate conventional knowledge in the context of logical phytotherapy, clinical research is thus desperately needed. For the vast majority of people on the planet, plants remain their primary source of pharmaceuticals. Thus, the task of developing effective, secure, and affordable pharmaceuticals continues, particularly for use in remote regions, for scientists. North America, Brazil, China, Malaysia, and the hottest regions of India are among the continents where the plant is abundantly found. It is necessary to conduct additional research on their quantification of certain phytoconstituents and pharmacological profiles based on in vitro, in vivo, and clinical trial data. As a promising source of antimicrobial compounds with potential for use in biological applications, our results pointed to X. strumarium. However, to ascertain the pharmacokinetics, toxicity, and adverse effects of the active ingredients in this medicinal plant, in vivo research is required. By separating active ingredients and figuring out the right dosages for efficient treatments, the antibacterial, antifungal, and scolicidal actions may also be enhanced. As is often the case with many traditional herbal practitioners, this would prevent the prescribing of unsuitable therapies. The field of food hygiene may be one specific application of the X. strumarium plant, helping to control food-borne illnesses and lower the danger of food contamination.

REFERENCES:

1. Physiological-ecology of xanthium strumarium linn. iv. effect of climatic factors on growth and distribution
2. Bioactivity-guided fractionation for anti-inflammatory and analgesic properties and constituents of Xanthium strumarium L.
3. Anti-hemolytic, anti-lipid peroxidation, antioxidant properties, and acute toxicity of Xanthium strumarium leaves extracts
4. Traditional Uses, Botany, Phytochemistry, Pharmacology, Pharmacokinetics and Toxicology of Xanthium strumarium L.: A Review
5. [HTML] Ethnomedicinal Uses, Phytochemistry, and Anticancer Potentials of African Medicinal Fruits: A Comprehensive Review
6. Ethnobotanical, phytochemical, and toxicological studies of Xanthium strumarium L
7. [HTML] Phytochemical Compositions and Biological Activities of Essential Oil from Xanthium strumarium L.
8. [HTML] Effects of extraction methods of phenolic compounds from Xanthium strumarium L. and their antioxidant activity
9. Isolation and Identification of Phytochemicals from Xanthium strumarium
10. Phytochemical Compositions and Biological Activities of Essential Oil from Xanthium strumarium L.
11. Phytopharmacological review of Xanthium strumarium L.
12. Ethnobotanical, phytochemical, and toxicological studies of Xanthium strumarium L
13. Acute and subacute toxicity of chloroform and hexane extracts of the root of Xanthium strumarium
14. Volatiles Profiling, Allelopathic Activity, and Antioxidant Potentiality of Xanthium Strumarium Leave Essential Oil from Egypt: Evidence from Chemometrics …
15. Studies on Anti-tussive Activity of Xanthium strumarium L.
16. Photosynthetic activity of MSMA-resistant and - susceptible
17. Antifungal activities and phytochemical screening of Xanthium strumarium
18. Chemical composition and antifungal activity of essential oil from Xanthium strumarium L. leaves