



## Phytochemical and Pharmacological Properties of *Argemone mexicana* (*Mexican poppy*)

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**Conflicts of Interest:** Nil

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### ABSTRACT

Mexican poppies, also known as *Argemone mexicana* or "Satyanasi or Bhatkatiya" in India, are valued medicinal plants that are said to have extraordinary curative potential.

Indigenous people in Mexico and the western United States have long employed the stress-resistant herb *Argemone mexicana*, a member of the Papaveraceae family, in traditional medicine. For more than 5000 years, the Indian traditional medical system of Ayurveda has employed it to treat a variety of illnesses. Its seeds, latex, roots, stems, and leaves all have various pharmacological effects. Numerous bioactive substances derived from *Argemone* seeds are particularly effective in the treatment of chronic diarrhoea, dysentery, peptic ulcers, anti-inflammatory, anti-oxidative, anti-microbial, anti-cancer, anti-malarial, expectorant, anti-diabetic, neuro-pharmacological activity, anti-HIV activity, as well as respiratory infections.

*Argemone mexicana* has been shown to offer a wide variety of therapeutic effects, including those of analgesic, antispasmodic, depurative, emetic, antipyretic, emmenagogue, sedative, antispasmodic, healing dermatological disorders, etc. There is a common belief that this plant is toxic and produces epidemic dropsy, which is characterised by excessive swelling, especially in the legs, but this is what happens during the process of adulterating edible oils, thus its medical use is not often promoted.

### Introduction

*Argemone mexicana* (AM) is widespread to Mexico and a prominent annual weed of the Papaveracea family, mostly associated with agricultural crops and harsh environments. In the tropical, subtropical, and humid temperate regions of the globe, it is a major weed for various cash crops. [1] *Argemone mexicana* is native to South America and has naturalised in tropical and subtropical locations such as the United States, India, Bangladesh, and others.

[2]. In India, this species is common in states such, Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Telangana, Rajasthan, Uttar Pradesh, and West Bengal[3]. The Mexican prickly poppy (*Argemone mexicana*), commonly known as goatweed, Mexican thistle, prickly poppy, and yellow thistle, is a member of the poppy family. [4]



Figure 1:

**Taxonomy [5]**

Kingdom : Plantae  
 Superdivision : Spermatophyta  
 Division : Magnoliophyta  
 Class : Magnoliopsida  
 Subclass : Magnoliidae  
 Order : Papaverales  
 Family : Papaveraceae  
 Genus : Argemone  
 Species : *Argemone mexicana*

**Vernacular Names**

Shialkanta is the name given to the Mexican poppy in the Bengali language. In Hindi, It is referred as Pila-dhatura, Shiakanta and Bharbhand. Prickly poppy and Mexican poppy are both names that are used to refer to the Mexican poppy in English. Similarly ,In Oriya,Tamil and Telegu is called as Kantakusham ,Karukkansedi ,Brahmdandidandu correspondingly. [6]

**Morphological Description**

Prickly shrub with leaves 2.5–4 cm long, sessile, sinuate-lobbed, blotched with white,

and lobes tipped with slender yellow spines; flowers pale yellow, 7-8 cm broad; sepals and oblong pod prickly, the latter opening by valves from the top, leaving the thread-like placentae between; seeds small and black; milky yellowish juice. Height: 45–75 cm. [7]

**Reported Phytochemicals [8]:**

The following list is comprised of some of the phytochemicals that may be found in the various portions of the Mexican prickly poppy:

**Whole Plant:** 6-Acetyl Dihydrochelerythrine, Allocryptopine, Angoline, Arachidic Acid, Argemexicaine, Argemexirine, Argemomic Acid, Chelerythrine, Columbamine, Coptisine, Cryptopine, Dehydrocorydalmine, Dehydrocheilanthifoline, Dihydrocoptisine, Dihydrosanguinarine, Jatrorrhizine, Nor-Chelerythrine, Nor-Sanguinarine, O-Methylzanthoxyline, Oxyberberine, Oxyhydrastinine, Quercetin, Rutin, Stylophine, Tannic Acid, Tetradecanoic Acid, Tetrahydrocoptisine, Thalifoline.



**Figure 2: (Whole Plant)**

**Seeds:** Cinnamic Acid, Dihydropalmatine Hydroxide, Ferulic Acid, Eriodictyol, Luteolin, Benzphetamine N-Demethylase, Benzoic Acid, Berberine, Caffeic Acid, Cinnamic Acid, Dihydropalmatine Hydroxide, Ferulic Acid, Eriodictyol, Luteolin, Myristic Acid, N-Demethyloxysanguinarine, Oleic Acid, Palmitic Acid, Sanguinarine, Sn-Glycerol-1-Eicosa-9,12-Dienoate-2-Palmitoleate-3-Linoleate, Stearic Acid.



**Figure 3: (Seeds)**

**Flowers:** Hentriacontane-3,20-Diol, Isorhamnetin, Isorhamnetin-3-O-B-Dglucopyanoside, Isorhamnetin-7-O-B-Ddiglucopyanoside, Vanillic Acid



**Figure 4: (Flowers)**

**LEAVES :**  $\beta$ -Amyrin, Phenylalanine, Isorhamnetin-3-O-B-Dglucopyanoside, Cysteine.

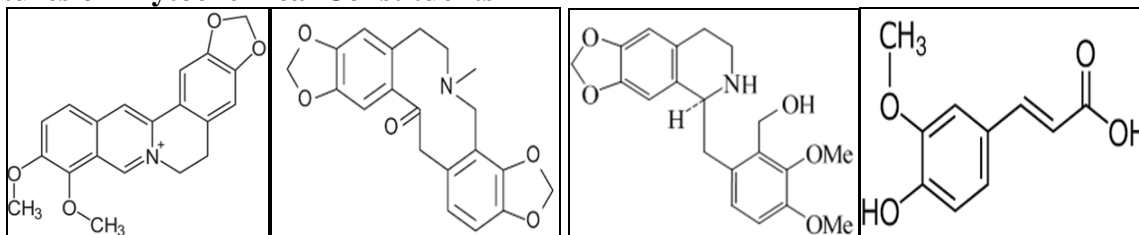


**Figure-5 (Leaves)**

**Aerial Parts-** 13-Oxoprotopine, Adenine, Adenosine, Argemexirine, Argenaxine, Higenamine, Mexicanic Acid, Mexitin, Pancorine, Protomexicine, Reticuline, Rutin, Triacotan-6, 11-Diol, A-Tocopherol.

**Apigeal Parts-** Berberine, Cheilanthifoline, Isocorydine, Protoberberine, Reticuline, Scoulerine.

#### Structures of Phytochemical Constituents

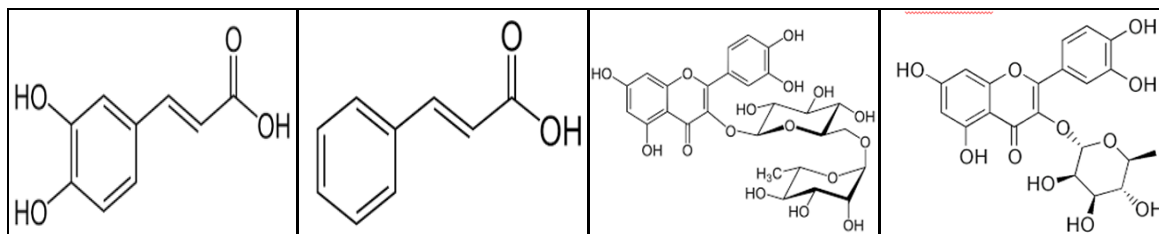


**Berberine**

**Protopine**

**Argenaxine**

**Ferulic acid**

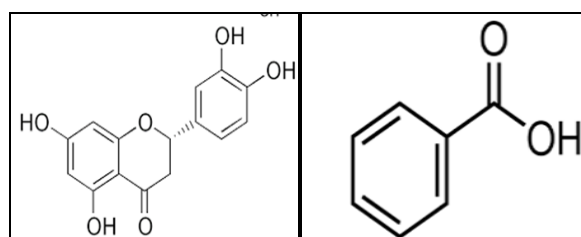


**Cinnamic acid**

**Caffeic acid**

**Rutin**

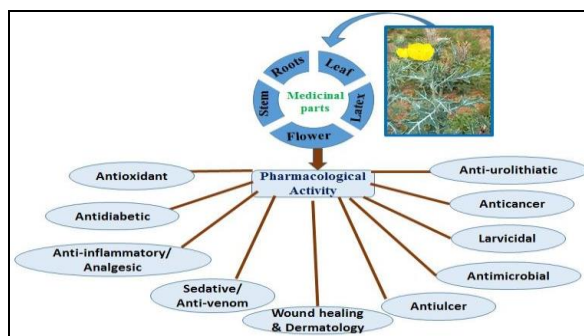
**Quercitrin**



**Eriodictyol**

**Benzoic Acid**

## Reported Pharmacological Activity



**Figure 6: (Pharmacological Activities of *A. Mexicana*)**

**1. Antidiabetic Activity:** The aerial component of the *Argemone mexicana* plant was tested for hypoglycemic action. In normal and experimentally induced diabetic rats, *Argemone mexicana* extract at doses of 200mg/kg and 400 mg/kg lowers blood glucose levels. It also had an effect on rising serum cholesterol and triglycerides. This impact is proportional to the amount of *Argemone mexicana* taken. The greater the dosage, the greater the hypoglycemic impact. The administration of ethanolic and aqueous extract at a dosage level of 400 mg/kg to Alloxan-induced diabetic rats results in a considerable drop in blood sugar level. In Wistar rats, the combination of Chloroform and hydroalcoholic aqueous extract has a comparable effect. In vitro tests of *Argemone*

*mexicana* hydroalcoholic and alkaloidal extracts revealed the strongest inhibitory activity of aldose reductase. [9]

On diabetic rats, an extract of the aerial portions of *A. mexicana* was tested. It demonstrated hypoglycemic activity in rats given an aqueous extract of the plant's aerial portion. As a consequence of regaining lost weight, readings for glucose, creatinine, urea, cholesterol, and triglycerides were reported to decrease. A dosage of 400 mg/kg was shown to be efficacious and equivalent to the standard medicine for diabetes, metformin, which demonstrates effectiveness at a dose of 300 mg/kg body weight; thus, the results seem good. [10]

Anti-diabetic activity		
Extract/active compound	Model	Result
Ethanolic and aqueous extract	Alloxan induced hyperglycemic rats	Progressive fall of blood sugar level in a significant extent
Hydroalcoholic extract	Streptozotocin induced Wistar albino rats	Reduces the fasting blood glucose level significantly
Chloroform and aqueous extract	Alloxan induced diabetic rats	Anti-diabetic and lipid-lowering activity
Hydroalcoholic and alkaloidal extracts	<i>In vitro</i>	Alkaloidal extracts shown highest aldose reductase inhibitory activity

**2. Anti-inflammatory/ Analgesic Activity:** The anti-inflammatory activity of *A. mexicana* was studied using the carrageenan-induced paw edoema technique, while its analgesic potential was studied using the hot plate test method and acetic acid writhing method. The extract of lyophilized leaves was employed and shown to be particularly efficient in acute inflammatory

diseases. The plant extract was lyophilized and evaluated for its analgesic efficacy. The experiments for both activities were carried out in-vivo on young male and female mice. The observed anti-inflammatory activity can be attributed to the presence of phytochemicals such as tannins, flavonoids, and alkaloids, among others, and the analgesic activity of the

lyophilized extract of plant can be attributed to phytochemicals such as tannins, flavonoids, isoquinoline, and alkaloids, among others). An interdisciplinary research that looked at the antibacterial, anti-inflammatory, and wound healing activities of a polyherbal formulation of *Plumbago zeylanica* Linn, *Datura stramonium* Linn, and *Argemone mexicana* Linn discovered a synergistic impact on the wound healing process. The anti-inflammatory and antibacterial properties of the polyherbal mixture may have aided in the wound healing process. These research studies have provided strong evidence for the traditional medicinal usage of *A. mexicana*, notably as anti-inflammatory drugs with analgesic efficacy. [11] Several nations

employ *Argemone mexicana* Linn as a medicinal herb. The seeds are used to treat toothaches in Mexico and are said to be an antidote to the venom of snakes in India. [12] The ethanolic extract of leaves of *A. mexicana* is reported to have significant anti-inflammatory and analgesic activity at a dose of 200 mg/kg in mice. It is also reported that leaf extract of *A. mexicana* is able to show significant anti-inflammatory activity in rats; the investigators are in opinion that the chemical constituents of the leaf extract such as isorhamnetin-3-*O*- $\beta$ -D-glucopyranoside (**70**),  $\beta$ -amyryn (**47**), cysteine (**66**) and phenylalanine (**67**) might be responsible for such activity.[13]

Anti-inflammatory/ analgesic activity		
Extract/active compound	Model	Result
Lyophilized leafextract	young male and female white mice	Exhibit effective anti-inflammatory and analgesic activity
Polyherbal methanolic extract	Healthy Wistaralbino rats	Significant anti-inflammatoryEffect

**3. Anti-Asthmatic Activity:** In vitro study- Contractions produced by histamine on isolated guinea pig ileum preparation and effects of ethanolic extract and different fractions of *Argemone mexicana* on it :

The ethanolic extracts of *Argemone mexicana* and their chloroform and ethyl acetate fractions were used to measure the contractile responses of the ileum to histamine in both presence and absence. After recording the dose response curve (DRC) of histamine at doses of 100, 200, 400, 800, and 1600 g, ethanolic extracts of *Argemone mexicana*, along with their chloroform and ethyl acetate fractions (10 mg/mL), were added to the bathing solution, and the same doses of histamine were repeated once more. To track DRC of histamine, a graph of the maximal contraction response on ordinate and log concentration of histamine was created. [14]

When administered twice daily for two weeks, *A. mexicana* seed powder (100-200 mg) had a notable impact on the prevalence of asthma as well as antiasthamatic action.[15]

**4. Antioxidant activity:** The Folin-Ciocalteu reagent may be used to assess the antioxidant capacity of plant extracts based on their phenolic content. 11 Using gallic acid as a reference, the greatest phenolic concentration was discovered in MEAM (305.61 mg of GAE/g of extractives) using gallic acid as the standard. MEAM > CTCAM > CAM > PEAM ranked highest in phenolic concentration among the extractives. The 2,2-diphenyl-1-picrylhydrazyl (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging experiment was performed to assess the antioxidant capacity of the extracts. In this investigation, the chloroform-soluble fraction of the methanol extract of the whole plant of *A. mexicana* exhibited the highest free radical scavenging activity with an IC<sub>50</sub> of 10.4 g/ml. The sequence of inhibitory potential against free radicals was CAM > CTCAM > MEAM > PEAM. [16]

The plant *Argemone maxicana* linn includes alkaloids, flavonoids, terpenoids, carbohydrates, saponins, and tannins. According to our findings, the ethanolic extract of *Argemone*

*maxicana* linn has high antioxidant activity. Antioxidants, which are produced in the human body by exogenous and endogenous causes, have been linked to several illnesses. The phytochemical antioxidants have significant capacity to neutralise cell-damaging free radicals or oxidants. *Argemone maxicana* linn was determined to be the most effective antioxidant in terms of DPPH radical scavenging activity based on the above-mentioned tested antioxidant parameters. The scavenging capability of ethyl acetate extract was tested. The antioxidants convert the stable free radical DPPH, which is purple in colour, into the colourless —diphenyl—picryl hydrazine. By detecting the drop in absorbance at 517 nm, the quantity of decreased DPPH

could be determined. Consequently, at a concentration of 200g/ml, the extract shown significant DPPH radical scavenging activity (89.46%) when compared to ascorbic acid. Antioxidant activity results reveal that the plant was potently active, and the plant extract includes chemicals capable of donating hydrogen to a free radical in order to remove an odd electron responsible for the radical's reactivity. [17]

Ethanol extract included a lower quantity of tannins and alkaloids, which are said to have adverse effects at larger concentrations. Consequently, ethanol extract is a powerful antioxidant and anti-steroidogenic agent that may be used for pharmaceutical purposes. [18]

Antioxidant activity		
Extract/active compound	Model	Result
Alcoholic, aqueous acidic and alkaline extract	<i>In vitro</i>	Scavenging activity against DPPH and Hydroxyl radical
Methanolic extracts of leaves, stems, roots, flowers and fruits	<i>In vitro</i>	Possess significant antioxidant Activity
Methanolic extract of plant	<i>In vitro</i>	Protection against free radicals Damage
Ethanol and aqueous extract	DPPH and Hydrogen peroxide-scavenging model	Ethanol extract of aerial parts showed high scavenging activity
Methanolic extract of stem and Leaves	<i>In vitro</i>	Free radical-scavenging activity comparable to standard antioxidant
Methanol extract of leaves	<i>In vitro</i>	Free radical-scavenging activity

### 5. Anti-microbial activity:

Methanol extract is antibacterial and antifungal against *Bacillus* sp., *Staphylococcus aureus*, *Candida albicans*, *Fusarium oxysporum*, and *Macrophomina phaseolina*. In methanol, leaves were more antibacterial and antifungal than roots. *Bacillus* sp., *Xanthomonas campestris*, and *Staphylococcus aureus* were inhibited. *Candida albicans*, *Macrophomina phaseolina*, and *Fusarium oxysporum* were inhibited. All leaf extracts were inactive against *Fusarium oxysporum*. *Papaveraceae* plant *A. maxicana* has broad-spectrum antibacterial and antifungal activities. Water extract yielded the most soxhlet (12.19 g/100g) and microwave (8.54

g/100g) extractions (water, methanol and acetone). The most efficient antifungal and antibacterial extracts were methanol, aqueous, and acetone. This study found that extraction method and solvents affected *A. maxicana* leaf and root extract yield and antibacterial activity. *A. maxicana* leaf and root extracts are antibacterial. [19]

Ethanol extracts were effective against *Staphylococcus aureus* and *Escherichia coli*, but aqueous extracts were more effective against *Salmonella typhi*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Trichophyton rubrum*, and *Candida albicans*. [20]

Antimicrobial (Antifungal/ Antibacterial/ Antiviral) activity		
Extract/active compound	Model	Result
Various extracts from stems	In vitro study against a range of food-borne bacteria	Potent antibacterial effect against <i>B. subtilis</i> , <i>S. aureus</i> , <i>L. monocytogenes</i> , <i>C. Botulinum</i> , <i>C. perfringens</i> , <i>E. coli</i> , <i>P. aeruginosa</i> and <i>S. typhimurium</i>
Various extracts of the poppy	Fungal stains viz. <i>Aspergillus niger</i> , <i>Aspergillus terreus</i> , <i>Aspergillus stolonifer</i> , <i>Candida albicans</i>	A good antifungal activity was observed
Leaf extracts using 3 organic solvent and water	<i>P. aeruginosa</i> NCTC strain no. 10662	The methanol extract has shown highest anti pseudomonad activity.

Ethanol and methanol extracts of seeds and leaves	Gram positive bacteria <i>S. aureus</i> and <i>B. subtilis</i> and Gram negative bacteria <i>E. coli</i> and <i>P. aeruginosa</i>	Great antibacterial against gram-positive as well as gram-negative bacteria
Cold aqueous and methanolic extracts of stem and leaves	<i>Mucor indicus</i> , <i>Aspergillus flavus</i> , <i>Aspergillus niger</i> and <i>Penicillium notatum</i> fungi	Strong antifungal activity
Cold aqueous and methanolic extracts of leaves	Gram positive bacteria <i>Staphylococcus aureus</i> & <i>Bacillus cereus</i> and Gram negative bacteria <i>Escherichia coli</i> & <i>Pseudomonas aeruginosa</i>	Exhibited comparable broad spectrum antibacterial activity
Methanolic extract of leaves	In vitro Antiamoebic Activity against <i>Entamoeba histolytica</i>	Showed growth inhibition activity against trophozoites of the <i>E. histolytica</i> strain
Methanol, ethanol and chloroform extracts of flowers, berries and leaves	Agar disc diffusion and agar tube dilution Methods	Good antimicrobial activities against all the tested micro-organisms.
Ethyl acetate extracts of stem and root	Antiviral and immunostimulant screening against WSSV and <i>Vibrio harveyi</i>	Effectively suppressed the WSSV and also boosted the hematological and immunological parameters

**6. Wound healing activity-** Nitrofurazone, an established medication, has a substantial response during *A. mexicana* extraction. Sterols, alkaloids, proteins, and carbohydrates found in the leaves of *A. mexicana* aid Patil and his team slow the healing of wounds in an albino rat model. Excision, incision, and dead space wound models were used to test the wound-healing abilities of several extracts from *A. mexicana* leaves in Wistar albino rats. In comparison to petroleum ether, chloroform, and aqueous extracts of the leaves of *A. Mexicana*,

methanol demonstrates better and faster results in wound healing. shown in Swiss albino rats, the ethanolic extract ointment of the root of *A. Mexicana* had more wound healing power than gentamycin (0.3% w/w). [21] To solve issues with wound healing, use the fresh seed. *Argemone mexicana* fresh stems are removed for their yellow-colored latex, which is used to treat wounds. [22]

Using excision, incision, and dead space wound models in Wistar albino rats, Das & Murthy studied the effects of several *A. mexicana* leaf

extracts on wound healing activities. Significant wound healing activity has been shown in the petroleum ether, chloroform, and aqueous extracts of the leaves of *A. mexicana*. Another research revealed that using a methanol extract of *A. mexicana* leaves significantly accelerated the rate at which rats' wounds healed. In a study on artificially caused excision wound in Swiss albino rats, the impact of *A. mexicana* roots and stem is confirmed. The ability of the plant *A. mexicana*'s stem, root, and other portions to cure wounds was tested, and the results were compared to those of gentamycin (0.3% w/w), a widely used wound healing agent. The results of this study showed that the ethanolic extract ointment of *A. mexicana* root has superior wound healing potency, which was demonstrated by an accelerated rate of wound contraction and a shorter time for epithelization, supporting its use as a potential herbal remedy for wound healing, as suggested in folklore. [23]

### 7. Larvicidal and Chemostiraant activity-

Larvicidal activity of any substance is something that might be used, especially during the season when mosquitos multiply and spread fever. The larvicidal property of *Aedes aegypti* and *Culex* has been examined. At both natural and laboratory circumstances, acetone fraction

of petroleum ether extract showed significant LC50 activity for 2nd-3rd 4th instar larvae of these mosquitos. [24]

The acetone fraction of the petroleum ether extract of seeds from *A. mexicana* exhibited larvicidal and growth inhibiting activity against *Aedes aegypti* 2nd instar larvae at concentrations ranging from 25 to 200 ppm, with IC50 values of 13.58 ppm and 17.43 ppm in the field and laboratory, respectively. Significant larvicidal activity of acetone fraction of petroleum ether extract of *A. mexicana* seeds against *Aedes aegypti* 2nd instar larvae was also discovered. The plant's leaf extract (in petroleum ether) also has a significant larvicidal capability, with an LC50 value of 48.89 ppm against *Culex quinquefasciatus* larvae in the third and fourth instars. A synergistic activity of this plant was also found in their studies; when combined (1:1) with *Clausena dentate*, the larvicidal capability of *A. mexicana* leaf extract rises (LC50 value of 28.60 ppm). [25] *A. mexicana* extract in petroleum ether at greater concentrations following acetone extraction shown larvicidal activities as well as growth restricting activity against *Aedes aegypti* subsequent (second) instar larvae. [26]

Larvicidal / anti-parasitic / antimalarial activity		
Petroleum ether leaf extracts of plants	<i>Culex quinquefasciatus</i> , vector of lymphatic filariasis	Synergistic action of <i>A. mexicana</i> against 3rd - 4th instar larvae of <i>Cx. quinquefasciatus</i> .
Petroleum ether and hexane extracts of leaf, stem, and roots	dengue vector, <i>Aedes aegypti</i>	Effective larvicides leading to 100 % larval mortality
Hexane, chloroform, methanol and water extracts	<i>Cx. Pipiens</i> and <i>Ae. Aegypti</i> colonies	Promising as naturally occurring insecticides
Silver Nanoparticle from <i>Argemone mexicana</i>	<i>Aedes Albopictus</i>	Suitable for bio-formulation against mosquitoes and microbes
Ethanol extracts of flowers	<i>Culex quinquefasciatus</i> and arboviral and filarial vector	Flower extract exhibited the strongest larvicidal activity
Petroleum ether, Chloroform and Methanol extracts of seeds, aerial part, and roots	grain pests <i>S. oryzae</i> , and <i>C. chinensis</i>	Lethal effect on <i>C. chinensis</i> and <i>S. oryzae</i> adults, and also have potentials to repel the test insects



**8. Molluscicidal activity:** The seed extract of *A. mexicana* has been reported to be lethal to snails. protopine and sanguinarine from the seeds have been recognised as lethal to snails by decreasing the level of proteins, DNA, and RNA in the nervous tissue of *Lymnaea acuminata*. Seed powder might be utilised to control snail populations and bring about their demise. [27]

The seeds of this plant were used as a molluscicide against the snail *Lymnaea acuminata*. The molluscicidal effect of the plant's seed powder was discovered to be dosage and time dependent. Co-migration of protopine and sanguinarine was identified as the active component in seed powder that induced snail death. [28]

**9. Anti-Malarial activity-** The findings suggest that the plant *Argemone mexicana* and its alkaloid (berberine) have significant antimalarial activity against *Plasmodium falciparum* in vitro. The in vivo antimalarial activity of crude alkaloid was increased several fold when co-administered with berberine, highlighting berberine's antimalarial potential. In terms of anti-protozoan activity, crude extracts outperform pure berberine, implying synergistic or additive actions with other substances. The current study's findings, which are consistent with earlier investigations, show that berberine has little in vivo activity when supplied alone, but that activity is greatly increased when combined with crude alkaloidal extract. This shows that multiple chemicals found in alkaloid extract may work together or independently to improve berberine's antimalarial potency in mice. [29]

A decoction of *A. mexicana* was tested in increasing dosages to determine its potential as a healer for the treatment of malaria. It was

shown that when malaria patients were given regulated dosages of decoction, their capacity to recuperate improved. [30]

**10. Anticonvulsant Activity-** According to the outcomes of several studies, the anticonvulsant activity of chloroform, ethanol, and aqueous extracts of the aerial portions of *Argemone mexicana* demonstrated considerable activities. Convulsions caused by maximum electroshock and convulsions caused by PTZ were used in the research on the anticonvulsant action of the compound. Diazepam was used as the benchmark medication throughout this study. In comparison to the control, ethanol, and water extracts, it has been demonstrated that the chloroform extract possesses a large amount of activity by eliminating the tonic extensor phase. It is possible to draw the conclusion that the leaf extracts include active elements that are responsible for the anticonvulsant action of the plant. [31]

**11. Anti-HIV activity** - The benzo[c]phenanthridine alkaloid, ( $\pm$ )-6-acetyl dihydrochelerythrine isolated from the methanolic extract of air-dried whole plants of *A. mexicana* was found to exhibit potent anti-HIV activity in H9 lymphocyte assay with EC50 value of 1.77  $\mu$ g/mL (Therapeutic Index: 14.6).[32]

**12. Anti-cancerous Activity:** Extracts from the leaves, in particular, have been shown to exhibit anti-cancer effect against human cell lines HeLa-B75, HL-60, and PN15. Sunanda Kulshrestha and Anjana Goel used the MTT test to determine the activity of methanolic extract of leaves against HeLa and MCF-7 cancer cells. The action was also determined to be apoptotic rather than necrotic, as expected by the presence of flavonoids and alkaloids[33].

Anticancer activity		
Extract/active compound	Model	Result
Methanol extract of aerial part	Human colon cancer cells	Strongly inhibit the cell proliferation
Cold aqueous and methanolic extracts	The human non-small cell lung carcinoma, -A549, human cervical cell, -SiHa, and oral cancer cell, -KB	Exhibit significant cytotoxicity on A549, SiHa and KB immortalized cell lines
Ethyl acetate fraction from	HepG2 cell lines (liver	Cytotoxic effect against HepG2 cell

the flower extract	cancer)	line
Root and leaf methanol extracts	<i>In vitro</i>	Inhibitory effects against T84 human colon cancer cells

**13. Hepato-protective activity:** The carbon tetrachloride-induced anti-hepatoprotective action of an aqueous extract of the stem of *A. mexicana* in male albino Wistar rats. Serum aspartate transaminase, alanine aminotransferase, and alkaline phosphatase levels in rats were observed to be decreased by the extract. Another group of researchers used crude leaf powder to demonstrate activity against CCl<sub>4</sub>-induced hepatotoxicity. They discovered a significant increase in ASAT/GOT (aspartate aminotransferase), ALAT/GPT (alanine aminotransferase), and ALP (alkaline phosphate), and a decrease in total bilirubin (TBIL) and direct bilirubin. [34]

**14. Sedative /Anti venom activity:-** *A. mexicana* has been shown to have high central and peripheral nociceptive activity in Swiss albino mice, according to a research examining its sedative and anxiolytic properties. Animals' motor activity and time falling off the revolving rod have significantly decreased in both methanolic and ethyl acetate extract studies. This study showed that the CNS depressing properties of plant extracts may be due to phytochemicals such as flavonoids, steroids, alkaloids, and tannins. Similar research looked at the anxiolytic-like effects of an ethanolic extract of *A. mexicana* in Wistar rats. Alkaloids, terpenoids, sterols, steroids, flavonoids, and quinones, all of which are inherently linked to some activity on the central nervous system, were found in the extracts, according to phytochemical screening. The alkaloid-enriched extract was given to separate groups of rats at a dose of 200 g/kg in order to assess the anxiolytic-like impact on the Elevated plus Maze (EPM) test. The findings were analysed in terms of the lowered anxiety index. It has been found that ethanolic extracts of *A. mexicana* (100 and 200 mg/Kg, respectively) and alkaloids mixtures (200 g/ml) significantly reduce anxiety index in a manner comparable to that of standard diazepam (2 mg/kg). This finding suggests that the plant's alkaloids have anxiolytic effects, and that these effects are likely mediated through chloride channels on

the gamma-aminobutyric acid (GABA) receptors. Additionally, *A. mexicana* plants have anti-venom qualities. For seven days, a leaf and seed decoction is taken internally; root paste is also employed. It is used to treat all poisonings, including those caused by scorpion stings. According to a research on anti-snake venom capabilities of medicinal plants, *A. mexicana*'s seeds and leaves can be decocted to treat snakebites and may be used instead of antivenom serum because of its anti-venom activity. [35]

Of all the extracts studied, the crude methanolic extract of *A. mexicana* is the most effective against *Naja naja* venom. According to the present research, these extracts have promise as a treatment for snake venom. Additionally, the discovery of the active metabolites that cause this inhibitory effect will aid in the creation of new drugs as a result of pharmaceutical investigations. [36]

**15. Antiplasmodial activity:** - *A. mexicana* also shown antiplasmodial efficacy at various extract concentrations (per kg/body weight). About twenty *Argemone* species were studied, and it was shown that they exhibit antiplasmodial action, with IC<sub>50</sub> values ranging from 9 to 43 mg dry extract ml<sup>-1</sup>, e.g., plant extracts [in vitro inhibition (%)] against a chloroquine-resistant strain of *P. falciparum*. [37]

**16. Effect on ileum organ:-** The effects of the methanolic extract, its partially purified fraction, and the isolated pure compounds such as protopine and allocryptopine from *A. mexicana* on the morphine withdrawal effect in guinea pig isolated ileum were studied by Capasso and his group. All of the tested materials were observed to significantly reduce the effect in a concentration-dependent manner, which suggests that isoquinoline alkaloids could be used as potential agents in the treatment of morphine withdrawal. Further research in this area revealed that extracts of CHCl<sub>3</sub>/MeOH and MeOH lowered the contractions of an isolated guinea-pig ileum in a dose-dependent manner. The effects of the extracts were attributed to the

active chemicals protopine, allocryptopine, and berberine, respectively. [38]

### Traditional Uses of *Argemone Mexicana* (L.) [39]

*A. mexicana* is widely used in traditional medicine to treat a wide range of illnesses. The plant's many components were widely used to make Ayurvedic, Siddha, Unani, and homoeopathic remedies.

According to Ayurveda, the whole plant of *A. mexicana* is useful as a purgative and diuretic for treating guinea-worm infestations. The plant's seeds are also used as an emetic, expectorant, demulcent, and laxative in addition to being utilised as an antidote for snake poisoning. Seed extract-containing protein-dissolving chemicals are used to treat warts, cold sores, skin infections, itches, jaundice, and dropsy. Infections of the skin, sores, dropsy, and jaundice can all be treated with seeds. The plant's juice treats corneal opacity and ophthalmic conditions. Skin conditions are treated with the seed oil. Roots are utilised for skin conditions, leprosy, and inflammations in addition to being antihelmentic.

In siddha medicine, this herb is frequently used to treat leucorrhoea, scorpion bites, photophobia, and venereal sores. To treat diabetes, leaves and black pepper are combined. Boils are treated using *A. mexicana*'s latex by applying it topically to the boil's location. Dental problems are treated with the whole plant. Ulcers and malarial fever are treated with leaf decoction. The plant's juice is administered to a scorpion sting. Dropsy, jaundice, and leprosy can all be treated with seeds.

*A. mexicana* is used in unani medicine to enrich blood, which has expectorant and aphrodisiac properties. Additionally, leucoderma and skin conditions are treated with it. In homoeopathic medicine, the substance made from this plant is highly successful in curing the tape worm condition. Whooping cough and bronchitis are reportedly treated using the whole plant.

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