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Phytochemical and Pharmacological Uses of Firangidhotra

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Abstract: *Argemone mexicana is an indigenous herb commonly known as Prickly poppy. It belongs to the family Papaveraceae. Argemone Mexicana is noted to possess medicinal benefits in traditional system of medicine. Various parts of the plant were widely used in Ayurveda, Siddha, Unani and Homeopathic medicines. It is reported to have antimicrobial activity, wound healing property, larvicidal and chemo sterilant activity, nematicidal and allelopathic potential, antimalarial, antibacterial and antifungal, molluscicidal, anticancer, hepatoprotective, anti-HIV and neuropharmacological activity. Beyond pharmaceutical efficacies, certain plant parts also show toxic effects as well. Argemone Mexicana oil adulteration poses a serious threat to human health and should be checked by appropriate regulatory measures. Hence, an up-to-date information on the chemical and pharmacological knowledge on this plant may be helpful to guide researchers anticipating to undertake further investigations in these directions.*

Keywords: Argemone Mexicana, healing property, Argemone oil

I. INTRODUCTION

Plants have been used in medicines since time immemorial. India has a rich heritage of using medicinal plants in traditional medicines, as in the Ayurveda, Siddha and Unani systems besides folklore practices. The plant kingdom is a virtual goldmine of biologically active compounds and it is estimated that only 10-15% of existing species of higher plants have been surveyed. Many plants have been successfully used in the treatment of various diseases. The ancient record is evidencing their use by Indian, Chinese, Egyptian, Greek, Roman and Syrian dates back to about 5000 years.

The plant Argemone Mexicana belonging to the family papaveraceae, is a widely distributed plant throughout the subtropical and tropical regions of the world. Mexican, known as Mexican poppy or Mexican prickly poppy, is a species of poppy found in Mexico and now in the United States, India and Ethiopia.

In India, around 20,000 medicinal plant species have been recorded recently, but more than 500 traditional communities use about 800 plant species for curing different diseases.

Argemone Mexicana is extensively used as traditional medicine for the treatment of numerous diseases. Fresh yellow, milky seed extract containing protein-dissolving substances is effective for the treatment of warts, cold sores, skin diseases, itching and jaundice [2]. Argemone mexicana has been investigated in terms of modern pharmacology for its anti-malarial activity .WHO had given the information that traditional medicines are safe for the treatment of infections originated from microbial and non microbialorigin.

1.1 Different names of Argemone Mexicana.

Table 1: Nomenclature of **Argemone *Mexicana*** in Different.

LANGUAGES	NAMES
Bengali	Siyal-Kanta
Hindi	Satyanashi, Bharband
Kannada	Datturigidda
Konkani	Phirangidhutro
Malayalam	Ponnummattu

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Malayalam	Khomthongpee
Marathi	Firangidhotra

Table 2: Scientific Classification

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida Dicotyledons
Subclass	Magnoliidae
Order	Papaverales
Family	Papavaraceae
Species	Argemone Mexicana

II. MORPHOLOGY OF ARGEMONE MEXICANA

Figure 1: Argemone Mexicana

The plant is an erect prickly annual herb of about 1 m high; leaves are usually 5 to 11 cm long, and more or less blotched with green and white, glaucous broad at the base, half-clasping the stem prominently sinuate-lobed, and spiny. The flowers of this plants having a 2-3 foliaceous bracts. Sepals of this 8-12 mm long and 5-7 mm broad, and acute in shapes, prickly is outside. Petals are 4-6 obovate in shapes and 2.5-3.5 cm long and (1.5-) 2-2.5 cm in broad, and bright yellow color. Stamens are indefinite, 8-12 mm long curved after flowering. Ovary ovate are 8-10 mm long and 3-5 mm broad covered with long soft spines. Fruits are capsules, prickly and oblong ovoid. Seeds are numerous, globosely, netted and brownish black. Pollen is tri-tetracolporate . The flowers become 4 to 5 cm in diameter and are terminal, yellow ,and scentless.

III. PHYTOCHEMISTRY

Higher plants are warehouses of assorted bioactive constituents or phytochemicals which find ample use in the pharmaceutical industry. About a quarter of all prescribed pharmaceuticals in advanced countries contain compounds that are directly or indirectly, derived from plants. Phytochemicals or secondary metabolites usually occur in complex mixtures that differ among plant organs and stages of development. Knowledge of the phytochemical constituents is very essential to enable investigation of the actual effectiveness of the plant in medicine. Argemone Mexicana is known to possess a wide range of phytochemical constituents which are mentioned below. Table gives the details of the phytochemical constituents that have been reported from different parts of Argemone Mexicana. Argemone *mexicana* is reported to posses alkaloids, amino acids, phenolics, and fatty acids *as major phytochemical groups. A series of bioactive compounds have been reported and some of them are isolated from different parts of Argemone Mexicana The whole plant of Argemone mexicana was* reported to posses isoquinoline alkaloids such as berberine, cheilanthifoline, coptisine, muramine, scoulerine, stylopine, cryptopine, thalifone, sanguinarine, protopine, optisine, chelerytherine and benzylisoquinoline alkaloids. Alkaloids such as berberine, tetrahydroberberine, protopine and Benzophenanthridines have been isolated from the plant . Seed oil otherwise called as Argemone Mexicana oil reported to contain sanguinarine

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and dihydrosanguinarine. It also contains palmitic, myristic, oleic and linoleic acids [35]. Some of the structures of isolated compounds of this plant are shown in **Figure 2 & 3.**

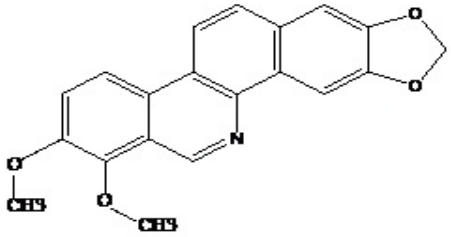

Figure 2: Structure of Norchelerythrine

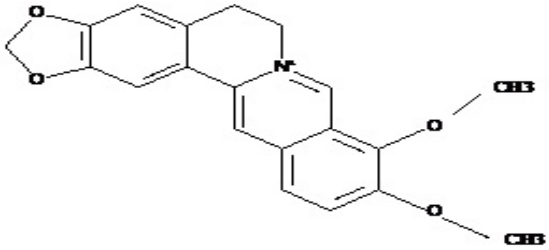

Figure 3: Structure of Berberine

IV. BIOLOGICAL ACTIVITY

Reports on the biological activities are many. The alkaloid Sanguinarine has been reported to prolong ventricular refractoriness and this property may be useful in treatment of ventricular arrhythmias. Plants are known to produce a variety of compounds which have evolved as defence compounds against microbes and herbivores. The elaboration on the biochemically active ingredients and the medicinal properties of Argemone Mexicana elicits queries on the effect of plant extracts on other biological organisms. Argemone Mexicana shown promise as an effective bio-control agent. The extracts of Argemone Mexicana possess inhibitory, deterrent or lethal activity on biological agents that cause disease and damage to other organisms. Table 3 summarises the effect of Argemone Mexicana on different pathogens and pests.

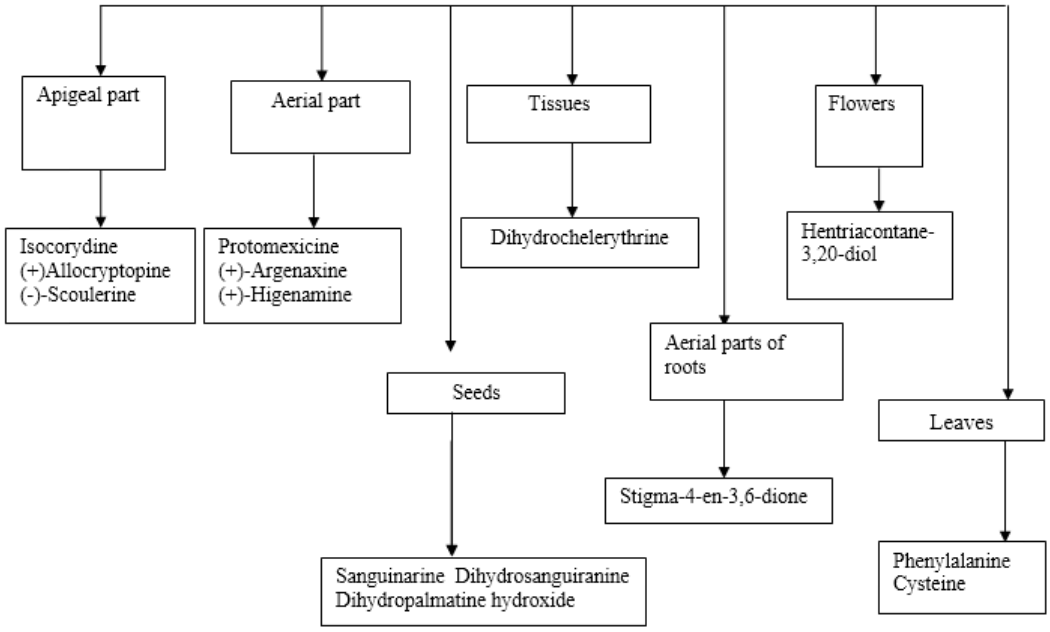

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Table 3: Activity of Argemone *Mexicana* extracts on biological pathogens and pests.

Activity	Action against
Anti-fertility	Spermatogenesis in dogs
Anticancer	Human cancer cell lines such as HeLa-B75 (48%), HL-60(20.15%) and PN-15 (58.11%), HeLa and MCF-7 Cancer cell lines
Anti-termitic	Formosan subterranean termite pest,*Coptotermes Formosanus* Shiraki
Wound healing	Animals, albino rats, Wistar albino rats
Larvicidal	2nd instar larvae of *Aedesaegypti,*
Analgesic, Locomotor	Wistar albino mice

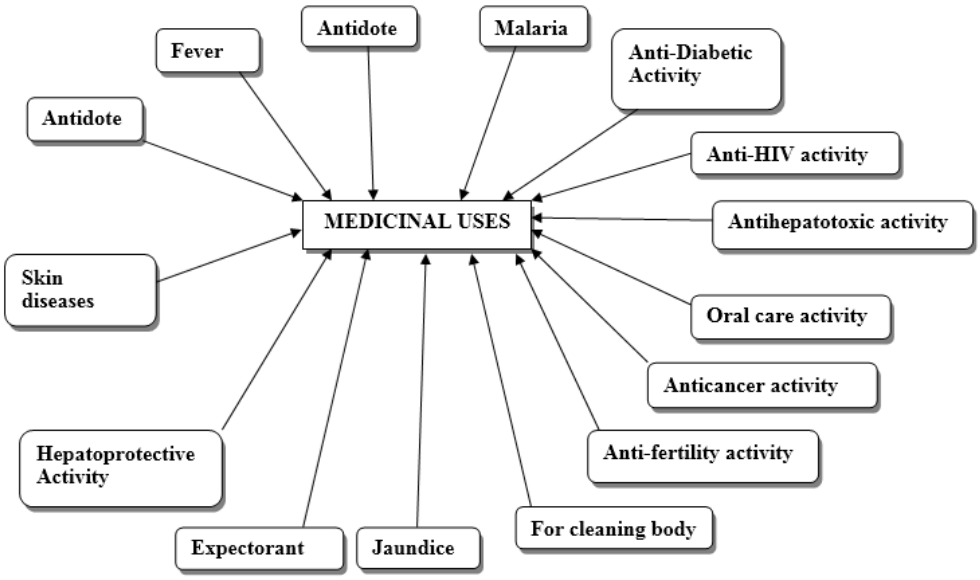

Figure 4: Medicinal Uses of Argemone Mexicana

V. MEDICINAL USES

- **Fever:** Roots of Argemone Mexicana are ground with *Piper nigrum.* The latex is useful in malarial fever One spoonful of the obtained extract is given twice a day for 5 days
- **Scabies:** Seeds are roasted on hot iron pan to get ash. Applied regurally till the cured
- **Skin diseases:** Along with the pouded seeds of Argemone Mexicana the pate prepared and applied on skin .The oil is useful for the skin diseases.The fresh yellow, extract also used for the skin diseases. The whole plant parts used in the skin diseases.
- **Antidote:** The fresh yellow, milky seed extract contains protein-dissolving substances effective in the treatment of antidote to various poisons. Paste of 20 g root of Argemone Mexicana along with 20 g petiole of *Maharukh* (*Ailanthus excels* Roxb.) is applied on the snake bite area as an antidote
- **Expectorant:** They are expectorant and can be used in the treatment of coughs and other chest complaints. The alkaloid fractions of the root are reported to possess anti-inflammatory activity and strong uterine stimulant effect.
- **Tooth ache and gastric problems :** Extract applied into the tooth activity Extract uncooked with the river water and black pepper taken as a orally
- **Wound:** The fresh seed can be used for the wound healing problems. Yellow coloured latex extracted from fresh stem of Argemone Mexicana is used to cure wounds

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- **Jaundice:** Plant juice of Argemone Mexicana is used orally.2-3 spoons daily for one week is used to cure jaundice. Tea from dried leaves is used to quit smoking and drug abuse
- **For curing injuries and to kill worms:** Argemone Mexicana (Papaveraceae) Sathyanashi. 1.Oil is extracted from seeds of Argemone mexicana. It is applied on injuries. 2. Seeds of Argemone Mexicana are burnt and the fumes are passed on gums to kill worms.
- **For cleaning body:** The series of sonera mexicouse the entire plant both fresh and dried. An infusion is made to relieve kidney pain, to help expel a torn placenta, and in general to help cleanse the body after parturition
- **Malaria:** An Argemone mexicana tea is used by traditional healers in Mali to treat maleria. The whole plant is used to make a tea and as much tea as possible is drunk until symptoms disappear This use has been studied clinically for the treatment of uncomplicated malaria.
- **Anti-fertility activity**: seeds of Argemone Mexicana were evaluated tohave inhibitory activity against spermatogenesis in dogsat the stage XII of late spermatids on administration.
- **Cytotoxic Activity:** line. At a dose of 200 µg/mL, protomexicine and 13-oxoprotopine exhibited mild cytotoxicity (~24–28%) whereas dehydrocorydalmine showed moderate cytotoxicity (~48%). 8-Oxyberberine was mildly cytotoxic (~27%) at 24 h but was more potent (~76%) at 48 h. Jatrorrhizine and 8-methoxydihydrosanguinarine were most potent (~95– 100%) in inhibiting the human colon cancer cell proliferation showing complete reduction in cell viability.
- **Antimicrobial Activity**: Pharmaceutical and toxicological studies of the root essential oils can be done in future to identify its pure compound and elucidate the components responsible for these antimicrobial activities.
- **Anti-Diabetic Activity:** Aqueous extract of aerial parts of Argemone mexicana at a dose of 200 and 400 mg/kg body weight was reported to have hypoglycemic efficacy in alloxan induced diabetic rats; significant reduction in blood glucose levels, plasma urea, creatinine, triacylglyceride, cholesterol values and recovery in body weight compared to diabetic control rats and the standard drug treated rats are found when treated with the aqueous extract at a dose of 400 mg/kg body weight
- **Anti-HIV activity:** Thebenzo [*c*] phenanthridine alkaloid, (±)-6-acetonyl dihydrochelerythrine isolated from the methanolic extract of air-dried whole plants of Argemone mexicana was found to exhibit potent anti-HIV activity
- **Anticancer Activity:** The ethanol extract of *Argemone Mexicana* was reported to exhibit inhibitory activity against human cancer cell lines such as HeLa-B75 (48%), HL-60 (20.15%) and PN-15 (58.11%) (Gacche et al., 2011)
- **Antihepatotoxic activity:** Das et al. (2009) showed promising antihepatotoxic activity of aqueous extract of *A. Mexican a*stem in carbon tetrachloride-induced hepatotoxic male Albino Wistar rats in oral administration
- **Neuropharmacological Activity**: Reported on neuropharmacological applications of Argemone Mexicana. According to that, in *Wistar albino* mice at an oral dosage of 100, 200 and 400 mg/kg b.w, the ethyl acetate and methanol extract of the whole plant of Argemone Mexicana exhibited analgesic, loco motor and muscle relaxant activity. Both extracts exhibited significant activities but methanol extract at a dosage of 200 mg/kg body weight was found to be more potent for central nervous system activities such as analgesic, anxiolytic and sedative effects.
- **Oral care activity**: whole plant of Argemone mexicana is used for common dental disorders.
- **Hepatoprotective Activity:** Showed very insignificant changes instead of producing toxicity compared to normal group. That is percent of increase of SGPT and SGOT for Argemone Mexicana were 79.77% and 4.4% respectively

VI. ADULTERATION

Consumption of adulterated mustard oil (*Brassica nigra*) with argemone oil (Argemone mexicana) even for a short duration leads to epidemic dropsy. In humans, adulteration of mustard oil with Argemone oil causes oxidative stress and death of red blood cells via met-hemoglobin formation by altering pyridine nucleotide(s) and glutathione redox potential. Argemone oil contamination poses a serious threat to human health

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VII. POISONING

Sanguinarine and dihydrosanguinarine, the interconvertible alkaloids, are the toxic etiological agents of argemone oil. The electrophilic nature of iminium group in sanguinarine is responsible for binding to DNA by interaction with GC rich regions. argemone oil and isolated sanguinarine alkaloid cause DNA damage in liver, bone marrow, and blood cells.
Argemone Mexicana oil contamination poses a serious threat to human health.
Suspected cases of epidemic dropsy have been investigated by Dr. R.E. Meaker in the North-western Cape districts. In all aspects the disease resembled Indian epidemic dropsy. In experiments conducted upon fowls with the seed of the Mexican poppy collected from the lands on which the wheat eaten by the victims was grown, symptoms and histological lesions similar to those seen in human epidemic were produced. With the information at our disposal we can come to no conclusion other than that the said outbreak in the Carnarvon district was epidemic dropsy caused by the consumption of wheat contaminated with the seed of the Mexican poppy.

VIII. CONCLUSION

The broad survey of literature reviewed that Argemone Mexicana has some significant medicinal activity but also cause significant toxicity. Few isolated novel chemical constituent shows anti-HIV properties also. Further evaluation need to be carried out on Argemone mexicana in order to explore masked areas, which can be used for the wellbeing of the manhood. There is a possibility to identify new compound and check claimed pharmacological activity by eliminating toxic effect.

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REFERENCES

[1]. Kamboj VP. Herbal medicine. J. Cur. Sci. 2000; 78(1):35-9.
[2]. chopra RN, Nayer SL,Chopra IC, Asolkar LV, Kakkar KK, Glossary of Indian Medicinal Plants. Council of Scientific and Industrial Research; New Delhi, India: 1986. Including the Supplement.
[3]. Sakthivadivel M and Thilagavathy D Larvicidal and chemosterilant activity of the acetone fraction of petroleum ether extract from Argemone Mexicana seed Journal of Biores Tech 2003;89(2):213-216.
[4]. Merlin L Willcox, Bertrand Graz, Jacques Falquet, Oumar Sidibe, Mathieu Forster, Drissa Diallo et al Argemone Mexicana decoction for the treatment of uncomplicated falciparum malaria Journal of Trans R Soc. Trop Medicinal Hygine 2007;101(12):1190-8.
[5]. Bertrand Graz, Merlin L, Willcox, Chiaka Diakite, Jacques Falquet, Florent Dackuo, OumarSidibe, SergioGiani, Drissa Diallo. et al Argemone Mexicana decoction versus artesunateamodiaquine for the management of malaria in Malipolicy and public-health implications. Journal of Trans R. Soc. Trop Medicinal Hygine 2010;104(1):33-41.
[6]. Siddiqui IA, Shaukat SS, Khan GH and Zaki MJ Evaluation of Argemone mexicana for control of root-infecting fungi in potato. Journal of Phytopathology 2002; 150:321-329
[7]. Katewa BL, Chaudary and Jain A Folk herbal medicines from tribal area of Rajasthan, India. Journal of Ethnopharmacology 2004; 92:41-46.
[8]. Chopra RN, Nayar SL, Chopra IC Glossary of Indian medicinal plants. New Delhi: NISCOM, CSIR;1956. 23.
[9]. Muhammad Zafar, Mir Ajab Khan, Mushtaq Ahmad, Shazia Sultana, Rahmatullah Qureshi, Rasool Bakhsh Tareen.et al Authentication of misidentified crude herbal drugs marketed in Pakistan. Journal of Medicinal Plants Research 2010; 4(15):1584-1593.
[10]. Banerji A, Chadha MS and Malshet VG. Isolation of 5-hydroxy-3,6,7,3',4'-pentamethoxyflavone from

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 5, June 2022
Impact Factor: 6.252

Vitexnegundo. Journal of Phytochemistry 1969;8:511-2.

[11]. Hussain SF, Nakkady S, Khan L and Shamma M Oxyhydrastinine, an isoquinoline alkaloid from the Papaveraceae. Journal of Phytochemistry 1983; 22: 319 – 320.

[12]. Nakkady S and Shamma M Studies on the chemical constituents of Argemone mexicana. Egypt Journal of Pharmaceutical Sciences 1988; 29: 53 – 61.

[13]. Dinda B and Bandyopadhyay MJ Free amino acids of Argemone mexicana. Journal of Indian Chemical Society 1986; 63: 934 – 936.

[14]. Harborne JB and Williams CA Flavonoids in the seeds of Argemone mexicana A reappraisal. Journal of Phytochemistry 1983; 22: 1520 – 1521.

[15]. Gunstone FD, Holliday JA. and Scrimgeour CM. The long-chain oxo acids (argemonic acids) in Argemone mexicana seed oil. Chemistry and Physics of Lipids 1977; 4: 331 – 335.

[16]. Israilov IA and Yunusov MS. Alkaloids of four species of Argemone. Chemistry of Natural compounds 1986; 22:189-192.

[17]. Santos AC and Adkilen P. The alkaloids of Argemone mexicana. Journal of the American Chemical Society 1932; 54: 2923.

[18]. Yu B T and Muraveva DA. Isolation and determination of the alkaloids of Argemone mexicana grown in different geographic regions. Rast Resur 1973; 9:200]

[19]. Haisova K Y and Savik J. On the minor alkaloids from Argemone mexicana. Collection of Czechoslovak Chemical Communications 1975; 40:1576.

[20]. Chang YC, Chang FR, Ashraf TK, Hsieh PW and Wu YC. Cytotoxic Benzophenanthridine and Benzylisoquinoline Alkaloids from Argemone Mexicana. Z. Naturforsch 2003; 58: 521 – 526.

[21]. Israilov IA, Yuhusov MS. Alkaloids of four Argemone species. J Khim Prir Soedin1986;2:204-06.

[22]. Chang YC, Hsieh PW, Chang FR, Wu RR, Liaw CC, Lee KH, Wu YC. et al. Two new protopines argemexicaines A and B and the anti-HIV alkaloid 6-acetonyl dihydrochelerythrine from formasan Argemone mexicana. Journal of Planta Med 2003b;69:148-52.

[23]. Chang YC, Chang FR, Khalil AT, Hsieh PW, Wu YC. Cytotoxic benzophenanthridine and benzylisoquinoline alkaloids from Argemone mexicana. J Z Naturforsch 58c. 2003a;521-26.

[24]. Singh S, Pandey VB, Singh TD. Alkaloids and flavonoids of Argemone mexicana. Journal of Nat Prod Res 2012;26:16-21.

[25]. Haisova K, Slavik J. On the minor alkaloids from Argemone mexicana. Journal Collect Czech Chem Commun 1975;40:1576-78.

[26]. Ito C, Furukawa H. Antifertility studies of isoquinoline alkaloids with special emphasis of structure activity relationship. Journal of Fitoterapia 1990;61:67-71.

[27]. Sukumar D, Nambi RA, Sulochana N. Studies on the leaves of Agremone mexicana. Journal of Fitoterapia 1984;55:325-53.

[28]. Gupta RS, Dixit VP, Dobhal MP. Antifertility studies of isoquioline alkaloids with special emphasis on structure activity relationship. Journal of Fitoterapia 1990;61(1):67-71.

[29]. Gacche RN, Shaikh RU, Pund MM. In vitro evaluation of anticancer and antimicrobial activity of selected medicinal plants from Ayurveda. Asian Journal of Traditioinal Medicines 2011;6:127-33.

[30]. Gali K, Ramakrishnan G, Kothai R, Jaykar B. In vitro anti-cancer activity of methanolic extract of leaves of Argemone mexicana. Int Journal of Pharm Tech Res 2011;3:1329-33.

[31]. Elango G, Abdul Rahuman A, Kamaraj C, Bagavan A, Abduz Zahir A, Santhoshkumar T, Marimuthu S, Velayutham K, Jayaseelan C, Vishnu Kirthi A, Rajakumar G. et al Efficacy of medicinal plant extracts against Formosan subterranean termite, Coptotermes formosanus. Journal of India Crop Prod 2012;36:524-30.

[32]. Dash GK and Murthy PN. Evaluation of Argemone mexicana leaves for wound healing activity. journal of Nat Prod Plant Resour 2011;1(1):46-56.

[33]. Sakthivadivel M and Thilagavathy D. Larvicidal and chemosterilant activity of the acetone fraction of petroleum ether extract from Argemone mexicana seed. Journal of Biores Tech 2003;89(2):213-6.

[34]. Amartha S, Chaudhari S. Neuropharmacological study of Argemone mexicana. Journal of App Pharm. Sci.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 5, June 2022
Impact Factor: 6.252

2011;1:121-26.

[35]. Prayaga Murty Pragada Agricultural weeds as medicinal plants of Kadapa district, A.P., India. Asian Journal of Pharmaceutical Science & Technology. 2015; 5 (3):202-209.

[36]. Patil PS, Dushing YA and Patil DA Observations on plantlore in Buldhana District of Maharashtra. Ancient Science of life July, August, September-2007; XXVII (I): 43-49.

[37]. Dnyaneshwar P Ghorband and Sharad D Biradar. Traditional medicines knowledge in Dh armabad taluka of Nanded district Maharashtra, India. Indian Journal of Natural Products and Resources 2011; 2(4):498-503.

[38]. Dinesh K Dahare & Aruna Jain. Ethano botanical studies on plant resources of Tahsil Multai, District Betul, Madhya Pradesh, India Ethno botanical Leaflets 2010; (14): 694-705.

[39]. Vashishta BD & Mandeep Kaur. Floristic and ethno botanical survey of Ambala district, Haryana. International Journal of Pharma and Bio Sciences. 2013; 4(2): 353 – 360.

[40]. Felger, RS. ; Moser, MB (1985) People of the Desert and Sea. Tucson, AZ: University of Arizona Press

[41]. Willcox ML , Graz B ; Falquet J (2007). "Argemone mexicana Decoction for the Treatment of Uncomplicated Falciparum Malaria". Transactions of the Royal Society of Tropical Medicine and Hygiene. 101 (12): 11901198. doi:10.1016/j.trstmh.2007.05.017. PMID 17920092

[42]. Merlin L Willco, Bertrand Graz, Jacques Falquet, Chiaka Diakite , Sergio Giani, Drissa Diallo (2011) et al . "A "reverse pharmacology" approach for developing an anti-malarial phytomedicine". MalariaJournal. 10 (Suppl.1)S8. doi:10.1186/1475-2875-10-S1 S8. PMC 3059466. PMID 21411019.