

INVESTIGATION OF PHARMACOLOGICAL ACTIVITIES OF SEED EXTRACTS OF ARGEMONE MEXICANA

Submitted in partial fulfillment of the requirements for the award of

Master of Technology degree in Medical Instrumentation

By

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DEPARTMENT OF BIOMEDICAL ENGINEERING

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of **Wajiha Safeen. C** (Reg. No. **41440014**) who carried out the project entitled "**Investigation of Pharmacological activities of seed extract of Argemone Mexicana**" under my supervision from **November 2022 to May 2023**.

Internal Guide

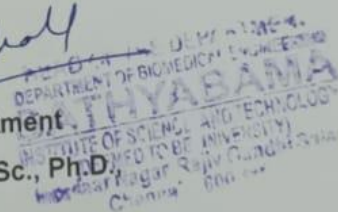
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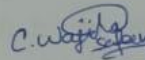
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DECLARATION

I, **Wajiha Safeen. C** (Reg. No. **41440014**) hereby declare that the project report entitled "**Investigation of pharmacological activities of seed extract of Argemone Mexicana**" done by me under the guidance of Ms. **A. Sabarivani** M.Tech, (Ph.D.), (Internal), **Dr. D. Saravanan**, M.Sc., M.Phil., Ph.D., (External), Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

DATE: 05/05/23

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SIGNATURE OF THE CANDIDATE

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ABSTRACT

Medicinal plants have been used as a source of medicine to alleviate diseases. *Argemone mexicana* (Papaveraceae) is commonly known as a prickly poppy. Found in Mexico now has been widely naturalized in the United States, India, Bangladesh, and Ethiopia. It is a valuable medicinal plant and is considered to have miraculous therapeutic potential. It is used to cure several diseases in the Indian traditional medicine system of Ayurveda for over 5000 years. The plant is known as both a toxic and medicinal herb. Numerous alkaloids, steroids, flavonoids, and amino acids have been isolated from this herb. The study is to investigate the pharmacological activities of seed extracts of *Argemone mexicana*. Antioxidant activity is to be carried out by DPPH radical scavenging method. Antibacterial activity is to be tested by the good diffusion method. Anticancer activity is to be evaluated by the MTT assay method.

Keywords: *Argemone mexicana*, Papaveraceae, prickly poppy, DPPH, MTT Assay.

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LIST OF ABBREVIATIONS

A.M	- Argemone Mexicana
ABTS	- 2,2'-azino-bis(3-ethylbenzothiazonline-6-sulfonic acid)
ALAT	- Alanine aminotransferase
ALP	- Alkaline phosphate
ASIR	- Age-standardized incidence rates
ASIR	- Age- Specific Incidence Rate
ATCE	- American type culture collection
BC	- Breast cancer
BHGI	- Breast health global initiative
CK	- Cytokeratin
DALYs	- Disability-adjusted life years
DBIL	- Direct bilirubin
DMEM	- Dulbecco's Modified Eagle Medium
DMSO	- Dimethyl Sulfoxide
DPPH	- 1,1-diphenyl 2-picryl hydrazyl
DTC	- Disseminated Tumour Cell
EGFR	- Epidermal Growth Factor Receptor
EMR	- Electro Magnetic Radiation
ER	- Estrogen Receptor
FBS	- Fetal Bovine Serum
FTIR	- Fourier transform infrared spectroscopy
GC	- Gas Chromatography
GLOBOCAN	- Global Cancer Observatory

HDI	- Human development index
HER2	- Human Epidermal Growth Factor Receptor 2
HPLC	- High performance Liquid Chromatography
IC50	- Inhibitory Concentration
mTOR	- mammalian Target of Rapamycin
MTT	- (3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide
NCCS	- National Centre for Cell Science
NLC	- Nanostructured lipid carriers
PARP	- Poly (ADP-Ribose) Polymerases
PBS	- Phosphate-Buffer Saline
PC	- Paper Chromatography
PR	- Progesterone receptor
SLN	- Solid-lipid nanoparticles
TBIL	- Total bilirubin
TLC	- Thin Layer Chromatography
TNBC	- Triple negative breast cancer
UV	- Ultra-violet visible spectroscopy
VEGF	- Vascular Endothelial Growth Factor
WHO	- World health organization

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CHAPTER 1

INTRODUCTION

Every year, there are alarmingly more fatalities from cancer, making it one of the leading causes of mortality globally. Although while a sizable portion of cancers may not necessarily result in death, they considerably reduce quality of life and generally come with higher costs.

According to the GLOBOCAN 2020 data, there are presently an estimated 2.3 million new instances of breast cancer worldwide, making it one of the most frequently diagnosed malignancies and the fifth leading cause of cancer-related deaths. When compared to transitioned nations (Australia/New Zealand, Western Europe, Northern America, and Northern Europe), deaths from breast cancer are more frequently reported (incidence rate is about 88% higher) in Melanesia, Western Africa, Micronesia/Polynesia, and the Caribbean. A number of processes. Regarding a potential reduction in the incidence rate of breast cancer and the adoption of early treatment, measures like preventative behaviours generally as well as screening programmes are significant. The Breast Health Global Initiative (BHGI) is currently in charge of creating appropriate guidelines and strategies to offer the most effective breast cancer control globally.

1.1 CANCER IN WOMEN - EPIDEMIOLOGY

The WHO estimates that 107.8 million Disability-Adjusted Life Years (DALYs) are associated with malignant neoplasms, of which 19.6 million are associated with breast cancer. 2.26 million [95% CI, 2.24-2.79 million] new cases of breast cancer will be detected in women worldwide in 2020. In the US, breast cancer will likely represent 29% of all new cases of cancer in females. Age-standardized incidence rates (ASIR) of breast cancer are highly and favourably correlated with the Human Development Index (HDI), according to the 2018 GLOBOCAN data. The ASIR was highest in countries with very high HDIs (75.6 per 100,000), according to data from 2020, and it was higher than Low HDI countries (27.8 per 100,000 and 36.1 per 100,000, respectively) have a 200% lower rate.

In addition to being the most prevalent, breast cancer also kills more women from cancer than any other type. Breast cancer caused 684,996 deaths worldwide [95% UI, 675,493-694,633] at a rate of 13.6/100,000 when adjusted for age. Although industrialised regions had the greatest incidence rates, 63% of all deaths worldwide occurred in Asia and Africa in 2020. In high-income nations, the majority of breast cancer patients survive; however, this is not the case for many women in low- and middle-income nations.

As a representative measure of 5-year survival rates, the mortality-to-incidence ratio (MIR) for breast cancer in 2020 was 0.30 globally. Considering into account Clinically advanced breast cancer had a 5-year survival rate of 89.6% for localised cancer and 75.4% for regional cancer in countries with developed healthcare systems (Hong Kong, Singapore, Turkey). The survival rates for localised and regional breast cancer in less developed nations (Costa Rica, India, Philippines, Saudi Arabia, Thailand) were 76.3% and 47.4%, respectively.

Over 2000 years have passed since the beginning of the Indian system of natural medicine known as Ayurveda. It is universally acknowledged that traditional medicines made from plant sources are a gift from God to humans. Herbal medicine has been used in practice to treat or prevent a variety of Diseases have existed for centuries. Natural phytochemicals that are abundant in medicinal plants have been intensively explored in recent years for their vital therapeutic relevance in the treatment of life-threatening diseases. Nature has provided a complete store house of remedies to use for mankind. screening of medicinal herb has become a potential source of biodynamic compounds of therapeutic value. Only a small percentage of the extant species of higher plants have been studied, despite the fact that the plant kingdom is a veritable gold mine of biologically active substances. Various diseases have been effectively treated using a variety of plants.

1.2 ARGEMONE MEXICANA

A. mexicana, also referred to as the Mexican poppy or Mexican prickly poppy, is a type of poppy that was once only found in Mexico but is now also present in the United States, India, and Ethiopia. The plant is a weed in abandoned areas and has a

pantropical distribution. It originated in America and has spread naturally throughout India. Despite being poisonous, some regions of Mexico have utilized it medicinally. It contains the alkaloid sanguinarine, which is thought to be the cause of pandemic dropsy. According to reports, *A. mexicana* has larvicidal and chemosterilant activity, the ability to heal rat wounds, nematocide and allelopathic potential, as well as antimicrobial activity. The aerial portion of the plant is used as a hypoglycemic infusion in Mexico. Natural healers have utilised *A. mexicana* in traditional medicine for hundreds of years, and information about its pharmacological potential has been passed down from generation to generation. These conventional medications, which can be found in powder, paste, latex, oil, or extract form, are popular since they are thought to be effective with few to no side effects.

1.3 SCIENTIFIC CLASSIFICATION

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida Dicotyledons
- Subclass: Magnoliidae
- Order: Papaverales
- Family: Papavaraceae
- Genus: *Argemone*
- Species: *A. mexicana*.

The leaf of *A. mexicana* has medicinal use. To treat diabetes, leaves and black pepper are combined. Ulcers and malarial fever are treated with leaf decoction. According to reports, leaves and seeds can help keep blood pressure and cholesterol levels in check in humans. These plant parts also have anti-venom properties. There have been claims that leaf aqueous extract has anti-inflammatory properties. In addition to being used in baths to relieve muscular pain, a decoction made from the leaves is consumed to cure stomachaches. The leaves can treat a variety of conditions, including cough, wounds, ulcers, warts, cold sores, cutaneous affections, skin conditions, itches, and more.

The value of *A. mexicana* root in medicine. The root is used as an alternative medicine and to treat chronic skin conditions. Roots have anthelmintic properties and are also used for inflammations, leprosy, and skin conditions. It functions as an antioxidant, antifungal, antibacterial, and cytotoxic agent. They can be used to treat coughs and other chest symptoms since they are expectorants.

The value of *A. mexicana* seed in medicine: The purgative properties of the seed oil are used to treat skin conditions. The seeds have been employed in Mexico as a remedy for snake poisoning. The seeds' smoke is used to treat toothaches in India. The fresh yellow, milky seed extract includes protein-dissolving compounds that are helpful as a diuretic, anti-inflammatory, treatment for leprosy, warts, cold sores, wound healing, skin illnesses, itches, and jaundice. They are also an antidote to different toxins.

The complete plant of *A. mexicana* has medicinal use. Purgative and diuretic properties of the entire *A. mexicana* plant make it beneficial against guineaworm infestations. This herb is frequently used to treat leucorrhea, scorpion bites, photophobia, and venereal sores. Dental conditions are treated using the entire plant. Traditional medicine makes extensive use of the entire plant, including the roots, leaves, stem, and flowers, to treat conditions like leprosy, malaria, jaundice, rheumatism, pain, inflammation, skin disorders, fever, piles, warts, dysentery, tumours, and worm infestations. The plant has diuretic, purgative, and worm-destroying properties. It is also useful for mending wounds. The plant has calming, antispasmodic, psychedelic, and analgesic properties. Blood is enriched by *A. mexicana*, which has expectorant and aphrodisiac properties. Additionally, leucoderma and skin conditions are treated with it.

1.4 MEDICAL SYSTEM AND MEDICINAL USES

1.4.1 Unani

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.

1.4.2 Ayurveda

In India, ayurveda, or herbal medicine, has long been used as one of the primary methods of treating a wide range of illnesses. According to Ayurvedic and other traditional medical systems, some 1250 medicinal plants are used in India to create therapeutic remedies. *A. mexicana* is well known for having medicinal properties that can be used to cure a variety of illnesses. In India, a decoction of the leaves is recommended for the treatment of bacterial infections, and the seeds have purgative and sedative properties.

1.4.3 Homoeopathy

In homoeopathy, whooping cough and bronchitis are reportedly treated orally using the tincture of the entire plant. Both the latex and the fresh juice from the leaves are reportedly applied externally to treat cuts and open wounds. With whooping cough, this plant's tincture has a calming, relaxing, and antispasmodic effect.

1.5 DESCRIPTION OF PLANT

Argemone mexicana is an annual herb that can reach a height of 150 cm and is a member of the Papaveraceae family. It has a tap root that is slightly branched. Its branching, typically highly thorny stem. When chopped, it releases a yellow liquid. It blooms in a brilliant yellow colour. The leaves are alternating, thistle-like, without leaf stems (petioles), serrated (toothed), and have prickly borders. In contrast to the upper leaf surface's bluish-green hue, the grey-white veins pop. The cross-section of the stem is oblong. Flowers are terminal (at the terminals of the branches), solitary, yellow, and 2.5– 5 cm in diameter. Fruit is an ovoid or oblong (ovoid) prickly capsule. There are many seeds that are practically spherical, brownish black, coated in a delicate network of veins, and measure around 1 mm in diameter.



Fig.1.1: *Argemone mexicana*

1.6 EXTRACTION

The first and most important step in producing high-quality research results is the preparation of medicinal plants for experimentation. It entails extraction, quality assessment, and before moving further with the proposed biological testing, the quantity of bioactive substances.

Fruits and vegetables include a variety of antioxidant substances, such as phenolics, carotenoids, anthocyanins, and tocopherols. The utilisation of 20% or more of all known plants in pharmaceutical research has had a favourable impact on the healthcare system, including the treatment of hazardous disorders like cancer. It is possible to prepare medicinal plants for experimentation or to extract and process them for use directly as herbal or conventional medicine. The idea of preparing a medicinal plant for experimental purposes entails the timely and appropriate gathering of the plant, professional authentication, sufficient grinding and drying. When necessary, the bioactive ingredient is then extracted, fractionated, and isolated. It also includes figuring out how much and what kind of bioactive chemicals are present. If a drug has many adverse effects or is resistant to therapy, herbal medicine may be an effective alternative. Several different bioactive chemicals can be produced by plants. Fruits and vegetables contain significant amounts of phytochemicals, which may offer protection against free radical damage. Beneficial phytochemical-rich plants may provide as a natural antioxidant supplement to the body's requirements. Many studies have demonstrated the abundance of antioxidants in numerous plants. For instance, plant-based phenolic substances including flavonoids, tannins, and lignins, as well as

vitamins A, C, and E all work isoantibodies. Several phenolics, ascorbic acid, and beta carotene all play vital roles in slowing down the ageing process and lowering reducing inflammation and avoiding some malignancies. The process of extracting medicinal plants involves separating active plant components or secondary metabolites including alkaloids, flavonoids, terpenes, saponins, steroids, and glycosides from inert or inactive components using the right solvent and accepted extraction techniques. Plant products with high levels of phenolic and flavonoid chemicals have been shown to have antioxidant characteristics and are therefore utilised to treat age-related illnesses like Alzheimer's disease, Parkinsonism, anxiety, and depression. Several techniques were employed to extract therapeutic herbs, including maceration, infusion, decoction, percolation, digestion, and superficial extraction methods including Soxhlet, ultrasound, and microwave. The secondary metabolites were also separated from one another and purified using thin layer chromatography (TLC), high-performance liquid chromatography (HPLC), paper chromatography (PC), and gas chromatography (GC). The type of plant material, the solvent being used, its pH, the temperature, and the solvent to sample ratio all play a role in selecting the best extraction technique. It also relies on how the finished items are going to be used.

1.7 CHARACTERIZATION

1.7.1 Ultraviolet -visible spectroscopy

The term used for the analytical assessment of various types of solvents and compounds is ultraviolet-visible spectroscopy. For the past 37 years, uv-visible spectroscopy has been used extensively. Spectroscopy is typically chosen, particularly by small-scale enterprises, because the equipment is less expensive and requires less maintenance.

1.7.2 Spectroscopy

The study of electromagnetic radiation (EMR) absorbed and released when molecules, atoms, or ions in a sample transition from one energy state to another is known as spectroscopy.

Based on the Beer-Lambert equation, which states that a solution's absorbance

is directly proportional to its wavelength of ultraviolet and visible light, ultraviolet-visible spectroscopy utilises light in the visible, ultraviolet, and near infrared ranges. Levels, only light with a precise quantity of energy that can cause transitions from one Level to another will be absorbed since the energy levels of matter are quantized. The use of UV-vis spectroscopy. There are numerous uses for ultraviolet-visible spectroscopy, Impurities' reflection, the structural elucidation of organic compounds, quantitative and qualitative examination of medicinal drugs, the dissociation of acid and base constants, the determination of molecular weight, Derivations from the Beer-Lambert law as an HPLC detector. Because of its accessibility, ease of use, versatility, and broad applicability in a variety of fields, including analytical chemistry and biochemistry, the UV-visible analytical approach has grown significantly in importance and acceptance throughout the world's scientific communities. To create analytical methods, it is currently important to reduce the number of samples and reagents. Hence, a UV-visible micro volume spectrometric apparatus has been created to analyse materials, particularly rare samples or hazardous liquids.

1.7.3 FTIR (*Fourier transform infrared spectroscopy*)

The identification of microorganisms has recently been proposed using an approach called FTIR (Fourier Transform infrared spectroscopy), which is based on optical spectroscopic methods. Microorganisms can be accurately identified at the species and sub-species levels using the very particular spectroscopic fingerprints that FTIR spectra reveal. This strategy is an analytical, most modern, non-destructive, and dynamic way to look at a population of cells with a small amount of biomass. On the vibrational stimulation of molecular bonds by infrared light energy absorption, FTIR spectroscopy is based (only the middle infrared section). An infrared absorption spectrum that resembles a molecular "fingerprint" for such biological material can be created by adding the vibrational spectra of a cell's macromolecules (nucleic acids, proteins, lipids, polysaccharides, etc.). Uses for this spectrum include applications for typing or identification using clustering. Fourier transform infrared (FTIR) spectroscopy is one of the promising approaches appropriate for regular examination, particularly when combined with some chemometrics methods.

The application of FTIR spectroscopy to food analysis has substantially increased. Its capabilities as a fingerprint technique, which can be applied to both qualitative and quantitative evaluations, are the cause of this. With the aid of FTIR spectroscopy, the distinction between porcine and bovine gelatine was successfully established.

1.8 PHYTOCHEMICAL ANALYSIS

We are aware of plants' significance. The plant kingdom is a treasure trove of potential medications, and the value of medicinal plants has gained attention in recent years. These plants' medicinal potential comes from a number of chemically active compounds that have a clear physiological effect on the human body. Alkaloids, tannin, flavonoid, and phenolic chemicals are the most significant of these bioactive plant components. The most obvious choice for looking at the current quest for therapeutically effective novel medications, such as anticancer drugs, antibacterial drugs, and antihepatotoxic chemicals, is the plants that have been selected for medical use over thousands of years. World Health Organization According to the World Health Organization (WHO), medicinal plants are the greatest place to get a variety of medications. Tannins, alkaloids, sugars, terpenoids, steroids, and flavonoids are only a few of the chemical components found in medicinal plants that have defined physiological effects on humans. It has been demonstrated that several phytochemicals from various chemical classes have inhibitory effects on all varieties of bacteria in vitro. Since the beginning of time, plant products have been used in phytomedicines. Barks, leaves, flowers, roots, fruits, and seeds can all be used to make this. The ability to synthesise complicated chemical substances will benefit from knowledge of the chemical components of plants.

1.9 CANCER CELL

The tumour regional or systemic spread is the primary determinant affecting the prognosis of patients with invasive cancer. Through an experimental strategy that combines the sorting of tumour cell subpopulations, identified on the basis of the different expression of surface markers, with functional transplantation into suitable

animal models, tumour-initiating cells have been discovered in blood, brain, and breast cancers. This discovery has important therapeutic ramifications since tumorigenic breast cancer cells may be highly invasive and metastasis-prone. Dontu and colleagues created a culture method in which cells from reduction mammoplasties were seeded in a non-adherent, non-differentiating culture environment by drawing a parallel with work on brain stem cells. As a result, creating long-term cultures of tumour-initiating cells would be a vital step that would give researchers a useful in vitro model to study these cells.

1.10 CELL LINE

Valuable cancer cell lines Systems for in vitro modelling that are frequently employed in cancer research and drug development. Its remarkable ability to offer an endless amount of biological material for research purposes is the main factor influencing their use. Cell lines offer a pure population of cells, a reliable sample, and repeatable outcomes. Cell lines have transformed scientific research and are now utilised in the manufacturing of vaccines, the cytotoxicity and metabolism testing of drugs, the production of antibiotics, the study of gene function, and the synthesis of biological chemicals. Consider therapeutic proteins A new cell line's formation is an extremely difficult process that is currently little understood. For every specimen of origin, the establishment's success rate is low and unpredictable. When you consider that the stability of a cell line begins with a sample of tumours that can develop quickly in vivo while evading all biological systems involved in the regulation of the cell cycle and cell death by apoptosis, the statement might sound counterintuitive. The number of publications that use cell lines and the American Type Culture Collection (ATCC) cell biology collection, which has over 3,600 cell lines from over 150 species, are good indicators of how popular cell lines are. Also, the process' effectiveness for in vitro continuous growth because creating new cell lines takes time and effort in and of itself, taking an additional year or two. Yet, because each cell line is derived from the disease that the patient has, this presents a chance to reveal pathological traits that would otherwise go undetected in traditional clinical diagnostic settings and are impossible to do in vivo. Recent studies confirmed the value of cell lines in medical research when 100 cell lines were characterised using omics technology (genomics, transcriptomics,

and proteomics). In fact, these statistics show that the majority of cancer cell lines currently in use comprehensive molecular and cellular modifications, including each cell line's gene and protein expression profiles, copy number variations, mutations, and gene expression patterns, have been published. In this method, properly authenticated cancer cell lines keep the majority of their origin's characteristics under the right circumstances and with the necessary controls and they develop into a useful model system for the advancement of medical research.

CHAPTER 2

LITERATURE SURVEY

Sharma et.al., (2010) Investigate 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

Patil et.al., (2001) reported Significant wound healing activity of petroleum ether and butanol fractions of ethanol extract of *A. mexicana*, containing some sterols, alkaloids, proteins and carbohydrates, in albino rat model

Murthy et.al., (2011) investigated wound healing activity using excision, incision and dead space wound models in Wistar albino rats with different extracts of *A. Mexicana* leaves. The results revealed that the treatment with methanol extract of leaves of *A. Mexicana* accelerated wound healing agent in rats.

Bhalke & Gosavi (2009) reported both the polar extracts (i.e. aqueous and methanolic) of *A. mexicana* stems were evaluated to exert antiallergic as well as antistress efficacy in asthma developed by milk-induced leucocytosis and milk induced eosinophilia at a dose of 50 mg/kg i.p. in albino mice model; both of the test extracts showed significant ($p < 0.05$) decrease in leucocytes and eosinophils in vivo.

Perumal et.al., (2010) reported that ethanol extract of *A. mexicana* roots possesses antioxidant activity; at a dose of 100 $\mu\text{g/mL}$ concentration, the extract showed high scavenging activity against DPPH (85.17%), ABTS (75.27%) and H_2O_2 (84.25%) radicals.

Bhardwaj et.al., (2011) also reported different extracts of *A. Mexicana* leaves to exhibit superoxide anion scavenging activity by Nitro blue tetrazolium assay with maximum percentage of free radical scavenging at a dosage of 200 $\mu\text{g/mL}$; acetone extract being the most active showing IC_{50} value double to that of L-ascorbic acid.

Gali et.al., (2011) also reported anticancer activity of methanolic extract of *A. Mexicana* leaves against HeLa and MCF-7 cancer cell lines with IC₅₀ values ranging from 1.35 to 1.2 µg/µL based on MTT assay results. The investigators also proved that the nature of this cytotoxic activity is apoptotic rather than necrosis and this activity may be due to the presence of flavonoid constituents in leaf.

Sourabie et.al., (2012) also investigated the anti-icterus activity of crude leaf powder of the plant against CCl₄-induced hepatotoxicity in Wistar rats; the investigators observed significant increase in the levels of ASAT/GOT (aspartate aminotransferase), ALAT/GPT (alanine aminotransferase) and ALP (alkaline phosphate) while decrease in total bilirubin (TBIL) and direct bilirubin (DBIL) level tested at different doses of 125, 250 and 500 mg/kg.

Xiaolin Fanga et.al.,(2020) explained that One of the most prevalent malignant tumours among women is breast cancer. Traditional breast cancer treatments work well, but they also have a number of drawbacks, such as limited bioavailability and considerable side effects. Effective tumour targeting, high bioavailability, fewer adverse effects, regulated medication release, and enhanced drug solubility are just a few benefits of nano-drug delivery systems. Recent years have seen a boom in research on the delivery of anti-breast cancer medications using nano-drug delivery systems. This article covers the state of current research on anti-breast cancer medications and the use of nano-drug delivery systems in breast cancer therapy by conducting a literature study and summarising pertinent works by authors inside and outside China. The review's objective is to offer new design ideas for nanocarriers that transport medications to treat breast cancer.

Vikas Jain, et.al.,(2020) explained that One of the most common malignancies in women, The most aggressive phenotype and increased metastasis in triple-negative breast cancer (TNBC), which lacks all three main receptors—the human epidermal growth factor receptor 2 (HER2), the progesterone receptor (PR), and the oestrogen receptor (ER)—lead to the emergence of treatment resistance. It has a number of

therapeutic benefits for the treatment of TNBC and BC. Some distinctive features of nanotechnology, include microscopic scale (nanometric), active and passive targeting, and the site-specific targeting, controlled release, and the capacity to connect several targeting moieties. The conventional medication therapy, current management techniques, and novel therapeutic modalities for BC and TNBC are the main topics of this review. Also, it has been made clear how breast cancer stem cells contribute to the recurrence of BC and TNBC. The treatment of BC/TNBC and breast cancer stem cells with a number of chemotherapeutic agents delivered using nanocarriers, such as polymeric nanoparticles/micelles, metallic/inorganic NPs, and lipid-based NPs (Liposome, solid-lipid nanoparticles (SLNs), and nanostructured lipid carriers (NLCs), etc., has received excellent results. Moreover, the use of nanomedicine, such as the CRISPR nanoparticle, exosomes for the therapy of BC/TNBC, and other molecular targets such poly (ADP-ribose) Further research on polymerase (PARP), vascular endothelial growth factor (VEGF), epidermal growth factor receptor (EGFR), etc. has also been discussed.

VarRuchi Sharma, et.al.,(2020) reported breast cancer is the leading global cause of mortality for women. Results from earlier detection and treatment of breast cancer have been positive. Many therapy alternatives have been made possible by contemporary genetic technology, however more people die when the disease is detected late in the process. Consequently, additional genomes and proteomics research in this field may produce novel biomarkers that improve the chances of survival for people with breast cancer. The signalling pathway for Akt, PI3K, and the mammalian target of rapamycin (mTOR) was found to be hyperactivated in the majority of breast carcinomas cause uncontrolled growth, proliferation, and tumour expansion. The advancement of nanotechnology has opened up a variety of intriguing pathways that can be used to target the PI3K/Akt/mTOR pathway in both pre-clinical and clinical settings. As a result, the current review provides an overview of the underlying mechanism, the significance of focusing on the PI3K/Akt/mTOR pathway, new biomarkers, and the utilisation of nanotechnological therapies in breast cancer.

Lina et.al.,(2017) explained about early detection and effective treatment of cancer sickness remain a significant problem in the twenty-first century, Cancer appears to be advancing fast with drug-resistant strains and recurrence rates despite the majority of resources, studies, and existing therapies. However, there is optimism for the future of oncology applications thanks to nanotechnologies. The US National Cancer Institute predicts that it will completely alter how people think about cancer treatment and diagnosis. Nanohybrid approach develops a wonderful preference with such success. Here in the realm of oncology, composites made of graphene and gold are receiving more attention due to their exceptional strength as delivery systems for therapeutic drugs, inherent optical diagnostic capabilities, and usefulness as theragnostic devices. Other treatment modalities, such as photothermal, photodynamic, and combination therapy, are also relevant. This review attempts to emphasise the key characteristics that made a system like this one a prospective ally in the fight against cancer while demonstrating the numerous cancer-related applications of graphene-gold based hybrids in terms of detection and therapy.

Richard Coe, et.al,(2018) reports disseminated tumour cells (DTC) are present in the bone marrow of breast cancer patients are a known independent prognostic factor. These cells' capacity for biological metastasis has not yet been demonstrated. Both primary tumours and distant metastases exhibit the presence of potential breast cancer stem cells. These cells, which have the phenotypic CD44+CD24/low and are related to self-renewal and tumorigenic potential, constitute a modest population in primary breast cancer. We examined the bone marrow DTC in order to assess the possible impact of the incidence of putative stem cells among DTC. They used the double/triple-staining immunohistochemistry method and added steps for new antigens, CD44 and/or CD24, to the existing bone marrow cytokeratin (CK) staining method. We examined 50 bone marrow samples from patients with early-stage breast cancer that had previously been designated as CK+. Spectral imaging, fluorescence microscopy, and light microscopy were used to assess the expression of CD44 and CD24 on CK+ cells. Results: In all CK+ specimens, we found the potential stem cell-like phenotype. Comparatively to primary tumours, where this characteristic is

described in 10% of cells, the mean prevalence of putative stem/progenitor cells was 72% and the median prevalence was 65% (range, 33-100%) among the overall DTC per patient. Conclusions: This is the first proof that the hypothesised stem-like trait exists in early breast cancer patients' bone marrow. Every patient among the DTC, and the majority of the DTC displayed a potential stem cell characteristic. It is necessary to characterise these cells' molecular makeup in the future.

Dario Ponti et.al., (2005) reports that Breast cancer–initiating cells have been recently identified in breast carcinoma as CD44+/CD24/low cells, which exclusively retain tumorigenic activity and display stem cell–like properties. However, at present, direct evidence that breast cancer– initiating cells that can be propagated in vitro is still lacking. We report here the isolation and in vitro propagation of breast cancer–initiating cells from three breast cancer lesions and from an established breast carcinoma cell line. Our breast carcinoma–derived cultures encompassed undifferentiated cells capable of self-renewal, extensive proliferation as clonal Differentiation along mammary epithelial lineages and non-adherent spherical clusters (ductal and myoepithelial). Intriguingly, when as few as 103 cultivated cells were introduced into the mammary fat pad of SCID animals, they overexpressed neo angiogenic and cytoprotective proteins, expressed the putative stem cell marker Oct-4, and produced new tumours. The development of treatment approaches aiming at eliminating the tumorigenic fraction within breast cancer can be studied using long-term cultures of breast tumorigenic cells with stem/progenitor cell features.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

- The aim of targeting breast cancer cell lines using *Argemone mexicana* extract would be to investigate the potential anti-cancer properties of this plant.
- To develop a safe and effective natural treatment option for breast cancer patients. However, further research is needed to determine the full potential of this plant extract and its possible side effects.

3.2 SCOPE

Millions of people worldwide are impacted by the serious health issue of breast cancer. While there is no known cure for breast cancer, there are numerous therapies and treatments that can help manage the condition and enhance patient outcomes. The potential use of plant-based therapies for the treatment of breast cancer has drawn more attention in recent years.

Prickly poppy, also known as Mexican poppy or *Argemone mexicana*, is a plant species that has long been used in herbal medicine to treat a variety of illnesses, including cancer. *Argemone mexicana* seed extracts have recently been shown to have potential anticancer properties, including effects against breast cancer.

Argemone mexicana plant seed has a promising future as a breast cancer treatment. In order to fully comprehend the mechanisms by which plant extracts function and to identify the most efficient dosages and delivery strategies, more research is required. Additionally, clinical trials will be required to evaluate the efficacy and safety of the plant-based therapy in patients. *Argemone mexicana* may be used to prevent and detect cancer in addition to being a potential treatment for breast cancer. For those who are at a high risk of developing breast cancer, the plant extracts may be helpful in creating new screening techniques or as a dietary supplement.

CHAPTER 4

MATERIALS AND METHODS

4.1 COLLECTION OF SAMPLES

The seeds of *Argemone mexicana* plant were collected located nearby Tambaram in Chennai in the month of January 2023.

4.2 FLOW CHART:

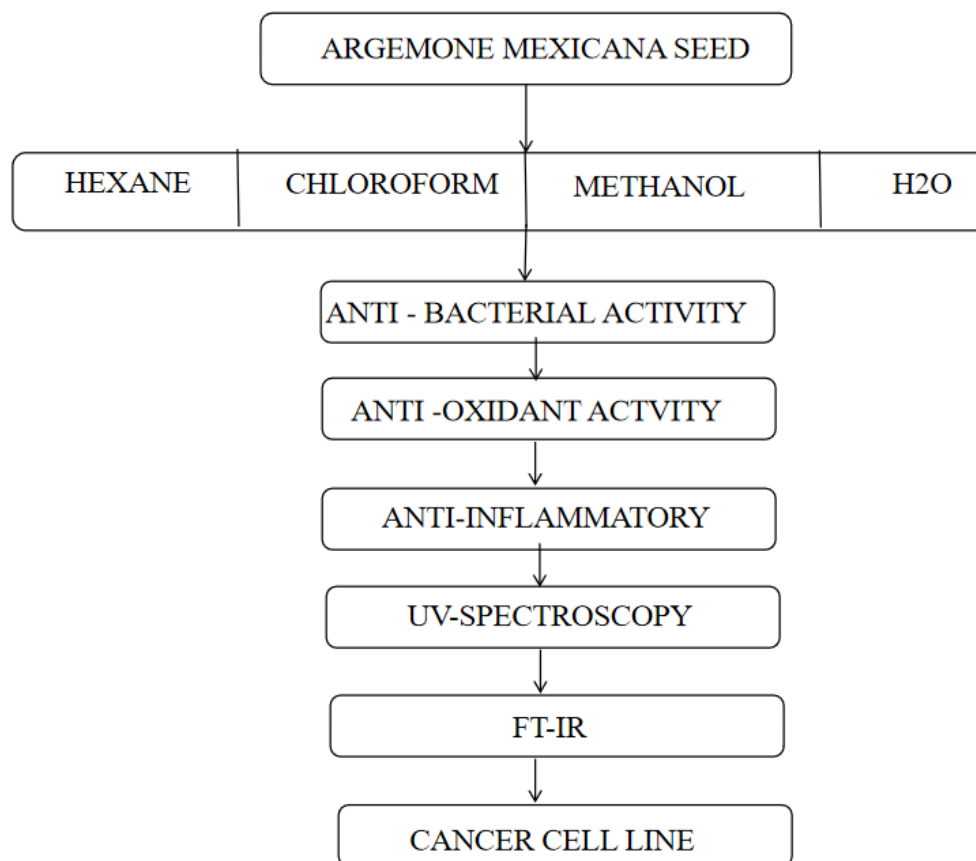


Fig. 4.1: Work flow of study

4.3 PREPARATION OF SAMPLE

Seed of the plant samples were thoroughly washed with running tap water 2-3 times and then finally washed with distilled water followed by shade-dried for seven

days and then dried in an oven below 50°C. The dried seed materials were then powdered using mixer and grinder. 30g of plant powder were extracted with 100ml of aqueous, hexane, chloroform, and methanol, Then the extracts with different solvents were evaporated. Extracts were transferred into pre-weighed sample containers and were stored later was used for phytochemical screening, Antibacterial activity and other activities.

4.4 ANTIBACTERIAL ACTIVITY

Agar well disc Diffusion method was used to test the antibacterial activity of the extracts against *Escherichia coli*, *Pseudomonas aeruginosa*, *Streptococcus mutans*, and *Candida albicans*. The essential Seed extracts were used for studying their antibacterial activity. A loopful of bacterial strains were inoculated into 5ml of nutrient broth and incubated for 24hrs at 37°C to get active strain by using agar well disc diffusion method. Muller Hinton Agar plates were prepared by pouring 20ml of molten media into sterile Petri plates. After solidification of media, inoculum of strains was swabbed uniformly and the inoculum was allowed to dry for 5 minutes. The extracts were dissolved in Dimethyl Sulfoxide (DMSO). The concentrations of extracts (500µg/disc) were loaded on 5mm sterile disc using micropipette. The loaded disc was placed on the surface of medium and the compound was allowed to diffuse for 5mins and the plates were kept for incubation at 37°C for 24hrs. At the end of incubation, zones formed around the disc were measured with transparent ruler in millimetre. Based on the diameter of the zone of inhibition, antibacterial susceptibility was ranked.

4.5 ANTIOXIDANT ACTIVITY

- The Antioxidant activity of seed extract *Argemone mexicana* was measured by stable 1, 1-diphenyl 2- picryl hydrazyl (DPPH) free Radical scavenging activity.
- With 0.4ml of methanol extract 0.1mm of DPPH is added.
- The reaction mixture was mixed properly loaded in well plates and incubated in dark at 37°C for 30 minutes.
- Absorbance was read against a blank at 517nm using a uv-vis spectroscopy.
- Decrease in Absorbance indicated increased in Radical scavenging activity.
- The percentage inhibition of DPPH was calculated using the following equation:

$\% \text{inhibition} = (\text{control} - \text{sample} / \text{control}) \times 100.$

4.6 ANTI-INFLAMMATORY ACTIVITY

4.6.1 Egg Albumin Denaturation Assay

- In this method, 2 mL of a test sample with a concentration of 100–400 µg/mL was mixed with 0.5 mL of egg albumin and 1 mL of Phosphate buffer (pH = 6.5) saline.
- The reaction mixture was incubated for 20 min at 37 °C followed by heating at 70 °C for 15 min.
- After cooling to room temperature, absorbance was measured at 660 nm with a spectrophotometer.
- Calculated the percentage inhibition according to the following equation:
Inhibition of denaturation (%) = $(1 - (AC/AS)) \times 100$
- Where AC = absorption of the control sample, and AS = absorption of the test sample

4.7 PHYTOCHEMICAL ANALYSIS

The seed extract was tested for various phytochemicals such as tanins, Anthraquinones, Flavonoids, alkaloids, cardiac glycosides, saponins, sterols, terpenoids, carotenoids.

4.7.1 Test for Tannins

With the extract, add few drops of ferric chloride, yellow colour appears in methanol.

4.7.2 Test for Anthraquinones

10l of extract, 2ml of Hcl after 5mins, 2ml of ammonia solution. Separate aqueous layer observed. Rose colour shows the presence.

4.7.3 Test for flavonoids

10l of extract, few drops of NAOH solution. Yellow colour to colourless solution presence of alkaloids.

4.7.4 Test for Alkaloids

Wagner's test - 1.5 ml of aqueous extract was mixed with 2ml of Wagner's reagent. Appearance of the Reddish-brown colour indicates the presence of alkaloids.

4.7.5 Test for cardiac glycoside

1ml of extract, 0.5ml of glacial acetic acid and ferric chloride +1ml of concentrated H₂SO₄. Blue colour indicates the presence of cardiac glycoside.

4.7.6 Test for saponins

Mix the extract with distilled water and shake well. Presence of foam indicates the presence of saponins.

4.7.7 Test for sterols

With the extract, add few drops of conc.H₂SO₄ and shake well. Reddish colour indicates the presence of sterols.

4.7.8 Test for Terpenoids

2.0 ml of chloroform was added with the 1.5 ml aqueous plant extract and evaporated on the water bath and then boiled with 3 ml of H₂SO₄ concentrated. A reddish-brown layer indicated the presence of terpenoids. With the extract, 1ml of chloroform, 85% of sulphuric acid added. A blue colour indicates the presence of carotenoids.

4.8 CHARACTERIZATION PROCESS

The bioactive compound identification by UV-Visible spectroscopy analysis and FTIR. The uv-visible profile of seed extract was analysis 200to800nm wavelength to identify the compound containing o-bonds, pair electrons and aromatic rings. The FTIR analysis the functional group present in the sample.

4.9 ANTICANCER ACTIVITY

4.9.1 Cell Culture Maintenance

MDA-MB-231 (Human breast adenocarcinoma epithelial cell line) was obtained from the National Centre for Cell Sciences (NCCS), Pune, India. Cells were maintained in the logarithmic phase of growth in Dulbecco's modified eagle medium (DMEM)

supplemented with 10% (v/v) heat inactivated fetal bovine serum (FBS), 100 U/mL penicillin, 100 µg/mL streptomycin. They were maintained at 37°C with 5% CO₂ in 95% air humidified incubator.

The anticancer activity of the sample was tested against MDA-MB-231 cell line by MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay (Mossman, 1983). The cells were seeded in 96-well microplates (1 x 10⁶ cells/well) and incubated at 37°C for 48 h in 5% CO₂ incubator and allowed to grow 70-80% confluence. Then the medium was replaced and the cells were treated with different concentrations of sample and incubated for 24 h. The morphological changes of untreated (control) and the treated cells were observed under digital inverted microscope (20X magnification) after 24 h and photographed. The cells were then washed with phosphate-buffer saline (PBS, pH-7.4) and 20 µL of (MTT) solution (5 mg/mL in PBS) was added to each well. The plates were then stand at 37°C in the dark for 2 h. The formazan crystals were dissolved in 100 µL DMSO and the absorbance was read spectrometrically at 570 nm. Percentage of cell viability was calculated using the formula, Cell viability (%) = (Absorbance of sample/Absorbance of control) X 100.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 PLANT SAMPLE



Fig. 5.1: Powdered sample of Argemone mexicana

Fig. 5.1 represents the powdered sample of Argemone mexicana Seed.

5.2 EXTRACTION PROCESS:

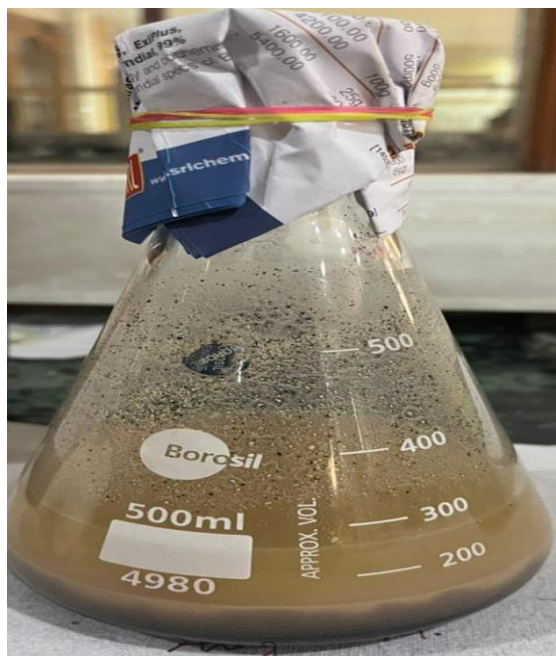


Fig. 5.2: Extraction of solvents

In Fig. 5.2, Extraction of solvent such as hexane, chloroform, methanol and H₂O

are done. Sample is weighed. 200ml of hexane is added, followed by methanol, chloroform, H₂O. Frequent shaking. Kept at room temperature for 24 hours. Then filtered out and kept aside for evaporation.

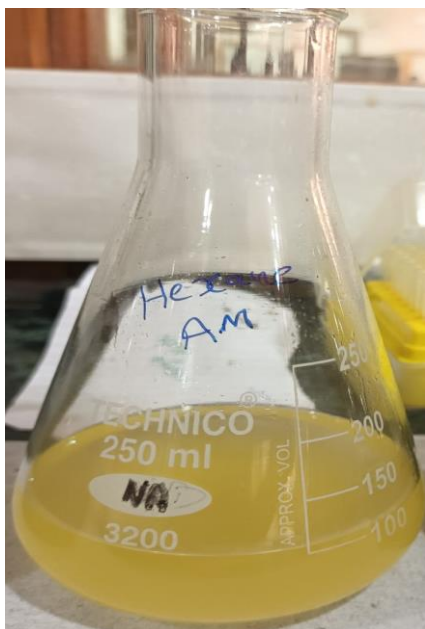


Fig. 5.3: Hexane extract

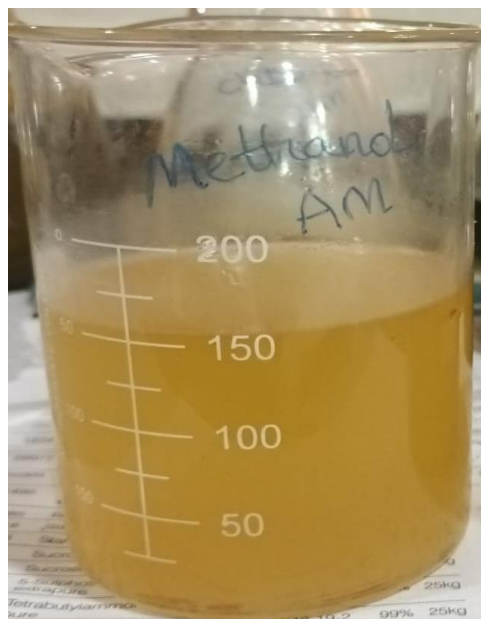


Fig. 5.4: Methanol extract

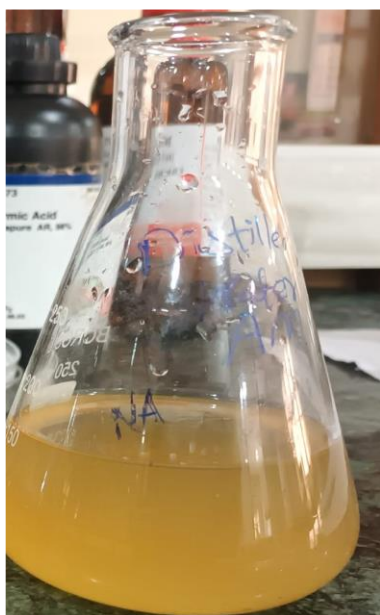


Fig. 5.5: H₂O extract

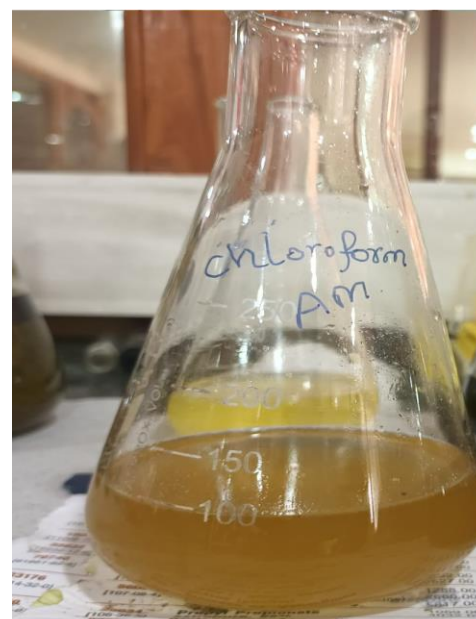


Fig. 5.6: Chloroform extract

In Fig. 5.3, 5.4, 5.5 and 5.6, the sequential extraction from solvents such as

hexane, chloroform, methanol and H₂O.

5.3 ANTI-BACTERIAL ACTIVITY

In Fig. 5.7, 5.8, 5.9 and 5.10 shows the anti-bacterial activity of seed extract of *Argemone mexicana*.

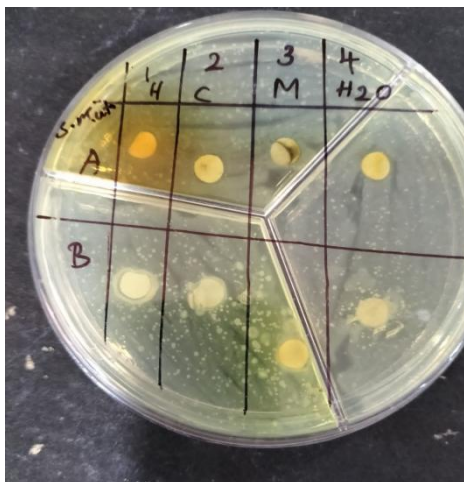


Fig. 5.7: *Pseudomonas aeruginosa*



Fig. 5.8: *Escherichia coli*

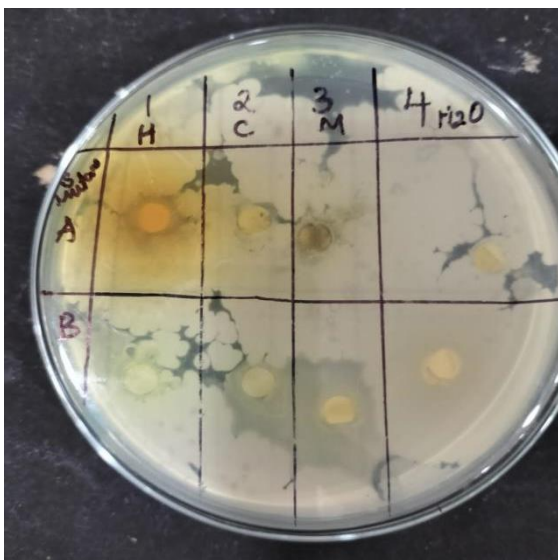


Fig. 5.9: *Streptococcus mutants*



Fig. 5.10: *Candida albicans*

Antibacterial activity of seed extract *Argemone mexicana* showed positive for

two bacteria namely E coli and candida in the chloroform and methanol extract. Chloroform extract of Argemone mexicana seed showed 6 in zone of inhibition against E coli. Methanol extract of Argemone mexicana seed showed 8 in zone of inhibition against Candida.

Table 5.1: The zone of inhibition of plant extract against different bacterial strain

EXTRACT	Zone of inhibition in MM			
	S.M	S.A	E,COLI	CANDIDA
CHLOROFORM	-	-	6mm	-
METHANOL	-	-	-	8mm
HEXANE	-	-	-	-
H2O	-	-	-	-

- Efficacy of Argemone mexicana seed extracts against bacteria and fungi. It was hoped to determine the seed extract's potential for inhibition in light of the aforementioned results.
- The methanolic extract's minimum inhibitory concentrations against test micro-organisms candida, E-coli were noted in accordingly

5.4 ANTIOXIDANT ACTIVITY

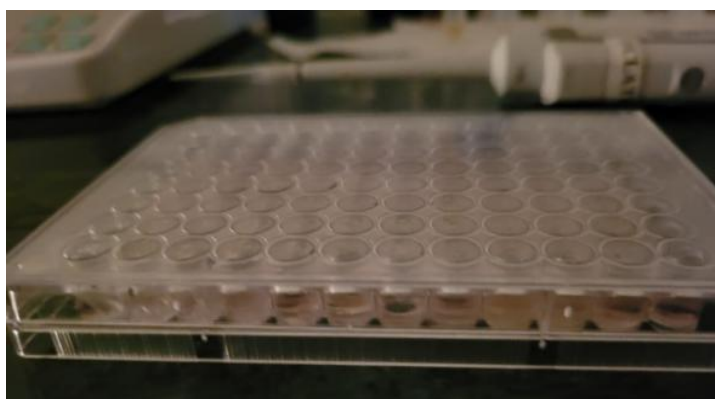


Fig. 5.11: 96 Well-plates

In 5.11, the 96 well plates are used for high through put screening, sample

storage and cell culture.

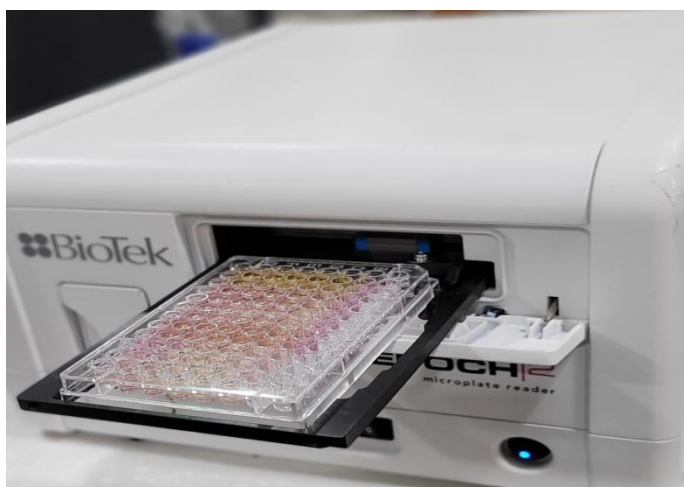


Fig. 5.12: Sample loaded in UV

In Fig. 5.2, the UV – Vis light is passed through a sample and the transmittance of light by a sample is measured.

5.5 CALCULATION OF % RADICAL SCAVENGING AND IC₅₀ FROM DPPH ASSAY

5.5.1 Methanol Extract

Table 5.2: DPPH activity of methanol extract

concentration	control average	sample 1	sample 2	Sample average	%RSA	IC ₅₀
1000	0.3495	0.12	0.147	0.1935	44.63519313	1004.197493
750	0.3495	0.212	0.198	0.311	11.01573677	754.197493
500	0.3495	0.214	0.217	0.3225	7.725321888	504.197493
250	0.3495	0.198	0.211	0.3035	13.16165951	254.197493
150	0.3495	0.271	0.266	0.404	-15.59370529	154.197493
100	0.3495	0.276	0.258	0.405	-15.87982833	104.197493

According to the table 5.2, the sample's absorbance gradually drops as sample concentration rises.

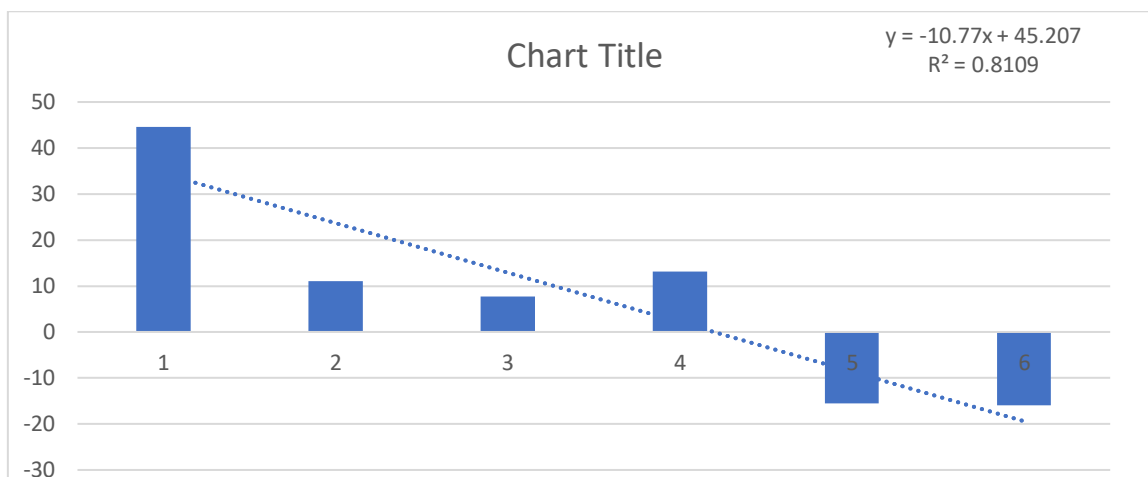


Fig. 5.13: DPPH assay activity of methanol extract

In Fig. 5.14 represents graph which X represents activity of the sample and y represent different concentration.

5.5.2 H2O Extract

Table.5.3: DPPH activity of H2O extract

concentration	Control average	sample 1	sample 2	sample average	%RSA	IC50
1000	0.3495	0.425	0.413	0.6315	-80.68669528	922.4316279
750	0.3495	0.448	0.456	0.676	-93.41917024	672.4316279
500	0.3495	0.446	0.424	0.658	-88.26895565	422.4316279
250	0.3495	0.422	0.392	0.618	-76.82403433	172.4316279
150	0.3495	0.457	0.434	0.674	-92.84692418	72.43162791
100	0.3495	0.45	0.434	0.667	-90.84406295	22.43162791

From the table, when the concentration of the sample increases the absorbance of the sample goes in negative.

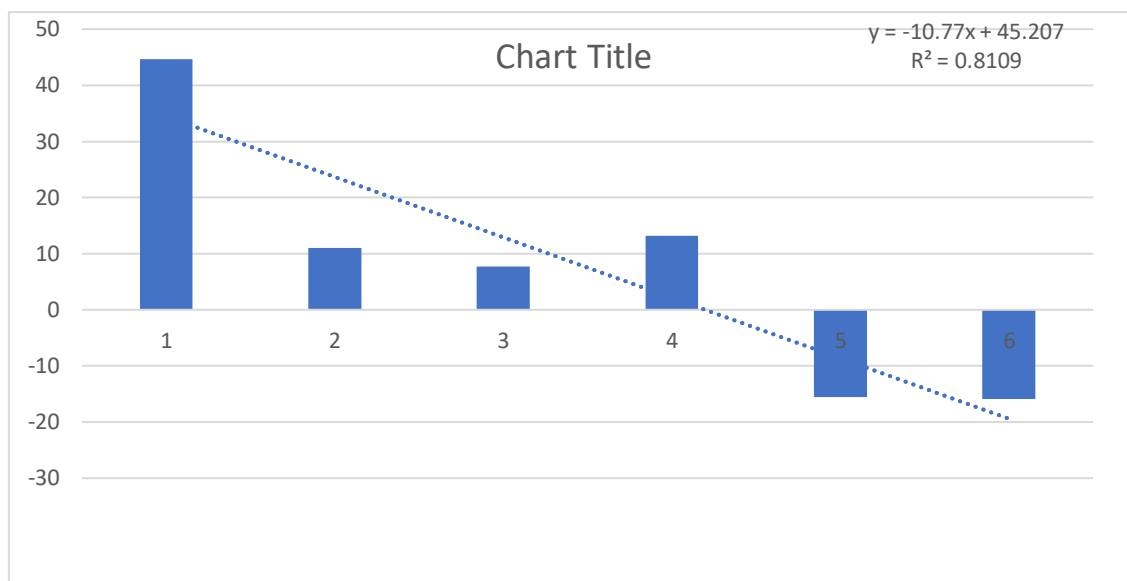


Fig. 5.14: DPPH assay activity of H₂O extract

In Fig. 5.14 represents graph which X represents activity of the sample and y represent different concentration.

5.6 ANTI-INFLAMMATORY ACTIVITY

5.6.1 Egg Albumin Denaturation Assay

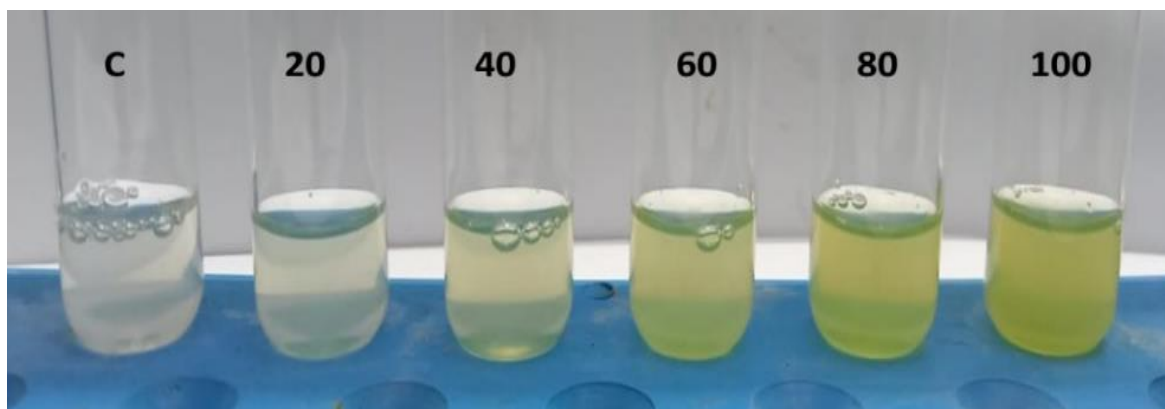


Fig. 5.15: Egg albumin denaturation assay

According to the color changes it shows that the inhibition rate increases with increasing concentration.

Table 5.4: Anti-Inflammatory activity (egg albumin)

Concentrations ($\mu\text{g/mL}$)	Absorbance	Inhibition (%)
Control	0.175	
20	0.222	11.72414
40	0.289	23.44828
60	0.401	36.55172
80	0.599	51.03448
100	0.743	68.96552

The study details the positive anti-inflammatory effects of *Argemone mexicana* seed extract against denaturation of egg albumin. The test sample proved successful.

5.7 PHYTOCHEMICAL ANALYSIS

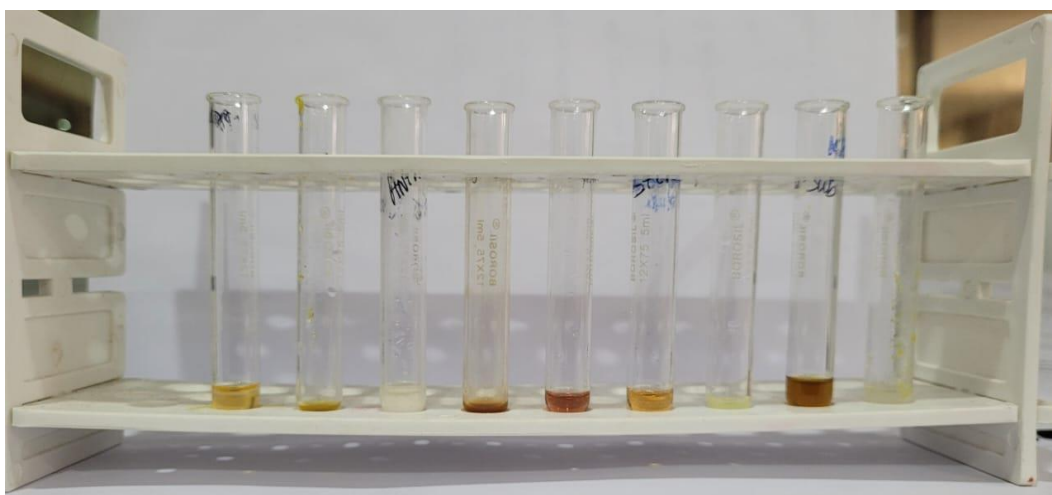


Fig. 5.16: Image of chemical screening

Fig. 5.16 represents different phytochemical analysis of the sample.

Table 5.5: Phytochemical constituents present in methanolic extract of A.M

S.NO	TEST NAME	OBSERVATION	RESULT
1	Tannins	Presence of yellow colour	+
2	Anthraquinones	Presence of rose colour	-
3	Flavonoids	Turns from yellow colour to colourless	-
4	Wagner's test	Reddish brown colour (Presence of alkaloids)	+
5	Cardiac glycosides	Blue of colour	-
6	Saponins	Foam	-
7	Sterols	Reddish colour	-
8	Terpenoids	Reddish brown colour	+
9	Carotenoids	Blue colour	-

According to the findings of phytochemical investigations, plant extract displayed positive results for tannins, alkaloids, and terpenes. These phytochemicals might help *Argemone mexicana* in its numerous therapeutic uses.

5.8 UV-VISIBLE SPECTROSCOPY

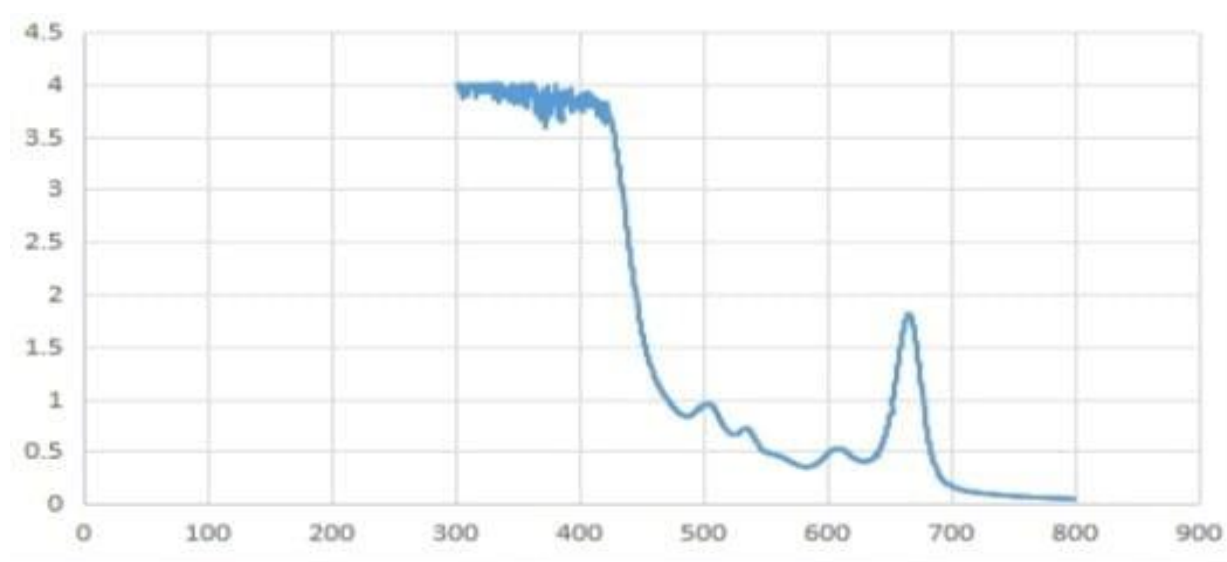


Fig. 5.17: UV-Visible spectrum of Methanolic Extract

In Fig. 5.17, the peak values of methanolic extract are observed.

Table 5.6: UV-Visible peak values of methanolic extract of Argemone mexicana

S.NO	WAVELENGTH (nm)	ABS
1	487	0.83
2	523	0.0663
3	597	0.43
4	662.5	1.661
5	664.5	1.762
6	677	1.107
7	682.5	0.624
8	682.5	0.624
9	691.5	0.268
10	709	0.129

At wavelengths between 300 nm and 800 nm, the UV visible profile of a methanolic extract of Argemone mexicana was taken. Peaks were seen in the profile at 487, 523, 597, and so forth. Absorbing 0.083, 0.0663, and 0.43 correspondingly. The table below shows the 300–800 nm wavelength range of the detected Argemone mexicana plant extract absorption bands.

5.9 FOURIER TRANSFORM INFRARED SPECTROSCOPY

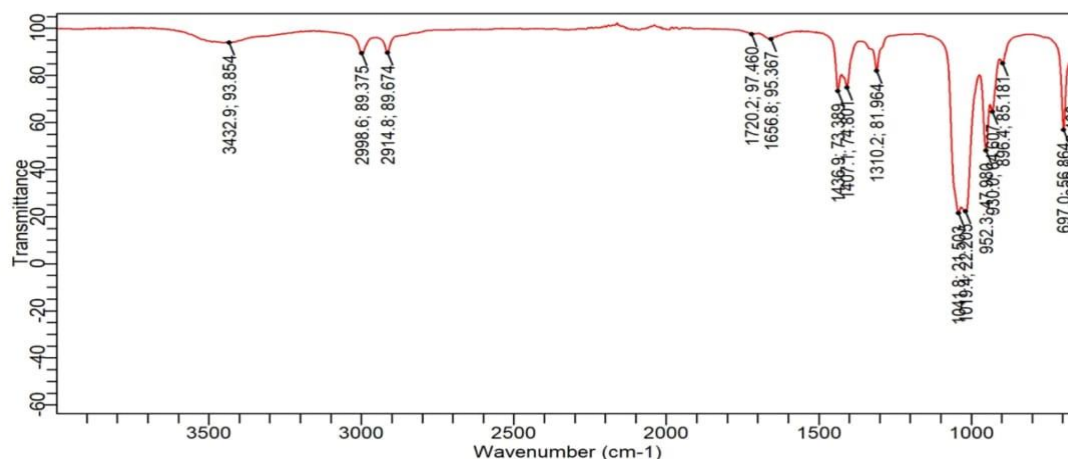


Fig. 5.18: FTIR analysis of methanolic extract

In Fig. 5.18, according to the readings observed in the FTIR analysis, the peak values are shown and functional groups are identified.

Table 5.7: FTIR peak values of Methanolic extract of Argemone mexicana

PEAK VALUE	FUNCTIONAL GROUP	FUNTIONAL GROUIP NAME	Appearance
669.05714	C-Br stretching	halo compound	Strong
697.01218	C=C Bending	alkene	Strong
896.42475	C-H Bending	1,2,4- trisubstituted	Strong
1041.79093	CO-O-CO stretching	anhydride	strong, broad
1310.15925	O-H Bending	phenol	Medium
1407.07003	S=O stretching	sulfonyl chloride	Strong
1436.88874	O-H Bending	carboxylic acid	Medium

The table 5.7 shows the FTIR peak values and functional groups. The FTIR spectrum demonstrated that the methanolic extract contained alkene, phenol, and halo compound.

5.10 ANTICANCER ACTIVITY

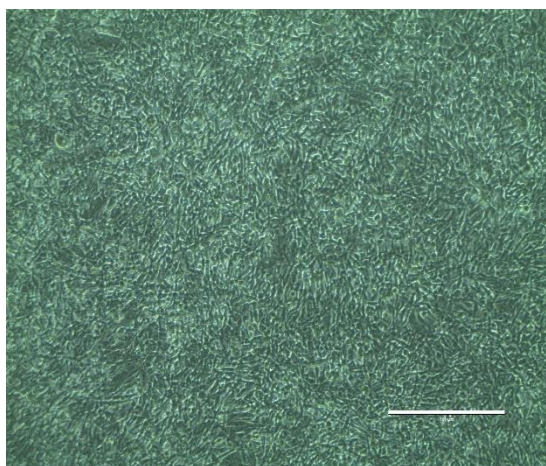


Fig. 5.19: Control

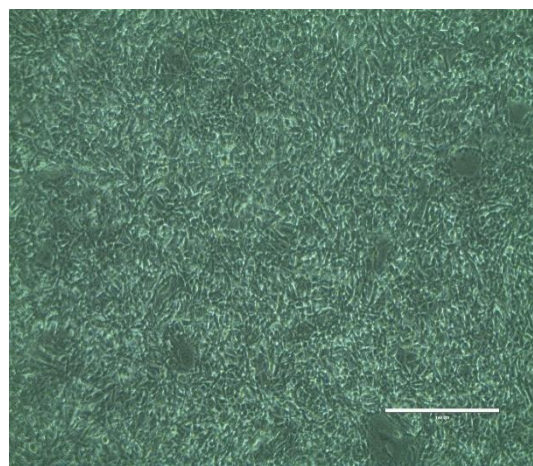


Fig. 5.20: 20 µl

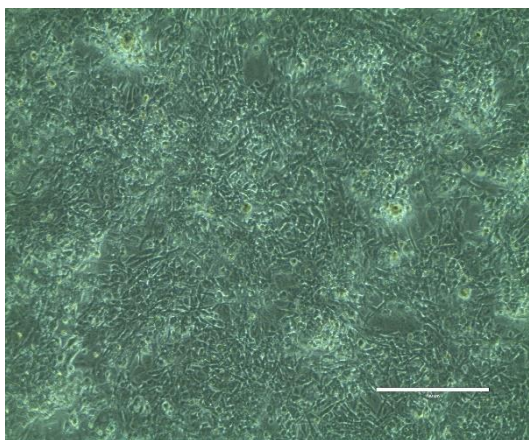


Fig. 5.21: 40 µl

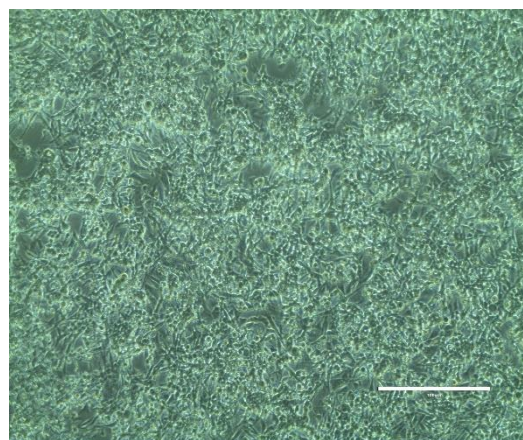


Fig. 5.22: 60 µl

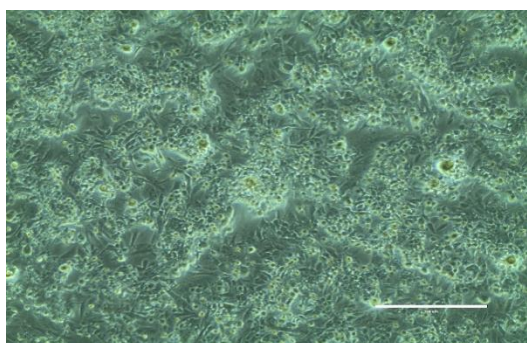


Fig. 5.23: 80 µl

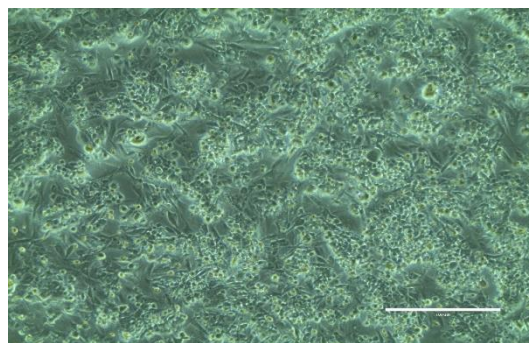


Fig. 5.24: 100 µl

The Fig. 5.17, 5.18, 5.19, 5.20, 5.21, 5.22, 5.23 and 5.24 represents cytotoxic effects of sample at different concentration. As the concentration increases cell viability rate decreases.

Table 5.8: MTT Assay of methanolic extract of *Argemone mexicana* in cell line

Concentrations (µg/mL)	Absorbance		Average	Cell Viability (%)
	I	II		
Control	0.786	0.772	0.779	100
20	0.699	0.687	0.693	88.96020539
40	0.501	0.511	0.506	64.9550706
60	0.395	0.387	0.391	50.19255456
80	0.243	0.229	0.236	30.29525032
100	0.176	0.165	0.1705	21.88703466

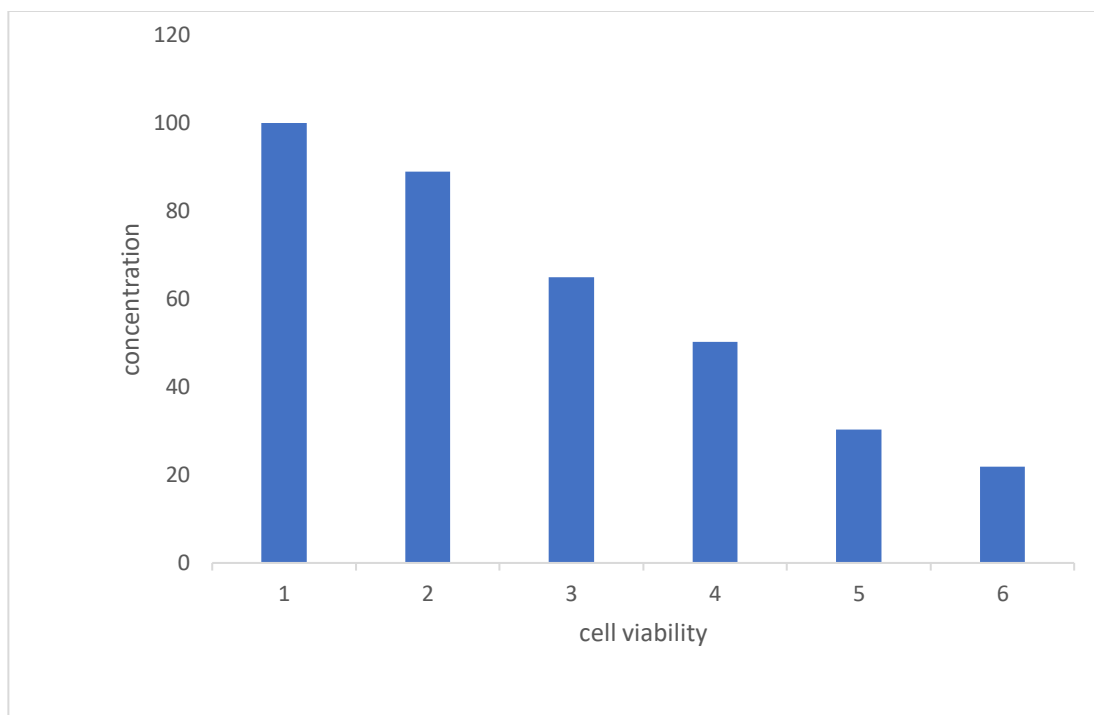


Fig. 5.25: Methanolic extract of *A.M* against cell line

Fig. 5.25 represents X axis cell viability and Y axis concentration of sample. The results of the Argemone mexicana methanol extract are shown in the images, and it has been found that the percentage of cell viability decreased when the concentration was raised. Based on the results, it was clear that Argemone mexicana's methanolic extract has the potential to be cytotoxic to the MDA-MB 231 cell line.

5.11 DISCUSSION

Finding effective treatments for breast cancer is crucial because it is a major global health issue. It has been demonstrated that the Argemone mexicana seed extract has a number of pharmacological activities, including anticancer properties, making it a potential natural source of therapeutic substances for concentrating on breast cancer cells. Argemone mexicana seed extract's impact on breast cancer cells has been studied in a number of different ways. According to one study, the extract stopped the cell cycle and caused apoptosis (programmed cell death), which prevented the proliferation of breast cancer cells. Multiple bioactive substances, including alkaloids, flavonoids, and phenolic acids, were thought to be responsible for this.

According to a different study, the extract had only a minor impact on healthy breast epithelial cells while exhibiting selective cytotoxicity against breast cancer cells. This suggests that the extract might be able to specifically target cancer cells while minimizing harm to healthy cells. Additionally, it was discovered that *Argemone mexicana* seed extract has anti-angiogenic properties, which means it can prevent the development of blood vessels that feed tumors. This is crucial because metastasis and tumor growth both require a blood supply, and stopping this process can slow the spread of cancer. Overall, the *Argemone mexicana* seed extract exhibits promise in the treatment of breast cancer cells by causing cell cycle arrest, apoptosis, and inhibition of angiogenesis. To pinpoint the precise bioactive substances in charge of these outcomes and comprehend the underlying mechanisms of action, additional study is necessary. As a potential treatment for breast cancer, the extract needs to be tested in clinical trials to determine its safety and effectiveness.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

Prickly poppy or Mexican poppy, also known as *Argemone mexicana*, is a plant species that is frequently used in traditional medicine to treat a variety of conditions including pain, inflammation, fever, and skin diseases. The pharmacological activity of *Argemone mexicana*'s seed extract has been the subject of numerous studies, and they have revealed a range of advantageous effects.

According to one study, alkaloids like protopine and allocryptopine explain why the seed extract had significant analgesic (pain-relieving) activity in animal models. Because the extract contains flavonoids and alkaloids, according to another study, it has anti-inflammatory properties. In addition, *Argemone mexicana* seed extract has demonstrated antimicrobial activity against a number of bacterial strains, including *Staphylococcus aureus* and *Escherichia coli*. Additionally, *Candida albicans* was resistant to its antifungal effects.

According to other studies, the extract might be useful in treating diabetes and its complications. In animal models, it was discovered to have antidiabetic activity by lowering blood glucose levels and enhancing insulin sensitivity. Additionally, the extract's antioxidant activity was demonstrated to have protective effects against oxidative stress-related illnesses like cancer and cardiovascular problems.

A natural source of therapeutic substances with analgesic, anti-inflammatory, antimicrobial, antidiabetic, and antioxidant activities, *Argemone mexicana* seed extract has demonstrated potential as a whole. In addition, *Argemone mexicana* seed extract has demonstrated antimicrobial activity against a number of bacterial strains, including *Staphylococcus aureus* and *Escherichia coli*. Additionally, *Candida albicans* was resistant to its antifungal effects. To fully comprehend the mechanisms of action and clinical potential of these compounds, additional study is necessary.

6.2 CONCLUSION

The current work is in favor of using plant extract in place of conventional medicine. *Argemone mexicana* is a beneficial drug that is used in traditional medicine. The use of ethnomedicine in various treatments and therapies is gradually regaining some of its former grandeur. The therapeutic qualities relating to one of the medicinal plants in this context. In this investigation, *Argemone mexicana* was utilized. *Argemone mexicana* seeds were extracted using hexane, chloroform, methanol, and water as solvents. The presence or absence of inhibition of zone values was used to evaluate the antibacterial activity of these extracts against four bacterial strains and their potential activity. *Argemone mexicana* extract shown strong antioxidant activity in methanol. In the current investigation, tannins, alkaloids, and terpenoids were detected in the methanol extract during the phytochemical screening process. For the purpose of identifying the phytoconstituents in the methanolic extract of *Argemone mexicana*, UV-visible and FTIR analyses were carried out. The sample has a good antiproliferative effect over the breast cancer cell line, according to anticancer experiments conducted on the MD-MBA 231 cell line.

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