Estimation of flavonoids and alkaloids in plants

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

OF

Master of Science

In

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Submitted by:

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DEPARTMENT OF BIOTECHNOLOGY

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I Nidhi Solanki, Roll Number: 2K120/MSCBIO/41, student of M.Sc. Biotechnology,

hereby declare that the work which is presented in the Major Project entitled- Estimation

of flavonoids and alkaloids in plants in the fulfillment of the requirement for the award of

the degree of Master of Science in Biotechnology and submitted to the Department of

Biotechnology, Delhi Technological University, Delhi, is an authentic record of my own

carried out during the period from February - May 2022, under the supervision of Dr.

Navneeta Bharadvaja.

The matter presented in this report has not been submitted by me for the award for any other

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CERTIFICATE

I hereby certify that the project dissertation titled "Estimation of Flavonoids and Alkaloids in plants" which is submitted by Nidhi Solanki, Roll number 2k20/MSCBIO/41, Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any degree or diploma to this university or elsewhere.

Place: Delhi

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Abstract

Ayurveda is the most traditional form of medicine prevailing in India for thousands of years. The ayurvedic system of medicine aims at promoting, preserving, and sustaining good health and preventing diseases in humans. The term "Ayurveda" means "Science of Life''. Ayurvedic and herbal treatments were so popular in ancient times. The plant-based natural treatment is still in demand worldwide. There is an increasing demand for pharmaceuticals, nutraceuticals, cosmetics, food supplements, and so on. In the twenty-first century, natural products account for more than half of all pharmaceuticals in clinical use. Up to 50% of herbal treatments approved in the previous three decades have come from natural sources such as plants, microbes, fungus, and animals, either directly or indirectly. Plants have phytochemicals that provide health benefits to people. Drugs extracted from the plants are safe, economical, ecofriendly, efficient, and easily available. Phytochemicals are a class of secondary metabolites that plants make to defend themselves against microorganisms. They have disease-preventive qualities and are non-nutritive in nature. They are produced during plant metabolism. Flavonoids, alkaloids, phenol, tannins, steroids, etc are the types of plant phytochemicals. In the present work, qualitative and quantitative phytochemical analyses of flavonoids and alkaloids were carried out on four plants, Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus present in North West part of Delhi (Delhi Technological University).

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Chapter 1-

INTRODUCTION

Ayurveda is the most traditional form of medicine prevailing in India for thousands of years. The ayurvedic system of medicine aims at promoting, preserving, and sustaining good health and preventing diseases in humans. It was practiced during the Vedic period of INDIA, according to ancient literature on Ayurveda. During the first millennium BC, the Charaka Samhita and Sushruta Samhita described approximately 700 plants. This system of medicine is also adopted and used in other countries (Saxena et al. 2013). The term "Ayurveda" means "Science of Life". Ayurvedic and herbal treatments were so popular in ancient times. The plant-based natural treatment is still in demand worldwide(Shaikh and Patil 2020). There is an increasing demand for pharmaceuticals, nutraceuticals, cosmetics, food supplements, and so on. In the twenty-first century, natural products account for more than half of all pharmaceuticals in clinical use. Up to 50% of herbal treatments approved in the previous three decades have come from natural sources such as plants, microbes, fungus, and animals, either directly or indirectly. However, through global networks, India is making progress in popularising the AYUSH (Ayurveda, Yoga, Unani, Siddha, and Homeopathy) Traditional Medical System in the health care industry. Bioactive phytochemicals or nutrients are abundant in medicinal plants(Greenwell and Rahman 2015).

Plants have phytochemicals that provide health benefits to people. Drugs extracted from the plants are safe, economical, eco-friendly, efficient, and easily available. Phytochemicals are a class of secondary metabolites that plants make to defend themselves against microorganisms. They have disease-preventive qualities and are non-nutritive in nature. They are produced during plant metabolism(Balamurugan et al. 2019). They are present in leaves, roots, stems, vegetables, etc. Flavanoids, alkaloids, tannins, steroids, phenol, terpenes, and other phytochemicals have anticancer, antiviral, antifungal, antidiuretic, and antibacterial properties that help to avoid a variety of disorders. Phytochemicals help in activating enzymes that help in free radical scavenging inside our bodies. Carcinogen-activating enzymes appear to be blocked, while carcinogen-detoxifying enzymes appear to be activated(Yadav and Agarwala 2011). Pollution, stress, dehydration, UV exposure, and pathogenic attack are all examples of environmental threats that phytochemicals defend plant cells from. Fruits, vegetables, nuts, beans, legumes, and other foods contain a large number of phytochemicals. Phytochemicals

can be found in varying amounts throughout the plant. The concentration of these chemicals is highest in the plant's outer tissue. Levels vary from plant to plant according to on the species, production, cooking, and growing conditions. According to the latest reports, more than 4000 phytochemicals are known now(Zumaina Mazumder et al. 2022).

Phytochemicals are not essential nutrients for human survival, but they do aid in the prevention of a variety of ailments. They are naturally occurring compounds that are safer to use as compared to the synthetic medicines available on the market. According to the most recent data, around 4000 phytochemicals have been discovered thus far. Traditional medicines must be used in the manufacture of current medical preparations, and so 'Phytomedicines' represent a link between traditional and modern medicine(Chanda and Sumitra Chanda 2014).

Primary and secondary metabolites are the two types of phytochemicals found in plants. Primary metabolites aid in the plant's regular growth and development. Sugar, amino acids, nucleic acid, protein, chlorophyll, and other substances are found in them. However, secondary metabolites are produced by plants which aid in the survival of the plant in extreme conditions. They form the smell, color, and taste of the plants and consist of flavonoids, tannins, saponins, alkaloids, and steroids. These secondary metabolites have various applications such as coloring agents, drugs such as flavoring agents, insecticides, pesticides, and anti-bacterial. Furthermore, they can be utilized to protect humans from a variety of ailments such as cancer, diabetes, cardiovascular disease, arthritis, and aging, among others (Chanda and Sumitra Chanda 2014).

In phytochemical analysis, the extraction of phytochemicals is the most important step. Maceration, percolation, digestion, hot continuous extraction, and other traditional procedures are often utilized. Some of the most modern ecologically friendly phytochemical extraction technologies include ultrasound-assisted extraction (UAE), microwave-assisted extraction (MAE), supercritical fluid extraction (SFE), and accelerated solvent extraction (ASE). Acetone, methanol, chloroform, benzene, ethanol, petroleum ether, and other solvents are employed in the extraction process(Mosić et al. 2021).

Pre-extraction variables such as plant part used origin and particle size, moisture content, drying method, degree of processing, and extraction-related variables such as extraction method, the solvent used, solvent to sample ratio, pH and temperature of the solvent, and extraction length influence phytochemical extraction from plant materials(Shaikh and Patil 2020).

In the present work, qualitative and quantitative phytochemical analyses of flavonoids and alkaloids were carried out on four plants, *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus* present in North West part of Delhi (Delhi Technological University).

Objectives-

- 1- Qualitative estimation of flavonoids and alkaloids in shade dried, sundried, and fresh leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus* plants using water as solvent.
- 2- Qualitative estimation of flavonoids and alkaloids in *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus* using organic solvents(methanol, chloroform, petroleum ether, hexane).

Chapter 2

BOTANICAL DESCRIPTION OF SOME MEDICINALLY IMPORTANT PLANTS

2.1-Solanum lycopersicum (Tomato)

Classification-

Kingdom: Plantae

Division: Magnoliophyta.

Class: Magnoliopsida.

Order: Solanales.

Family: Solanaceae.

Genus: Solanum.

Species: S. lycopersicum.



Fig 1- Solanum lycopersicum

2.2 Botanical description

Tomatoes (Solanum lycopersicum) are a member of the Solanaceae plant family and are one of the most commonly produced vegetables on the planet. It features bright red fruit with a high lycopene concentration. It is a nightshade plant with a weak stem that often reaches over the ground and vines over surrounding plants, growing to a height of 1–3 meters. It's a hardy perennial that thrives in mild climes. Tomatoes are eaten raw, as an ingredient in a variety of cuisines and sauces, and in beverages. Moisture, protein, total lipids, and carbs are all high, at 94.78 percent, 1.167 percent, 0.97 percent, and 3.18 percent, respectively(Salehi et al. 2019). It is a warm-season crop that, after potatoes, is the second most cultivated crop in the United States. Tomato plants are dicots, with branching stems and an apical bud at the tip that accomplishes the real growth. The tomato's main constituent is water, which makes up 93-95 percent of the whole fruit, with the remaining 5-7 percent made up of dry matter like carbohydrates, proteins, vitamins, and insoluble fiber hemicellulose, cellulose. The major flavonoid present in the skin of the tomato is Naringenin. Tomatoes are eaten in a variety of ways all around the world. They're made into ketchup, powder, sauce, juice, salsa, paste, and other products. Tomatoes are high in lycopene (87%) as well as other carotenoids like carotene, lutein, and L-ascorbic acid(Perveen et al. 2015)They're abundant in antioxidants, which help our bodies scavenge free radicals and reactive oxygen species (ROS), lowering the danger of oxidative stress. It also helps to prevent chronic diseases like cancer and cardiovascular disease, as well as cholesterol reduction. Tomatoes are less sweet in taste due to their low sugar content and calories. The green color of the tomato is due to the presence of chlorophyll in them(Dawid 2016).

The tomato consists of the toxic glycoalkaloid called tomatine. Tomatine is present in various parts of the tomato plant such as leaves, stems, and green unripe tomato. The fully ripened tomato has reduced the content of tomatine but has a good beneficial physiological effect on the human body. However, tomato leaf use as tea has been linked to tomatine toxicity, which has been linked to at least one of the following: Raw tomato eating can cause allergies and potentially life-threatening anaphylaxis, especially in youngsters and allergy-prone persons. Symptoms related to the toxicity of the tomatine in animals include vomiting, confusion, weakness, diarrhea, etc(Ademosun et al. 2021). tomato consists of good monounsaturated fatty acids which include Aspartic acid, oleic acid, and glutamic acid. The content of glutamic and aspartic acid is a maximum which is 0.16mg and 0.42 mg.

Tomatine has a good efficiency in reducing cholesterol. When rats consume it orally, it is extremely strong and poisonous. In a study, it was observed that a diet having good quantities of tomatine reduced the LDL cholesterol level to 41% and there was no change in HDL level was observed. The conventional methods for the extraction of lycopene involve sonication, blending, organic solvent extraction, blending, etc. but there are many drawbacks associated with these types of techniques such as the high cost of extraction, and the requirement of more quantities of solvents and samples, long extraction time. The final sample obtained after the extraction through these conventional techniques requires the final clean-up and the subsequent concentration before the analysis.

2.2.1-Medicinal uses of tomato

2.2.2-Diabetes

Diabetes is a multifactorial disease caused by oxidative stress, excessive cholesterol levels, insulin resistance (low insulin levels in the blood), diminished Glucose Transporter Type (GLUT)-4, and reduced insulin binding to its receptor. Diabetes leads to an increased incidence of heart disease, thicker blood, increased hypertension, and more risks of heart disease. The killing of beta-pancreatic cells by the host's reaction to T cells and macrophages is the major feature of diabetes. In the case of hyperglycemia, there are increased sugar levels in the blood which in turn affect the kidney, heart, and liver tissues. Other effects of diabetes are eyes, immunity, feet, etc. the excessive glucose concentration in the blood leads to the division of vascular smooth muscle cells which increases the incidence to increased incidence to many cardiovascular diseases. Enhancing glucose secretion, reducing immune cell formation, and stimulating cell survival proteins are all approaches to preventing diabetes and avoiding its complications. A randomized trial was done on 12 women and 13 men 27-28 years of age comparing the effect of high-fat meals without tomatoes and a high tomato-rich diet. The blood glucose levels were measured after the 6 days and good results ie. Sufficiently low glucose levels were found in the blood of those people who were on a tomato-rich diet. Thus, it was found that beta-carotene supplementation avoids the chances of developing diabetes. Tomatoes are a good source of antioxidants which decreases the chance of developing diabetes.

2.2.3-Cardiovascular diseases

Cardiovascular diseases are caused by the accumulation of fat inside the arteries which blocks them leading to the state called atherosclerosis. Conditions like obesity, diabetes, and hypertension lead to other serious complications like coronary heart disease, cardiomyopathy, etc. cardiovascular diseases are also caused by increased production of thromboxane and adenosine diphosphate. The tomatoes contain a good amount of carotene, lycopene, and tomatine which decreases the LDL cholesterol levels in the blood. A high intake of tomatoes leads to LDL oxidation and production of lipid peroxidases which help in controlling the cholesterol levels in the blood. A study was conducted in which volunteers were taken and were fed on a tomato-free diet for 3 weeks and a tomato-rich diet. It was observed that at the end of 3 weeks patients fed on a high tomato-rich diet showed low LDL levels in blood up to 5.9% and cholesterol levels up to 12.9%. the blood levels showed a good concentration of lycopene, beta and gamma carotene.

2.3 Helianthus annus

Classification

Kingdom – Plantae,

Phylum/ Division – Tracheophyta

Subdivision – Spermatophyta

Class – Magnoliopsida

Order – Asterales

Family – Asteraceae

Genus – Helianthus

Species – annus.



Fig 2- Helianthus annuus

2.4-Botanical description

Helianthus annus (sunflower) is a plant of good medicinal value and therapeutic importance. It is commonly cultivated in different parts of the world such as America, Africa, Australia, and Asia. The seed of the sunflower is eaten and used for the extraction of the oil and that edible oil is used throughout the world. Phytochemicals such as flavonoids, alkaloids, tannins, phenol, steroids, carbohydrates, and others are abundant in sunflowers. The seeds of the Helianthus annus can be used for a variety of purposes such as garnishing, eating, salad, and bakery(Harris et al. 2017).

The *Helianthus annus* plant is approximately 3 meters tall and it has a hairy stem. The leaves of the plant are toothed edge, rough, and have alternate symmetry. The color of the flowers is yellow and the plant has taproots. The sunflower genome is diploid and it has 17 chromosomes. The main characteristic of the sunflower is its head always follows the sun throughout the sky. Almost all the parts of the plant- seeds, leaves, bark, the stem has medicinal importance(Akpor et al. 2019).

The main property of the sunflower is the antioxidant, antifungal and anticancer activity. The phytochemical analysis of the sunflower showed that it has a large number of phenols and has good free radical scavenging properties.

The different parts of the sunflower have a good medicinal value. The crushed leaves of the sunflower are used as medical coverage for the snakebites, sores, and spider bites. The flower of *H. annuus* is used for cancer treatment(Sreekanth and Devi 2019).

2.5Mangifera indica Classification

Kingdom: Plantae.

Division: Angiospermae.

Class: Dicotyledonae.

Order: Sapindales.

Family: Anacardiaceae.

Genus: Mangifera.

Species: indica.



Fig 3- Mangifera indica

2.6-Botanical description

Mangifera indica

Mangoes are high in dietary fiber, which is a crucial ingredient that keeps you regular and healthy. Mango is also high in vitamin C and potassium, all of which are beneficial to blood pressure and heart health. Mango is also a good source of folate, which is crucial for a healthy neural system and may help to prevent cancer in some cases. Indian mangosteen is another name for it. Mangoes are grown for their leaves, which can be used to manufacture a range of herbal treatments and drinks in addition to their fruit. The fruit is widely consumed raw, in addition to being utilized in a variety of meals and beverages. It is also juiced. Smooth, dark brown, and thick, with vertical furrows that are lighter on the bottom side, the bark is smooth, dark brown, and thick. The inner bark is fibrous and whitish. The leaves are small, serrated, dark green leaves that are typically twisted at the tip. They are alternating, simple, and asymmetrical. The leaves are frequently found on the tree's top branches (Helen et al. 2013).

The mango is an important source of food for humans and animals, as well as a source of income for farmers in tropical and subtropical countries. The tree is propagated by seeds, with the exception of the durian, which is propagated by cuttings, and the cashew, which is propagated by grafting with an output of over 12 million tonnes, the mango is India's second most important fruit crop, accounting for about half of the country's fruit yield. The majority of mango production in India is in the state of Maharashtra, which is home to the world's largest mango-producing region – the coastal region of Pune. Mango is cultivated in in an area of approximately 3.7 million ha worldwide, of which approximately 90% is dedicated to commercial production(Maldonado-Celis et al. 2019).

Mango trees have a long, unbranched taproot (up to 6-8 m in length) as well as a dense mass of shallow feeder roots. The crown of the tree has the largest, healthiest, and deepest roots. A young tree's crown is compact and tightly knit, with a diameter of 5-10 cm. The crown of the tree gradually widens as it develops, reaching a diameter of 50-70 cm. The base of the leaf is normally tapered, but it can also be rounded. At the apex, the edge is dentate (notched), and it might be whole or crenate (scraggly). The midrib is not visible on the leaf's upper surface and is inconspicuous (Kumar et al. 2021).

The upper surface of the panicle is sparkling and dark green, while the lower portion is hairless. In the same panicle, both male and female flowers are produced, with the latter having a higher abundance. Male flowers have a wide, green calyx and a small, white, egg-shaped corolla, and can be found in groups of up to three. Solitary or in pairs, the female flowers have a brown calyx and a big, white to pinkish bell-shaped corolla (Shah et al. 2010).

2.6.1-Medicinal uses

2.6.2-Anticancer property –

On the proliferation of several cancer cells, mango fruit pulp, expressed juice, expressed seed, and expressed leaf extracts have shown strong inhibitory efficacy. On the hepatoma cell line (HepG2) and the myeloma cell line, the mango leaf extract demonstrated substantial antiproliferative activity (K562). On lung cancer cells (A549) and skin cancer cells, the seed extract demonstrated substantial antiproliferative activity (MesoS). In a number of investigations, methanolic mango leaf extract has been demonstrated to have anti-cancer action(Mirza et al. 2021).

The high quantities of quercetin and kaempferol, both of which have been demonstrated to impede the activities of the cyclin-dependent kinases CDK2 and CDK4, respectively, are believed to be the mechanism by which whole mango fruit and leaves extract suppresses the cell cycle. The findings imply that whole mango juice and mango juice extracts could be used as a dietary supplement or as part of traditional healing methods for the prevention and treatment of cancer (Noratto et al. 2010).

Mangiferin is a potent inhibitor of telomerase, which is an enzyme that lengthens telomeres. Telomeres are DNA structures that cap and protect the ends of chromosomes. In humans, telomeres shorten as cells age, which may affect the cells' ability to divide. Thus, mangiferin is thought to be a promising anti-cancer agent that may be useful in the treatment of various cancers, including liver, breast, kidney, colon, melanoma, and leukemia(Ribeiro and Schieber 2010).

2.6.3-Anti-diabetic activity of mango leaves –

It is recommended to take these leaves on an empty stomach so that they control blood sugar levels. Other benefits include the reduction of blood sugar levels, the treatment of diabetic

angiopathy, and the reduction of diabetic retinopathy. A compound in leaves, ethyl acetate, reacts with insulin in the blood and stimulates glycogen synthesis(Jaiswal 2016).

2.6.4-Prevent from kidney failure

This was accompanied by increased GFR, TGF- $\beta 1$ and HGF levels, and decreased TNF- α levels in the kidney tissues. These findings suggest that creatine supplementation may favorably impact the renal health of athletes. Creatine is an amino acid that is commonly fed to the dog to enhance renal function. It has been suggested that; creatinine is the most common excreted nitrogenous waste product in the body. The kidney excretes it in the urine and the urinary creatinine concentration may be used as a measure of the effectiveness of renate 1 function.

2.7-Mentha

Classification

KINGDOM: Plantae

SUBKINGDOM: Tracheobionta

SUPERDIVISION: Spermatohyta

PHYLUM: Angiospermophyta

CLASS: Magnoliopsida **ORDER:** Lamiales

FAMILY: Lamiaceae GENUS: Mentha

SPECIES: Mentha piperita



Fig 4- Mentha piperita

2.8-Botanical description

Mentha piperita

Mint is found in the family Labiatae (Lamiaceae). Mints are grown as an herb, shrubs or small tretreeshe leaves are most commonly used in cooking, often in beverages or dishes such as mint tea. The oils from the leaves, either alone or mixed with other oils, are used for cooking, as well as for their flavor. Mentha is a genus of flowering plants that contain a variety of mint species. The most common of them are peppermint, spearmint, and wild mint.

Mentha species are known for their aromatic leaves and small, tubular flowers. They are commonly used in teas, salads, and other foods. The leaves are also used for their strong flavor in various medicines, such as tea for indigestion. Mint is the most commonly used medicinal plant because it is the rich source of anti-oxidant and exhibit polyphenol in high amounts. The results showed that some plants regulators enhanced the growth of mint while the uptake of heavy metals by mint was suppressed. The result of this study showed that mint is a rich source of polyphenols(Ram et al. 2013).

The present study demonstrated that the aqueous extract of mint has great potential as natural food additive in the form of mint tea against cancer cells. Mint leaves and herbs contain that compounds which have vast biological activities. mint (31%), menthol (11%), menthone (5%), menthofuran (3%), menthoxypropan-1,2-diol (2%), methyl and ethyl esters of menthone, menthofuran, menthol, and limonene, menthone is the first to be isolated from peppermint and is a major contributor to the aroma of peppermint oils. Menthol is used as a flavoring and cooling agent in foods, pharmaceuticals, and cosmetics. It has also been used as an analgesic and as anesthetic. In the human body, menthol is mainly excreted through the lungs.

Mint leaves, which have a cooling effect on the body, and are used in many foods and beverages as a condiment, flavouring agent, or preservative. Mint leaves and plant extracts have been used as a flavouring and cooling agent in a variety of foods including ice cream, candy, and chewing gum(E. Sulieman et al. 2012).

2.8.1-Medicinal uses of Mentha piperita

Mint is grown for its aromatic leaves, which have been used for flavoring and for making teas and other infusions. The herb has also traditionally been used as a mouthwash to treat bad

breath and as a general detoxifier. Today, mint is used to flavour a variety of foods and beverages, such as ice cream and chewing gum.

Gastric distension: The decoction of mint is an effective remedy for gastric distension. The decoction of mint is also useful in treating flatulence and dizziness. The decoction of mint is also a valuable remedy for nausea and vomiting during and in the aftermath of the pregnancy. It is also used as a cure for various bodily inflammations.

Sugarcane leaves are used to prepare a refreshing drink obtained by crushing sugarcane with mint leaves or by eating fat-rich yogurt with the addition of powdered sugarcane leaves. The drink is taken to prevent heat strokes and dehydration. The crushed sugarcane leaves are used to prepare a refreshing drink obtained by crushing sugarcane with mint leaves or by eating fat-rich yogurt with the addition of powdered sugarcane leaves (E. Sulieman et al. 2012).

2.8.2-Antimicrobial activity of mint

Menthone is a naturally occurring cyclic terpene alcohol with a molecular weight of 156 and chemical formula of C10H20O. It is a colorless liquid with a menthol-like aroma. It occurs naturally in the oil of Mentha species, which are commonly known as peppermint plants. It is also synthesized industrially by the condensation of menthone with isobutene. Menthone is used in the production of menthol-based flavors and fragrances. Some researchers have demonstrated the anti-pathogenic effect of petroleum ether, ethyl acetate, chloroform, and water extract, which prevents further growth of the pathogens on the treated agar plates. The highest zone of inhibition was noted against B. subtilis with an ethyl acetate extract (13.1 mm diameter) against which the zones of inhibition of the water, chloroform, and petroleum ether extracts were 11.1mm, 9.9, m,m, and 8.9mm, respectively(Yassin et al. 2020).

2.8.3Anti-cancer effect of mint

perillaldehyde (PAL) are two common monoterpene alcohols that are naturally occurring in essential oils of mint, as well as of ginger grass, lavender, cranberries, cherries, perilla, savin, and sage. PAL and POH (perillyl alcohol) are both known for their antimicrobial, anti-inflammatory, and analgesic properties. POH and PAL can be extracted from the above-mentioned essential oils, and then purified to produce a number of different products. POH is also the major component in certain natural supplements, such as lip balm, candle wax, and salve, while PAL is primarily used as a flavoring agent in food, such as cheeses and desserts(Yassin et al. 2020).

2.8.4-Antioxidant activity of mint

Free radicals are unstable, small molecules with unpaired atomic electrons that are able to interact with other molecules. They are known for their ability to cause oxidative damage in biological tissues and molecules. Hydroxyl radicals (OH \bullet), superoxide anion radicals (O $_2\bullet$), and non-free radical species such as hydrogen peroxide are the most prevalent forms of free radicals (H $_2$ O $_2$) (E. Sulieman et al. 2012).

Chapter-3

LITERATURE REVIEW

3.1-Phenolic compounds – flavonoids

Flavonoids are secondary phenolic compounds present in medicinal plants' fruits, vegetables, grains, bark, roots, stems, and flowers. These natural compounds, are abundant in the human diet and have been shown to have a high medicinal value and physiological effects, including anticancer, anti-inflammatory, antioxidant, antimutagenic, antifungal, antiallergic, and antiviral properties(Lotha and Sivasubramanian 2018a; Liskova et al. 2020a)The fact that polyphenols can be extracted using easy and eco-friendly methods like ultrasound-assisted extraction, and that following sterilization, polyphenols retain the majority of their capabilities, will aid research into polyphenols as possible anticancer treatments. Flavonoids can be divided into seven classes based on their chemical structure - flavonols, flavones, flavanones, flavan-3-ols, isoflavones, chalcones, and anthocyanidin(Tungmunnithum et al. 2018a). Flavonoids aid cancer chemoprevention by regulating a number of important pathways involved in cancer growth and metastasis.

Flavonoids have the ability to control tumor formation via regulating signaling molecules such as VEGF, MMPs, ILs, HIF, and othersFlavonoids and their synthetic counterparts have been extensively studied in the treatment of ovarian, breast, cervical, pancreatic, in recent years(Panche et al. 2016).

Flavonoids are a type of low-molecular-weight natural substance in a wide variety of plant species. They play a variety of roles in plants, bacteria, and flowers. In flowers, they are responsible for the smell and the color of the flower petals(Batra and Sharma 2013a). In fruits, they help in seed dispersal, spore germination, and attracting pollinators. Approximately 6000 flavonoids contribute to the vibrant colors seen in fruits, herbs, vegetables, and medicinal plants. Flavonoids are an essential component in a number of nutraceuticals, therapeutic, clinical, and cosmetic uses because they have a wide range of health-promoting benefits(Panche et al. 2016).

3.1.1-Role of flavonoids as anticancer agents

In both industrialized and developing countries, cancer is a major public health concern. Although there are numerous cancer treatment options, they are typically uncomfortable owing to side effects and ineffectual due to increased resistance to traditional anti-cancer medications or radiation therapy. In recent years, the discovery of anticancer medicines including natural substances has grown exponentially. Natural chemicals originating from plants are of particular interest because of their high bioavailability, safety, few side effects, and, most importantly, low cost(Chahar et al. 2011).

Cancer is a multifactorial disorder characterized by aberrant cell proliferation and differentiation with anti-apoptotic properties which results in neoplastic cell expansion (Batra and Sharma 2013b)Cancer development involves three stages initiation, promotion, and progression. It is one of the leading causes of death worldwide. Cancer can be caused by oxidative stress, poor eating habits, lifestyle disorders, smoking, radiation, stress, genetic mutations, pollution, and so on (Yao et al. 2011). The hallmarks of cancer include angiogenesis, metastasis, evading growth suppression, proliferative signaling, replicative immortality, and resisting cell death. Furthermore, while chemotherapy medications are currently helpful in the treatment of cancer, many cancers cannot be completely cured and may be accompanied by unanticipated side effects (Romagnolo and Selmin 2012). There is a need to discover novel chemopreventive medications, which include natural or synthetic compounds or their combination to halt, retard, or reverse cancer's development and progression. Cancer chemoprevention entails the use of drugs that restrict tumor growth, hence lowering the occurrence of cancer(Liskova et al. 2020b). Major risk factors for cancer growth and progression have been identified as lifestyle and nutritional choices (Liu et al. 2010). Increased fruit and vegetable intake have been related to lower cancer risk. Plants produce phytochemicals, a group of compounds that aid in plant growth and protect them from predators(Liskova et al. 2020c). Using phytochemicals, particularly polyphenols, as anticancer drugs is currently a promising option, as it minimizes or eliminates the detrimental effects of more severe standard therapy. Furthermore, our bodies develop resistance to several traditional cancer medicines(Yao et al. 2011).

Flavonoids are polyphenolic chemicals found in nature that make up a wide collection of secondary plant metabolites with intriguing biological propertiesDue to their nontoxicity in nature and a wide and broad aspect of their benefits in biological activities, flavonoids have been extensively investigated for their health benefits, in addition to their abundant availability

in our everyday diets, such as green leaves, fruits, red wine, and tea vegetables (Romagnolo and Selmin 2012). Several studies have demonstrated flavonoids' potential to inhibition of cancer cells. Because flavonoids have a range of anti-cancer pathways, they have a significant anti-cancer effect. Flavonoids have anti-cancer properties not just in the initial stages, but also as the disease advances and spread to other parts of the body (Liu et al. 2010). Flavonoids may stimulate the cell death pathways by targeting the apoptotic signaling cascade. Flavonoids and their subgroups could trigger and proliferate the various signaling pathways such as protein kinase C (PKC), tyrosine kinase, EGRF signaling pathway, Topoisomerase inhibition, and Population of T- and B cells enhancement (Saini et al. 2017). Flavonoids act as potent aromatase inhibitors in breast cancer (Montané et al. 2020).

3.1.2-Anti-inflammatory activity of flavonoids.

Inflammation triggers the body's defensive system, which leads to tumor growth, angiogenesis pathways, proliferation, and metastasis. Flavonoids with anti-inflammatory properties include quercetin, hesperidin, apigenin, and luteolin. Flavonoids have the ability to control the number and differentiation of immune cells(Tungmunnithum et al. 2018a). It inhibits T effector differentiation by triggering the activity of the mammalian target of rapamycin (mTOR).

3.1.3-Steroid-genesis modulators

It has been found in a study that the three prominent enzymes 3β hydroxysteroid dehydrogenase (HSD), 17β -HSD, and aromatase involved in steroid synthesis can be modulated by Abyssinones and related flavonoids. Flavanones have a stronger affinity for flavanones than chalcones, according to the virtual screening experiment. Flavanones have a constant binding affinity for all three enzymes studied and are more effective steroidogenesis modulators in hormone-dependent cancers(Lotha and Sivasubramanian 2018b).

3.1.4-Anti-oxidant activity of flavonoids –

The amount of ROS produced is strongly related to the inflammatory process, which creates oxidative stress, which leads to cancer and degenerative illness. Flavonoids perform a dual role in maintaining the balance of reactive oxygen species (ROS) (Batra and Sharma 2013a). It acts as an anti-oxidant and powerful anti-oxidant in cancer cells and triggers apoptotic pathways in normal conditions. Flavonoids include phenolic hydroxyl, which can bind metal ions and scavenge reactive oxygen species (ROS).

3.2-Alkaloids

Alkaloids are a class of naturally occurring molecules that have a basic nitrogen atom in their structure and are found in plants, fungus, and bacteria. They are present in large quantities in the plants. The term alkaloids were introduced by W. Meisner at the beginning of the nineteenth century to designate the compounds which act as bases. Alkaloids get their name from the word "alkaline," which was once used to denote any nitrogen-containing base. Alkaloids were used by man for the past 3000 years as potions, teas, and medicines but the actual compound was not isolated. In the late nineteenth century, the alkaloids were isolated from plants and it was found that these compounds contain nitrogen and form salts with acid. Most of the alkaloids taste bitter. Quinine has a molar concentration of 1×10 -5, making it one of the most bitter chemicals. It's difficult to categorise alkaloids because they're so numerous and have such a diverse molecular structure. The best way to categorize them is to divide them into families based on the heterocyclic ring they have(Qiu et al. 2014).

3.2.1-Characteristics of alkaloids

The main property of alkaloids that distinguishes them from other compounds in the presence of nitrogen base. An alkaloid, according to Pelletier, is a chemical with a negative oxidation state and a limited distribution across living species. They are characterized as basic chemicals that create salts with acids. In addition to carbon, hydrogen, and nitrogen, most alkaloids contain oxygen in their free state, as salts, or as N oxides in plants. Hemlock contine and tobacco nicotine are two examples of oxygen-free liquids. Colored alkaloids are not rare; berberine is yellow, while sanguinarine salts are copper-red. Alkaloids are soluble in solvents like water, diluted alcohol, and most of organic solvents(Yan et al. 2021). Alkaloids are compounds of pharmacological importance. These compounds have pharmacological importance and are used in the treatment of various diseases. They have anticancer, antiviral, antifungal, and antiviral activity which makes them biologically important molecules. Some of the alkaloids are toxic in nature having a killing effect if they are consumed. Photoberberine alkaloids present in plants are used as antiseptic, sedative, etc. Alkaloids also affect the central nervous system(Article et al.).

Some of the methods used to extract alkaloids include paper chromatography, thin-layer chromatography, high-performance liquid chromatography, and gas chromatography. Other

methods include microwave-assisted extraction, ultrasound-assisted extraction, CO2 extraction, and a combination of ultrasound and surfactants for alkaloid extraction(Roy 2017).

3.2.2-Biological roles of alkaloids

Alkaloids have a variety of biological roles for human beings.

Anticancer activity- Vinblastine and vincristine, alkaloids derived from Catharanthus roseus (Apocynaceae), are used to treat patients with leukaemia and Hodgkin's disease. Alkaloids help in the depolymerization of the microtubules that prevent the cancerous cells from dividing. Calcium ions in the body help in signal transduction and help in cellular metabolism. Vinca alkaloids are found to reduce the cellular uptake of the calcium ions in the body which therefore changes the calcium ion concentration in the mitochondria which enhances the release of cytochrome c and reactive oxygen species. Studies have found that curcumin can inhibit the Shh pathway and downregulates the Shh protein. Berberine has been shown to inhibit the migration of SW480 and HCT116 cells. Alkaloids isolated from *Emblica Officinalis* fresh ripe fruits have a high cytotoxic and inhibitory effect on gram-positive and negative bacteria (Article et al.).

3.2.3-Antibacterial and antiviral activity-

Yan et al. discovered that isoquinoline alkaloids extracted from *Chelidonium majus* were highly effective against *P. aeruginosa* and sanguinarine was effective against *S. aureus* in a study. Using a waste utilization extraction approach, certain alkaloids may be extracted from the stems and leaves of plant species such as *Sophora flavescens* and *Sophora alopecuroides* which show antimicrobial activity.

3.2.4-Antioxidant activity of alkaloids-

Because of their ability to scavenge free radicals, as well as their excellent metal chelating activity and ability to transfer electrons and hydrogen, alkaloids can act as antioxidants. A quinoline alkaloid isolated from the aleurone layer of *Oryza sativa cv*. Heugjinmi was found to exhibit moderate antioxidative activities using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals as a substrate. Moura et al. discovered the ROS scavenging ability, antimutagenic, and antigenotoxic activities of betacarboline alkaloids, which are widespread in medicinal plants and a variety of foods, using *Saccharomyces cerevisiae* strains and the comet test in the V79

cell line. El-Desouky et al. discovered that pyrrole alkaloids isolated from Arum palaestinum Boiss have a strong DPPH radical scavenging ability, whereas Correche et al. discovered that alkaloids like berberine, canadine, anonaine, and antioquine have the same antioxidant and cytotoxic effects as alpha-tocopherol and Trolox(Article et al.).

3.3-Steroids

Plants have a variety of phytochemicals in them such as steroids, tannins, alkaloids, phenol, flavonoids, resins, and so on. These compounds are called secondary metabolites which basically have a definite structure and have medicinal usesSteroids are distinguishable from the other phytochemicals by their structure, which consists of four carbon rings known as the steroid nucleus. Steroids are classified into different groups based on their chemical makeup. Distinct forms of steroidal compounds are formed when different chemical groups are present at different places in the carbon backbone. Physiologically active steroids are created by the enzymatic conversion of 2,3-epoxysqualene to cycloartenol in plants. Steroids extracted from plants possess a variety of pharmacological, nutraceutical, medicinal and agrochemical uses. Plant steroids have anti-tumor, immunosuppressive, hepatoprotective, antibacterial, plant growth hormone regulators, and sex hormone effects(Heftmann 1975). Cholesterol belongs to the class of sterols which has a long side chain at the C-17 position in its structure. It has a crucial role in both plants and animals. It serves as a starting point for the production of a range of plant steroids. Orchardgrass and other plant species have been used to isolate cholecalciferol. The compounds of biological importance are steroidal sapogenins and alkaloids. They exist in the form of glycosides in plants. Saponins play a very important role in plants by inhibiting root growth and promoting seed germination. The biological actions of glycoalkaloids are remarkably similar to saponins. They are active on the surface. Add sterols to the mix. can result in hemolysis. Degradation of other plant steroids produces analogous chemicals. As a result, we discovered that tomatoes metabolize tomatidine to allopregnanolone in the same way that the basic step in the incomplete production of steroid hormones does. Higher plants also metabolize steroidal sapogenins in this fashion(Patel Assistant Professor et al. 2015).

Table 1- Plants with anti-inflammatory properties and steroidal components

| S.n | Name of plant | Common | Type of steroid | Biological role | References |
|-----|---------------|-----------|-----------------|-----------------------|------------|
| 0 | | name | present | | |
| 1 | Trigonella | Fenugreek | contains | Inflammation, | (Shishodia |
| | foenum | | diosgenin, a | treatment of | and |
| | graecum | | steroidal | rheumatoid arthritis, | Aggarwal |
| | | | saponin | anti-inflammatory | 2006) |
| | | | | activity | |

| 2 | Solanum | Yellow | steroidal | Treatment of | (Govindan |
|---|-------------|--------------|-----------------|------------------------|--------------|
| | xanthocarpu | berried | glycoalkaloids | bronchial asthma, | et al. 1999) |
| | m | nightshade | like | anti-inflammatory | |
| | | | Solasodine | role, anti-allergic | |
| | | | | activity | |
| 3 | Boswellia | Indian | contains | diminishes | (Akamatsu |
| | serrata | frankincense | boswellic acid. | polymorphonuclear, | et al.) |
| | | | Boswellic acid | and inhibits the | |
| | | | is a | classical | |
| | | | triterpenoid | complement system, | |
| | | | | diminishes | |
| | | | | polymorphonuclear | |
| | | | | leukocyte | |
| | | | | infiltration and | |
| | | | | migration, reduces | |
| | | | | primary antibody | |
| | | | | formation, and | |
| | | | | inhibits the classical | |
| | | | | complement system. | |
| 4 | Glycyrrhiza | Licorice | pentacyclic | The anti- | (Dahmen et |
| | glabra | | triterpenoid | inflammatory effect, | al. 2001) |
| | | | | It lowers vascular | |
| | | | | permeability and is | |
| | | | | used to treat lung | |
| | | | | inflammatory | |
| | | | | disorders. | |
| 5 | Commiphora | Guggul | guggulsterone | It has anti- | (Gebhard et |
| | mukul | | | inflammatory | al. 2009) |
| | | | | properties and is | |
| | | | | used to treat | |
| | | | | arthritis. | |

| 6 | Withania | Ashwagandh | Withanolide | anti-inflammatory, | (Peana' et |
|---|-------------|------------|---------------|---------------------|------------|
| | somnifera | a | | anti-stress, | al.) |
| | | | | antioxidant, | |
| | | | | immunomodulatory | |
| | | | | , hemopoietic, and | |
| | | | | regenerative | |
| | | | | qualities | |
| 7 | Smilax | Catbriers | sarsasepogeni | arthritis and | (Mathur et |
| | officinalis | | n | rheumatism, anti- | al. 2006) |
| | | | | inflammatory | |
| | | | | activity, treatment | |
| | | | | of scaling skin | |
| | | | | conditions such as | |
| | | | | psoriasis | |

3.4-Phenols

Phenols are a class of secondary metabolites that contain one or more hydroxyl groups in their aromatic ring. They are classified into two groups based on their ability to dissolve in water. phenolic acids, phenylpropanoids, flavonoids, and quinones are examples of water-soluble phenolic chemicals. Whereas, water-insoluble compounds consist of tannins and lignins. Phenolic chemicals give plants and fruits their distinct taste, flavor, and health-promoting characteristics. Phytochemicals called phenolics are abundant in the plant world and maybe easily be isolated from fruits and vegetables(Li et al. 2015). They perform multiple functions in the plant which include plant growth, development, and providing defense. Phenolic chemicals give the plant its color and flavor. These compounds are also produced in the plant due to the response to some abiotic or environmental stresses such as pollution, light, chilling, etc. These chemicals are also created in plants as a result of regular metabolic processes, and they operate as signaling molecules in plants that regulate physical function. In plants, these phenolic chemicals also have a protective role. They defend plants from bacteria, fungus, viruses, and insects(Ghasemzadeh and Ghasemzadeh 2011).

Consumption of phenolic phytochemical-rich foods has been linked to a variety of health advantages for the human body in both epidemiologic and experimental investigations. People that consume phenolic compounds reap numerous health benefits. Food, nutritional, and medicinal sciences have all been drawn to phenolic phytochemicals. The absorption rate of phenolic compounds is too low in the human body. A nanoparticle delivery system uses nanocarriers to enclose bioactive chemicals and transport them to either improve absorption in the digestive tract through active endocytosis or boost bioactivity in the systemic circulation through selective targeting(Martins et al. 2016). More than 8000 phenolic phytochemicals have been confirmed to exist in various fruits and vegetables, making them the biggest category of phytochemicals. The molecular structure of plant phenolic compounds varies, but they all have hydroxylated aromatic rings Secondary metabolites, such as phenolic chemicals, are poorly known in plants.

Phenolic acids have been shown to have a variety of biological functions. Increases bile output and lowers blood pressure. Some biological functions of phenolic acids include cholesterol and lipid levels, as well as antibacterial activity against bacteria such as *Staphylococcus aureus*.

Phenolic acids also have properties like anti-inflammatory, antispasmodic, antidepressant activities, and anti-tumor activity(Haminiuk et al. 2012).

They play an excellent role as antioxidants. They can contribute an electron, allowing the oxidizable substrate to be converted into less detrimental compounds. The antioxidant capacity of phenolic compounds is greatly influenced by the extraction solvent used, as well as plant origin, growing circumstances, harvesting time, and storage conditions. They believe that free radical scavenging properties prevent the onset of chronic, age-related degenerative diseases, and that dietary antioxidants can help to counteract this and lower disease risk. The study of the antioxidant potential of phenolic extracts obtained from plant species is one of the most popular topics in science; nonetheless, in vitro investigations are the most common. Studies have demonstrated the importance of eating fruits on a regular basis, particularly for improving the quality of life and preventing diseases linked to oxidative stress. Antiviral, antibacterial, and antimicrobial actions are among the other biological effects of phenolic acids(Martins et al. 2016).

Phenolic acids are made through the shikimic acid pathway, which converts phenylalanine to phenolic acid. The production of phenolic compounds is catalyzed by the enzyme phenylalanine ammonia-lyase (PAL). PAL is an important enzyme in the secondary metabolic pathway that leads to the formation of phenolic compounds. Controlling PAL activity appears to be a significant aspect of this pathway's regulation (Tungmunnithum et al. 2018b).

Chapter-4

EXPERIMENTAL

4.1-Chemicals used-

Acetone, 10% aqueous potassium permanganate, 6M sulphuric acid, conc. sulphuric acid, iodine solution, potassium iodide, chloroform, Petroleum ether, methanol, hexane, distilled water.

4.2-Equipments

Test tubes, conical flask, beakers, Whatman filter paper No 42, pipette, measuring cylinder, hot plate, weighing balance, burette, funnel, biological oxygen demand (BOD), Heating mantle, mortar and pestle, cultural tubes, test tube stand, centrifuge, spectrophotometer, spatula, Tissue paper, glass rod, falcon tubes, china dish, aluminum foil, micropipette, tips, cuvette.

4.3-Plant materials

Leaves of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus

4.4-Methodology

4.4.1-Collection of plant material

Plants (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus)

in Delhi Technological University was selected for the collection of leaves. The collection of the plant was done in the month of February. Healthy plants were selected for the collection of leaves. The leaves of the plants were collected and washed to remove latex and dirt.

4.4.2-Drying

Shade dried

After the collection of the leaves of the four selected plants (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) the leaves were washed first with tap water and then with double distilled water to remove dirt. The leaves were then spread evenly on the

newspaper and were shade dried for 7 days at room temperature in the plant biotechnology lab of Delhi Technological University.

The leaves were crushed and finely powdered in a pestle and mortar after seven days to form a thin powder. After that, the powder was placed in a china dish and covered with aluminum foil for further testing.

Sundried

After the collection of the leaves of the four selected plants (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) the leaves were washed first with tap water and then with double distilled water to remove dirt. The leaves were then spread evenly on the newspaper and were shade dried for 7 days in the sun at the Delhi Technological University.

The leaves were crushed and finely powdered in a pestle and mortar after seven days to form a thin powder. After that, the powder was placed in a china dish and covered with aluminum foil for further testing.

Fresh sample preparation

for the production of fresh plant leaf samples (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*). The leaves were freshly picked rinsed with tap water and then with double distilled water to eliminate debris and then thick paste was prepared separately in the grinder. For additional testing, the paste was stored in sealed glass bottles.

4.5-Extract preparation

Shade dried-

- 1- 2g of the finely powdered shade dried leaves of (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) was put on the aluminum foil and was weighed separately on the weighing balance.
- 2- The 2g powder of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) leaves was separately transferred into 4 different conical flasks.
- 3- The 4 different conical flasks were labelled with the black permanent marker with the name of the respective plant species.

- 4- 100ml of double distilled water was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 2g of powdered sample.
- 5- To ensure that the material was thoroughly mixed, the flasks were shaken in a clockwise motion.
- 6- The flasks having the material were then boiled on the heating mantle at 60°C for 5 mins with occasional shaking.
- 7- The heated sample was allowed to cool at room temperature and then it was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 8- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 9- The filtrate was then stored for further phytochemical analysis.

Sundried-

- 1- 2g of the finely powdered sun dried leaves of (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) was put on the aluminum foil and was weighed separately on the weighing balance.
- 2- The 2g powder of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) leaves was separately transferred into 4 different conical flasks.
- 3- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 4- 100ml of double distilled water was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 2g of powdered sample.
- 5- To ensure that the material was thoroughly mixed, the flasks were shaken in a clockwise motion.
- 6- The flasks having the material were then boiled on the heating mantle at 60°C for 5 mins with occasional shaking.
- 7- The heated sample was allowed to cool at room temperature and then it was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 8- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 9- The filtrate was then stored for further phytochemical analysis.

Fresh sample-

- 1- The 10ml of freshly prepared paste of the leaves of (*Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus*) was put in the conical flask and then was separately transferred into 4 different conical flasks.
- 2- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 3- 100ml of double distilled water was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 2g of powdered sample.
- 4- To ensure that the material was thoroughly mixed, the flasks were shaken in a clockwise motion.
- 5- The flasks having the material were then boiled on the heating mantle at 60°C for 5 mins with occasional shaking.
- 6- The heated sample was allowed to cool at room temperature and then it was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 7- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 8- The filtrate was then stored for further phytochemical analysis.

4.6-Phytochemical screening

Qualitative estimation of the phytochemicals in the medicinal plants

Reagents used for phytochemical screening

Wagner's reagent-

2.5 g of iodine and 12.5g of potassium iodide were taken and it was mixed with 250ml of distilled water and the solution was stirred properly.

Preparation of 10% potassium permanganate solution

5g of potassium permanganate powder was mixed with 50ml of distilled water.

Preparation of 6M sulphuric acid

4.2ml of sulphuric acid was mixed with 5.8ml of distilled water.

4.7-Qualitative estimation of Alkaloids

1ml of crude extract of shade dried leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) was taken separately into four different labeled test tubes and then mixed with a few drops of Wagner's reagent (iodine in potassium iodide solution) and then it was allowed to stand for 10 minutes without any disturbance after that result was observed.

4.8-Qualitative estimation of flavonoids

2ml of crude extract of shade dried leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) was taken separately into four different labeled test tubes then 6ml, 6M concentrated sulphuric acid was added after that few drops of potassium dichromate was added slowly from the sidewall of the tube. Then the test tubes were allowed to stand at room temperature for 15 minutes without any disturbance.

5-Phytochemical screening using organic solvents

5.1-Extract preparation

4 different organic solvents (methanol, chloroform, petroleum ether, hexane) were used for the phytochemical screening shade dried, a sundried and freshly prepared paste of the leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus).

Solvent extract preparation

For petroleum ether solvent

- 1- The 1g of shade-dried powder of the leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) was put in the conical flask and then was separately transferred into 4 different conical flasks.
- 2- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 3- 15ml petroleum ether was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 1g of powdered sample.
- 4 To ensure that the material was thoroughly mixed, the flasks were put in the BOD shaker for 48h at 35°C.
- 6- sample was then transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 7- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 8- The filtrate was then stored for further phytochemical analysis.

For n-hexane solvent

1- The 1g of shade-dried powder of the leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) was put in the conical flask and then was separately transferred into 4 different conical flasks.

- 2- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 3- 15ml n-hexane was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 1g of powdered sample.
- 4 To ensure that the material was thoroughly mixed, the flasks were put in the BOD shaker for 48h at 35°C.
- 5- Th sample was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 6- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 7- The filtrate was then stored for further phytochemical analysis.

For Methanol solvent

- 1- The 1g of shade-dried powder of the leaves of (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) was put in the conical flask and then was separately transferred into 4 different conical flasks.
- 2- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 3- 15ml methanol was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 1g of powdered sample.
- 4 To ensure that the material was thoroughly mixed, the flasks were put in the BOD shaker for 48h at 35°C.
- 5- The sample was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 6- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 7- The filtrate was then stored for further phytochemical analysis.

For chloroform solvents

- 1-- The 1g of shade-dried powder of the leaves of (Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus) was put in the conical flask and then was separately transferred into 4 different conical flasks.
- 2- The 4 different conical flasks were labeled with the black permanent marker with the name of the respective plant species.
- 3- 15ml chloroform was taken in the measuring cylinder and then it was put separately into the 4 different conical flasks having 1g of powdered sample.
- 4 To ensure that the material was thoroughly mixed, the flasks were put in the BOD shaker for 48h at 35°C.
- 5- The sample was transferred into the falcon tubes and centrifuged at 40000rpm for 10mins in the centrifuge.
- 6- The centrifuged sample was then filtered in the conical flask using Whatman filter paper.
- 7- The filtrate was then stored for further phytochemical analysis.

The same phytochemical tests for the presence of alkaloid and flavonoid were performed on the collected filtrate of (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) leaves in 4 different organic solvents.

6-Results

Phytochemical screening for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) plants when water was used as the solvent.

The appearance of blue-green color confirmed the presence of flavonoids in the shade dried leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the shade dried leaf extract of *Solanum lycopersicum and Mentha piperita* which confirmed the presence of alkaloids in the plant sample.

Shade dried-

Table 2- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus*) plants using water as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference | |
|------|------------------|------------|--|-----------|------------------------------|--|
| 1 | Mentha piperita | + | The appearance of blue-green color (flavonoids), | + | Reddish-brown ppt(alkaloids) | |
| 2 | Mangifera indica | + | The appearance of blue-green color (flavonoids), | - | | |

| 3 | Solanum lycopersicum | + | The appearance of blue-green color (flavonoids) | + | Reddish-brown alkaloids) | ppt(| |
|---|-------------------------|---|---|---|--------------------------|------|--|
| 4 | Helianthus annuus | + | The appearance of blue-green color (flavonoids) | - | | | |

Fig 5- flavonoids in leaf extract of shade dried *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*.



FigA- flavonoids in Mangifera indica



FigB- flavonoids in *H.annuus*



FigC- flavonoids in Mentha piperita



FigD-flavonoids in Solanum lycopersicum

Fig 6- alkaloids in leaf extract of shade dried *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*.



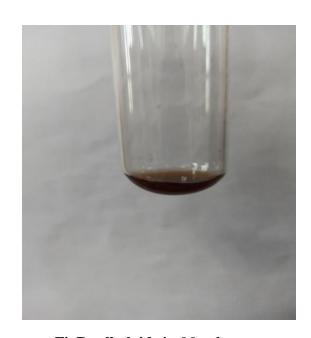
 ${\bf Fig A-alkaloids\ in\ } \textit{M.indica}$



FigB- alkaloids in S. lycopersicum



FigC- alkaloids in *H.annuus*



FigD- alkaloids in Mentha. p

Sundried-

The appearance of blue-green color confirmed the presence of flavonoids in the sun dried leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the sun dried leaf extract of *Solanum lycopersicum and Mentha piperita* which confirmed the presence of alkaloids in the plant sample.

Table 3- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus*) plants using water as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|---|-----------|----------------------------------|
| 1 | Mentha piperita | + | The appearance of blue-green color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 2 | Mangifera indica | + | The appearance of blue-green color (flavonoids) | - | |
| 3 | Solanum lycopersicum | + | The appearance of blue-green color | + | Reddish-brown ppt(alkaloids) |

| | | | (flavonoids) | | |
|---|----------------------|---|------------------------------|---|--|
| 4 | Helianthus annuus | + | The appearance of blue-green | - | |
| | | | color (flavonoids) | | |

Fig 7- flavonoids in leaf extract of sundried *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*.



FigA flavonoids in sundried Mangifera indica

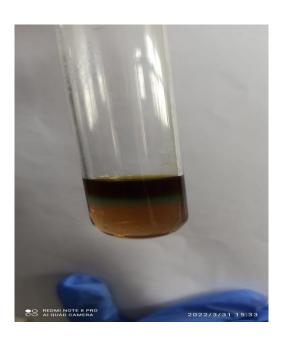


Fig B- flavonoid in sundried S. lycopersicum



Fig C-flavonoid in sundried M. piperita

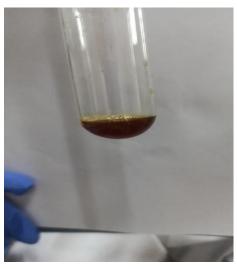


FigD-flavonoid in sundried Solanum.l

Fig 8- Alkaloids in leaf extract of sundried Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



FigA-alkaloids in sundried M. indica



FigB- alkaloids in sundried S. lycopersicum



FigC- alkaloids in the sundried sample of Mentha piperita



FigD- alkaloid in sundried *Helianthus annuus*

Fresh sample

The appearance of blue-green color confirmed the presence of flavonoids in the fresh leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the fresh leaf extract of *Solanum lycopersicum and Mentha piperita* which confirmed the presence of alkaloids in the plant sample.

Table 4- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) plants using water as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|--|-----------|----------------------------------|
| 1 | Mentha piperita | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 2 | Mangifera indica | + | The appearance of bluegreen color (flavonoids) | - | |
| 3 | Solanum lycopersicum | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |

| 4 | Helianthus | + | The | - | |
|---|------------|---|--------------|---|--|
| | annuus | | appearance | | |
| | | | of blue- | | |
| | | | green color | | |
| | | | (flavonoids) | | |

Fig 9- flavonoids in leaf extract of fresh sample of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



FigA- flavonoids in a fresh sample of sample of H.annuus



FigB- flavonoids in a fresh sample Solanum lycopersicum



FigC- flavonoids in a fresh sample of Mentha piperita



FigD-flavonoids in fresh sample M.indica

Fig 10- alkaloids in leaf extract of fresh sample of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.

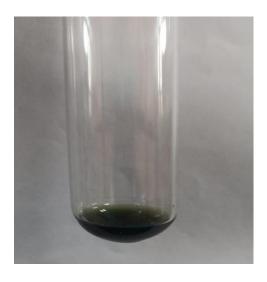


Fig A- alkaloids in a fresh sample of Solanum lycopersicum



Fig B- alkaloids in a fresh sample of Mentha piperita

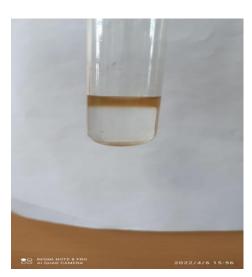


Fig C- alkaloids in a fresh sample of *M.indica*



Fig D- alkaloids in a fresh sample of *Helianthus annuus*

Phytochemical screening for the presence of alkaloids, flavonoids, and phenol in (*Solanum lycopersicum*, *Helianthus annuus*) plants using organic solvents (methanol, chloroform, petroleum ether, hexane).

The appearance of blue-green color confirmed the presence of flavonoids in the methanolic leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the methanolic leaf extract of *Solanum lycopersicum*, *Mentha piperita*, *M.indica* which confirmed the presence of alkaloids in the plant sample.

Methanol -

Table 5- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) plants using methanol as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|---|-----------|----------------------------------|
| 1 | Solanum lycopersicum | + | The appearance of blue-green color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 2 | Helianthus annuus | + | The appearance of blue-green color (flavonoids) | - | |
| 3 | Mentha piperita | + | The appearance of blue-green color (flavonoids) | + | Reddish-brown ppt(alkaloids) |

| 4 | Mangifera indica | + | The appearance of blue-green | + | Reddish-brown alkaloids) | ppt(|
|---|---------------------|---|------------------------------|---|--------------------------|------|
| | | | color | | , | |
| | | | (flavonoids) | | | |

Fig 11- flavonoids in methanolic leaf extract of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



Fig A- flavonoid in the methanolic extract of *Mangifera indica*



Fig B- flavonoid in the methanolic extract of *H.annuus*



Fig C- flavonoid in the methanolic extract of Solanum lycopersicum



Fig D- flavonoid in the methanolic extract of *Mentha piperita*

Fig 12-Alkaloids in methanolic leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



Fig A- alkaloid in the methanolic extract of *M.indica*

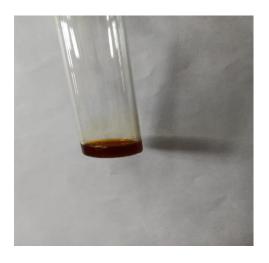


Fig B- alkaloid in the methanolic extract of *Mentha piperita*

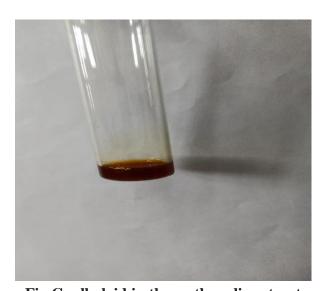


Fig C- alkaloid in the methanolic extract of Solanum lycopersicum

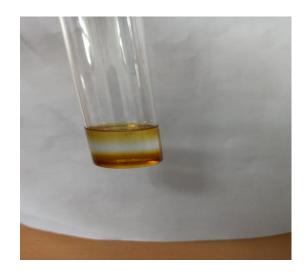


Fig D- alkaloid in the methanolic extract of *H.annuus*

Chloroform-

The appearance of blue-green color confirmed the presence of flavonoids in the chloroform leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the chlororform leaf extract of *Solanum lycopersicum*, *Mentha piperita*, *M.indica* which confirmed the presence of alkaloids in the plant sample.

Table 6- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus*) plants using chloroform as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|--|-----------|----------------------------------|
| 1 | Solanum lycopersicum | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 2 | Mentha piperita | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 3 | Helianthus annuus | + | The appearance of bluegreen color (flavonoids) | - | |

| 4 | Mangifera | + | The | + | Reddish-brown |
|---|-----------|---|--------------|---|-----------------|
| | indica | | appearance | | ppt(alkaloids) |
| | | | of blue- | | |
| | | | green color | | |
| | | | (flavonoids) | | |

Fig 13-flavonoids in chloroform leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.

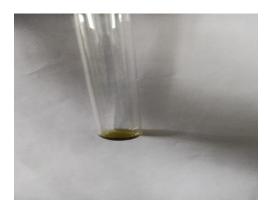


Fig A- flavonoid in the chloroform extract of *Mangifera indica*



Fig B- flavonoid in the chloroform extract of *H.annuus*



Fig C- flavonoid in the chloroform extract of *Solanum lycopersicum*



Fig D- flavonoid in the chloroform extract of *Mentha piperita*

Fig 14-Alkaloids in chloroform leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



Fig A- alkaloid in the chloroform extract of *M.indica*

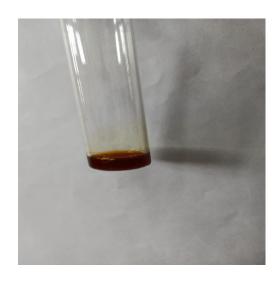


Fig B- alkaloid in the chloroform extract of *Mentha piperita*

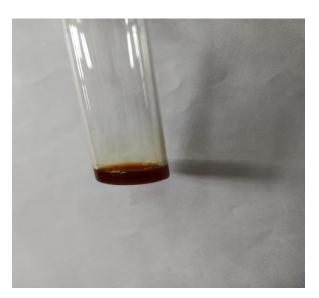


Fig C- alkaloid in the chloroform extract of *Solanum lycopersicum*

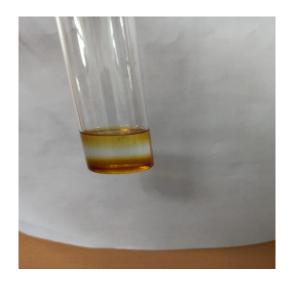


Fig D- alkaloid in the chloroform extract of *H.annuus*

Hexane-

The appearance of blue-green color confirmed the presence of flavonoids in the heaxne leaf extract of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus plants*. The appearance of reddish-brown ppt was observed in the hexane leaf extract of *Solanum lycopersicum*, *Mentha piperita*, *M.indica* which confirmed the presence of alkaloids in the plant sample.

Table 7- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus*) plants using hexane as solvent.

| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|--|-----------|-------------------------------|
| 1 | Solanum lycopersicum | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 2 | Mentha piperita | + | The appearance of bluegreen color (flavonoids) | | |
| 3 | Mangifera indica | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |

| 4 | Helianthus | + | The | + | Reddish-brown |
|---|------------|---|--------------|---|-----------------|
| | annuus | | appearance | | ppt(alkaloids) |
| | | | of blue- | | |
| | | | green color | | |
| | | | (flavonoids) | | |

Fig 15-Alkaloids in hexane leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.



Fig A- alkaloids in the hexane extract of *Mentha piperita*

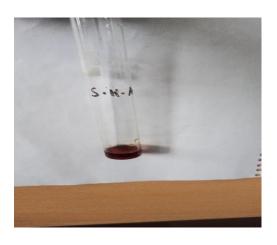


Fig B- alkaloids in the hexane extract of *Solanum lycopersicum*

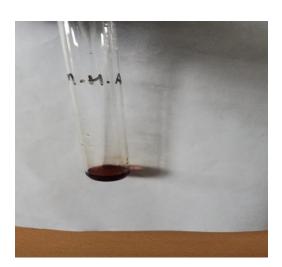


Fig C- alkaloids in the hexane extract of M.indica

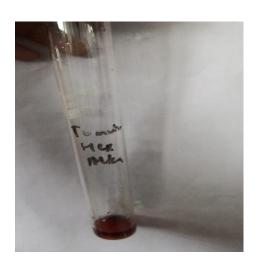


Fig D- alkaloids in the hexane extract of *H.annuus*

Fig 16-Flavonoids in hexane leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.

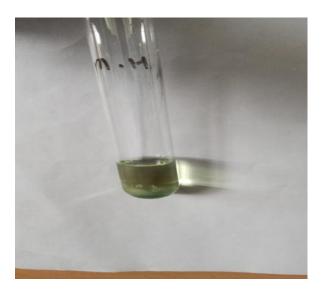


Fig A- flavonoids in the hexane extract of Solanum lycopersicum

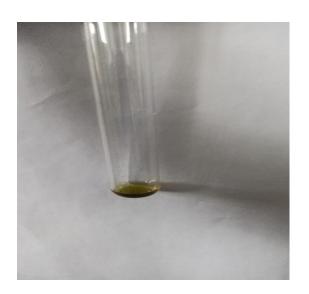


Fig B- flavonoids in the hexane extract of *M.indica*

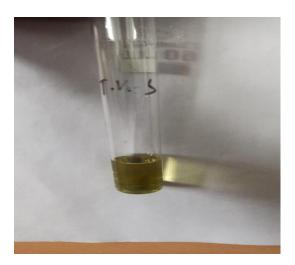


Fig C- flavonoids in the hexane extract of M. *Mentha piperita*

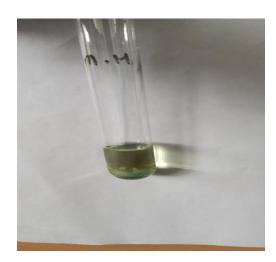


Fig D- flavonoids in the hexane extract of *H.annuus*

Petroleum ether

The appearance of blue-green color confirmed the presence of flavonoids in the petroleum ether leaf extract of *Mentha piperita*, *Helianthus annuus plants*. The appearance of reddishbrown ppt was observed in the petroleum ether leaf extract of *Solanum lycopersicum*, *Mentha piperita*, *M.indica* which confirmed the presence of alkaloids in the plant sample

Table 8- qualitative test for the presence of alkaloids, flavonoids, and phenol in (*Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*) plants using petroleum ether as solvent.

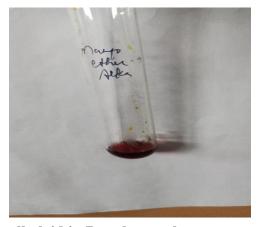
| S.no | Name of plants | Flavonoids | Inference | Alkaloids | Inference |
|------|-------------------------|------------|--|-----------|----------------------------------|
| 1 | Solanum lycopersicum | - | | + | Reddish-brown ppt(alkaloids) |
| 2 | Mentha piperita | + | The appearance of bluegreen color (flavonoids) | + | Reddish-brown ppt(alkaloids) |
| 3 | Mangifera indica | - | | + | Reddish-brown ppt(alkaloids) |

| 4 | Helianthus | + | The | - | |
|---|------------|---|--------------|---|--|
| | annuus | | appearance | | |
| | | | of blue- | | |
| | | | green color | | |
| | | | (flavonoids) | | |

Fig 17 alkaloids in petroleum ether leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.

Fig

A-



alkaloid in Petroleum ether extract of M.indica



Fig B- alkaloid in Petroleum ether extract of Solanum lycopersicum

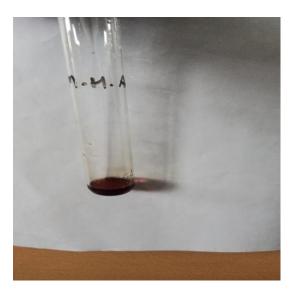


Fig C- alkaloid in Petroleum ether extract of Mentha piperita

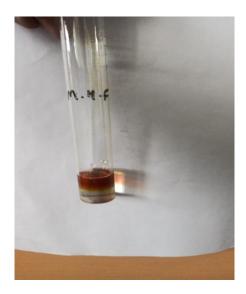


Fig D- alkaloid in Petroleum ether extract of *H.annuus*

Fig 18-flavanoids in petroleum ether leaf extract of of Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus.

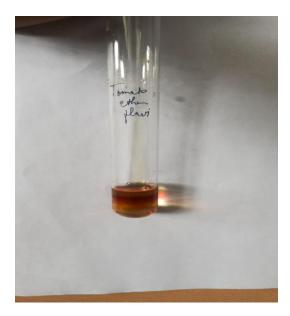


Fig A- flavonoid in the petroleum ether extract of *Solanum lycopersicum*



Fig B- flavonoid in the petroleum ether extract of *M.indica*

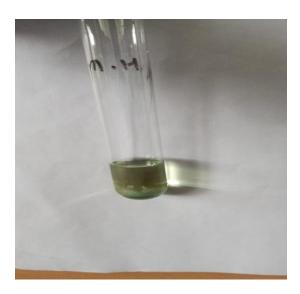


Fig C- flavonoid in the petroleum ether extract of *H.annnus*



Fig D- flavonoid in the petroleum ether extract of *Mentha piperit*

Discussion

Ayurveda is the most traditional form of medicine prevailing in India for thousands of years. The ayurvedic system of medicine aims at promoting, preserving, and sustaining good health and preventing diseases in humans. The term "Ayurveda" means "Science of Life'.

Ayurvedic and herbal treatments were so popular in ancient times. The plant-based natural treatment is still in demand worldwide. Phytochemicals are a class of secondary metabolites that plants make to defend themselves against microorganisms. They have disease-preventive qualities and are non-nutritive in nature. They are produced during plant metabolism. Flavonoids, alkaloids, phenol, tannins, steroids, etc are the types of plant phytochemicals.

In the present study, we performed the qualitative and quantitative phytochemical screening on the leaf extract of four different plants *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus*.

The leaves of *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus* was shade dried and sundried for 7 and 5 days. The leaf extract was then prepared from the powdered plant sample using water solvent. The qualitative test for the phytochemical screening of flavonoids in *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus s*howed a positive result using water as solvent. The alkaloid was present in *Mentha piperita and Solanum lycopersicum* respectively in shade dried, sundried and fresh sample of the plant extract.

The phytochemical screening for the presence of flavonoids in the leaf extract of *Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus* was done using four solvents -hexane, chloroform and methanol, and petroleum ether. They showed positive results Alkaloids were present in all of the plant species except *Helianthus annuus* (in all four solvents hexane, chloroform, petroleum ether, and methanol) and *Mentha piperita* in hexane as the solvent. The appearance of blue-green color confirmed the presence of flavonoids in the methanolic, chloroform, hexane, leaf extract of *Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus plants. Mentha piperita, Helianthus annuus* plants showed positive results for the presence of flavonoids in the petroleum ether extract. The appearance of reddish-brown ppt was observed in the methanolic, chloroform, hexane and petroleum ether leaf extract of *Solanum lycopersicum, Mentha piperita, M.indica* which confirmed the presence of alkaloids in the plant sample

Conclusion

Ayurveda is the most traditional form of medicine prevailing in India for thousands of years. The ayurvedic system of medicine aims at promoting, preserving, and sustaining good health and preventing diseases in humans. It was practiced during the Vedic period of INDIA, according to ancient literature on Ayurveda. During the first millennium BC, the Charaka Samhita and Sushruta Samhita described approximately 700 plants. This system of medicine is also adopted and used in other countries. Up to 50% of herbal treatments approved in the previous three decades have come from natural sources such as plants, microbes, fungus, and animals, either directly or indirectly. Phytochemicals are a class of secondary metabolites that plants make to defend themselves against microorganisms. They have disease-preventive qualities and are non-nutritive in nature. They are produced during plant metabolism. Flavonoids, alkaloids, phenol, tannins, steroids, etc are the types of plant phytochemicals. In the present work, qualitative and quantitative phytochemical analyses of flavonoids and alkaloids were carried out on four plants, Mentha piperita, Mangifera indica, Solanum lycopersicum, Helianthus annuus present in North West part of Delhi (Delhi Technological University). Flavonoids are secondary phenolic compounds present in medicinal plants' fruits, vegetables, grains, bark, roots, stems, and flowers. Flavonoids are secondary phenolic compounds present in medicinal plants' fruits, vegetables, grains, bark, roots, stems, and flowers. Flavonoids have the ability to control tumor formation via regulating signaling molecules such as VEGF, MMPs, ILs, HIF, and others. Alkaloids are the group of naturally occurring compounds present in plants, fungi, and bacteria that contains basic nitrogen atom in their structure. They have anticancer, antiviral, antifungal, and antiviral activity which makes them biologically important molecules. Some of the alkaloids are toxic in nature having a killing effect if they are consumed. Steroids are classified into different groups on the basis of their chemical structure. The presence of different chemical groups at different positions in the carbon backbone leads to the formation of different types of steroidal compounds. Plant steroids produced by the enzymatic conversion of 2,3-epoxysqualene to cycloartenol are further metabolized to yield physiologically active steroids. Steroids extracted from plants possess a variety of pharmacological, nutraceutical, medicinal and agrochemical uses. Antitumor, immunosuppressive, hepatoprotective, antibacterial, plant growth hormone regulator, and sex hormone, are all properties of plant steroids. Phenols are the group of secondary metabolites which have one or more hydroxyl groups in the aromatic ring of their structure.

They are divided into two categories based on their water-soluble capabilities- water-soluble phenolic compounds consist of phenolic acids, phenylpropanoids, flavonoids, and quinones. The qualitative test for the phytochemical screening of flavonoids in *Mentha piperita*, *Mangifera indica*, *Solanum lycopersicum*, *Helianthus annuus s*howed a positive result. The alkaloid was present in *Mentha piperita and Solanum lycopersicum* respectively.

The phytochemical screening revealed the presence of flavonoids in all four solvents hexane, chloroform and methanol, and petroleum ether insoluble fractions. Alkaloids were present in all of the plant species except *Helianthus annuus* (in all four solvents hexane, chloroform, petroleum ether, and methanol) and *Mentha piperita* in hexane as the solvent

References

- 1- Ademosun OT, Adebayo AH, Ajanaku KO (2021) Solanum lycopersicum and Daucus carota: Effective anticancer agents (a mini review). In: Journal of Physics: Conference Series. IOP Publishing Ltd
- 2- Akamatsu H, Asada Y, Niwa Y Mechanism of Anti-Inflammatory Action of Glycyrrhizin: Effect on Neutrophil Functions Including Reactive Oxygen Species Generation
- 3- Akpor O, Olaolu T, Rotimi D (2019) Antibacterial and antioxidant potentials of leave extracts of helianthus annuus. Potravinarstvo Slovak Journal of Food Sciences 13:1026–1033. https://doi.org/10.5219/1228
- 4- Article R, Kaur R, Arora S ALKALOIDS-IMPORTANT THERAPEUTIC SECONDARY METABOLITES OF PLANT ORIGIN
- 5- Balamurugan V, Sheerin FMA, Velurajan S (2019) The development of a methylation-specific PCR test to diagnose high grade serous carcinoma of the ovary/ fallopian tube. View project A GUIDE TO PHYTOCHEMICAL ANALYSIS
- 6- Batra P, Sharma AK (2013a) Anti-cancer potential of flavonoids: recent trends and future perspectives. 3 Biotech 3:439–459. https://doi.org/10.1007/s13205-013-0117-5
- 7- Batra P, Sharma AK (2013b) Anti-cancer potential of flavonoids: recent trends and future perspectives. 3 Biotech 3:439–459. https://doi.org/10.1007/s13205-013-0117-5
- 8- Chahar MK, Sharma N, Dobhal MP, Joshi YC (2011) Flavonoids: A versatile source of anticancer drugs. Pharmacognosy Reviews 5:1–12
- 9- Chanda S, Sumitra Chanda C (2014) Importance of pharmacognostic study of medicinal plants: An overview. ~ 69 ~ Journal of Pharmacognosy and Phytochemistry 2:69–73
- 10- Dahmen U, Gu YL, Dirsch O, et al (2001) Boswellic Acid, a Potent Antiinflammatory Drug, Inhibits Rejection to the Same Extent as High Dose Steroids
- 11- Dawid J (2016) Medicine and Nursing www.iiste.org ISSN
- 12- E. Sulieman AM, E. Abdelrahman S, Abdel Rahim AM (2012) Phytochemical Analysis of Local Spearmint (Mentha spicata) Leaves and Detection of the Antimicrobial Activity of its Oil. Journal of Microbiology Research 1:1–4. https://doi.org/10.5923/j.microbiology.20110101.01
- 13- Gebhard C, Stämpfli SF, Gebhard CE, et al (2009) Guggulsterone, an anti-inflammatory phytosterol, inhibits tissue factor and arterial thrombosis. Basic Research in Cardiology 104:285–294. https://doi.org/10.1007/s00395-008-0757-5
- 14- Ghasemzadeh A, Ghasemzadeh N (2011) Flavonoids and phenolic acids: Role and biochemical activity in plants and human. Journal of Medicinal Plant Research 5:6697– 6703
- 15- Govindan S, Viswanathan S, Vijayasekaran V, Alagappan R (1999) A pilot study on the clinical efficacy of Solanum xanthocarpum and Solanum trilobatum in bronchial asthma
- 16- Greenwell M, Rahman PKSM (2015) Medicinal Plants: Their Use in Anticancer Treatment. Int J Pharm Sci Res 6:4103–4112. https://doi.org/10.13040/IJPSR.0975-8232.6(10).4103-12
- 17- Haminiuk CWI, Maciel GM, Plata-Oviedo MSV, Peralta RM (2012) Phenolic compounds in fruits - an overview. International Journal of Food Science and Technology 47:2023–2044
- 18- Harris KK, Verma D, Sahu M (2017) PHYTOCHEMICAL ANALYSIS OF HELIANTHUS ANNUS LIN., (ANGIOSPERMS: ASTERACEAE PHYTOCHEMICAL ANALYSIS OF HELIANTHUS ANNUS LIN.,

- (ANGIOSPERMS: ASTERACEAE). www.wjpps.com 6:. https://doi.org/10.20959/wjpps20173-8725
- 19- Heftmann E (1975) FUNCTIONS OF STEROIDS IN PLANTS*. Pergamon Press. Printed in England
- 20- Helen PAM, Aswathy MR, Deepthi KG, et al (2013) PHYTOCHEMICAL ANALYSIS AND ANTICANCER ACTIVITY OF LEAF EXTRACT OF MANGIFERA INDICA (KOTTTUKONAM VARIKA). IJPSR 4:819–824
- 21- Jaiswal SS (2016) EVALUATION OF ANTIBACTERIAL POTENTIAL AND PHYTOCHEMICAL STUDIES OF MANGIFERA INDICA L. LEAVES
- 22- Kumar M, Saurabh V, Tomar M, et al (2021) Mango (Mangifera indica l.) leaves: Nutritional composition, phytochemical profile, and health-promoting bioactivities. Antioxidants 10:1–23
- 23- Li Z, Jiang H, Xu C, Gu L (2015) A review: Using nanoparticles to enhance absorption and bioavailability of phenolic phytochemicals. Food Hydrocolloids 43:153–164
- 24- Liskova A, Koklesova L, Samec M, et al (2020a) Flavonoids in cancer metastasis. Cancers (Basel) 12:1–29. https://doi.org/10.3390/cancers12061498
- 25- Liskova A, Koklesova L, Samec M, et al (2020b) Implications of flavonoids as potential modulators of cancer neovascularity. Journal of Cancer Research and Clinical Oncology 146:3079–3096
- 26- Liskova A, Koklesova L, Samec M, et al (2020c) Flavonoids in cancer metastasis. Cancers (Basel) 12:1–29. https://doi.org/10.3390/cancers12061498
- 27- Liu HL, Jiang WB, Xie MX (2010) Flavonoids: Recent Advances as Anticancer Drugs
- 28- Lotha R, Sivasubramanian A (2018a) FLAVONOIDS NUTRACEUTICALS IN PREVENTION AND TREATMENT OF CANCER: A REVIEW. Asian Journal of Pharmaceutical and Clinical Research 11:42. https://doi.org/10.22159/ajpcr.2017.v11i1.23410
- 29- Lotha R, Sivasubramanian A (2018b) FLAVONOIDS NUTRACEUTICALS IN PREVENTION AND TREATMENT OF CANCER: A REVIEW. Asian Journal of Pharmaceutical and Clinical Research 11:42. https://doi.org/10.22159/ajpcr.2017.v11i1.23410
- 30- Maldonado-Celis ME, Yahia EM, Bedoya R, et al (2019) Chemical Composition of Mango (Mangifera indica L.) Fruit: Nutritional and Phytochemical Compounds. Frontiers in Plant Science 10
- 31- Martins N, Barros L, Ferreira ICFR (2016) In vivo antioxidant activity of phenolic compounds: Facts and gaps. Trends in Food Science and Technology 48:1–12
- 32- Mathur R, Gupta SK, Singh N, et al (2006) Evaluation of the effect of Withania somnifera root extracts on cell cycle and angiogenesis. Journal of Ethnopharmacology 105:336–341. https://doi.org/10.1016/j.jep.2005.11.020
- 33- Mirza B, Croley CR, Ahmad M, et al (2021) Mango (Mangifera indica L.): a magnificent plant with cancer preventive and anticancer therapeutic potential. Critical Reviews in Food Science and Nutrition 61:2125–2151
- 34- Montané X, Kowalczyk O, Reig-Vano B, et al (2020) Current perspectives of the applications of polyphenols and flavonoids in cancer therapy. Molecules 25
- 35- Mosić M, Dramićanin A, Ristivojević P, Milojković-Opsenica D (2021) Extraction as a critical step in phytochemical analysis. J AOAC Int 103:365–372
- 36- Noratto GD, Bertoldi MC, Krenek K, et al (2010) Anticarcinogenic effects of polyphenolics from mango (Mangifera indica) varieties. Journal of Agricultural and Food Chemistry 58:4104–4112. https://doi.org/10.1021/jf903161g
- 37- Panche AN, Diwan AD, Chandra SR (2016) Flavonoids: An overview. Journal of Nutritional Science 5

- 38- Patel Assistant Professor SS, Savjani Assistant Professor JK, Patel SS, Savjani JK (2015) Systematic review of plant steroids as potential anti-inflammatory agents: Current status and future perspectives
- 39- Peana' A 1, Moretti1' MDL, Manconi2 V, et al Anti-Inflammatory Activity of Aqueous Extracts and Steroidal Sapogenins of A gave americana
- 40- Perveen R, Suleria HAR, Anjum FM, et al (2015) Tomato (Solanum lycopersicum) Carotenoids and Lycopenes Chemistry; Metabolism, Absorption, Nutrition, and Allied Health Claims—A Comprehensive Review. Critical Reviews in Food Science and Nutrition 55:919–929. https://doi.org/10.1080/10408398.2012.657809
- 41- Qiu S, Sun H, Zhang AH, et al (2014) Natural alkaloids: Basic aspects, biological roles, and future perspectives. Chinese Journal of Natural Medicines 12:401–406. https://doi.org/10.1016/S1875-5364(14)60063-7
- 42- Ram M, Rao K, Kumar MS, et al (2013) Comparitive study on phytochemicals from leaves of Mentha piperita (Mint), Psidium guajava (Guava) and Moringa oleifera (Drumstick) Some of the authors of this publication are also working on these related projects: herbal medinice standardization View project Standardization and authentication of herbal medicines View project Comparitive study on phytochemicals from leaves of Mentha piperita (Mint), Psidium guajava (Guava) and Moringa oleifera (Drumstick)
- 43- Ribeiro SMR, Schieber A (2010) Bioactive compounds in mango (Mangifera indica L.). In: Bioactive Foods in Promoting Health. Elsevier Inc., pp 507–523
- 44- Romagnolo DF, Selmin OI (2012) Flavonoids and Cancer Prevention: A Review of the Evidence. Journal of Nutrition in Gerontology and Geriatrics 31:206–238. https://doi.org/10.1080/21551197.2012.702534
- 45- Roy A (2017) A review on the alkaloids an important therapeutic compound from plants Green synthesis of nanoparticles View project Molecular docking analysis of plumbagin View project
- 46- Saini N, Gahlawat SK, Lather V (2017) Flavonoids: A nutraceutical and its role as anti-inflammatory and anticancer agent. In: Plant Biotechnology: Recent Advancements and Developments. Springer Singapore, pp 255–270
- 47- Salehi B, Sharifi-Rad R, Sharopov F, et al (2019) Beneficial effects and potential risks of tomato consumption for human health: An overview. Nutrition 62:201–208
- 48- Saxena M, Saxena J, Nema R, et al (2013) Phytochemistry of Medicinal Plants. Journal of Pharmacognosy and Phytochemistry 1:
- 49- Shah K, Patel M, Patel R, Parmar P (2010) Mangifera indica (Mango). Pharmacognosy Reviews 4:42–48
- 50- Shaikh JR, Patil M (2020) Qualitative tests for preliminary phytochemical screening: An overview. International Journal of Chemical Studies 8:603–608. https://doi.org/10.22271/chemi.2020.v8.i2i.8834
- 51- Shishodia S, Aggarwal BB (2006) Diosgenin inhibits osteoclastogenesis, invasion, and proliferation through the downregulation of Akt, IκB kinase activation and NF-κB-regulated gene expression. Oncogene 25:1463–1473. https://doi.org/10.1038/sj.onc.1209194
- 52- Sreekanth D, Devi P (2019) Qualitative and quantitative phytochemical studies of helianthus tuberosus L. ~ 247 ~ Journal of Pharmacognosy and Phytochemistry 8:247–250
- 53- Tungmunnithum D, Thongboonyou A, Pholboon A, Yangsabai A (2018a) Flavonoids and Other Phenolic Compounds from Medicinal Plants for Pharmaceutical and Medical Aspects: An Overview. Medicines 5:93. https://doi.org/10.3390/medicines5030093

- 54- Tungmunnithum D, Thongboonyou A, Pholboon A, Yangsabai A (2018b) Flavonoids and Other Phenolic Compounds from Medicinal Plants for Pharmaceutical and Medical Aspects: An Overview. Medicines 5:93. https://doi.org/10.3390/medicines5030093
- 55- Yadav R, Agarwala M (2011) Phytochemical analysis of some medicinal plants. Journal of Phytology 3:10–14
- 56- Yan Y, Li X, Zhang C, et al (2021) antibiotics Review Research Progress on Antibacterial Activities and Mechanisms of Natural Alkaloids: A Review. https://doi.org/10.3390/antibiotics
- 57- Yao H, Xu W, Shi X, Zhang Z (2011) Dietary flavonoids as cancer prevention agents. Journal of Environmental Science and Health Part C Environmental Carcinogenesis and Ecotoxicology Reviews 29:1–31. https://doi.org/10.1080/10590501.2011.551317
- 58- Yassin MT, Mostafa AA, Al-Askar AA (2020) Anticandidal and anti-carcinogenic activities of Mentha longifolia (Wild Mint) extracts in vitro. Journal of King Saud University Science 32:2046–2052. https://doi.org/10.1016/j.jksus.2020.02.008
- 59- Zumaina Mazumder T, Lal M, Sharma M (2022) Phytochemical properties of some important medicinal plants of north-east India: A brief review. ~ 167 ~ The Pharma Innovation Journal 11:167–175

CANDIDATE'S DECLARATION

I Nidhi Solanki, Roll Number: 2K120/MSCBIO/41, student of M.Sc. Biotechnology, hereby declare that the work which is presented in the Major Project entitled- Estimation of flavonoids and alkaloids in plants in the fulfillment of the requirement for the award of the degree of Master of Science in Biotechnology and submitted to the Department of Biotechnology, Delhi Technological University, Delhi, is an authentic record of my own carried out during the period from February - May 2022, under the supervision of Dr. Navneeta Bharadvaja.

The matter presented in this report has not been submitted by me for the award for any other degree of this or any other Institute/University.

The work has been accepted in SCI/SCI expanded /SSCI/Scopus Indexed Journal OR peer reviewed Scopus Index Conference with the following details:

Title of the Paper: - PHYTOCHEMICALS: OPEN THE NOVEL AVENUES IN CANCER TREATMENT

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CERTIFICATE

I hereby certify that the project dissertation titled "Estimation of Flavonoids and Alkaloids in plants" which is submitted by Nidhi Solanki, Roll number 2k20/MSCBIO/41, Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any degree or diploma to this university or elsewhere.

Place: Delhi

Date: 6 May, 2022

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