Comparative Study of Phytochemical Analysis in Leaves, Buds and Flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

By

HARSHA VARDINI M

(Reg. No: 20PBO006)

The thesis submitted to the

Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641043

In Partial Fulfilment of the Requirement for the degree of

Master of Science in Botany

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Certified as bonafide research work

A. Vijayalakshmi 25/5/22

Signature of the
Head of the Department

A. Vijayalakshmi 25/5/22

Signature of the
Guide

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CHAPTER I

INTRODUCTION

Plants are essential components of nature. Plants occupy a special place in all forms of life. Not only in living forms but also in non-living forms that help humans to live a comfortable life. Medicinal plants act as a combined source of different fields of science while performing various functions. Various chemical reactions occur in plants and also everything in nature is composed of chemicals as in the way plants are composed of phytochemicals. The biologically active chemical compounds which occur naturally in plants are called phytochemicals. Phytochemicals provide various health benefits to mankind.

The phytochemicals protect plants from diseases and other environmental hazards like pollution, external stress, drought and exposure to ultraviolet rays. Phytochemicals contribute to the colour, aroma, flavor and some features of the plant. Phytochemicals have been categorized based on their function, and physical and chemical characteristics. Phytochemicals get accumulated in various parts of the plant body including the parts like leaf, flower, flower bud, root, stem, seed, fruit, etc. (Saxena *et al*., 2013).

A wide range of bioactive chemicals including alkaloids, flavonoids, polyphenols, saponins, terpenoids, carotenoids, tannins, curcumins, and phytosterols have been documented in medicinal plants (Dhivya *et al*., 2017). These active metabolites of natural origin are good candidates for the development of drugs, because being elaborated within the living systems, they are believed to show more similarities to drugs and exhibit more biological friendliness than the synthetic ones (Dias *et al*., 2012).

Medicinal plants are important natural products for a large population, especially because of their use as herbal medicines resulting from traditional knowledge arising from direct contact with nature (Abdala and Carlos, 2020). It is considered one of the strategic materials which play an important role in emphasizing the growth of the economy of a country (Djaafar and Ridha, 2014). Phytochemicals act as medicines and those medicines that are manufactured from the chemicals obtained from plants with medicinal properties are nowadays renowned as green medicine (Chanda, 2014). These green medicines are safer as it is extracted from plant-based products. They create lesser or no side effects. Plant-based medicines are different from synthetic medicines in ways like their origin, not creating any side effects, easy availability, economic friendly, and no harm caused to the human who consumes them and also to the environment after their disposal.

There are two categories of phytochemicals. They are primary and secondary metabolites. Identifying and analysing the phytochemicals helps to study the biologically active compounds present in plants. Those bioactive compounds have various therapeutic properties for various diseases and disorders (Kousalya and Doss, 2020). Primary metabolites are those chemicals present in the plants which get directly involved in the normal physical and metabolical growth, developmental process and proper reproduction. These are chemical compounds that are produced during the growth and development of a plant and are involved in the process of respiration and photosynthesis. Primary metabolites are essential for the existence of the plant. They are also called central metabolites because of the maintenance and regulation of physiological functions. Primary plant metabolites include carbohydrates, amino acids, proteins, etc.

Secondary metabolites are the chemical compounds that are produced by the plant to perform various essential activities like protection, production, etc. These compounds encompass various biological and chemical properties. The absence of secondary metabolites does not lead to the death of the organism but leads to non-compatibility of the plant with its environment. The absence of secondary metabolites also leads to some disorders and minor diseases. Secondary plant metabolites include alkaloids, terpenoids, pigments, phenolics, antibiotics, etc. Phytochemicals not only benefit the plant by providing protection and proper functioning of the plant but also provides human with the necessary nutrients to lead a healthy life. It helps to build a stronger immune system for humans, animals and plants. The phytochemicals have a magnificent ability to repair the damages in the DNA. Some phytochemicals have the potential to stop the growth of cancer cells and also regulate hormones.

Research on plants has tremendously increased all over the world. Many evidences have been collected to reveal the outstanding potential of medicinal plants in the treatment of various diseases and disorders in both traditional and modern medicine systems (Obouayeba *et al*., 2015). The identification and evaluation of the phytochemicals are done by studying the compounds using various methods. The majority of phytochemicals are analysed by qualitative and quantitative screening. Qualitative phytochemical screening shows the presence of the metabolites in the plant sample. Quantitative phytochemical screening shows the amount of the particular phytochemicals present in the plant sample.

Fluorescence is the phenomenon exhibited by different chemical constituents in the plant (Kumar *et al*., 2013). Some components shows fluorescence in the visible range in daylight. Fluorescence is produced by ultraviolet light in many natural products which do not fluoresce in visible light. The substances without fluorescence become fluorescent after the addition of various reagents. Fluorescence analysis is an important parameter for pharmacognostic evaluation (Chanda, 2014).

The present study investigates phytochemical efficiency and medicinal uses of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. *Tecoma stans* L. Juss. ex Kunth (Plate-1 (a)) belongs to the family Bignoniaceae. It is commonly known as yellow elder, yellow trumpet, trumpet bush and trumpet flower. It is a fast-growing small tree or a large shrub that grows to a height of 8 to 10 m and is much branched (Sadananda *et al*., 2011). Leaves are dark green on the upper surface and light green on the lower surface. They are smooth or hairy around veins. Leaves are pinnate and 100 to 200 mm long. Leaves have 5 to 7 leaflets and leaf margins are toothed. The inflorescence is terminal or subterminal with up to 20 showy, yellow flowers which arise in clusters. Fruit is a slender capsule, pointed at the end and 12 to 22 cm long (Bhat, 2019).

The leaf, root, flower, seed, fruit and bark of *Tecoma stans* L. Juss. ex Kunth is a powerful diuretic, vermifuge, antisyphilitic. It is used for digestive problems, control of yeast infections and stomach pain (Bhat, 2019). Leaves act as anthelmintic, antispasmodic, antibacterial, anticancer and heal wound. Flowers are used for antidiabetic, anticancer activities and roots have antibacterial activity (Larbie *et al*., 2019). It also has antioxidant, hypoglycemic, antitumor, free-radical, anti-inflammatory and antimicrobial properties (Verma, 2016).

Moringa oleifera Lam. (Plate-1 (b)) belongs to the family Moringaceae and is commonly known as drumstick, ben oil, miracle tree and horseradish. It is a fast-growing evergreen tree that grows up to 12 m (Patel *et al*., 2014). Leaves are tripinnately compound and 45 cm in length. Leaflets are green, 4 to 6 in pairs, ovate to elliptical, glabrous, 2 to 2.8 cm in length and 0.9 to 1.8 cm wide. The upper surface of the leaflets is darker than the lower surface. The leaflet has an entire margin, round or blunt apex, round base, petiolate, and pedicel 0.3 to 0.7 cm in length. The inflorescence is axillary panicle, 10 to 30 cm long with a spreading pattern. Flowers are fragrant, bisexual, white and 0.7 to 1.6 cm in length and buds are greenish-white in colour. Fruits are capsules with triangular and winged seeds (Singh *et al*., 2020).

PLATE 1

Habitat of *Tecoma stans* L. Juss. ex Kunth

Habitat of *Moringa oleifera* Lam.

Moringa oleifera Lam. acts as an antibiotic, and nutrient supplement with a good source of minerals and vitamins A, B and C. Leaves have antidiabetic and hypocholesterolemic. It regulates thyroid hormones, the central nervous system, digestive system, genito-urinary system and eye metabolism. It is used to treat scurvy and gastric ulcers (Patel *et al*., 2014). Seeds, fruits and pods show antimicrobial and antifungal activities and roots have antispasmodic and antimicrobial activity used for diarrhoea and asthma. (Fahal *et al*., 2018). Leaves are used to suppress tumours in laboratory animals (Ojiako, 2014). *Moringa oleifera* Lam. helps to treat typhoid, diarrhoea, diabetes, hypertension, and gastrointestinal disorder.

Objectives

- To analyse the phytochemicals in leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. using various extracts.
- To estimate the fluorescence characterization in leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

CHAPTER II

REVIEW OF LITERATURE

The given literature investigates the comparative study of phytochemical screening and fluorescence analysis of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. in leaves, buds and flowers.

Ayoola and Adeyeye (2010) observed that phytochemical analysis of green, yellow and brown leaves of *Carica papaya* belonging to the family Caricaceae. The results indicated the presence of saponins, alkaloids and cardiac glycosides.

Javale and Sabnis (2010) determined that the aqueous and methanolic extracts revealed the presence of flavonoids, phenols, saponins and tannins in fruits and leaves of *Emblica officinalis.*

Sivasankari *et al*., (2010) evaluated that the methanol, aqueous, chloroform and petroleum ether leaf extracts of *Caesalpinia pulcherrima* Swartz showed the presence of carbohydrates, terpenoids, betacyanins and quinones and *Caesalpinia bonduc* (L) Roxb showed the presence of carbohydrates, terpenoids and betacyanins in all the extracts.

Chonoko and Rufai (2011) observed that the phytochemical screening of back peel and seeds of *Cucurbita pepo* (pumpkin) against *Staphylococcus aureus* and *Salmonella typhi*. Phytochemical screening showed the presence and absence of components in different parts and different extracts. The methanol seed extract was observed to be more active than ethanol extract with *Salmonella typhi*.

Geetha *et al*., (2011) found that acetone, ethanol, aqueous, benzene, chloroform and petroleum ether leaves and flowers extracts of *Michelia champaca* showed the presence of alkaloids, tannins, glycosides, carbohydrates, amino acids, flavonoids and sterols.

Kala *et al*., (2011) observed that fluorescence characteristics of *Enicostemma littorale* which showed the appearance of green, brown, yellowish green, light green, dark green, dark brown colours, *Euphorbia hirta* which showed the appearance of green, fluorescent green, light green, dark green, and yellowish green colours, *Desmodium laxum* which showed the appearance of green, fluorescent green, light green, dark green, and brown colours and

Tephrosia purpurea which showed the green, fluorescent green, light green, dark green, yellowish green and brown colours.

Arya *et al*., (2012) investigated that the leaf powder of *Psidium guajava* was extracted with petroleum ether, chloroform, ethanol, water and hydroalcohol. Results showed the presence of flavonoids, tannins, triterpenoids, saponins, sterols, alkaloids and carbohydrates.

Bhandary *et* al., (2012) evaluated the preliminary phytochemical screening of ethanolic, aqueous and chloroform extracts of *Punica granatum* peel, fruit and seeds. Results showed the presence of triterpenoids, steroids, glycosides, tannins, carbohydrates and vitamin C in all three parts.

Chiejina and Ukeh (2012) found the phytochemical properties of methanolic extracts in seeds of *Aframomum melegueta* and rhizomes of *Zingiber officinale.* The results showed the presence of tannins, phlobatannins, steroids, terpenes, saponins, flavonoids and alkaloids.

Singh (2012) studied that the leaf, pod, flower, stem and root of *Prosophis juliflora* showed the presence of tannins, phenolics, flavonoids, alkaloids, terpenes, steroids and saponins.

Subashini and Rakshitha (2012) investigated that the methanolic extract of seeds of *Helianthus annuus* L. showed the presence of tannins, saponins, flavonoids, carbohydrates, steroids, fixed oils and fat.

Kuldeep and Pathak (2013) showed that various phytochemicals have been found in various extracts of *Tridax procumbens*.

Parameswari and Ananthi (2013) observed that the phytochemical analysis of *Mukia maderaspatana* L. showed the presence of various phytochemical constituents which are very useful for various treatments.

Kumar *et al*., (2013) evaluated that the fluorescence analysis of leaves of *Lasia spinosa* which showed brown, yellowish brown, brownish black, blackish brown, bluish brown and yellowish black colours under visible light, short UV light (254nm) and long UV light (365nm).

Khan *et al*., (2014) reported that the presence of alkaloids, flavonoids, terpenoids, phenolic compounds, sterols, carbohydrates, glycosides and tannins content in flower extracts of *Lycopersicon esculentum*.

Marimuthu and Ravi (2014) indicated that the aqueous leaf extract of *Parthenium hysterophorus* L. showed the presence of carbohydrates, alkaloids, steroids, glycosides, saponins, proteins, aminoacids, oils, tannins, phenolic compounds and flavonoids.

Soni *et al*., (2014) estimated that the phytochemical analysis of dried fruit of *Ficus carica* (Fig) showed the presence of phenolics, flavonoids, alkaloids, saponins and more carbohydrate and a moderate amount of protein also.

Uddin *et al*., (2014) carried out the phytochemical investigation of leaf petiole of *Pterospermum acerifolium*. Methanolic extract showed the presence of tannins, saponins, steroids, terpenoids, coumarins and betacyanins.

Balabhaskar and Vijayalakshmi (2015) reported that the Phytochemical analysis of *Bauhinia tomentosa* showed the presence of alkaloids, tannins, saponins, flavonoids, quinones, phenols, reducing sugars and calcium oxalate crystals.

Bhushan *et al*., (2015) reported that the petroleum ether, chloroform, ethyl acetate, ethanol and water extracts of *Clerodendrum inerme* leaves revealed the presence of alkaloids, carbohydrates, glycosides, anthraquinones, flavonoids, saponins and steroids.

Gayathri and Kiruba (2015) investigated the fluorescence characters of the leaf powder of *Psidium guajava L* and *Citrus aurantium*. The results showed green, pale green, dark green, brown and yellow colours under different chemical treatments.

Kulkarni *et al*., (2015) reported that the methanol, aqueous and petroleum ether extracts of *Cassia fistula* showed the presence of alkaloids, carbohydrates, glycosides, fats, saponins, tannins, flavonoids, anthraquinones, phenolic compounds, proteins and amino acids.

Adham (2015) evaluated that fluorescence screening of leaves of *Mentha piperita* showed the appearance of green, purple, brown, blue, rose brown, reddish brown, light green, etc, *Mentha longifolia* showed light green, golden red, rosy brown, light brown, yellowish

grey, etc, *Osimum basilicum* showed olive drab, gold, light brown, lavender, yellowish green, purple, colours etc.

Rahman and Hussain (2015) studied the phytochemical and fluorescence analysis in leaves of *Cordia dichotoma* Linn. Phytochemical screening showed the presence of steroid, carbohydrate, alkaloid, saponin, cardiac glycoside, flavonoid and phenolic compounds in methanolic extract. Fluorescence analysis showed greenish-brown, purple, light green, dark green and black colours under visible light and UV light.

Alam and Najum (2015) observed that the fluorescence analysis of *Gaultheria trichophylla* showed the appearance of brown, light green, reddish brown, yellowish brown, dark brown, light brown, pink, pinkish brown, red, greenish brown and light blue colours.

Gopukumar *et al*., (2016) revealed that the abundance of phytochemical constituents in methanolic fruit extracts of *Ficus benghalensis*.

Rashmi *et al.,* (2016) observed that phytochemical screening of ethanolic, methanolic and aqueous leaf extracts of *Murraya koenigii* showed the presence of various phytochemicals in different extracts.

Krishnaveni *et al*., (2016) found that *Loranthus elasticus* showed the presence of amino acids, anthocyanins, coumarins, diterpenes, fatty acids and phytosterols, etc., in various extracts.

Neethu *et al*., (2016) observed that water, alcohol and chloroform extracts of *Annona squamosa* leaves showed the presence of glycosides, alkaloids, oils, saponins and flavonoids.

Sinaga *et al*., (2016) reported that phytochemical analysis of methanol, hexane and acetone bark and seed extracts of *Azadirachta indica* showed the presence of alkaloids, carotenoids, cardiac glycosides, saponins, anthraquinones, polyphenols, flavonoids, phenolic compounds, glycosides and phytosterols.

Ahmad *et al*., (2017) results indicated that the leaves and flowers of *Euphorbia hirta* showed alkaloids, flavonoids, terpenoids, tannins, and carbohydrates content. Leaf extracts showed the presence of saponins content also.

Jimoh *et al*., (2017) revealed that the presence of tannins, saponins, phenolic compounds, terpenoids, glycosides, alkaloids and flavonoids in methanolic extract of

Syzygium aromaticum and presence of tannins, saponins, phenolic compounds, terpenoids, glycosides, alkaloids, flavonoids, phlobatannins, reducing sugars and steroids in aqueous extract.

Rajvanshi and Dwivedi (2017) revealed that the presence of flavonoid, terpenoid, alkaloid, quinones, carbohydrates, tannins and coumarins in fresh and dry flowers and leaves of *Tagetes erecta*.

Ramos and Bandiola (2017) observed that the phytochemical screening of leaf extracts of *Syzygium cumini* showed the presence of alkaloids, glycosides, flavonoids, proteins, phenols, saponins, steroids, triterpenoids, tannins, etc.

Suvarna *et al*., (2017) found that the methanolic leaf extract of *Coldenia procumbens* showed the presence of alkaloids, flavonoids, steroids, terpenoids, amino acids, proteins, phenols and glycosides.

Velaga *et* al., (2017) concluded that the petroleum ether, chloroform and methanol flower extracts of *Moringa oleifera* showed the presence of alkaloids, phytosterol, triterpenoids, phenolic compounds and carbohydrates in all the extracts.

Wagay *et al*., (2017) studied the phytochemical characters of stem and leaf of *Murraya paniculata*. Phytochemical screening done by petroleum ether, benzene, chloroform, acetone, methanol and aqueous extracts. The stem and leaf showed the presence of alkaloids, carbohydrates, steroids, glycosides, saponins, tannins, phenolics, fixed oils, proteins, cardiac glycosides, flavonoids, quinones and coumarins.

Yamuna *et al*., (2017) found that the presence of tannins, phenols and saponins in ethanolic and aqueous extracts of *Gomphrena globosa*. *Gomphrena decumbens* showed the presence of proteins, tannins, phenols and saponins in both the extracts.

Ayeni *et al*., (2018) observed that phytochemical analysis of the aerial parts of *Daucus carota* showed the presence of saponins, flavonoids, tannins, steriods and triterpenes in ethyl acetate, n-hexane and methanol extracts.

Chintalapani *et al*., (2018) studied that the phytochemical screening of *Sesuvium portulacastrum* L. showed the presence of alkaloids, carbohydrates, cardiac glycosides,

flavonoids, phenols, saponins, sterols, terpenoids, quinones, diterpenes and resins in ethanol, methanol, acetone, hexane and diethyl ether solvents.

Karole *et al*., (2018) observed that chloroform, ethyl acetate, ethanol and aqueous extracts of leaf and bark of *Bombax ceiba* showed the presence of phenols, flavonoids, tannins, carbohydrates, saponins, proteins and glycosides.

Rana and Sharma (2018) investigated that the ethanolic and aqueous extracts of seed and pulp of *Tamarindus indica* showed the presence of flavonoids and tannins in the pulp and saponins in the seed.

Tiwari *et al*., (2018) reported that *Achyranthes aspera* leaf showed the presence of alkaloids, flavonoids and coumarins. Inflorescence showed the presence of alkaloids, flavonoids, saponins and coumarins, stem showed the presence of tannins, alkaloids, saponins and coumarin contents. Root showed the presence of tannins, alkaloids and coumarins.

Bhorga and Kamle (2019) determined that chloroform, ethanol, ethyl acetate and aqueous leaf and flower extracts of *Delonix regia* revealed the presence of alkaloids, glycosides, flavonoids, saponins, phenolics, proteins, amino acids and diterpenes. Leaf extracts showed the presence of carbohydrate content also.

Gupta *et al*., (2019) showed the presence of flavonoids, phenols, tannins, cardiac glycosides, alkaloids and coumarins in ethyl acetate extract of *Cymbopogon citratus*.

Indhumathi *et al*., (2019) evaluated the phytochemical analysis of white and red flowers of *Nerium oleander*. The ethanol, acetone and diethyl ether extracts revealed the presence of carbohydrate, reducing sugar, alkaloid, flavonoid, tannin, terpenoid, cardiac glycoside, steroid, leucoanthocyanin and protein in red and white flowers.

Kalebar *et al*., (2019) investigated that the petroleum ether, chloroform, methanol and water extracts of fruits of *Solanum macranthum* showed the presence of alkaloids, flavonoids, glycosides, phenols, saponins, tannins, terpenoids, steroids and carbohydrates.

Kumaresan *et al*., (2019) reported that phytochemical screening of leaves and flowers of *Jasminum multiflorum* carried out with methanol, ethanol, ethyl acetate, chloroform and petroleum ether extracts showed presence of alkaloids, tannins, flavonoids, carbohydrates, sterols, terpenoids, cardiac glycosides, proteins and amino acids. Total flavonoid and phenol content was assessed.

Ogidi *et al*., (2019) studied the phytochemical screening of leaf, stem and root of *Bryophyllum pinnatum* which showed the presence of alkaloids, tannins, flavonoids, saponins, terpenoids, glycosides and phenols.

Yadav and Saravanan (2019) evaluated that the phytochemical analysis of *Curcuma caesia* showed the presence of diterpenes and carbohydrates in chloroform, ethyl acetate, methanol and aqueous extracts and *Curcuma amada* showed the presence of proteins in all the extracts.

Bhutia (2020) reported that the fluorescence analysis of *Ocimum sanctum, Azadirachta indica, Trigonella foenum-graecum, Tinospora cordifolia* and *Gymnema sylvestre* were conducted by using the visible and ultra violet light. Its reveals the various colouration ranges from black to greenish brown with distinct morphological characteristics also.

Kousalya and Doss (2020) observed the phytochemicals and secondary metabolites in leaves of *Artabotrys hexapetalus*. Phytochemical screening revealed the presence of alkaloids, flavonoids, saponins, carbohydrates, proteins, amino acids, phenols, glycosides, tannins, sterols and terpenes in different extracts.

Tiwari and Gupta (2020) studied the preliminary phytochemical screening of bark of *Ficus religiosa*. Petroleum ether, chloroform, methanol and ethanol:water extracts revealed the presence of carbohydrates, glycosides, flavonoids, alkaloids, proteins, amino acids, phytosterol and tannins.

Abbasi and Najam-Us-Saqib (2021) observed the presence of carbohydrates, flavonoids, phenols, tannins, glycosides, proteins, phytosterols and triterpenoids content in buds of *Bauhinia variegata*.

Priya and Sharma (2021) observed the phytochemical analysis of the root, flower and leaf of *Hibiscus rosa-sinensis*. The results revealed that methanolic and aqueous extracts showed the presence of alkaloids, carbohydrates, flavonoids, reducing sugars, polyphenols, cardiac glycosides, phlobatannins, terpenoids, saponins and tannins.

Pandian and Ilango (2022) studied the preliminary phytochemical screening of the leaf of *Huberantha senjiana.* Chloroform, ethyl acetate, n-hexane, isopropyl alcohol and methanol extracts showed the presence of alkaloids, flavonoids, proteins, carbohydrates, etc.

Swarnendu and Nayan (2022) evaluated the phytochemical analysis of the leaf of *Jatropa nana* var. *bengalense* which showed the presence of alkaloids, flavonoids, reducing sugars, tannins, saponins, proteins and lignins in methanol, ethanol and water extracts.

Winka *et al*., (2022) reported that the presence of alkaloids, reducing sugars, tannins, cardiac glyosides, coumarins, phytosterols and flavonoids in ethanolic leaf extracts of *Mimusops elengi* L.

CHAPTER III

MATERIALS AND METHODS

The present investigation was carried out to analyse the presence of phytoconstituents and fluorescence characterization in the leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

Collection of Plant Materials

Tecoma stans L. Juss. ex Kunth (BSI/SRC/5/23/2022/Tech/66) and *Moringa oleifera* Lam. (BSI/SRC/5/23/2022/Tech/67) authenticated at Botanical Survey of India (BSI), Tamil Nadu Agriculture University (TNAU) Coimbatore, India. The leaves, buds and flowers of plants **(Plate 2 & 3)** were collected from Kovaipudur, Coimbatore district, Tamilnadu, India.

Preparation of Plant Extracts

The plant leaves, buds and flowers were collected, washed and dried in shade for two weeks. The dry plant sample was powdered with the help of electric blender. The plant powder sample **(Plate 4 & 5)** is stored in an air tight container. The plant sample is extracted using acetone, chloroform, ethanol and water. The sample is soaked for overnight extraction and filtered with Whatmann No. 1 filter paper.

Phytochemical screening of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

Preliminary phytochemical screening for various primary and secondary plant metabolites were analysed using Harborne (1984) method.

Qualitative Estimation

The extract obtained was then subjected to qualitative chemical tests for identification of various plant constituents present in the crude drug. The extract should be subjected to preliminary phytochemical investigation for detection of the following.

Test for Alkaloids

Mayer's Test: 1 ml of extract was treated with few drops of Mayer's reagent. Appearance of cream coloured precipitate indicates the presence of alkaloids.

Test for Flavonoids

Alkaline Test: 1 ml of extract was treated with 2% sodium hydroxide. Appearance of yellow colour which changes to colourless solution on addition of dilute hydrochloric acid indicates the presence of flavonoids.

Test for Sterols

Libermann Test: To few drops of extract, chloroform, acetic anhydride and concentrated sulphuric acid were added. Appearance of green or greenish blue colour after few minutes indicates the presence of sterols.

Test for Terpenoids

Libermann Test: To few drops of extract, chloroform, acetic anhydride and concentrated sulphuric acid were added. Appearance of dark green colour indicates the presence of terpenoids.

Test for Anthraquinones

Borntrager's Test: To 1g of plant powder, 5 to 10 ml of dilute sulphuric acid is added and is boiled and filtered. The filtrate is treated with chloroform or benzene and then dilute nitric acid is added. Appearance of pink to red colour indicates the presence of anthraquinones.

Test for Anthocyanins

HCL Test: To 2 ml of plant extract, 2 ml of 2N hydrochloric acid is added. Appearance of pink to red colour which changes to purplish blue colour after addition of ammonia indicates the presence of anthocyanins.

Test for Proteins

Xanthoproteic Test: To 1 ml of plant extract, 1 ml of concentrated nitric acid is added. Appearance of yellow colour indicates the presence of proteins.

Test for Phenolic Compounds

Ferric chloride test: 1 ml of the plant extract is treated with 5 % neutral ferric chloride. Appearance of red, blue, green or purple colour indicates the presence of phenolic compounds.

Test for Quinones

HCL Test: A small amount of extract is treated with concentrated hydrochloric acid. Appearance of yellow precipitate indicates the presence of quinones.

Test for Carbohydrates

Molisch's test: To 1ml of extract 2 to 3 drops of Molisch's reagent is added followed by few drops of concentrated sulphuric acid along the sides of the test tube. Appearance of violet or purple or red ring indicates the presence of carbohydrates.

Test for Tannins

Braymer's test: To 1ml of extract few drops of distilled water is added followed by 5% ferric chloride. Appearance of dirty green precipitate indicates the presence of tannins.

Test for Saponins

When 1 ml of extract is shaken with water, formation of foam indicates presence of saponins.

Test for Cardiac Glycosides

Bromine water test: To 1 ml of extract, 1ml of bromine water solution is added. Appearance of yellow precipitate indicates the presence of cardiac glycosides.

Test for Glycosides

NaOH TEST: To 1 ml of extract, 1 ml of aqueous sodium hydroxide was added. Appearance of yellow colour solution indicates the presence of Glycosides.

Test for Lignins

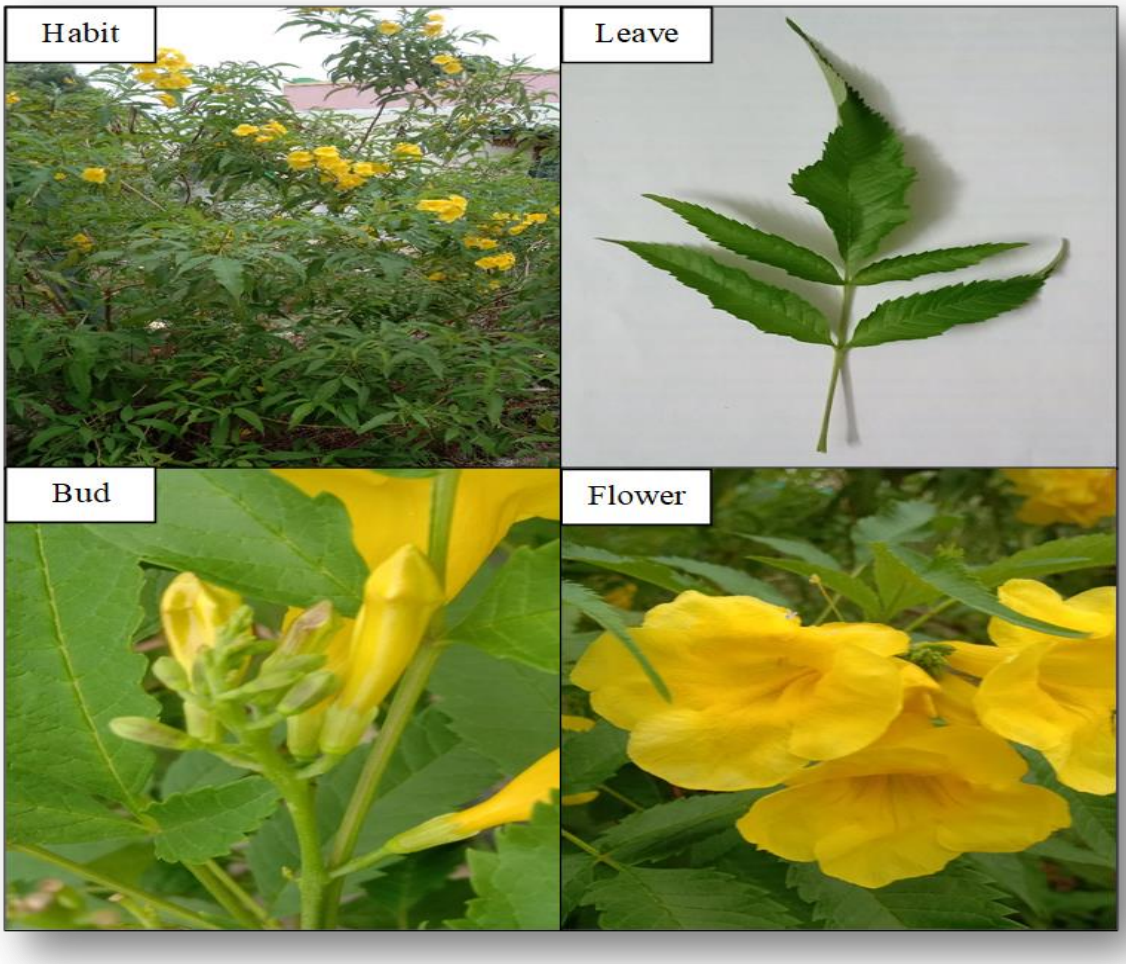
Lebat Test: To 1 ml of extract, 1 ml of gallic acid is added. Appearance of olive green colour indicates the presence of lignins.

Test for Coumarins

To 1 ml of extract, 10% sodium hydroxide and chloroform were added. Appearance of yellow colour indicates the presence of coumarins.

PLATE 2

Tecoma stans L. Juss. ex Kunth.



Taxonomic classification of *Tecoma stans* L. Juss. ex Kunth.

Kingdom : Plantae

Sub Kingdom : Viridiplantae

Division : Tracheophyta

Class : Magnoliopsida

Order : Lamiales

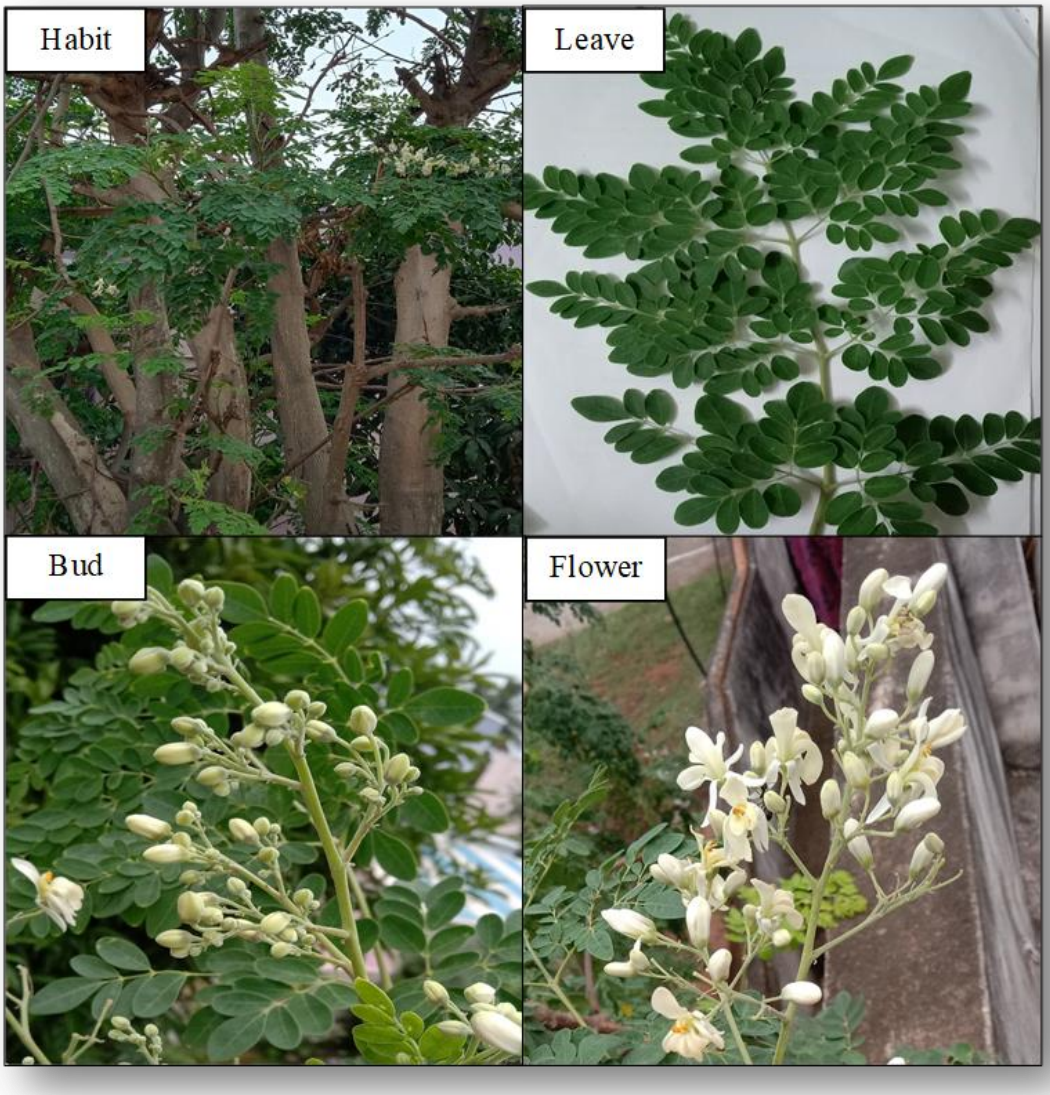
Family : Bignoniaceae

Genus : *Tecoma*

Species : *stans*

PLATE 3

Moringa oleifera Lam.



Taxonomic classification of *Moringa oleifera* Lam.

Kingdom : Plantae

Division : Tracheophyta

Class : Magnoliopsida

Order : Brassicales

Family : Moringaceae

Genus : *Moringa*

Species : *oleifera*

PLATE 4

a - Leaves powder of *Tecoma stans* L. Juss. ex Kunth

b - Buds powder of *Tecoma stans* L. Juss. ex Kunth

c - Flowers powder of *Tecoma stans* L. Juss. ex Kunth

PLATE 5

a - Leaves powder of *Moringa oleifera* Lam.

b - Buds powder of *Moringa oleifera* Lam.

c - Flowers powder of *Moringa oleifera* Lam.

B. Fluorescence characterization of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

The fluorescence analysis of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. extracts (leaves, buds and flowers) were observed under visible light and UV light (245nm). Fluorescence characterization was carried out with ammonia, sodium hydroxide, picric acid, concentrated and dilute sulphuric acid, concentrated and dilute nitric acid, concentrated and dilute hydrochloric acid, ethyl acetate, bromine water, glacial acetic acid, ferric chloride, acetone, ammonium chloride, distilled water. (Koroma *et al*., 2018).

CHAPTER IV
RESULTS AND DISCUSSION

The present investigation explores the secondary metabolites of two medicinal plants *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. that are used in medicine for the treatment of various diseases. The various phytoconstituents can be obtained from leaves, buds and flowers of both the plants which are important biocompounds for mankind.

The results and discussions carried out under the following heads.

A. Preliminary phytochemical screening

B. Fluorescence Analysis

A. Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth

Phytochemical composition in leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth depicted in the Tables I to III.

I. Leaves extract

Presence of different phytochemicals in *Tecoma stans* L. Juss. ex Kunth leaves is shown in Table I. Alkaloids were present in acetone, ethanol, chloroform extracts and absent in aqueous extract. Flavonoids were present in chloroform, acetone and aqueous extracts. Test for the presence of carbohydrate showed positive result in acetone, chloroform and ethanol extracts while tannins, proteins, phenolic compounds and coumarins present in aqueous medium. Anthocyanins, sterols and quinones showed negative results in all the extracts. Terpenoids and anthraquinones only present in ethanolic extract. Lignins and saponins showed positive results only in ethanolic extract. Cardic glycosides were present in ethanol and aqueous extracts and glycosides showed its presence in chloroform and aqueous extracts.

A similar result was reported by Sharma (2012) on preliminary phytochemical screening of leaf extracts of *Aegle marmelos, Annona squamosa, Ficus racemosa, Hibiscus rosa sinensis* and *Psidium guajava* which revealed the presence of different types of compounds like alkaloids, coumarins, flavonoids and steroids that could be responsible for antidiabetic activities.

The present finding was supported by Kaladhar *et al*., (2014) who have carried out phytochemical analysis of raw fruit peel crude extracts of *Annona squamosa* L. The result of phytochemical studies showed the presence of alkaloids, flavonoids, phenols and saponins.

The present finding is in conformity with Silva *et al*., (2017) who found that various phytochemicals like reducing sugars, organic acids, alkaloids, depsides and depsidones, foamy saponins, phenols and tannins in *Tabebuia serratifolia.*

The present finding was supported by Gul *et al.,* (2017) who observed that phytochemical analysis of *Ephedra intermedia* extract evidenced the existence of various bioactive components such as reducing sugars, phenolic compounds, cardiac glycosides, flavonoids, and alkaloids.

A similar result was reported by Souza *et al*., (2020) who found that the presence of various metabolites like total phenols, alkaloids, total flavonoids, saponins, tannins and ascorbic acid in *Chaptalia nutans* (L.).

II. Buds extract

Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth buds is given in Table II. The results showed that alkaloids were present in ethanol, chloroform and acetone extracts and absent in aqueous extract only. Flavonoids were absent in ethanolic extract but positive results showed in other three extracts. Sterols, terpenoids, coumarins, quinones, phenolic compounds and proteins showed positive results in aqueous extract only. Lignins, anthocyanins and saponins were completely absent in the four extracts of *Tecoma stans* L. Juss. ex Kunth. Carbohydrates were present in ethanol, chloroform and acetone extracts. Glycosides were present only in chloroform and acetone extracts. Cardiac glycosides showed positive results in ethanol and aqueous extracts only.

A similar result was reported by Panchal and Parvez, (2019) who confirmed that the *O.sanctum* leaf extract, documented the existence of several phytochemicals like phenols, flavonoids and tannin compounds. The present finding was supported by Dharmapal *et al.,* (2018) who observed that the presence of diverse phytochemicals in stem extracts of *Fibraurea darshani.*

III. Flowers extract

Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth flower extracts results is shown in Table III. Test for the presence of alkaloids and carbohydrates showed positive results in ethanol, chloroform and acetone extracts. Flavonoids were present in chloroform and acetone extracts only. Presence of sterols in ethanolic extract only. However terpenoids and proteins showed their presence in aqueous extract only. Anthraquinones, anthocyanins, phenolic compounds, quinines, lignins and coumarins were absent in all the four extracts.

Test for glycosides showed positive results in acetone and aqueous extracts of *Tecoma stans* L. Juss. ex Kunth flowers.

The present finding is in conformity with Ashfaq *et al*., (2012) who found that the alcoholic and aqueous extracts of *Mentha longifolia* Linn. leaves showed many bioactive chemical constituents like alkaloids, flavonoids, cardiac glycosides, phenolics, saponins and terpenes, but lack proteins and carbohydrates.

Similarly Saidulu *et al*., (2014) revealed the presence of alkaloids, saponins, tannins, flavonoids, terpenoids, coumarins, quinines, cardiac glycosides, xanthoproteins, glycosides, steroids, phenols, resins, carboxylic acid in *Withania somnifera*.

The present observation is in accordance with the findings of Johnsy *et al.,* (2015) who observed the presence or absence of phytoconstituents in leaves and fruits of *Garcinia gummi-gutta* (L.).

Phytochemical analysis of *Moringa oleifera* Lam

Phytochemical composition in leaves, buds and flowers of *Moringa oleifera* Lam. was depicted in Table IV to VI.

I. Leaves extract

This study shows the presence of alkaloids and carbohydrates in ethanol, chloroform and acetone extracts while flavonoids showed positive results in all the four extracts of *M. oleifera* Lam. Proteins were present in acetone extract only. Phenolic compounds and anthraquinones showed positive results only in ethanol and aqueous extracts. Tannins were present in ethanol and aqueous extracts and absent in chloroform and acetone extracts. Terpenoids, anthocyanins, saponins and lignins showed negative results in all the extracts of *Moringa oleifera* Lam. Cardiac glycosides and coumarins were present only in aqueous extract. Glycosides showed positive results in chloroform and aqueous extracts. The result is given in Table IV.

The present finding is in conformity with Rajkumar *et al.,* (2015) who found that the presence of various bioactive components like alkaloids, flavonoids, steroids, glycosides, phenols, saponins, terpenoids, resins, carbohydrates and tannins in methanolic extracts of both leaf and stem bark of *Garcinia imberti*.

The present finding is in accordance with the result of Ranjani Sivapalan (2015) who confirmed that ethanol extract of leaves of *Sida cordifolia* showed the presence of alkaloids, flavonoids, lignins, glycosides, saponins, phytosterols and fixed oils.

The present finding is supported by Jayasudha *et al*., (2016) who confirmed that the presence of phenols, alkaloids, tannins, terpenoids, saponins, steroids, reducing sugars and phlobatannins in methanolic extract of leaf and fruit of *Garcinia gummi-gutta*.

II. Buds extract

Phytochemical analysis in bud of *Moringa oleifera* Lam. results is presented in Table V. It is evident from the results that the presence of alkaloids in ethanol and acetone extracts. Flavonoids showed positive results in all the four extracts (ethanol, chloroform, acetone and aqueous). Sterols and phenolic compounds were present in ethanol and aqueous extracts. Terpenoids, proteins and coumarins were present only in aqueous extract. Test for anthocyanins, anthraquinones, saponins, cardiac glycosides and lignins showed negative results in all the four extracts. Carbohydrate is present in ethanol, chloroform and acetone extracts. Quinones were present only in ethanolic extract.

The result is on par with Ayoola and Adeyeye (2010) who observed the presence of saponins, alkaloids and cardiac glycosides in *Carica papaya.* The result is in agreement with Geetha *et al*., (2011) who reported the presence of alkaloids, tannins, glycosides, carbohydrates, amino acids, flavonoids and sterols in *Michelia champaca* leaves and flowers.

Similar results were obtained by Kumar *et al*., (2013) who reported that leaves of *Lasia spinosa* showed the presence of alkaloids, carbohydrates, flavonoids, glycosides, proteins, saponins, terpenoids and phenolic compounds in petroleum ether, chloroform, ethyl acetate, methanol and aqueous extracts.

Similar work was done by Krishnaveni and Dhanalakshmi (2014) who revealed that the presence of carbohydrates, alkaloids, steroids, glycosides, saponins, proteins, aminoacids, oils, tannins, phenolic compounds and flavonoids in aqueous leaf extract of *Parthenium hysterophorus* L.

The present findings coincide with the results of Gowri *et al*., (2016) who found that the Leaf, stem and flower extracts of *Sphenoclea zeylanica* showed the presence of secondary metabolites such as flavonoids, alkaloids, steroids, etc.

Prakash and Vedanayaki (2019) found that *Zephyranthes citrina* bulb showed the presence of cardiac glycosides, alkaloids, flavonoids, phenolic compounds, terpenoids, saponins, tannins and carbohydrates in aqueous, methanol, acetone, ethyl acetate, chloroform and hexane extracts.

III. Flowers extract

The phytoconstituents in flower extracts of *Moringa oleifera* Lam. results is shown in Table VI. Ethanol, chloroform and acetone extracts showed the presence of alkaloids. Flavonoids were present in ethanol, acetone and aqueous extracts. Alkaloids were absent in aqueous extract and flavonoids were absent in chloroform extract only. Sterols showed positive results in ethanol and aqueous extracts and absent in chloroform and acetone extracts. Terpenoids, proteins, phenolic compounds, tannins, glycosides and coumarins were absent in ethanol, chloroform and acetone extracts and it showed positive results in aqueous extract. Anthraquinones were present in ethanolic extract only.

The present findings coincide with the results of Chintalapani *et al*., (2018) who observed that the presence of alkaloids, carbohydrates, cardiac glycosides, flavonoids, phenols, saponins, sterols, terpenoids, quinones, diterpenes in *Sesuvium portulacastrum* L.

Similarly Karole et al., (2018) found that chloroform, ethyl acetate, ethanol and aqueous extracts of leaf and bark of *Bombax ceiba* showed the presence of phenols, flavonoids, tannins, carbohydrates, saponins, proteins and glycosides.

Yadav and Saravanan (2019) evaluated that phytochemical analysis of *Curcuma caesia* showed the presence of diterpenes and carbohydrates in chloroform, ethyl acetate, methanol and aqueous extracts and *Curcuma amada* showed presence of proteins in all the extracts.

The results were positively correlated with the findings of Indhumathi *et al.,* (2019) who observed that the white and red flowers of *Nerium oleander* showed the presence of carbohydrates, reducing sugars, alkaloids, flavonoids, tannins, terpenoids, cardiac glycosides, steroids, leucoanthocyanins and proteins.

The present findings coincide with the results of Kousalya and Doss (2020) who observed the phytochemicals and secondary metabolites in leaves of *Artabotrys hexapetalus.* Phytochemical screening revealed the presence of alkaloids, flavonoids, saponins, carbohydrates, proteins, amino acids, phenols, glycosides, tannins, sterols and terpenes in different extracts.

Table I

Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth leaves

S. No	Phytochemical constituent	Leaves of *Tecoma stans* L. Juss. Ex Kunth			
		Acetone	Aqueous	Chloroform	Ethanol
1	Alkaloids	+	-	+	+
2	Flavonoids	+	+	+	-
3	Sterols	-	-	-	-
4	Terpenoids	-	-	-	+
5	Anthraquinones	-	-	-	+
6	Anthocyanins	-	-	-	-
7	Proteins	-	+	-	-
8	Phenolic Compounds	-	+	-	-
9	Quinones	-	-	-	-
10	Carbohydrates	+	-	+	+
11	Tannins	-	+	-	-
12	Saponins	-	-	-	+
13	Cardiac Glycosides	-	+	-	+
14	Glycosides	-	+	+	-
15	Lignins	-	-	-	+
16	Coumarins	-	+	-	-

+ positive - negative

Table II

Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth Buds

S. No	Phytochemical constituent	*Tecoma stans* L. Juss. Ex Kunth Buds			
		Acetone	Aqueous	Chloroform	Ethanol
1	Alkaloids	+	-	+	+
2	Flavonoids	+	+	+	-
3	Sterols	-	+	-	-
4	Terpenoids	-	+	-	-
5	Anthraquinones	-	+	-	+
6	Anthocyanins	-	-	-	-
7	Proteins	-	+	-	-
8	Phenolic Compounds	-	+	-	-
9	Quinones	-	+	-	-
10	Carbohydrates	+	-	+	+
11	Tannins	-	+	-	-
12	Saponins	-	-	-	-
13	Cardiac Glycosides	-	+	-	+
14	Glycosides	+	-	+	-
15	Lignins	-	-	-	-
16	Coumarins	-	+	-	-

+ positive - negative

Table III

Phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth flowers

S. No	Phytochemical constituent	Flowers *of Tecoma stans* L. Juss. Ex Kunth			
		Acetone	Aqueous	Chloroform	Ethanol
1	Alkaloids	+	-	+	+
2	Flavonoids	+	+	+	-
3	Sterols	-	+	-	+
4	Terpenoids	-	+	-	-
5	Anthraquinones	-	-	-	-
6	Anthocyanins	-	-	-	-
7	Proteins	-	+	-	-
8	Phenolic Compounds	-	-	-	-
9	Quinones	-	-	-	-
10	Carbohydrates	+	-	+	+
11	Tannins	-	-	-	-
12	Saponins	-	-	-	-
13	Cardiac Glycosides	-	-	-	+
14	Glycosides	+	+	-	-
15	Lignins	-	-	-	-
16	Coumarins	-	-	-	-

+ positive - negative

Table IV

Phytochemical analysis of *Moringa oleifera* Lam Leaves

S. No	Phytochemical constituent	Leaves of *Moringa oleifera* Lam			
		Acetone	Aqueous	Chloroform	Ethanol
1	Alkaloids	+	-	+	+
2	Flavonoids	+	+	+	+
3	Sterols	-	-	-	+
4	Terpenoids	-	-	-	-
5	Anthraquinones	-	+	-	+
6	Anthocyanins	-	-	-	-
7	Proteins	+	-	-	-
8	Phenolic Compounds	-	+	-	+
9	Quinones	-	+	-	+
10	Carbohydrates	+	-	+	+
11	Tannins	-	+	-	+
12	Saponins	-	-	-	-
13	Cardiac Glycosides	-	+	-	-
14	Glycosides	-	+	+	-
15	Lignins	-	-	-	-
16	Coumarins	-	+	-	-

+ positive - negative

Table V

Phytochemical analysis of *Moringa oleifera* Lam Buds

S. No	Phytochemical constituent	**Buds of *Moringa oleifera* Lam**			
		Acetone	**Aqueous**	**Chloroform**	**Ethanol**
1	Alkaloids	+	-	-	+
2	Flavonoids	+	+	+	+
3	Sterols	-	+	-	+
4	Terpenoids	-	+	-	-
5	Anthraquinones	-	-	-	-
6	Anthocyanins	-	-	-	-
7	Proteins	-	+	-	-
8	Phenolic Compounds	-	+	-	+
9	Quinones	-	-	-	+
10	Carbohydrates	+	-	+	+
11	Tannins	-	+	-	+
12	Saponins	-	-	-	-
13	Cardiac Glycosides	-	-	-	-
14	Glycosides	+	+	+	-
15	Lignins	-	-	-	-
16	Coumarins	-	+	-	-

+ positive - negative

Table VI

Phytochemical analysis of *Moringa oleifera* Lam flowers

S. No	Phytochemical constituent	Flowers of *Moringa oleifera* Lam			
		Acetone	Aqueous	Chloroform	Ethanol
1	Alkaloids	+	-	+	+
2	Flavonoids	+	+	-	+
3	Sterols	-	+	-	+
4	Terpenoids	-	+	-	-
5	Anthraquinones	-	-	-	+
6	Anthocyanins	-	-	-	-
7	Proteins	-	+	-	-
8	Phenolic Compounds	-	+	-	-
9	Quinones	-	-	-	-
10	Carbohydrates	+	-	+	+
11	Tannins	-	+	-	-
12	Saponins	-	-	-	-
13	Cardiac Glycosides	-	-	-	-
14	Glycosides	-	+	-	-
15	Lignins	-	-	-	-
16	Coumarins	-	+	-	-

+ positive - negative

Similar results were obtained by Priya and Sharma (2021) who observed the phytochemical analysis of the root, flower and leaf of *Hibiscus rosa-sinensis*. The results revealed that in methanolic and aqueous extracts the presence of alkaloids, carbohydrates, flavonoids, reducing sugars, polyphenols, cardiac glycosides, phlobatannins, terpenoids, saponins and tannins.

Pandian and Ilango (2022) studied the preliminary phytochemical screening of the leaf of *Huberantha senjiana.* Chloroform, ethyl acetate, n-hexane, isopropyl alcohol and methanol extracts showed the presence of alkaloids, flavonoids, proteins, carbohydrates, etc.

B. Fluorescence analysis of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam.

Fluorescence characterization of the leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. was treated with various chemical reagents and observed under visible and ultra violet rays (254 nm). The results are shown in Table VII to XII.

I. *Tecoma stans* L. Juss. ex Kunth

The fluorescence analysis in leaf powder of *Tecoma stans* L. Juss. ex Kunth showed dark brown colour in visible light and light brown colour in UV light**.** When the powdered leaf material was treated with distilled water and ammonia, it showed dark green colour under visible light. Light green colour was shown when treated with ammonia, bromine water and Ferric chloride under UV light. Blackish green colour was observed under visible light when the leaf powder was treated with sodium hydroxide and conc. sulphuric acid. Brownish yellow colour was observed under visible light when the powder was treated with conc. nitric acid and dil. sulphuric acid. Pinkish green colour was shown in UV light when treated with ethyl acetate, acetone and glacial acetic acid.

The fluorescence analysis in buds of *Tecoma stans* L. Juss. ex Kunth showed brownish yellow colour under visible light when the bud powder was treated with distilled water, Picric acid, dil. sulphuric acid, dil. nitric acid, ethyl acetate, bromine water, glacial acetic acid, ferric chloride and acetone and normal powder (without chemical reagents). Golden yellow colour was observed in visible light when the bud powder was treated with conc. sulphuric acid and hydrochloric acid. Light yellow colour was found under visible and UV light when treated with sodium hydroxide and dil. hydrochloric acid.

The fluorescence analysis in flower of *Tecoma stans* showed yellow colour under visible light when the flower powder was treated with ammonia solution, sodium hydroxide, conc. nitric acid, hydrochloric acid, ethyl acetate, bromine water, glacial acetic acid, ferric chloride and ammonium chloride as well as, the powder without any chemical treatment. Bright yellow, golden yellow and reddish yellow colours were observed in visible light when treated with picric acid, conc. sulphuric acid and acetone reagents. The data presented in the Table IX.

II. *Moringa oleifera* Lam

The fluorescence analysis in leaves of *M. oleifera* Lam showed light green colour under visible light when leaf powder was treated with ammonia, dil. nitric acid, dil. hydrochloric acid as well as, the powder without any chemical treatments. When the leaf powder was treated with sodium hydroxide, ethyl acetate, bromine water and ammonium chloride, it showed bright green colour. Fluorescent green colour was observed under UV light when treated with distilled water, conc. sulphuric acid, picric acid and bromine water as well as, the powder without any chemical treatments. The results shown in Table -X.

Green, black, red, olive green and pale green colours were observed under visible light when leaf powder was treated with distilled water, conc. sulphuric acid, conc. nitric acid, conc. hydrochloric acid and dil. sulphuric acid. Brownish red, bright green, fluorescent green, pinkish green, fluorescent blue colours were found in UV light when the leaf powder was treated with conc. nitric acid, conc. sulphuric acid, bromine water, glacial acetic acid and acetone.

The fluorescence analysis in bud of *M. oleifera* Lam (Table XI) showed pale green colour under visible light when the bud powder was treated with dil. sulphuric acid, dil. nitric acid, dil. hydrochloric acid, ethyl acetate, ferric chloride and ammonium chloride. Light yellow colour was shown in visible light when treated with conc. nitric acid as well as, the powder without any chemical treatment. Light green colour was observed in UV light when treated with conc. hydrochloric acid and ferric chloride. Whitish yellow colour was found in UV light when treated with dil. nitric acid and bromine water. White, pale white, light green and pinkish green colours were observed under UV light when the bud of *M. oleifera* Lam was treated with dil. sulphuric acid, dil. nitric acid, ferric chloride and acetone reagents.

The fluorescence analysis in flowers of *M. oleifera* Lam was shown in Table XII. The results showed the presence of pale yellow colour in visible light when treated with dil.

sulphuric acid, dil. nitric acid and bromine water. Light yellow, bright yellow, dark yellow, brownish yellow, orange yellow colours were shown under visible light when the flower powder was treated with distilled water, sodium hydroxide, picric acid, conc. sulphuric acid and glacial acetic acid. Greenish yellow colour was observed in UV light when treated with distilled water, ethyl acetate and glacial acetic acid, acetone and ammonium chloride. Golden yellow, bluish white, brownish green colours were shown under UV light when the flowers of *M. oleifera* were treated with conc. nitric acid, dil. hydrochloric acid and ferric chloride solvents.

The similar work was done by Udayan (2014) who revealed that fluorescence analysis of leaf powder of *Clerodendrum philippinum* showed black, green, yellowish green, pale green and dark green colours under visible and UV light.

The result is in line with the observations of Viji *et al*., (2010) who found that fluorescence analysis in leaf and stem of *cardiospermum helicacabum* showed green, dark green, blackish red, yellow, blackish green, yellowish green, brownish green, dark yellow and brownish yellow colours.

The present finding is in conformity with Gayathri and Kiruba (2015) who found that the fluorescent characters of the leaf of *Psidium guajava L* and *Citrus aurantium* showed green, pale green, dark green, brown and yellow colours under different chemical treatments.

Similar result was obtained by Bhutia (2020) who observed the fluorescence analysis of *Ocimum sanctum, Azadirachta indica, Trigonella foenum-graecum, Tinospora cordifolia* and *Gymnema sylvestre* which showed black to greenish brown colour with distinct morphological characteristics under visible and ultra violet light.

The present investigation is on par with the result of Azizur and Arshad (2015) who confirmed that greenish-brown, purple, light green, dark green and black colours in *Cordia dichotoma* Linn under visible light and UV light.

Similar work was carried out by Rahman and Hussain (2015) who revealed that fluorescence analysis of *Cordia dichotoma* leaves showed greenish-brown, purple, light green, dark green and black colours under visible and UV light.

The present findings are in conformity with the results of Ranjith (2018) who reported that the fluorescence analysis of *Curcuma longa* rhizome, *Murraya koenigii* leaves and

Psidium guajava leaves which showed the appearance of light green, dark green, light blue, dark blue, dark brown, blue, green, brown, fluorescent green, violet, yellow, greenish blue, pale yellow and fluorescent yellow colours.

The results were positively correlated with the findings of Azhagumadhavan *et al*., (2019) who reported that fluorescence analysis of rhizome extract of *Costus spicatus* which showed the appearance of black, brown, light brown, dark brown, creamish yellow, creamish white, yellow and brownish yellow colours.

The present finding observed by with Pakkirisamy *et al.*, (2021) who studies the fluorescence analysis in *Kabasura Kudineer* herbal decoction revealed brown color in 1N HCl, 50% KOH and NaOH, green in 1N NaOH + Methanol, 50% H_2SO_4 and acetic acid, orange in Conc. HNO_3 and 50% HNO_3, colorless in Iodine solution in visible light whereas Light green in 1N HCl and Iodine solution, green in 1N NaOH, 50% H2SO4 and 50% HNO_3, pink in 1N NaOH + Methanol, pale green in Conc. HNO_3 under UV light.

The results coincide with Kamble and Gaikwad, (2019) who studied the fluorescence analysis in leaves and stem of *E. ribes* when treated with different chemical reagents and observed characteristic fluorescent green color when treated with 1N NaOH, 10% HCL, Conc. HCL, Conc. HNO_3, Conc. H_2SO_4, 5% iodine, 5% KOH, 5% $FeCl_3$, acetone and distilled water under short UV light.

The present findings coincide with the results of Swarnendu and Nayan (2022) who observed that the fluorescence characteristics of the leaf powder of *Jatropa nana* var. *bengalense* which showed the green, reddish green, blackish green, greenish black, deep green, reddish orange and fluorescent orange colours.

The results coincide with the finding of Zahid *et al.*, (2016) who studied the fluorescent analysis in flower of *Hibiscus schizopetalus* and *Hisbiscus rosa sinensis* and noted various colour such as purple, dull red (powder), yellow, light yellow (NaOH), Marron, light brown (50 % sulphuric acid), orangish red, yellow (picric acid), green, light green ($FeCl_3$), pink, peach pink (HCl) in visible light and black, reddish red (powder), brown, colorless (NaOH), black, pinkish brown (50 % sulphuric acid), brown, dark green ($FeCl_3$), brown, colorless (HCl) under UV light at 366 nm.

Table VII

Fluorescence analysis in leaves of *Tecoma stans* L. Juss. ex Kunth

S.NO	REAGENT	VISIBLE LIGHT	UV LIGHT
1	Powder (without reagent)	Dark brown	Light Brown
2	Powder + Distilled water	Dark green	Yellowish green
3	Powder + Ammonia solution	Dark green	Light green
4	Powder + Sodium Hydroxide	Blackish green	Dark green
5	Powder + Picric acid	Yellowish green	Brownish green
6	Powder + Conc. H_2SO_4	Blackish green	Dark green
7	Powder + Conc. HNO_3	Brownish yellow	Red
8	Powder + Conc. HCL	Greenish brown	Green
9	Powder + Dil. H_2SO_4	Brownish green	Brown
10	Powder + Dil. HNO_3	Brown	Brownish green
11	Powder + Dil. HCL	Brownish green	Brown
12	Powder + Ethyl Acetate	Black	Pinkish green
13	Powder + Bromine Water	Brown	Light green
14	Powder + Glacial acetic acid	Brownish green	Pinkish green
15	Powder + $FeCl_3$	Brownish yellow	Light green
16	Powder + Acetone	Dark green	Pinkish green
17	Powder + NH_4Cl	Brown	Pale green

Table VIII

Fluorescence analysis in buds of *Tecoma stans* L. Juss. ex Kunth

S.NO	REAGENT	VISIBLE LIGHT	UV LIGHT
1	Powder (without reagent)	Brownish yellow	Brown
2	Powder + Distilled water	Yellowish green	Greenish yellow
3	Powder + Ammonia solution	Yellowish green	Green
4	Powder + Sodium Hydroxide	Light yellow	Greenish yellow
5	Powder + Picric acid	Brownish yellow	Greenish yellow
6	Powder + Conc. H_2SO_4	Reddish black	Dark green
7	Powder + Conc. HNO_3	Golden yellow	Dark yellow
8	Powder + Conc. HCL	Golden yellow	Fluorescent green
9	Powder + Dil. H_2SO_4	Brownish yellow	Greenish yellow
10	Powder + Dil. HNO_3	Brownish yellow	Yellow
11	Powder + Dil. HCL	Dark yellow	Light yellow
12	Powder + Ethyl Acetate	Brownish yellow	Pinkish brown
13	Powder + Bromine Water	Brownish yellow	Bluish brown
14	Powder + Glacial acetic acid	Brownish yellow	Bluish yellow
15	Powder + $FeCl_3$	Brownish yellow	Greenish brown
16	Powder + Acetone	Brownish yellow	Pinkish yellow
17	Powder + NH_4Cl	Brownish yellow	Bluish yellow

Table IX

Fluorescence analysis in flowers of *Tecoma stans* L. Juss. ex Kunth

S.NO	REAGENT	DAY LIGHT	UV LIGHT
1	Powder (without reagent)	Yellow	Yellow brown
2	Powder + Distilled water	Yellowish green	Cream yellow
3	Powder + Ammonia solution	Yellow	Yellow
4	Powder + Sodium Hydroxide	Yellow	Brownish yellow
5	Powder + Picric acid	Golden yellow	Yellowish green
6	Powder + Conc. H_2SO_4	Reddish yellow	Greenish yellow
7	Powder + Conc. HNO_3	Yellow	Reddish yellow
8	Powder + Conc. HCl	Yellow	Fluorescent green
9	Powder + Dil. H_2SO_4	Light yellow	Light green
10	Powder + Dil. HNO_3	Yellow	Fluorescent green
11	Powder + Dil. HCl	Yellow	Greenish yellow
12	Powder + Ethyl Acetate	Yellow	Greenish yellow
13	Powder + Bromine Water	Yellow	Bluish yellow
14	Powder + Glacial acetic acid	Yellow	Bluish green
15	Powder + $FeCl_3$	Yellow	Brownish green
16	Powder + Acetone	Bright yellow	Greenish yellow
17	Powder + NH_4Cl	Yellow	Greenish yellow

Table X

Fluorescence analysis in leaves of *Moringa oleifera* Lam.

S.NO	REAGENT	DAY LIGHT	UV LIGHT
1	Powder (without reagent)	Light green	Fluorescent green
2	Powder + Distilled water	Green	Fluorescent green
3	Powder + Ammonia solution	Light green	Olive green
4	Powder + Sodium Hydroxide	Bright green	Dark green
5	Powder + Picric acid	Yellowish green	Fluorescent green
6	Powder + Conc. H_2SO_4	Black	Fluorescent blue
7	Powder + Conc. HNO_3	Red	Brownish red
8	Powder + Conc. HCl	Olive green	Light green
9	Powder + Dil. H_2SO_4	Pale green	Dark green
10	Powder + Dil. HNO_3	Light green	Pale green
11	Powder + Dil. HCl	Light green	Bright green
12	Powder + Ethyl Acetate	Bright green	Pinkish green
13	Powder + Bromine Water	Bright green	Fluorescent green
14	Powder + Glacial acetic acid	Dark green	Fluorescent pink
15	Powder + $FeCl_3$	Dark green	Light green
16	Powder + Acetone	Dark green	Pinkish green
17	Powder + NH_4Cl	Bright green	Light green

Table XI

Fluorescence analysis in buds of *Moringa oleifera* Lam.

S.NO	REAGENT	DAY LIGHT	UV LIGHT
1	Powder (without reagent)	Light yellow	White
2	Powder + Distilled water	Greenish yellow	Pale green
3	Powder + Ammonia solution	Light green	Whitish yellow
4	Powder + Sodium Hydroxide	Pale yellow	Fluorescent green
5	Powder + Picric acid	Greenish yellow	Light green
6	Powder + Conc. H_2SO_4	Brownish white	Fluorescent green
7	Powder + Conc. HNO_3	Light yellow	Yellow
8	Powder + Conc. HCl	Yellowish green	Light green
9	Powder + Dil. H_2SO_4	Pale green	White
10	Powder + Dil. HNO_3	Pale green	Whitish yellow
11	Powder + Dil. HCl	Greenish white	Yellowish white
12	Powder + Ethyl Acetate	Pale green	Pinkish green
13	Powder + Bromine Water	Greenish yellow	Whitish yellow
14	Powder + Glacial acetic acid	Brownish green	Pale white
15	Powder + $FeCl_3$	Pale green	Light green
16	Powder + Acetone	Greenish yellow	Pinkish green
17	Powder + NH_4Cl	Pale green	Yellowish green

Table XII

Fluorescence analysis in flowers of *Moringa oleifera* Lam.

S.NO	REAGENT	DAY LIGHT	UV LIGHT
1	Powder (without reagent)	Yellow	Pale white
2	Powder + Distilled water	Light yellow	Greenish yellow
3	Powder + Ammonia solution	Yellow	Yellowish green
4	Powder + Sodium Hydroxide	Bright yellow	Fluorescent green
5	Powder + Picric acid	Dark yellow	Brownish green
6	Powder + Conc. H_2SO_4	Brownish yellow	Fluorescent blue
7	Powder + Conc. HNO_3	Yellow	Golden yellow
8	Powder + Conc. HCl	Orange yellow	Greenish yellow
9	Powder + Dil. H_2SO_4	Pale yellow	Whitish yellow
10	Powder + Dil. HNO_3	Pale yellow	Greenish yellow
11	Powder + Dil. HCl	Whitish yellow	Bluish white
12	Powder + Ethyl Acetate	Light yellow	Greenish yellow
13	Powder + Bromine Water	Pale yellow	Whitish yellow
14	Powder + Glacial acetic acid	Bright yellow	Greenish yellow
15	Powder + $FeCl_3$	Brown	Brownish green
16	Powder + Acetone	Dark yellow	Greenish yellow
17	Powder + NH_4Cl	Yellowish white	Greenish yellow

CHAPTER V
SUMMARY AND CONCLUSION

Medicinal plants parts and their parts and products have been successfully used for drug development. In the present study phytochemical analysis and fluorescence characterization of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. leaves, buds and flowers were carried out. The both plants were authenticated at Botanical Survey of India, Tamil Nadu Agriculture University (TNAU) Coimbatore, India.

Phytochemical analysis

The fine powder of leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. extracted in acetone, aqueous, ethanol and chloroform. The *Tecoma stans* leaves results revealed that alkaloids were present in acetone, ethanol, chloroform extracts and flavonoids were present in chloroform, acetone and aqueous extracts. Presence of carbohydrate showed in acetone, chloroform and ethanol extracts while tannins, proteins, phenolic compounds and coumarins were present in aqueous extracts. Anthocyanins, sterols and quinones were absent in all the extracts and the ethanol extract showed the presence of terpenoids, anthraquinones, lignins, saponins and cardiac glycosides.

The bud extracts of *Tecoma stans* showed that alkaloids were present in ethanol, chloroform and acetone extracts. Flavonoids were absent in ethanol extract only but positive results were shown in other three extracts. Sterols, terpenoids, coumarins, quinones, phenolic compounds and proteins showed positive results in aqueous extracts only. Carbohydrates were present in ethanol, chloroform and acetone extracts. Glycosides were present only in chloroform and acetone extracts. Cardiac glycosides showed positive results in ethanol and aqueous extracts. The flowers extracts of *Tecoma stans* showed the presence of alkaloids and carbohydrates in ethanol, chloroform and acetone extracts. Flavonoids were present in chloroform and acetone extracts and presence of sterols was shown in ethanol extract only. Terpenoids and proteins showed their presence in aqueous extract only. The presences of glycosides were found in acetone and aqueous extracts.

Moringa oleifera Lam leaves showed the presence of alkaloids and carbohydrates in ethanol, chloroform and acetone extracts and flavonoids were present in all the four extracts. Ethanol and aqueous extracts showed presence of Phenolic compounds, anthraquinones and tannins in ethanol and aqueous extracts. Presence of cardiac glycosides, and coumarins was shown in aqueous extract. Glycosides showed positive results in chloroform and aqueous extracts. Bud extracts of *Moringa oleifera* Lam. showed the presence of alkaloids in ethanol

and acetone extracts and flavonoids showed positive results in all the four extracts. Ethanol and aqueous extracts showed the presence of sterols and phenolic compounds. Terpenoids, protein and coumarins were present in aqueous extract. Carbohydrate was present in ethanol, chloroform and acetone extracts and quinones were present in ethanol extract. *M. oleifera* Lam flower extracts showed the presence of alkaloids in ethanol, chloroform and acetone extracts and flavonoids were present in aqueous, ethanol, and acetone extracts. Terpenoids, proteins, phenolic compounds, tannins, glycosides and coumarins were present in aqueous extract. Anthraquinones were present in ethanolic extract and sterols showed positive results in ethanol and aqueous extracts.

Fluorescence analysis

The fluorescence analysis of the leaves of *Tecoma stans* L. Juss. Ex Kunth showed dark brown colour in visible light and light brown in UV light when the powder was treated with distilled water and ammonia showed dark green colour under visible light. Ammonia, bromine water and ferric chloride showed light green colour under UV light. Blackish green colour was observed in visible light when the leaf powder was treated with sodium hydroxide and Conc. sulphuric acid. Pinkish green colour was shown in UV light when treated with ethyl acetate, acetone and glacial acetic acid. *Tecoma stans* buds showed brownish yellow colour under visible light when powder was treated with distilled water, Picric acid, dil. sulphuric acid, dil. nitric acid, ethyl acetate, bromine water, glacial acetic acid, ferric chloride and acetone and normal powder. Conc. Sulphuric acid and hydrochloric acid showed golden yellow colour in visible light. Light yellow colour was found under visible and UV light when treated with sodium hydroxide and dil. hydrochloric acid. The fluorescence analysis in flower of *Tecoma stans* showed yellow colour in visible light when the flower powder was treated with ammonia solution, sodium hydroxide, conc. nitric acid, hydrochloric acid, ethyl acetate, bromine water, glacial acetic acid, ferric chloride and ammonium chloride as well as, the powder without any chemical treatment. Picric acid, Conc. sulphuric acid and acetone reagents showed bright yellow, golden yellow and reddish yellow colours under visible light.

The fluorescence analysis in leaves of *M. oleifera* Lam. showed light green colour under visible light when leaf powder was treated with ammonia, dil. nitric acid, dil. hydrochloric acid. Sodium hydroxide, ethyl acetate, bromine water and ammonium chloride showed bright green colour in visible light. When the leaf was treated with distilled water, conc. sulphuric acid, picric acid and bromine water showed fluorescent green colour. Green, black, red, olive green and pale green colours were observed in visible light when the powder

was treated with distilled water, conc. sulphuric acid, nitric acid, conc. hydrochloric acid and dil. sulphuric acid. When the leaf powder treated with conc. nitric acid, conc. sulphuric acid, bromine water, glacial acetic acid acetone showed brownish red, bright green, fluorescent green, pinkish green, fluorescent blue colours under UV light. The bud of *M. oleifera* Lam showed pale green colour under visible light when the bud powder was treated with dil. sulphuric acid, dil. nitric acid, dil. hydrochloric acid, ethyl acetate, ferric chloride and ammonium chloride. Light green colour was observed in UV light when treated with conc. hydrochloric acid and ferric chloride. When the bud was treated with dil. sulphuric acid, dil. nitric acid, ferric chloride and acetone reagents, it showed white, pale white, light green and pinkish green colours under UV light. The presence of pale yellow colour in flowers of *M. oleifera* Lam. when treated with dil. sulphuric acid, dil. nitric acid and bromine water under visible light. Light yellow, bright yellow, dark yellow, brownish yellow, orange yellow colours were shown in visible light when the powder was treated with distilled water, sodium hydroxide, picric acid, conc. sulphuric acid, glacial acetic acid. Distilled water, ethyl acetate and glacial acetic acid, acetone and ammonium chloride showed greenish yellow colour in UV light.

CONCLUSION

The present study is to provide the phytochemical and Fluorescence characteristics of leaves, bud and flower of two medicinal plants *Tecoma stans* L. Juss. ex Kunth and *Moringa oleifera* Lam. The phytochemical analysis of *Tecoma stans* L. Juss. ex Kunth and *M. oleifera* Lam results showed presence of various secondary metabolites such as alkaloids, flavonoids, sterols, terpenoids, anthraquinones, anthocyanins, proteins, carbohydrates, cardiac glycosides, glycosides, etc and it indicate their potential use in drug synthesis and production. Preliminary phytochemical analysis revealed that the secondary metabolites are known to support bioactivity in these plants. The fluorescence analyses for two plants were conducted by using the visible light and ultra violet light at 254 nm. The results showed that leaves, buds and flowers of *Tecoma stans* L. Juss. ex Kunth and *M. oleifera* Lam powder showed varied colours like light green, bright green, black, yellowish green, brownish white, greenish white, golden yellow, bluish white, fluorescent green, etc under different chemical reagents. Fluorescence characters of plants play an important role in the quality and purity of the drug. The present experimental work have a future scope for in-depth study of these two plants for bioactive compounds and their pharmacological activities and evaluations.

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