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PHARMACOGNOSTICAL, PHYTOCHEMICAL AND CARDIOPROTECTIVE ACTIVITY OF *TAMARINDS INDICA* LINN. BARK

S. Chaturvedi, A. Joshi* and B. K. Dubey

Department of Pharmacognosy, TIT College of Pharmacy, Bhopal-462021, Madhya Pradesh, India

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Correspondence to Author:

Amit Joshi

Department of Pharmacognosy, TIT College of Pharmacy, Bhopal-462021, Madhya Pradesh, India

ABSTRACT

Many herbal remedies have been employed in various medicine systems for the treatment and management of the different diseases. The *Tamarinds indica* commonly known as 'imali' has been recognized in different system of traditional medicines for the treatment of different diseases and aliments of human being. This review supports of all updated information on its pharmacognostical, pharmacological activity and traditional uses. Preliminary phytochemical screening of this plant revealed the presences of, flavonoids, steroid, glycoside alkaloid and Triterpenoids. It has been reported as Anti-helminthic, antimicrobial, antiseptic, antiviral, asthma, astringent, bacterial skin infections, constipation (chronic or acute), and diabetes. There is no report available on isolated constituents of bioactive compound from plant bark of *Tamarinds indica* which supports it's further to isolating a useful pharmacologically active compound as a drug.

INTRODUCTION: All over the world, plants were used as main source of medicines by ancestors. The rise of modern Western medicine was initially accompanied by a decline in the practice of herbalism in all cultures and it was believed that synthetic chemicals were best medicines to treat illness and cure disease.

The quest for a healthier lifestyle has made people to once again recognize the healing power of herbs. Even in the west, natural products are now widely available and herbalism is again coming into lime light in a world which is becoming healthier and environmentally conscious. Herbal remedies can work without many of the unpleasant side effects of modern medicines [1].

The World Health Organization (WHO) estimates that about 80% of the population living in the developing countries relies almost exclusively on traditional medicine for their primary health care needs.

Antioxidant: A free radical is any chemical species (capable of independent existence) possessing one or more unpaired electrons, an unpaired electron being one that is alone in an atomic or molecular orbital. Free radicals are formed from molecules via the breakage of a chemical bond such that each fragment keeps one electron (free radicals may also be formed by collision of the non radical species by a reaction between a radical and a molecule - which must then result in a radical since the total number of electrons is odd), by cleavage of a radical to give another radical and, finally via redox reactions.

Three partially reduced species of oxygen are generated depending upon the number of electrons transferred. These are:

Super oxide oxygen (O_2): one electron

Hydrogen peroxide (H_2O_2): two electrons

Hydroxyl radical (OH^-): three electrons

Oxidative stress is the term referring to the imbalance between generation of reactive oxygen species and the activity of the antioxidant defences. The term 'reactive oxygen species' (ROS) and 'reactive nitrogen species' (RNS), is a collective term that includes not only the radicals but also the non-radicals [6].

The major enzymes, constituting the first line of defence, directly involved in the neutralization of ROS/RNS are: Superoxide dismutase (SOD), Catalase (CAT) and glutathione peroxidase (GPx) [8].

The second line of defence is represented by radical scavenging antioxidants such as vitamin C, vitamin A and plant phytochemicals like phenolics (emphasised later in this review) that inhibit the oxidation chain initiation and prevent chain propagation [10].

This may also include the termination of a chain by the reaction of two radicals. The repair and de novo enzymes act as the third line of defence by repairing damage and reconstituting membranes. These include lipases, proteases, DNA repair enzymes and transferases [11].

Cardiovascular Diseases: During the last few decades, research data has prompted a passionate debate as to whether oxidation, or specifically, oxidative stress mediated by free radicals/reactive oxygen species (ROS)/reactive nitrogen species (RNS), is a primary or secondary cause of many chronic diseases. As a result, scientific resources have focused to a large extent on the role that antioxidants could play to delay or prevent oxidative stress and consequently the incidence of chronic disorders. (Wilson Kathleen. 1996)

MATERIAL AND METHODS:

Collection and Identification of the Plant Material: The stem bark of *Tamarindus indica* was collected from the Bhopal in the month of October 2010 and authenticated at Safia collage of science, Bhopal. Voucher specimen no. 236/Bot/Saf/11.

Preparation of *Tamarindus indica* powder: The barks of *Tamarindus indica* was dried in shade and then powder with a mechanical grinder. The powder was passing through sieve no. 60 and stored in a labeled air tight container for further studies.

Physicochemical Studies: Physicochemical studies include loss on drying, ash value and extractive value to determine the quality and purity of the powder of barks of *Tamarindus* [13].

Loss on drying: Accurately weighed quantity of sample was taken in a tarred loss on drying bottle and initial weight was noted. The sample was heated at 105°C in an oven and weighed. This procedure was repeated until a constant weight was obtained. The moisture content of the sample was calculated with reference to crude air dried drug.

Ash Values:

Total Ash Value: Accurately weighed 2 g of air dried sample were taken in a tarred silica dish and incinerated at a temperature not exceeding 650°C until free from carbon. Then cooled and weighed. When a carbon free ash could not be obtained in this way, the charred mass was exhausted with hot water, residue was collected in an ash less filter paper, incinerated the residue along with the filter paper until the ash was white or nearly so, filtrate was added, evaporated to dryness and ignited at a temperature not exceeding 650°C. Percentage of ash value was calculated with reference to the crude air-dried drug [16].

Acid Insoluble Ash: Ash was boiled with 25 ml of 2 M HCl for 5 min; insoluble matter was collected in a Gooch crucible in an ash less filter paper, washed with hot water, ignited, cooled in a dessicator and weighed. Percentage of acid insoluble ash was calculated with reference to the air dried drug [16].

Water Soluble Ash: Ash was boiled for 5 min with 25 ml of water, insoluble matter was collected in a Gooch crucible in an ash less filter paper, washed with hot water and ignited for 15 min at a temperature not exceeding 650°C. Weight of insoluble matter was subtracted from the weight of the ash; the difference in weight represents the water-soluble ash. Percentage of water soluble ash was calculated with reference to the air dried drug [16].

Extractive Values:

Water Soluble Extractives: 5.0 g of air dried plant material was added to 50 ml of boiled water at 80°C in a glass stopper flask. It was shaken well and was

allowed to stand for 10 min, cooled and filtered. The 5 ml of the filtrate was transferred to a tarred evaporating dish, 7.5 cm in diameter, the solvent was evaporated on a water bath, allowed to dry for 30 min, finally dried in an oven for 2 h at 100°C and residue was weighed. Percentage of water soluble extractives was calculated with reference to the crude air dried drug [16].

Alcohol Soluble Extractives: 5.0 g of air dried plant material was macerated with 100 ml of ethanol in a closed flask, shaking frequently during the first 6 h and allowed to stand for 18 h. Thereafter it was filtered rapidly taking precaution against loss of ethanol. 25 ml of filtrate was evaporated to dryness in a tarred flat bottom shallow dish dried at 105°C and weighed. Percentage ethanol soluble extractive was calculated with reference to the crude air dried plant material.

Preliminary Phytochemical Screening: The preliminary phytochemical screenings of various extracts of *Tamarindus indica* [15].

Alkaloids:

Mayer's Test: Alkaloids give cream colour precipitate with Mayer's reagent (potassium mercuric iodide solution).

Dragandroff's Test: Alkaloids give reddish brown precipitate with Dragandroff's reagent (potassium bismuth iodide solution).

Wagner's Test: Alkaloids give a reddish brown precipitate with Wagner's reagent (Solution of iodine in potassium iodide).

Hager's Test: Alkaloids give yellow colour precipitate with Hager's reagent (saturated solution of picric acid).

Glycosides:

General test for the presence of glycosides: Part A: extracted 200 mg of the drug by warming in a test tube with 5 ml of dilute (10%) sulphuric acid on a water bath at 100°C for 2 min, centrifuge or filter, pipette off supernatant or filtrate. Neutralize the acid extract with 5% solution of Sodium hydroxide (noting the volume of NaOH added). Added 0.l ml of Fehling's solution A and then B until alkaline (test with pH paper) and heat on a water bath for 2 min. Noted the quantity of red precipitate formed and compare with that formed in Part -B.

Part B: extracted 200 mg of the drug using 5 ml of water instead of sulphuric acid. After boiling add volume of water equal to the volume of NaOH used in the above test. Add 0.l ml of Fehling's solution A and B until alkaline (test with pH paper) and heat on water bath for 2 min. noted the quantity of red precipitate formed.

Compare the quantity of precipitate formed in Part-B with that of formed in Part-A. If the precipitate in Part-A was greater than in Part-B then Glycoside may be present. Since Part-B represents the amount of free reducing sugar already present in the crude drug. Whereas Part-A represents free reducing sugar plus those related on acid hydrolysis of any sides in the crude drug [15].

Saponin glycosides:

Froth Test: Placed 1 ml solution of drug in water in a semi micro tube shake well and note the stable froth.

Anthraquinone glycosides:

Borntrager's Test: Boiled test material with 1.0 ml of dil. sulphuric acid in a test tube for 5 min (anthracene glycosides are hydrolyzed to aglycone and sugars by boiling with acids) centrifuge or filter while hot (if centrifuged hot, the plant material can be removed while anthracene aglycones are still sufficiently soluble in hot water, they are however insoluble in cold water), pipette out the supernatant or filtrate, cool and shake with an equal volume of dichloromethane (the aglycones will dissolve preferably in dichloromethane) separate the lower dichloromethane layer and shake with half its volume with dilute ammonia. A rose pink to red colour is produced in the ammonical layer (aglycones based on anthroquinones give red colour in the presence of alkali).

Modified Borntrager's Test: Boiled 200 mg of the test material with 2 ml of dilute sulphuric acid, 2 ml of 5% aqueous ferric chloride solution for 5 min and continued the test as above. As some plant contain anthracene aglycone in a reduced form, if ferric chloride was used during the extraction, oxidation to

anthroquinones took place, which showed response to the Borntrager's test.

Cardiac glycosides:

Kedde's Test: Extracted the drug with chloroform, evaporated to dryness, added one drop of 90% alcohol and 2 drops of 2% 3, 5-dinitro benzoic acid (3, 5-dinitro benzene carboxylic acid Kedde's reagent) in 90% alcohol, made alkaline with 20% sodium hydroxide solution. A purple colour was produced if cardiac glycosides are present. The colour reaction with 3, 5-diinitrobenzoic acids depends upon the presence of α, β-unsaturated-o- lactones in the aglycone.

Keller Killiani Test (Test for deoxy sugars): Extracted the drug with chloroform and evaporated it to dryness, added 0.6 ml of glacial acetic acid containing a trace amount of ferric chloride. Transferred to a small test tube; added carefully 0.5 ml of concentrated sulphuric acid by the side of the test tube, blue color appears in the acetic acid layer if cardiac glycoside was present.

Cyanogenetic glycosides: Placed 200 mg of drug in a conical flask and moisten with few drops of water, there should be no free liquid at the bottom of the flask (the test will not work if there is any liquid in the flask as the hydrogen cyanide produced will dissolve in the water rather than, come off as a gas to react with the paper). Moisten a piece of picric acid paper with sodium carbonate solution (5% aqueous) and suspended by means of cork in the neck of the flask, warm gently at about 37°C. Observe the change in colour. Hydrogen cyanide is liberated from cyanogenetic glycoside by the enzyme activity and reacts with sodium picrate to form the reddish purple sodium isopicrate.

Tannins and Phenolic Compounds:

Gelatin Test: Extract with 1% gelatin solution containing 10% sodium chloride gives white precipitate.

Ferric chloride Test: Test solution gives blue green color with ferric chloride.

Vanillin hydrochloride Test: Test solution when treated with few drops of vanillin hydrochloride reagent gives purplish red color.

Tannins get precipitated in the solution when treated with heavy metals. Tannins yield bulky precipitate with phenazone especially in the presence of sodium and phosphate.

Alkaline reagent test: Test solution with sodium hydroxide solution gives yellow to red precipitate within short time.

Mitchell's test: With iron and ammonium citrate or iron and sodium tartarate. Tannins give a water soluble iron tannin complex, which is insoluble in solution of ammonium acetate [15].

Flavonoids:

Shinoda Test:

(**Magnesium hydrochloride Reduction Test**): To the test solution add few fragments of magnesium ribbon and add conc. hydrochloric acid drop wise, pink scarlet, crimson red or occasionally green to blue colour appears after few min.

Zinc hydrochloride Reduction Test: To the test solution add a mixture of zinc dust and conc. hydrochloric acid. It gives red colour after few minutes.

Alkaline Reagent Test: To the test solution add few drops of sodium hydroxide solution; formation of an intense yellow colour, which turns to colourless on addition of few drops of dil. acid, indicates presence of flavonoids. [15]

Proteins and Amino Acids:

Millons Test: Test solution with 2 ml of Millons reagent (mercuric nitrate in nitric acid containing traces of nitrous acid), white precipitate appears, which turns red upon gentle heating.

Ninhydrin Test: Amino acids and proteins when boiled with 0.2% solution of ninhydrin (Indane 1, 2, 3 trione hydrate), violet colour appears [15].

Steroids and Triterpenoids:

Libermann Buchard Test: Extract treated with few drops of acetic anhydride, boil and cool, cone. Sulphuric acid is added from the sides of the test tube, shows a brown ring at the junction of two layers and the upper layer turns green which shows the presence

of steroids and formation of deep red colour indicates the presence of triterpenoids.

Salkowski test: Treat extract in chloroform with few drops of conc. sulphuric acid, shake well and allow to stand for some time, red colour appears at the lower layer indicates the presence of steroids and formation of yellow coloured lower layer indicates the presence of triterpenoids [15].

Pharmacognostical Study:

Macroscopical evaluation: Medicinal plant materials are categorized according to organoleptic, microscopical and macroscopical characteristics. Taking into consideration the variations in source of crude drug and their chemical nature, they are standardized by using different techniques including the methods of estimation of chief active constituents. Organoleptic evaluation of drugs refers to the evaluation of drugs by color, odour, size, shape, taste and special features including touch and texture etc. Organoleptic evaluations can be done by means of organs of special sense which includes the above parameters and thereby define some specific characteristics of the material which can be considered as a first step towards establishment of identity and degree of purity.

The following organoleptic investigations were done;

Color: The untreated samples were properly examined under diffused sunlight or artificial light source with wavelengths similar to that of daylight.

Shape and size: the length, breadth and thickness of the drugs are of great importance while evaluating crude drugs. A graduated ruler with basic unit in millimeter is adequate for the measurement. Bark and leaves were measured by aligning ten of them on a sheet of a calibrated paper approx. 1mm apart between the lines and the result was divided by 10. Average length, breadth and thickness were determined.

Odor and taste: the odor and taste of crude drugs are extremely sensitive criteria based on individual's perception. Therefore the description of this feature may sometimes cause some differences of opinion. The sample was crushed in a mortar by applying pressure by pestle and the strength of the odour like weak, distinct, strong was first noted and then the odour sensation like rancid, aromatic etc was determined.

Surface characteristics, texture and fracture: The texture was best examined by taking a small quantity of material and rubbing it between the thumb and forefingers, it was usually described as smooth, rough and gritty. The physical evaluation of the bark by palpitation (touch) of the material determines the softness or hardness. The study of morphology of bark and leaves was done by taking ten samples and was observed for various qualitative and quantitative macroscopical characters (Khandelwal, 2006).

Microscopical Evaluation: Microscopical parameters observed were;

- Arrangement of tissues in a transverse section.
- Type of epidermal cells, stone cells, testa and endosperm.
- Presence and type of crystalline structures eg. Calcium oxalate, starch etc.
- Presence of oil globules, aleurone grains and trichomes.
- All determination was carried out by using Almicro compound microscope (100x) attached with a camera [16].

Powder microscopy: The dried bark of *Tamarindus indica was* powdered and sieved to obtained fine powder it was taken up for powder microscopy evaluation as follows;

A small quantity of powder was kept on a slide and after mounting on glycerin, 10 min were provided as spread out time. Finally, it was observed for powder microscopical characters.

Another small quantity of powder was stained with phloroglucinol and HCl, ruthenium red, safranin, sudan red III, iodine and acetic acid respectively. Mounted with glycerin on microscopical slide and observed for powder microscopic characters [17].

Extraction: The collected, cleaned powder of barks *Tamarindus indica was* used for the extraction process respectively. The powder of bark (500 g) material was evenly packed in the soxhlet apparatus and extracted with various solvent including petroleum ether, chloroform, ethyl acetate, ethanol by hot continuous extraction process for about 26 h except aqueous, separately. The aqueous extraction was carried out by cold maceration process after each solvent extraction process. The extracts were filtered while hot, through Whatmann filter paper to remove any impurities if present. The extracts were concentrated by vacuum distillation to reduce the volume 1/10. The concentrated extracts were transferred to 100 ml beaker and the remaining solvents were evaporated on the water bath. Then they were collected and placed in desiccators to remove the excessive moisture. The dried extracts were packed and labeled in air tight container for the further studies such as a phytochemical screening and pharmacological activities [18].

Chromatographic Evaluation of Plant Extract:

- Thin Layer Chromatography
- HPLC

Thin Layer Chromatography:

1. **Introduction:** TLC is a relatively new discipline. Chromatography historians usually date the advent of modern TLC to 1958.They succeeded in separating medicinal plants on unbound alumina spread on gals plates. They applied drops of solvents to the plate containing the sorbet layer and sample; as a result several circles of substances were seen in UV-light [19]. There layers were used in the separation of inorganic ions. He was the first to separate mixtures by adsorption chromatography on filter paper and, later, on glass fiber paper impregnated with silica and alumina.

2. **Experimental**

   I. Apparatus: Plates 20x20 cm and Glass

   II. Material

      a. TLC Plates: Silica gel

      b. Regents: Acetic acid 100%, Anisaldehyde 98%, Ammonia solution [26], 5%.

   III. Application of TLC Plates: Silica gel 60, HPTLC aluminium sheets used in combination with the following derivatization reagents: R (silver nitrate- ammonia), Al (thymol - sulfuric acid).

3. **TLC Adsorbent:** In the teaching labs at CU Boulder, we use silica gel plates (SiO_2) almost exclusively. (Alumina (Al_2O_3) can also be used as a TLC adsorbent)

4. **TLC solvents or Solvent System:** Choosing a solvent is covered on the Chromatography Overview page. The charts at the bottom of that page are particularly useful.

5. **The R_f value:** R_f is the retention factor, or how far up a plate the compound travels. If R_f value of a solution is Zero, the remains in the stationary phase and thus it is immobile. If R_f value = 1 then the solute has no affinity for the stationary phase and travels with the solvent front.

6. **Analysis:** The components, visible as separated spots, are identified by comparing the distances they have travelled with those of the known reference materials. Measure the distance of the start line to the solvent front (=d+. Then measure the distance of center of the spot to the start line (=a). Divide the distance the solvent moved by the distance the individual spot moved. The resulting ration is called R_{f-} and 1.0 (spot moved with solvent front) and is unit less.

7. **Plate preparation:** TLC plates are made by mixing the adsorbent, such as silica gel, with a small amount of inert binder like calcium sulfate *gypsum) and water. This mixture is spread as thick slurry on an uncreative carrier sheet, usually glass, thick aluminium foil, or plastic, and the resultant plate is dried and activated by heating in an oven for thirty minutes at 110^{o}C. The thickness of the adsorbent layer is typically around 0.1-0.25 mm for analytical purposes and around 1-2 mm for preparative TLC. Every type of chromatography contains a mobile phase and a stationary phase.

RESULTS AND DISCUSSION:

Pharmacognostical study:

Macroscopical study: The bark is grey white; the surface is smooth with shallow irregular fissures at frequent places. The bark is hard and brittle, fibrous and flexible. The bark consists of periderm and secondary phloem and the entire bark is about 4 mm thick.

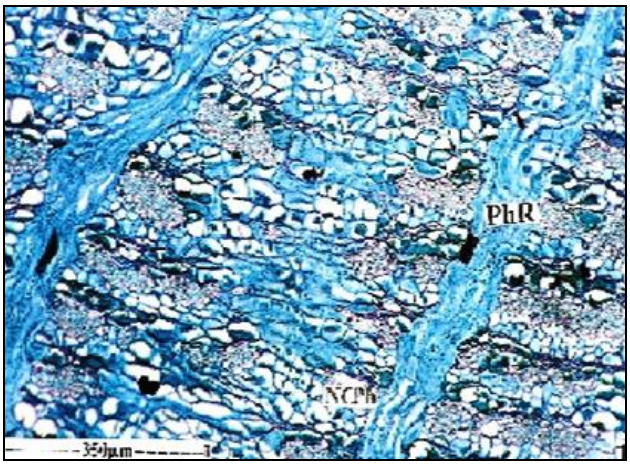
Microscopical study:

Periderm: The periderm is superficial and undulate with deep folding and irregular thick endings. The periderm is 150-200µm thick. The outer part of the periderm consists of thin walled, sub sized phloem, the cells being tubular in shape and sub sized walls.

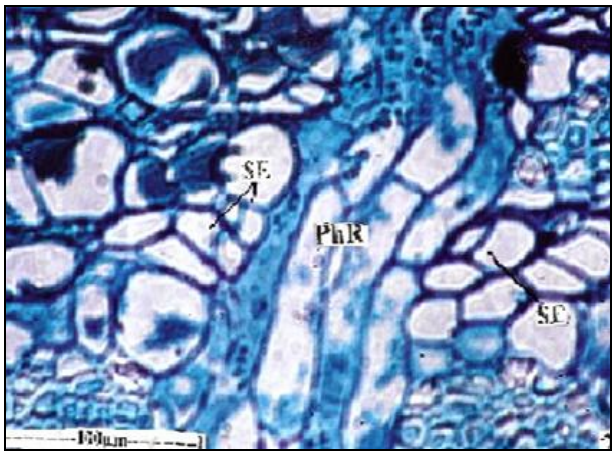
Secondary phloem: The secondary phloem is differentiated into outer wider zone of collapsed phloem and inner narrow zone of non-collapsed phloem.

Collapsed phloem: The collapsed phloem is characterized by wide phloem-rays which gradually dilate into wide funnel shaped expansions. The rays are wavy and dilated the rays cells are arranged in tangential bands.

Noncollapsed phloem:- This consist of intact phloem elements and narrow phloem rays, the sclerenchyma cylinder are reduced in thickness or totally absents. The phloem elements are polygonal in outline and have prominent companion cells (**Fig. 1**).

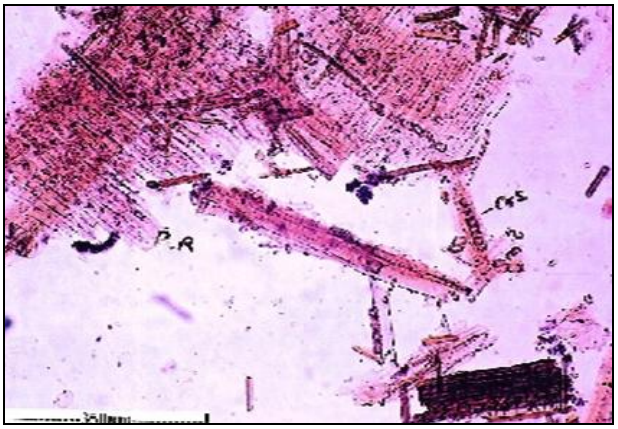


PhR=Phloem Rays

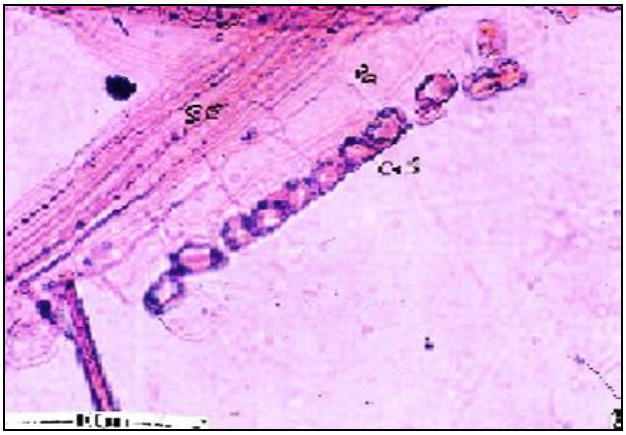


Sc=Starch Crystal

FIG 1: T. S. OF *TAMARINDUS INDICA* BARK



Cr= Crystal strands



Fi =Fiber fragment

FIG. 2: POWDER MICROSCOPY OF *TAMARINDUS INDICA*

Powder microscopy: The bark powder exhibits the following inclusions when examined under the microscope. Fragments of phloem fibers: Broken pieces of fibers are abundant in the powder, the fiber-fragment have thick and lignified walls and narrow lumen. The fibers are 10-12µm thick; they range from 40-150 µm. Wide pieces of phloem tissues are visible in the powder. They consist of phloem ray cells which are horizontal in orientation and the ray cells are

rectangular and thin walled (**fig. 2**). Sieve tubes and parenchyma cells were observed in the powder. The sieve tubes are narrow, long tubes. The parenchyma cells are wide, short, vertically oblong cells, often found in bundles. Crystal strands are very common. They are scattered individually or in continuous vertical strand.

Physicochemical study: Loss on drying of barks of *Tamarindus indica* was found to be not less than 1.58% w/w. Ash value of any crude drug gives an idea about the earthy matter and/or inorganic composition and/or other impurities present along with the crude drug. In the present, study ash values (total ash, acid insoluble ash and water soluble ash value) **Table 1**.

TABLE 1: ASH VALUE OF *TAMARINDUS INDICA*

Extracts	Total ash	Water soluble	Acid insoluble
Stem bark of *Tamarindus indica*	15%	10%	7.5%

The water soluble extractive value and alcohol soluble extractive value for *Tamarindus indica* was found to be not less than 7.5% w/w and 15.0% w/w. (**Table 2**).

TABLE 2: EXTRACTIVE VALUE OF *TAMARINDUS INDICA*

Extracts	Water soluble ext. Value	Alcohol soluble ext. Value
Ethanol extract of *Tamarindus indica*	7.5% w/w	15.0% w/w

Preliminary Phytochemical Screening: The preliminary phytochemical screening of various extracts of *Tamarindus indica* barks were carried out and it was found that (**table 3**):

- Petroleum ether shows positive result for tannins, steroids.
- Chloroform shows positive result for alkaloids.
- Ethyl acetate shows positive result for alkaloids, tannins, and glycoside.
- Ethanol shows positive result for alkaloids, flavonoids, steroid, glycoside and Water shows positive result for flavonoids and Triterpenoids.

TABLE 3: PHYTOCHEMICAL SCREENING OF *TAMARINDUS INDICA* LINN. BARK

Extract	Alkaloids	Glycosides	Flavonoids	Triterpenoids & steroids	volatile oil	Tannins
Pet. Ether ext. of *T. indica*	+ ve	-ve	+ ve	+ve	+ ve	+ve
Chloroform ext. of *T. indica*	+ve	+ ve	-ve	+ ve	-ve	+ ve
Ethyl acetate ext. of *T. indica*	+ve	-ve	+ ve	-ve	-ve	-ve
Ethanol ext. of *T. indica*	+ ve	+ve	+ve	+ ve	-ve	- ve
Aqueous ext. of *T. indica*	-ve	-ve	+ ve	+ve	+ ve	+ve

TLC: The principle of separation is adsorption One or more compounds are spotted on a thin layer of adsorbent coated on a chromatographic plate. The mobile phase solvent flows through because of capillary action against gravitational force). The components move according to their affinities towards the adsorbent (**Fig. 3**).

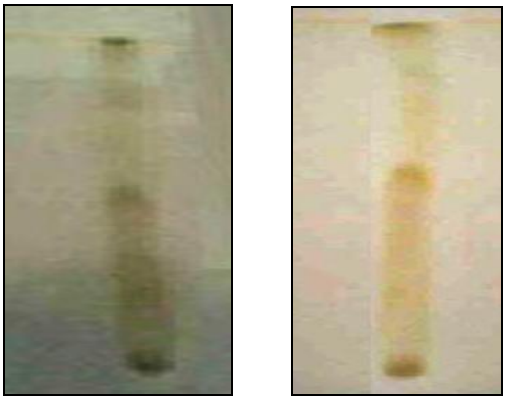


FIG. 3: TLC OF ETHANOLIC EXTRACT OF *TAMARINDUS INDICA*

The TLC of Ethanol extract of *Tamarindus Indica* bark in the ratio of Butanol: Acetic acid: Water (4.1:5) gives a spot and the Rf value was found to be;

Rf = 0.8

From the Rf value found that the extract content triterpenoids (**Table 4**).

TABLE 4: TLC OF *TAMARINDUS INDICA* LINN. BARK

Extract	Solvent system	No. of spots	Rf value
Ethanol extract of *T. indica* bark	Butanol : Acetic acid : Water (4.1:5)	1	0.8

CONCLUSION: The results from macroscopical, micrscopical and powder characters are useful to detect the stem bark of *Tamarindus indica* Linn. *bark* from other adulterants. From the study the aqueous and ethanol extracts of stem bark of *Tamarindus indica* linn bark showed significant present of the pharmacologically active principles like alkaloids,

glycosides, flavonoids, etc. Among them, some active groups have significant protective effects through there antioxidant property. Moreover, the active constituents may be identified by its further study. Further studies will be focused on determination of the mechanism of action and isolation of bioactive principles from aqueous and ethanol extracts of stem bark of *Tamarindus indica* linn bark which are responsible for protective effect of plant on cardiotoxicity induced by doxorubicin.

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