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Natural dye yielding plants used by the tribes of Wayanad, Kerala, India: A search

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Abstract

To explore the ethnic medicinal plants used by the tribes for discovering new lead molecules as natural drugs so as to provide information for its scientific validation. Field survey was conducted during 2014–2016 to collect information on herbals used by the various tribes and questionnaires were made on the different species of plants used generally and occasionally as medicinal. The present study documents knowledge on 34 herbals used by the tribes of Wayanad, Kerala as medicinal or as health rejuvenator. The different parts of the plants are used by the local ethnic people for diverse medicinal purposes. They display different ethnic and economic values. It has also been noted that the plants used by them are eco-friendly without side effects. However, indigenous method of extraction and practice of using the plants has now declined due to availability of cheaper modern drugs. Interestingly, teak leaves are used by them for multi purposes. The present information on the folklore uses of the herbals by tribes leads to potential utilization of phytomedicines in future. Therefore, it is the need of the hour to document and conserve these herbal species.

Keywords: Traditional knowledge, Herbals, Medicinal importance, Tribes, Wayanad.

1. Introduction

Indigenous plant-based knowledge on health or as medical care has been recorded from time immemorial. Collection of information and documentation of traditional knowledge plays an important role in scientific research on drug development. Indian herbal drugs have served as a major source of medicines for the prevention and treatment of many diseases. Diverse plant decoctions or herbal pastes are used by tribes and folklore traditions as wound healers or health drinks. Plants contain natural colours ranging from yellow to black (Wanyama *et al*., 2010). Around 2600 BCE, China recorded the extraction of natural colours from plant sources. Similarly, Indus valley civilization during 3500 BCE at Mohenjo-Daro and Harappa documented colouring garments with natural madder (*Rubia tinctorum* L.) (Siva, 2007). Natural colour yielding plants may possess more than one chemical constituent, each displays a different colour and properties, operating singly or in combination with the different groups, depending on their chemistry and composition (Samanta & Agarwal, 2009). Recently, there has been an increasing awareness about the herbal colours because of the ecological and health related issues associated with the chemical dyes. The chemistry of colour in plant parts is generally because of anthocyanins. The colorful anthocyanins are flavonoid class of phytochemicals present in honey, wines, fruits, vegetables, nuts, olive

oil, cocoa and cereals. The common fractions reported are apigenin, myricetin, naringin, naringenin, hesperetin, catechin, epicatechin, gallocatechin, genistein and daidzein. The major functional role is free-radical scavenging and antioxidant capacities and thereby to intervene with human therapeutic targets and health benefits. Anthocyanin may provide protection from DNA cleavage, estrogenic activity, enzyme inhibition, boosting production of cytokines, anti-inflammatory activity, lipid peroxidation, decreasing capillary permeability and fragility and membrane strengthening (Ann Lila, 2004). Indians are forerunners in the art of natural colouring. Natural pigments find use in the colouring of textiles, drugs, cosmetics and health promoters. Due to their non toxic effects, they are also employed for colouring many food products. The bulk of natural dyes are made from plant parts like leaves, flowers, berries, roots, bark, rhizomes, tubers, shoots, sap and wood. Natural colours can provide the essential alternative to the complex world of chemical dyes. They are inherently carbon neutral. Vibrant colours can be produced from natural dyes. The significant research on ethnobotany has created a mass awareness among the scientists in India during the last few decades. A number of outputs have come from different parts of India including the north eastern states related to the traditional health care practices, wild edible plants, ethnoveterinary plants and fiber plants (Sutradhar *et al*., 2015; Jamir, 2008; Kar & Borthakur, 2007). The main task of this study was to assess the diversity of medicinal plants including dye yielding species used by the major tribes of Wayand and document the traditional medicinal practices including their ethnic knowledge that has been vanishing among tribal communities.

2. Materials and Methods

Wayanad, located in the Western Ghats region of Kerala with an altitude range from 700 to 2100 m sea level. Nilgiri and Mysuru of Tamil Nadu and Karnataka respectively bound it on the East, Coorg of Karnataka on the North, Malappuram of Kerala on the South and Kozhikode and Kannur of Kerala on the West. Wayanad lies between 11°27′N and 15°58′N, and 75°47′E and 70°27′E.

Intense field surveys were carried out during 2014- 2016 to collect data on medicinal plants used by tribes in their daily life activities. The survey was conducted among the tribes including Paniyas, Adiyas, Kattunayakans, Kurichiyans, Kurumas and Ooralis. 20 persons (male and female) were selected randomly with an age group ranging from 25 - 70 and interviewed with the help of a local guide. Questionnaires were made on the different species of plants used commonly and often to meet their needs. After collecting required information, the nomenclature of the recorded plants was confirmed with the help of The Plant List, International Plant Name Index and authenticated with the herbarium specimens deposited at JNTBGRI, Palode.

3. Results and Discussion

The present analysis includes information on 35 plant species belonging to 29 families used by the tribal people of Wayanad, Kerala for curing many ailments (Table 1). Most of the plant species are dominated naturally in various habitats and their characters are unique in ethnic herbal medicine. The common practice of preparing the crude drugs from plants are fresh juice, powder, paste and decoction. This mode of traditional way of treatment based on herbals are important part of their routine

life. Leaves, flowers and seeds constituted the major parts used by tribal people for preparation of medicine. Generally, the preparation of medicine is based on single plant aqueous extract. The field survey reveals that the study area was abode of medicinal plants useful to treat diverse human ailments. Further, the tribal people of the area possess practical ethnic knowledge about the crude herbal preparations. This may provide valuable clues for pharmacologists and phytochemists to design new drugs for curing many human ailments. Interestingly, the new tribal generation lack the attitude for conserving the traditional skills and knowledge practiced by their older generations. This further demands complete documentation of their ethnic knowledge for the benefit of the future generations. Most of the preparations are prepared with water and are differently coloured.

Table:1. Common dye yielding plants from different parts of Wayanad used by tribal people

Plant Name	**Local Name**	**Uses**	**Family**	**Part used**	**Colour obtained**
Abrus precatorius L.	Kunni	Ulcers, keratitis, hypertension, tetanus, cholera, dysentery	Fabaceae	Seed	Black
Acacia catechu (L.f.) P.J.H.Hurter & Mabb	Karingali	Sore throat and cough	Mimosaceae	Bark	Pink
Aegle marmelos (L.) Correa	Vilvam	Astringent, used as digestive and for curing stomach ache, diarrhoea	Rutaceae	Fruit	Yellow
Barleria prionitis L.	Karimkurunni	Juice of leaves given with honey in catarrhal infections of children	Acanthaceae	Flower	Yellow
Bauhinia purpurea L.	Mandaram	Ulcers, cure wounds and injuries, for treating boils and sores, used to get rid of asthma, cold and cough	Caesalpiniaceae	Bark	Violet
Bixa orellana L.	Kurannumannal	Used as an astringent and purgative. Seeds: used as an astringent, febrifuge, remedy for gonorrhea. Leaves: useful in jaundice	Bixaceae	Seed	Red/ Orange red
Bombax ceiba L.	Unnamurika	Used for diarrhea and dysentery, very effective as an aphrodisiac	Bombacaceae	Flower	Red
Butea monosperma (Lam.) Taub.	Chamata	Bark astringent, used for piles, tumor and menstrual disorders.	Fabaceae	Flower	Yellow / Orange
Butea superba Roxb.	Valli plash	Decoction applied to children for inducing sleep; juice used as an antiseptic. Flower used as diuretic & astringent.	Fabaceae	Flower	Deep yellow

Cassia fistula L.	Kanikkonna	Bark astringent, used for piles, tumour, menstrual disorders and used for rheumatism	Caesalpiniaceae	Bark	Brown
Cassytha filiformis L.	Moodillathali	Used in digestive problems, urinary problems, hepatitis, piles, sinusitis and used to stimulate menstruation	Lauraceae	Stem	Brown
Catharanthus tinctorius L.		Laxative, sedative and stimulant; hot infusion diaphoretic in jaundice; also used as cold infusion	Apocynaceae	Flower	Pink / Red
Clitoria ternatea L.	Shangupuzhpam	Causes abortion and also useful in burning sensation, leprosy. Decoction used to cure remove dry cough. Whole plant used in snake poison.	Fabaceae	Flower	Blue
Curcuma longa L.	Manjal	Used as condiment; also used as stomachic, tonic, blood purifier.	Zingiberaceae	Rhizome	Yellow
Dioscorea bulbifera L.	Kattukachil	Used for the treatment of diabetes, eczema, psoriasis, intestinal parasites, *etc*	Dioscoreaceae	Tuber	Pale yellow
Erythrina suberosa Roxb.	Murukkumaram	Paste externally applied to treat wounds in cattle.	Fabaceae	Flower	Pink/ Orange
Indigofera tinctoria L.	Neelamari	Used for the treatment of fever, liver and spleen disorders, rheumatoid arthritis, gout, grey hair *etc*. Leaves promote hair growth	Fabaceae	Flower	Indigo / Blue
Lawsonia inermis L.	Maylanchi	Used as prophylactic against skin disorders.	Lythraceae	Leaf	Deep red Orange
Madhuca longifolia (J.Koing) J.F.Macbr.	Illuppa	Used as fermenting initiator, used against skin diseases, nerve disorders, cough, burning sensation and diarrhea.	Sapotaceae	Flower	Red
Mallotus philippensis (Lam.) Muell.Arg.	Kumkumapoomaram	Used against intestinal worms, leaves used to cure worms.	Euphorbiaceae	Fruit	Red
Melastoma malabathricum L.	Kadali	Leaves used to treat dysentery, diarrhea, piles, *etc*	Melastomataceae	Fruit	Purple
Michelia champaca L.	Champakam	Useful in diabetes, quick wound healing, cardiac disorders, gout, dysuria, *etc*.	Magnoliaceae	Flower	Yellow

Mirabilis jalapa L.	Naaluma-nipoovu	Used as a purgative, diuretic and for wound healing purposes and reduces inflammation.	Nyctaginaceae	Flower	Pinkish red
Nyctanthes arbor-tristis L.	Paarijatham	To cure influenza**,** juice given with honey in chronic fever	Oleaceae	Flower	Orange
Nymphaea pubescens Willd.	Aambal	Used for diabetes, epilepsy, anorexia, cough, jaundice, snake bites, cystitis	Nymphaeaceae	Rhizome	Blue
Oldenlandia umbellata L.	Chayaveru	Best for external bleeding	Rubiaceae	Root	Red
Pithecellobium dulce (Roxb.) Benth.	Korukkapuli-maram	Used to treat muscular swellings, can cure indigestion and as a febrifuge	Mimosaceae	Bark	Pink
Polygonum hydropiper (L.) Delabre		Useful in treating bleeding, skin problems, diarrhoea	Polygonaceae	Leaf	Blue
Pterocarpus marsupium Roxburgh	Venga	Useful for anaemia, intestinal worms, urinary problems, lipid disorders *etc*.	Fabaceae	Bark	Red
Pterocarpus santalinus L.f.	Rakthachandan-am	Used for eye disorders, sexual disorders and nasal bleeding	Fabaceae	Bark	Red
Rubia cordifolia L.	Chovvalikkottii	For blood detoxification and used in many skin diseases	Rubiaceae	Whole plant	Deep red
Semecarpus anacardium L.f.	Alakkucheru	Helps to relieve bronchitis, chronic cough and asthma, internal infections	Anacardiaceae	Fruit	Black
Syzygium cumini (L.) Skeels.	Njaval pazham	Natural blood purifier, used for hyperglycemia. Used for mouth ulcers and sore throat	Myrtaceae	Fruit	Blue
Tectona grandis L.f.	Teekku	Leprosy, diabetes, and bronchitis. Seed paste applied to cure ringworm infection	Verbenaceae	Leaf	Brick red
Terminalia chebula Retz.	Katukka	Fruits have antibacterial properties and useful in many diseases.	Combretaceae	Bark	Blackish brown
Woodfordia fruticosa (L.) Kurz	Thathiripoovu	Flower decoction with honey against seminal weakness. Calyx boiled in ghee applied to boils.	Lythraceae	Flower	Red

The yellow coloured dye was extracted from rhizome of *Curcuma longa*. Fruit is the important source of purple dye in *Melastoma malabathricum* L. Floral dyes (violet) includes *Bauhinia purpurea* L., *Butea monosperma* (Lam.) Taub*., Clitoria ternatea* L., *Erythrina*

suberosa Roxb., *Nyctanthes arbor-tristis* L. *etc*. Commonly used fruit dyes are obtained from *Terminalia bellirica* Roxb. and *T. chebula* Retz.,. The leaf dyes are extracted from *Lawsonia inermis* L., *Tectona grandis* L. f. *etc*. Dyes extracted from the various plant parts are weak in nature and their retention of colour varies from plant to plant and traditional techniques of preparation employed. Usage of multiple plants parts in a particular combination may increase the longevity of dye *i.e*., polyherbal. Often techniques *viz*. heat and cold treatment may increase dye stability. The selection of plants also depends on the color choice, product type and need. The present study recorded 15 different colors from 34 different plant parts. The ethnic communities used their own customary method to isolate and preparation of the natural crude colour. Ethnic communities used the dye yielding plants for various day to day activities like coloring food and clothes, making cosmetics, jewelries and effectively against stress prone disorders.

3.1. Preparation of dye

The tribal people have traditionally been engaged in extraction, processing and preparation of dyes using barks, leaves, fruits and roots of plants like *Rubia cordifolia, Melostoma malabathricum, Indigofera tinctoria*, etc. Animal residues like hide, fat and secretion of insects commonly known as the lac insect, are used in the preparation of natural dyes. During the course of the investigation, traditional dyers informed us that mixing of natural dyes with animal residues and bovine urine yields fast colour and permanency in the fabrics. Indigenous dye extraction processes applied by the ethnic communities were documented during the course of this study.

In one of the indigenous dye extraction processes, fresh, mature fruits and bark of *Terminalia chebula* and *Phyllanthus emblica* almost in equal parts by weight, are crushed and boiled in water for long time in iron pots. The boiled mixture is then transferred to a pot having minute pores at the bottom through which only the thin liquid can percolate, leaving behind the residues in the pot. The pot with the mixture is placed over a tripod stand and another pot is placed below it, where the black thick liquid from the upper pot is collected in drops and allowed cool down. The thick liquid so collected in the lower pot is the dye (black) used for colouring clothes.

In another process, the whole plant, leaves of *Rubia cordifolia*, shoots of *Ficus altissima* separately or in mixture with parts (flowers, fruits, bark, leaves, etc.) of other natural dye-yielding plant species like *Woodfordia fruticosa* are crushed and put in an earthen pot, to which little water is added. The pot is kept undisturbed for 20–25 days during which period the contents of the pot get fermented. The fermented content is boiled to get a thick liquid and the extract is filtered through a piece of thin cloth to yield the natural dye. The colour of the dyes thus extracted and prepared through this process depends upon the plant species and parts used.

In yet another process, hides of buffalo/ox/yak are burnt and about 50 gm of the ash is mixed with gall bladder of locally available fish and crushed with leaves of *Solanum indicum.* The mixture is thoroughly mixed in about 1 L of water and boiled till it becomes thick. The mixture is squeezed through a cloth to separate the liquid dye. To make the dye fast and non-washable, soot scraped out from cooking pots or burnt resin is added. However, addition of a few drops of bovine urine assigns quick drying property to the natural dyes.

3.2. Other indigenous techniques of natural dyeing

3.2.1. Golden yellow colour

Yarn used: Mulberry silk

Ingredients: Turmeric, Chebula, Areca nut husk (green/tender),tea, Cow dung

Dye extraction and dyeing techniques: Collect the whole ingredients. Cut the turmeric, chebula and green areca nut husk into small pieces and crushed to paste form with the help of the stone grinder. Add required amount of tea powder and cow dung into the paste. Soak the paste overnight. Strain the dye liquor next day and soak the yarn for atleast 3 h. Air dry the yarn and it is ready for use

3.2.2. Bright yellow colour

Yarn Used: Mulberry silk

Ingredients: Turmeric (double the amount of other ingredients), Chebula, Tea, Cow dung (little bit)

Dye Extraction and Dyeing Techniques: To obtain the bright yellow colour of natural mulberry silk, the techniques of dye material extraction and dyeing of yarn are same as prescribed earlier. But in this process, turmeric is added in double of the other ingredients.

3.2.3. Light brown colour

Yarn Used: Cotton yarn

Ingredients: Chebula (green), Bark of *Ziziphus jujuba*, Tea

Dye Extraction and Dyeing Techniques: Cut the fresh chebula and bark of *Ziziphus jujuba* into small pieces and crushed with the help of the grinder. Add required amount of tea powder and into the paste. Soak the paste at least 8-10 h. Strain the dye liquor and soak the yarn for 2 h. Air dry the yarn and it is ready for use.

3.2.4. Dark brown colour

Yarn Used: Both cotton and mulberry silk yarn

Ingredients: Chebula, Areca nut husk, *Cordia*, Tea

Dye Extraction and Dyeing Techniques: Grind the whole ingredients except tea to make a paste. Add required amount of tea powder into the paste. Soak the paste overnight. Strain the dye liquor and soak the yarn for 5 h. Air dry the yarn and it is ready for use.

Natural dyes are environment friendly for example, turmeric, the brightest of naturally occurring yellow dyes is a powerful antiseptic which revitalizes the skin, while indigo gives a cooling sensation (Hussein *et al*., 1997). Many of the plants used for dye extraction are classified as medicinal and some of these have recently been shown to possess antimicrobial activity (Siva, 2007). *Punica granatum* L. and many other common natural dyes are reported as potent antimicrobial agents owing to the presence of a large amount of tannins. Several other sources of plant dyes rich in naphthoquinones such as lawsone from *Lawsonia inermis* L. (henna), juglone from walnut and lapachol from alkanet are reported to exhibit antibacterial and antifungal activity. Singh *et al.* (2005) studied the antimicrobial activity of some natural dyes. Optimized natural dye powders of *Acacia catechu* (L.f.) Willd, *Kerria lacca*, *Rubia cordifolia* L. and *Rumex maritimus* were obtained from commercial industries and they showed antimicrobial activities (Singh *et al*., 2005).

Anthocyanins are the most oxidized flavonoids with the C ring fully unsaturated and a hydroxyl at position 3. The basic structure is an aglycone, or anthocyanidin, with one or more sugars attached at most often C3, C5, or C7 and possibly

esterification on the sugars. Currently, there are 19 naturally occurring anthocyanidins. The six most common anthocyanidins found in edible plants include pelargonidin, peonidin, cyanidin, malvidin, petunidin, and delphinidin. These naturally occurring anthocyanidins can all be associated with three parent aglycone structures, pelargonidin, cyanidin, and delphinidin, due to the substitution pattern seen in the B-ring. When referring to the six major anthocyanidins, they can be grouped together with peonidin and cyanidin having 3′ and 4′ substitutions while petunidin, malvidin and delphinidin are trisubstituted at the 3′, 4′ and 5′ positions and pelargonidin is monosubstituted. The prevalence of sugar occurrence in natural anthocyanins is glucose, rhamnose, xylose, galactose, arabinose, and fructose. Many anthocyanins have been found to be acylated by aliphatic or aromatic acids, the most commonly seen acyl groups being coumaric, caffeic, ferulic, *p*-hydroxy benzoic, synapic, malonic, acetic, succinic, oxalic, and malic acids. Considering all these factors, the number of probable anthocyanin compounds is quite large, leading to over 600 having been identified from natural sources.

The antioxidative activity of anthocyanins has been exhaustively examined. Anthocyanin-rich plants have historically been used to treat a number of symptoms and diseases, such as the improvement of visual acuity. Administration of cyanidin-3-rutinoside enhanced night and overall vision due to its effect on rhodopsin regeneration. Studies show that the anthocyanin accelerates formation of an intermediate to regenerate the G-protein-coupled receptor in the retina of the eye. Protection from heart attacks is also associated with administration of anthocyanins, particularly in the form of grape juice and wine but also from other sources. This role is attributed to the ability of these products to reduce inflammation, enhance capillary strength and permeability, and inhibit platelet formation. The mechanism of vasorelaxation that was observed is due to increased nitric oxide release. Anthocyanins can even be shown to aid in the prevention of obesity and diabetes. Studies show that anthocyanin pigments from purple corn inhibit both body weight and adipose tissue increases. The symptoms of hyperglycemia that can follow a high-fat diet were also suppressed with ingestion of this cyanidin-3-glucoside (Welch *et al.,* 2008).

3.3. Single plant drugs used by tribes of Wayanad

Abrus precatorius L.

The seeds were detoxified by boiling them in milk and then drying it. The protein which causes toxicity is denatured by high temperature. Paste of roots is used to cure abdominal pains, tumors and also for abortion. Root is chewed as a remedy for snake bite. Hot water extract of fresh root is an anti-malarial and anti-convulsant. Decoction of dried root is used to treat bronchitis and hepatitis. For graying of hair, a paste of leaves and seeds is applied. Tea made from the leaves are used orally for cough, fever and cold.

Acacia catechu (L.) Willd., Oliv.

The heartwood of the tree is mainly used for extracting Katha and Cutch (decoction obtained after filtration) which are sold in the market. Katha is commonly used in ayurvedic preparations. Besides this, it serves as one of the major components in masticatory *i.e*. chewing of betel leaf (pan) in India. Heartwood of *Senagalia catechu* (khair) is boiled with other ingredients to prepare the decoction. Decoction of heartwood is

applied in mouth and on tongue to cure mouth ulcer. It is also applied externally on ulcers, boils, skin eruptions and on gums as disinfectant. It is taken as tea by the pregnant ladies to keep warm their body. It is also given to cure fever due to cold during the pregnancy. The decoction of bark mixed with milk is taken to cure cold and cough. The bark decoction is either alone or used in combination with opium to cure severe diarrhea.

***Aegle marmelos* (L.) Correa.**

Juice prepared from the leaf extract acts as a laxative agent and is helpful for treating ophthalmic infections and asthmatic complaints. Medicated oil prepared from leaves of the plant not only helps to prevent cold, cough and other respiratory ailments but is also a good hair tonic when mixed with cumin seeds and massaged on the scalp. Bark juice, mixed with cumin in milk, increases seminal fluid volume. Extracts of distilled flower is used as tonic for stomach, intestine, anti-dysenteric, antidiabetic, diaphoretic and local anesthetic. Fine powder of unripe fruit can be an alternative medicine to cure intestinal parasites, like *Entamoeba histolitica*, *Ascaris lumbricoides*.

***Barleria prionitis* L.**

Plant powder is used in dental troubles. The leaf juice mixed with honey given to children in catarrhal affections and fever. The root paste is externally applied to disperse boils and glandular swellings. The flowers are used internally for the treatment of migraine, internal abscesses, oedema, haemoptysis, urethral discharges, seminal disorders and reduce obesity. Ash of the whole plant with honey is given in bronchial asthma.

***Bauhinia purpurea* L.**

The decoction of the root is used for expelling gases, flatulence and griping pain from the stomach and bowel, the bark of the plant is used as an astringent in the treatment of diarrhea. Its decoctions are recommended for ulcers as a useful wash solution. The bark or root and flower mixture with boiled rice water is used as maturant for boils and abscesses. The decoction of flower works as a laxative. Fresh bark of Kaanchanaara (*B. purpurea*) mixed with Shunthi (dry *Zingiber offficinale*), pounded with sour gruel, was prescribed in enlarge cervical glands (Vrindamaadhava) as well as in goiter (Shaarangadhara Samhitaa, Bhavaprakaasha). Over the counter Kaanchanaara (*B. purpurea*) Guggulu (Shaarangadhar Samhitaa) is used to treat enlarge cervical glands, goiter and scrofulous tumors, so is kaanchan-gudikaa (Bhaishjya Ratnaavali).

***Bixa orellana* L.**

Leaf juice is used against snakebites. Leaf paste is used against skin infections. Leaves, roots and seed extracts are popular as aphrodisiac medicines as well as a remedy to treat fevers, inflammatory conditions and parasitic diseases. A decoction of the leaves is used to stop vomiting and nausea, as a mild diuretic, to treat heartburn, prostate, urinary difficulties, and stomach problems.

***Bombax ceiba* L.**

Its young roots are roasted in the fire and eaten like roasted sweet potato while some tribes eat even raw roots during famine or otherwise also. It is most widely used in match-industry and for planking ceilings, canoes, shingles, toys, scabbards, coffins, well curbs, brush-handles and artifact production. Oil isolated from its seeds is comparable to true Kapok plant and can be used as an edible oil substitute for cottonseed oil, for soap making and as an illuminant.

***Butea monosperma* (Lam.) Taub.**

The bark of *Butea monosperma* yielding a kind of coarse and brown colored fiber and these are used for rough cordage. The gum of tree (BM) is a dried juice obtained from incisions in the stem of the tree and it posses astringent effect. The flowers of *Butea monosperma* yielded an red or orange dye which is used as an insecticide and as coloring agent. The use of its gum as external astringent application is mentioned by 'Chakradatta'. Seed paste mixed with honey and ghee is applied on the vagina to avoid pregnancy.

***Butea superba* Roxb.**

Flowers are ground with the leaves of *Cinnamomum zeylanicum* and the paste is administered orally twice a day. Bark decoction for Leucorrhoea -half cup for alternate days for a week.

***Cassia fistula* L.**

Leaf paste is used as poultice in leprosy and skin diseases. Bark decotion is used for bath in leprosy and skin diseases. As a remedy against snakebite, one teaspoonful fruit powder is taken internally.

***Cassytha filiformis* L**

The brown colour of the stem is used as the colouring agent and hence possess a major application in the dyeing industries. In hydrocele, plant paste used as an external application. During burns, decotion of whole plant boiled in goat urine is applied externally. Plant paste with goat urine is applied and tied with bandage during bone fracture.

***Clitoria ternatea* L.**

Root powder (One teaspoonful) mixed with ghee is taken orally immediately after snakebite. Root paste is applied on poison affected regions. Apply the powdered root externally for the treatment of goiter. The root is administered with honey as a general tonic to children for improving mental faculty.

***Dioscorea bulbifera* L.**

Raw tuber is eaten to enhance appetite. Bulbils are used to reduce throat pain. Boiled tubers are taken orally to reduce body heat. Tuber powder mixed with butter is given to check diarrhoea. Tender shoots and twigs are crushed and rubbed on wet hair to remove dandruff. Tubers are boiled after processing and given for abdominal pains. The tubers are dried and pea sized pieces are cut and given in early morning with water for 3 days to cure piles.

***Indigofera tinctoria* L.**

Root decotion is given internally in decotion for kidney stone. Leaf juice is used for the preparation of oil for hair growth. Root juice or leaf juice is used internal for snake poison, rat poison *etc*. 200g of leaf paste boiled with 500ml coconut oil is applied over head for headache. Leaves & twigs paste mixed with slaked lime for preparing blue dye.

***Lawsonia inermis* L.**

Filtrate of fresh leaves kept overnight in water is taken in the morning to treat jaundice. Stem bark decoction is given to treat renal calculi. Leaves crushed with leaves of *Indigofera tinctoria* is used for curing wounds. Leaf extract is applied to treat allergic dermatitis.

***Madhuca longifolia* (J. Koing) J.F. Macbr**

Pinch of seed powder is snuffed to treat hysteria. The bark is used for rheumatism, chronic bronchitis, *diabetes mellitus,* decoction for rheumatism, bleeding and spongy gums. It is

a good remedy for itch, swelling, fractures and snake- bite poisoning, internally employed in diabetes mellitus, fruits are astringent and largely employed as a lotion in chronic ulcer, in acute and chronic tonsillitis and pharyngitis. Leaves are expectorant and also used for chronic bronchitis, Cushing‟s disease, verminosis, gastropathy, dipsia, bronchitis, consumption, dermatopathy, rheumatism, cephalgia and hemorrhoids. The seed fat has emuluscent property, used in skin disease, rheumatism, headache, laxative, piles and sometimes as galactogogue.

***Melastoma malabathricum* L.**

Ethnopharmacologically, the leaves, shoots, barks, seeds and roots of *M. malabathricum* have been used to treat diarrhoea, dysentery, hemorrhoids, cuts and wounds, toothache and stomachache. The leaves are chewed up, pounded and applied as paste on cuts or wounds or finely chopped up and squeezed to apply the juice into the wound to stop bleeding. The young leaves are eaten to treat diarrhea while the young premature leaves are consumed raw to cure dysentery. The roots can also be used as mouthwash to relieve toothache and to treat epilepsy, given to postpartum women to aid healing and womb strengthening. The decoction of the roots is used to treat diarrhoea. The powdered leaves and roots can be applied to wounds and pox scars to aid the healing process. The decoction of roots and leaves or roots alone are also traditionally used to tone up the uterus after childbirth in order to strengthen the womb and accelerate wound healing.

***Michelia champaca* L.**

Mature seeds powder is applied over foot to repel leeches. Cleaning of hair with leaf decoction helps in removing lices and dandruffs. Powder prepared from sun dried stem bark mixed with coconut oil is effective for treatment of skin diseases.

***Mirabilis jalapa* L.**

The leaf juice is used to treat wounds. The leaves are diuretic, while a decoction is used to treat abscesses. A paste of the root is applied as a poultice to treat muscular swellings and scabies. The juice of the root is used in the treatment of diarrhea, fever, and indigestion. The powdered root, mixed with corn flour (*Zea mays*) is baked and used in the treatment of menstrual disorders. Dried root tuber ground to paste with water; the paste applied externally to treat the sebaceous cysts and polyps.

***Nyctanthes arbor-tristis* L.**

Young leaf juice along with honey mixed with hot cow milk is given to children twice daily for 2 weeks in case of bronchitis, asthma and whooping cough. The decoction of flowers are used in the treatment of gout. Leaves are used against dry cough. The aqueous paste of leaves is used externally in the treatment of skin related troubles specifically in treatment of ring worm.

***Nymphaea pubescens* Willd.**

Rhizome ground with seeds of *Piper nigrum* and paste applied externally on neck against Goitre. Powdered rootstock (10-15 gm) is taken orally twice daily for a week in acidity and stomach pain by Santal, Rabha, Bodo and Jayantipur tribes.

***Oldenlandia umbellata* L.**

The root paste is applied topically to arrest bleeding.

***Pithecellobium dulce* (Roxb.) Benth.**

Daily licking of paste form of leaf with mixtures of honey and turmeric powder upto 4-7 days to cure fever and the paste prepared with

mixtures of 5 year old children urine poultice to stomach to cure nerve disorders in the case of postpartum mothers

***Polygonum hydropiper* (L.) Delabre.**

Leaf paste used externally to reduce pain. A combination of leaves and roots are taken orally to treat helminthic infections

***Pterocarpus marsupium* Roxburgh.**

The leaf paste is used as an ointment to treat skin diseases, sores and boils. The flower is used as appetizing and febrifuge and also taken to treat anorexia and fever. The gum is taken to treat bitter, styptic, vulnerary, antipyretic, anthelmintic and liver tonic.

***Rubia cordifolia* L.**

Root paste mixed with rhizome paste of turmeric is applied on the affected portion in the treatment of skin diseases. The decoction of plant cooked with ghee and *Moringa oleifera* is useful for bleeding piles. Externally, paste of the whole plant was applied on major burns, mixed with honey on freckles and blemishes. Root is used externally and internally to gain lustre and glow of the skin and aids to remove pimples, freckles, and discoloration.

***Syzygium cumini* (L.) Skeels.**

Ripe fruits are edible. Bark juice is used for dysentery. Fruit juice is good for leucorrhea and diabetes. Powdered seeds are mixed with sugar are given orally 2–3 times daily in the treatment of dysentery. The juice of leaves is given orally as antidote in opium poisoning and in centipede bite. The juice of ripe fruits is stored for 3 days and then is given orally for gastric problems.

The juice obtained from the bark is given orally for the treatment of women with a history of repeated abortion.

***Terminalia chebula* Retz.**

Powder of roasted fruit mixed with honey is given for cough. Fruit powder with a pinch of iron rust powder is taken with raw milk or honey in empty stomach twice a day for 7 days to cure jaundice

3.4. Unexplored potentialities of *Tectona grandis* : a search

Generally, teak was known for its durable timber, which can be used for many construction purposes. Interestingly, the present study area is flourished with the prominence of teak trees and most of the tribes revealed that the red coloured extract of young teak leaves, bark and fruits were used for curing many ailments and used for the preparation of many therapeutic formulations.

For dyeing

Dyes from *Tectona grandis* L.f. were extracted both from leaves as well as bark. Leaves yield shades of red dye whereas the bark yielded black dye.

As medicine

Teak is used in traditional medicines. The different extracts from various parts of teak shows expectorant, anti-inflammatory, anthelmintic properties. Similarly, it is used against bronchitis, biliousness, hyperacidity, diabetes, leprosy, astringent, and helmintiasis. Further, a wood powder paste has been used against bilious headache and swellings. According to Ayurveda, the teak wood is acrid, cooling, laxative, sedative to gravid uterus and useful in treatment of piles, leucoderma and dysentery. Leaf extract are widely used in the folklore by tribes for the treatment of various kinds of wounds, especially burn wounds. A decoction of leaves is used for treating menstrual disorders and hemorrhages and as a gargle.

Tribal people in other parts of India are also use the charred wood soaked in poppy juice and made into a paste for swollen eyelids. Flowers and seeds have diuretic properties while the oil from the fruit seeds is used to stimulate hair growth and soothe irritated skin. In Manipur state, the boiled extract of young leaves along with fish is reported to be useful in blood circulation. Dried teak leaves can be used at low concentrations (not more than 5–25%) as a dry season feed supplement for goats and sheep (Reddy & Reddy 1984; Anabarasu *et al.,* 2001 & 2004). Sawdust of teak is used in Indonesia to make incense. Asian countries use this plant extract for the treatment of diabetes, lipid disorders, ulcers, inflammation, bronchitis, cancer, skin diseases, malaria and tuberculosis (Rajuri *et al*., 2010; Warrier, 1994). In Cameroon, it is locally used in the treatment of fever (Thedora *et al*., 2014)

Culinary purposes

Young teak leaves are used for preparing various curries by the tribes especially during famine periods. This was substantiated by the people of Indonesia, Yogyakarta and Central Java to produce assorted dishes such as soup, stew or gudeg. Gudeg is a local Javanese cuisine form and give the dish its dark brown color. Leaves of the teak are used in making pellakai gatti, where better is poured into a teak leaf and is steamed. This type of usage is found in the coastal district of Udupi in the Tulunadu region in South India.

Antiasthmatic properties

Teak contains antiasthmatic properties and as such, both the leaves, stems and barks of this plant can be used for preparing herbal medicines for preventing and treating asthma attacks. Goswami *et al*., (2010) screened various extracts of *Tectona grandis* barks for antiasthmatic properties by using various *in-vivo* animal models such as clonidine-induced catalepsy in mice, haloperidol-induced catalepsy in mice, milk-induced leucocytosis and eosinophilia.

Anthelmintic properties

Teak contains anthelmintic properties and as such it is effective for destroying parasitic worms. Gururaj *et al*., (2011) investigated the ethanolic extract of teak fruits to ascertain their anthelmintic properties. Furthermore, the bark of the teak plant can be used for preparing herbal medicines for destroying parasitic worms.

Dermatological care

Tribes use teak leaf decoction or squeezed extract as herbal medicines for treating skin borne disorders. The leaves also help to tackle pruritus, which is a skin condition marked by severe itching of the skin. The bark extract can be used for treating leucoderma, which is a cutaneous condition with localised loss of skin pigmentation that may occur after a series of inflammatory skin conditions, post-dermabrasion and burns. The oil extracted from teak flowers was used for treating scabies, which is a contagious skin disease symptomized by the itching of skin with small raised red spots, caused by the itch mite. The bark can be used for treating leprosy.

Diuretic properties

Teak extracts was also used as diuretic agent and as such, it was used for increasing the urination. Phalphale (2013) evaluated the aqueous extract of teak to ascertain its diuretic effects. Their study also showed that the aqueous extract of *T. grandis* in three doses exhibit diuresis at the various time interval and there was a significant increase in urinary Na+, and Cl-excretion.

Anti-oxidizing power

Young leaf extract is used as health tonic and recommended by the tribals as a dose in the early morning. This may be due to their anti-oxidizing properties thus it is effective for inhibiting the deleterious effects of free radicals in the body. Ramachandrana *et al*., (2011) revealed that the phenolic compounds of teak leaves was a proven anti-oxidizing agent.

Wound healing potentiality

Tribes employ the leaf extract as healing agent for burns and cracks. According to Majumdar *et al*., (2007), the frontal leaves of teak can be prepared herbally and used for treating and healing wounds, especially scald or burn wound. These researchers evaluated the effect of a hydrochloric extract of teak on experimentally induced wounds in rats. A significant increase in the breaking strength was observed in the incision wound model. Furthermore, an oral treatment of *T. grandis* leaf extract produced a significant increase in the dry weight, breaking strength and hydroxyproline content of the granulation tissue in dead space wound. These researchers concluded that the oral (250 mg and 500 mg/kg body weight) or topical (5% and 10% gel formulation) application of teak leaf extract exhibit wound healing effects.

Supports hair growth

Tribes also revealed that the seed oil is used as a stimulant of hair growth. According to Ragasa *et al*. (2008), the oil extracted from teak flowers can be applied on hair for promoting hair growth. Furthermore, Jaybhaye *et al*. (2009) reported that teak seeds are traditionally prepared and used as hair tonic especially in the Indian system of medicine.

Antifungal properties

Many results suggest that coloured leaf extract of teak is antiseptic. Astiti and Suprapta (2012) revealed *in vivo* antifungal activity of the teak leaf extract against *Arthrinium phaeospermum*.

Laxative properties

Raw teak wood may be used for preparing herbal tonic that can be taken as a laxative. Due to the laxative properties of teak wood, it tends to stimulate and facilitate the evacuation of fecal matters from the bowel.

Antidiabetic properties

Bark of the teak can be decocted and used for curing diabetes.

Treatment of haemoptysis

Teak leaves can be used for treating haemoptysis.

Treatment of gastrointestinal disorders

Teak wood was decocted and used for treating gastrointestinal disorders such as dysentery, stomach ache, piles and constipation.

Treatment of headache

Oil extracted from teak wood can be applied on the forehead for relieving headache. This is attributed to the analgesic properties of this plant.

Treatment of anuria

The roots of the teak plant can be decocted and used for treating anuria. Anuria is a health condition marked by the failure of the kidneys to produce urine.

Haemostatic properties

Teak leaves also said to be haemostatic thus can be squeezed and applied on a cut skin to stop bleeding.

Treatment of bronchitis

Teak flowers are used by them for curing bronchitis. Bronchitis is the inflammation of the mucous membrane in the bronchial tubes, which causes bronchospasm and coughing.

3.5. Mode of extraction and administration of polyherbal dyes

Curcuma longa L.

Twenty drops of fresh turmeric rhizome juice mixed with a pinch of salt taken in the empty stomach morning daily for worms. Take seven leaflets of neem (*Azadiracta indica*), even dried berries of black pepper and fresh turmeric rhizome for 21 days continuously along with one ounce of milk in the morning for dueodenal ulcer. For asthma, a teaspoon of turmeric powder with a glass of milk daily is effective. Turmeric powder with few drops of honey and juice of leaves of bitter gourd is taken in for measles. *Hemidesmes indica* tuber, turmeric powder and ghee are mixed and eaten for leech poisoning. For dog biting, fresh turmeric rhizome, *Alangium salviifolium* root and *Vitex nigundo* roots are applied for dog bite.

Mallotus philippensis (Lam.) Muell.Arg.

Ripe fruits crushed and boiled in water is used for diarrhea. The powder and a few other parts of Kamala are also used in external applications to promote the healing of ulcers and wounds. They are used to treat parasitic affections of the skin like scabies, ringworm, and herpes, puerperal fever, cancer, pneumonia, fever, tuberculosis, leucorrhea, passing of semen with urine, loss of appetite, stomach disorders, indigestion. Paste is prepared from leaves of *Mallotus philippensis*, tubers of *Colocasia esculenta*, bark of *Cinnamomum verum*, camphor (terpenoid from *Cinnamomum camphora*), fruit of *Piper cubeba*, leaf of *Scoparia dulcis*, fruit of *Ficus scandens*, clove of *Syzygium aromaticum*, fruits of *Amomum subulatum*, and *A. aromaticum*, fruit of *Piper longum*, rhizome of *Curcuma zedoaria*, top of stem with leaf of *Bambusa tulda*, leaf pulp of *Aloe vera*, rhizome of *Alpinia nigra*, and calcined copper, lead, iron, brass, any color and bell metal. Tablets prepared from the paste are dried and taken orally. Paste made from an equal quantity of leaves and tender fruits mixed with honey are taken orally twice a day for 13 days to get relief from rheumatism. During this period, consumption of salt, spicy food and tamarind has to be avoided.

Pterocarpus santalinus L.f.

Decoction of fresh stem barks of the plant, *Calamus tenuis* root and *Azadirachta indica* stem bark is given orally either with sugar candy or honey in empty stomach for 21 days to cure piles and blood setting piles. The wood paste is applied externally, specially for healing various skin diseases and blemishes. The decoction of fresh stem barks of the plant, *Calamus tenuis* root and *Azadirachta indica* stem bark being given orally either with sugar candy or honey in empty stomach for 21 days to cure piles and blood setting piles. The wood is powdered and soaked in water and the paste is applied on skin for prickly heat. For smooth and fair skin, the powdered wood is mixed with flour and egg and is applied on the body.

Semecarpus anacardium L.f.

Fruit oil is applied on cuts and wounds . Fruit of *S. anacardium, Allium sativum* & resin of *Gardenia resinifera* warmed in castor oil is applied on cuts and wounds . Seed oil is applied on cuts and wounds for healing. For sprain, sesame oil is applied on the affected part of the body and then the seed oil is applied.

Tectona grandis L.f.

Tender leaves are used for the preparation of oils for burns. The coloured sap from the leaves is applied for eczema. Leaves of *Annona*

squamosa, *Vitex negundo*, *Tectona grandis*, *Tinospora cordifolia* and Vanda plant is equally mixed and boiled; filtrate is used for bath in case of swelling and rheumatism.

Woodfordia fruticosa (L.) Kurz

For cough, asthma, bronchitis and tuberculosis, about 1 kg flowers and leaves are mixed in 150 ml water, heated for 1 h and juice is extracted, which is kept in earthen pot. Then, 40 g of NH_4Cl and 20 ml aqueous extract of *Datura stramonium* is added. The drug is administered to the patient for 1 week, thrice in a day. For rheumatism, about 300 g of leaves are crushed and boiled in 1 l water in an iron vessel, till it is left to half and given to the patient with honey for 2 weeks, 4 times daily.

4. Conclusion

Thus, the overall study highlights the importance of different traditional and pharmacological activities of medicinal and dye yielding plants with special reference to *Tectona grandis*. Most of the tribal knowledge of the plant species were carried with the crude extract which is either monoherbal or polyherbal. The knowledge on the folklore uses of the medicinal plants leads to open up new avenues for optimal utilization of herbal drugs in future. Mode of preparation of dye from the plant varies. For increasing intensity animal products are used. Future work is warranted to isolate the lead molecules from the leaf extract and to evaluate its hepato-protective and immunomodulatory potential.

Conflict of interest statement

We declare that the authors have no conflict of interest.

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