Available online at www.worldscientificnews.com

World Scientific News

WSN 42 (2016) 143-155 EISSN 2392-2192

# A digitized database of bark morphology for identification of common tree species and literature study of bark phytochemicals and therapeutic usage

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**ABSTRACT**

Bark is used for several therapeutic purposes by traditional knowledge from ancient time. The present study was attempted to digitize the bark morphology by image based database for common tree species and compilation of recent research works by literature survey to know potent phyto-constituents present in the bark of tree species and their ability in disease prevention. In conclusion, present study of digital database on bark morphology may help easy detection of common tree species in biodiversity research work. In the present study, also the compilation of bark phytochemicals and their therapeutic efficiencies may also serve a databank as ready references in future pharmacological researches.

***Keywords*:** Bark morphology; Bark images database; Phytochemicals in bark; Common tree species; Terrestrial ecosystem

## 1. INTRODUCTION

Bark is the outermost covering of the tree that consists of tissues outside the vascular cambium, with different types and species of trees, its morphology changes. The barks varies in their size, colour, chemical and cellular composition, length etc. It has been reported that the bark in mature tree varies in colour from brown to greyish to blackish depending on their cellular composition and phytochemical contents, accompanied by fissures, furrows, rings, scales etc. on it (Wojtech, 2013). Generally barks have different morphologies like ringed, smooth, fissured, furrowed, scaly etc. The primary functions of the inner bark help in transport and storage of photosynthetic chemicals while inner bark supports carbon fixation. It was observed that main functions of outer bark is reduction in water loss from stems and roots, protect pathogen entry, avoidance of mechanical injury to underlying tissues, and protection against environmentally adverse conditions such as extreme cold and heat (Romero, 2012).

According to Kalbande (2014), different morphological features of bark is a suitable tool for easy identification of tree species. According to him, digital bark library supports taxonomical identification and biodiversity study of plant species easily. In China, Jingzhu et al. (2006) have documented sustainable forestry development through a database framework of digital forestry. It was documented by researchers regarding digital herbarium (Rai et al., 2003; Sambandan and Chowdhery, 2004) but in recent research arena digital databank of plant species with special reference to morphology of different barks may lead to taxonomical easy identification (Kalbande, 2014) and digital forestry database research works have already been done before (Zhao et al., 2005; Jingzhu et al., 2006).

The barks of many species have exhibited the storage sites for various substances viz. carbohydrates, nitrogen, and water (Pomeroy et al., 1970). Bark products have been essential as sources of raw materials, used in medicines. According to Young (1971), chemical compounds found in low concentrations in different parts of plant while in some species bark contained in high concentration. The phytochemicals are potent bioactive compounds, which found naturally, protect the plants against bacterial and fungal infections and showed characteristic features to the plants.

The present study was aimed to digitize database on different types of bark by individual morphological features of common tree species located around Nature park, Kolkata, India for easy taxonomical identification and discussion made on phytochemicals present in the bark of theses tree species and beneficial to disease prevention, which was compiled on the basis of recent literature survey.

## 2. MATERIALS AND METHODS

The study area was selected as around Nature park (latitude = 22° 52'N and longitude = 88°29'E), Kolkata, India. The field study was done in the month of December 2015 – January 2016. In the present study randomly selected common tree species as per their different morphological features of the bark. The field assessment was carried out by locating the common tree species around the study area, studied their bark morphology and taken photographs to make image based digital database, which may lead to easier identification in

taxonomical features of tree species. The study of bark morphology was followed by the research work and concept of Kalbande (2014) and Wojtech (2013).

The usage of the bark in treating several diseases in the early times and also recently by the people of villages. The bark phytochemicals as medicinal importance documented by different researchers worldwide. The present study was compiled from recent literatures. All the data containing the bark morphology of particular tree species by images and observable features was tabulated as well as important phytochemicals content in the bark helps in disease prevention was discussed and compiled through the recent research works by several researchers.

## 3. RESULTS AND DISCUSSION

The present results clearly indicate that digital image of different types of bark in the studied tree species can be a suitable tool in taxonomical identification. From the literature study, it was observed that several phytochemicals obtained in the bark of individual tree species and their potent properties of health benefit. Each tree species with their common name, scientific name, observable bark structure, bark image were tabulated in Table 1.

There were 25 types of common tree species were randomly selected in the field (Table 1). The bark images were detected peeled, smoothen, scaled, furrowed, fissured, vertically cracked, ring scared and warty types. In the present study, the various images based database help to identify easily all the common tree species in relation to family. According to Kalbande (2014), bark morphological features were mainly smooth, scaly, shaggy, furrowed, and warty types that identified and documented in the digital bark library. But the present study with an agreement of other images of barks in various tree species by Wojtech (2013). He has documented in an image for the bark types viz. smooth, lenticels, peeling strips, vertical cracks, scales, plates, vertical strips, intersecting ridge, horizontally broken ridges and uninterrupted ridges.

From ancient time, bark of various tree species have been used as medicines by traditional knowledge of villagers. Mostly all the barks have an considerable amount of tannins, suberin, lignin along with phytochemicals like saponins, terpenes, phenolic acids, glycosides, alkaloids, flavonoids, vitamins, steroids etc. for which the concentration varies with different plant species. Cellulose is the principal carbohydrate in bark. Compounds like flavonoids are some of which have economic importance as known phytochemicals viz. quercetin, taxifolin, etc. as well as anthocyanins and leucoanthocyanins (Romero, 2012). Various researchers have carried out studies on the bark and their phytochemical content that prevent several diseases. According to Daniel and Dishi (2011), 10 groups of phytochemicals have been observed in *Azadirachta indica*. Significant amount of tannins ranging from 13-25% have been found in species like *Azadirachta indica*, *Delonix regia*, *Mangifera indica* etc. (Malviya and Mahajan, 2013). Significant antimicrobial, antifungal, anti-inflammatory, analgesic, anti-diabetic and certain other properties are actively seen in the bark due to their phytochemicals content. Gulmohar bark have analgesic and anti-inflammatory activity and bark of mango is used in treating throat diseases, diphtheria and rheumatism (Malviya and Mahajan, 2013).

The data was published for phytoconstituents viz. alkaloids flavonoids saponins and total phenols and also phlobatannins, present in the bark of *Azadirachta indica*, which help to

prevent diseases like malaria, diarrhea, inflammatory disorder, microbial, cancer, vasorelaxation and also potent antioxidative agent (Daniel and Dishi, 2011).

Sivakumar et al. (2011) have studied the antibacterial potential of *Cocos nucifera* tree bark by the presence of phytochemicals viz. flavonoids, glycosides, carbohydrates, tannin and saponin.

The tree species, *Ficus religiosa* have contained several natural chemicals viz. tannins, saponins, flavonoids, steroids, terpenoids and cardiac glycosides in the bark and have used in the treatment of diabetes and other therapies for cells and tissue damages, antibacterial, gonorrhoea, diarrhoea, haemorrhoids by constipation and ulcer in stomach, inflammatory disorder, burns etc. (Warrier, 1996; Makhija et al., 2010).

The phytochemicals such as carbohydrates, phenols, flavonoids, tannins and saponins was detected in the bark of *Acacia auriculiformis* that have wound healing capacity when prepared aqueous extract (Singh and Sharma, 2014).

The bark of *Delonix regia* contained β-sitosterol, flavonoids, saponins, alkaloids, carotene, hydrocarbons etc. and these have prevented inflammatory disorder, microbial load, etc. (Sama and Xavier Vergeese, 2011).

According to Prakash Yoganandam et al. (2012), the phytochemicals were observed majorly in leaves and seeds of *Sterculia foetida*, the bark phytochemicals and their medicinal usage have not been found in the literatures.

The bark extracts of *Artocarpus* sp. have showed potent anti-microbial activity against *Bacillus subtilis* and *Pseudomonas fluorescens* (Binumol and Sajitha, 2013).

The bark of plum, *Ziziphus* sp. (Indian plum) has been used for herbal medicines as laxative, pain killer, tranquilizer, anticonvulsant, antibacterial and also for the treatment of insomnia and anxiety (Peng and Zhu, 2001) and contained several bioactive compounds such as glycosides, phenol and tannin (Ahmad et al., 2011).

The presence of alkaloids, glycosides, flavonoids, etc. have alredy been established in the bark of *Albizia lebbeck* and the bark showed antimicrobial and antioxidant activity (Malla et al., 2014).

The tree bark of *Terminalia arjuna* possess a number of activities like antioxidant and antimicrobial, antidysenteric, antipyretic, cells and tissue repairing, cardio tonic, lithotriptic, anticoagulant, antimicrobial and antiuremic (Mandal et al., 2013).

The bark of *Samanea saman* contains a higher percentage of alkaloid, which acts as antimicrobial agent and also used in alternative medicines (Gonzales and Tolentino, 2014).

Al-daihan and Bhat (2012) have reported that carbohydrates, alkaloids, flavonoids and tannin are the main bioactive compounds inhibited the growth of bacteria that present in the bark of *Phoenix dactylifera*.

The phytochemical screening of bark extract of *Kigelia africana* shows the presence of glycosides, phenolic compounds, alkaloids, etc. (Abdulkar et al., 2015) alongwith antimicrobial agents.

It was documented by Gurjar et al. (2010), the bark extract of *Anthocephalus cadamba* (Roxb.) Miq., has contained various phytochemicals viz. carbohydrate, proteins, flavonoids, alkaloids and glycoside compounds, which have been treated for astringent febrifugal, anti-diuretic, cough tonic, eye inflammation, semen quality induction.

The bark of *Alstonia scholaris* contained carbohydrates, fixed oils and fats, alkaloids, tannins, terpenoids, saponins, flavonoids, steroids, etc. which can be used for the therapy as cells and tissue repairing, digestive, laxative, body heat generation, fever, etc. It is also used in

stomach disorders, fever, leprosy, skin diseases, ulcers, breathing problems and helminthiasis (Saxena et al., 2012).

Kapur and John, (2014) have analysed phytochemicals such as saponins, quinine, alkaloids, lignin and glycosides, from bark extract of *Tamarindus indica*, which used for antimicrobial activities.

The bark of *Casuarina equisetifolia*, it was documented various phytochemicals viz. casuarin, and tannins that have been used for many therapy like astringent, dysentery, headache, fever, cough, ulcers, toothache, inflammation, diabetes, anticancer, anthelmintic and antimicrobial activities (Maiden, 1989; Chopra et al., 1992; Han, 1998; Mhaskar et al., 2000; Ahmad and beg, 2001; Prajapati, 2003; Parekh et al., 2005; Aher et al., 2006, 2008; Aher et al., 2009, 2010; Gumgumjee and Hajar, 2012).

The bark of *Dalbergia sissoo* has contained different compounds like dalbergenone, dalbergin, methyl dalbergin, 4-phenylchromene, dalbergichromene and also contained dalbergichromene, nordalbergin and isodalbergin in low level. The species have showed analgesic activities alongwith postagladin synthatase inhibition by the flavonoids content (Mojahid-ul-Islam and Elhddad, 2012).

The bark of *Polyalthia longifolia* has also been studied by researchers that a new clerodane-type gamma hydroxylbutenolide diterpenes viz. (Z)-4-hydroxy-3-(2"6"-hydroxy-5"-(hydroxymethyl)-5", 8"a-dimethyloctahydro-1*H*-spiro[naphthalene-2", 2"-oxiran]-1"-yl) ethylidene) dihydro-furan-2(3*H*)-one were investigated. The phytochemical, dimeric clerodane diterpene has also been further isolated and these are commonly called as bisclerodane compound namely Longimide A and B, which showed potent antimicrobial activities on several bacteria and fungi (Dixit et al., 2014).

The mango bark has contained 16% - 20% tannin and used in the treatment of gum inflammation, diseases in throat and also used in treatment of bacterial diseases, rheumatism, etc. (Malviya and Mahajan, 2013).

The bark of *Moringa oleifera* was analyzed by researchers that alkaloids (moringine and moringinine), sterols (β-sitosterol and β-sitostenone) and benzylglucosinolates, which have been used in drugs (Sholapur and Patil, 2013).

The ellagic acid rhamnosides namely 3-*O*-methylellagic acid 3′-*O*-*α*-3″-*O*-acetyl-rhamnopyranoside, 3-*O*-methylellagic acid 3′-*O*-*α*-rhamnopyranoside, 3-*O*-methylellagic acid 3′-*O*-*α*-2″-*O*-acetylrhamnopyranoside and 3-*O*-methylellagic acid 3′-*O*-*α*-4″-*O*-acetylrhamno-pyranoside have investigated from the stem bark of *Eucalyptus globulus*, these constituents have antioxidant properties (Kim et al., 2001). According to Boulekbache-Makhlouf et al. (2012), the crude extract of bark of same tree species contained polyphenol, tannin, flavonoids and flavonol, which used for traditional therapy viz. lung tuberculosis, viral fever, blood sugar, toothache, snakebite, diarrhea and other diseases.

The phytoconstituents viz. alkaloids, carbohydrates, flavanoids, proteins, saponins and tannins and phenolic compounds, glycosides have been analysed in the bark extract of *Ficus bengalensis* and these chemicals have potent therapeutic efficacies for cracked or inflammated feet sole, toothache, diabetes etc. (Singh et al., 2012).

According to Elekwa et al. (2009), the bark of *Psidum guajava* contained steroid rings, deoxy sugar (cardiac glycosides), cardenolides, tannins, alkaloids and saponins and these natural chemicals have potent antibacterial and antifungal properties.

It was isolated phytochemicals like stigmasterol, β-sitosterol, lupeol and lupenone from bark of *Peltophorum pterocarpum* and these have used in disease prevention as dysentery, as eye lotion, embrocation for pains and sores (Jash et al., 2013).

Therefore, the present study may be an easy tool for taxonomical identification of tree species having digital database of specific morphological features. The study of biodiversity for important medicinal trees can be compared with present digitized database, which was in a tabulated form. In recent research era of digital forestry may be achieved faster and easily with the present tool that have already been documented internationally (Zhao et al., 2005; Jingzhu et al., 2006). The present study was also done with the help of recent literatures related to phytoconstituents and their therapeutic efficacies of the bark of common tree species can also be a ready references for researchers and biotechno-personnel's in the field of biodiversity, pharmacology and drug development from plant origin.

## 4. CONCLUSIONS

It was concluded that the present study based on digitized database of bark morphology is an easy tool to taxonomical identification and may help in research work on biodiversity of trees. In other way, the compilation of several recent literature data of bark phytoconstituent and their remedial measures in disease from these common tree species were also an ready references for scholars, researchers, students and herbal industries for further research work and drug development as phytomedicines.

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( Received 11 February 2016; accepted 23 February 2016 )

**Table 1.** Digitization for morphological features of bark in common tree species.

| Sl. no. | Tree species (common name) | Tree species (scientific name) | Family | Different bark morphology | Images of different types of bark |
|---|---|---|---|---|---|
| 1. | Neem | *Azadirachta indica* | Meliaceae | furrowed in shape; dark brown to grey in colour |  |
| 2. | Coconut | *Cocos nucifera* | Arecaceae | ringed scars; greyish to dark brown in colour |  |
| 3. | Peepal | *Ficus religiosa* | *Moraceae* | smooth surface; brownish in colour |  |
| 4. | Australian acacia / Akashmoni | *Acacia auriculiformis* | Fabaceae | vertically fissured, cracked surface; black in colour |  |
| 5. | Gulmohar | *Delonix regia* | Caesalpiniaceae | smooth surface, sometimes cracked surface; greyish brown in colour |  |

| | | | | | |
|---|---|---|---|---|---|
| 6. | Wild almond | *Sterculia foetida* | Malvaceae | rough surface with lenticels; greyish black in colour |  |
| 7. | Jackfruit | *Artocarpus heterophyllus* | *Moraceae* | smooth surface; black to grey brown in colour |  |
| **8.** | Plum | *Ziziphus jujuba* | Rhamnaceae | longitudinal furrowed surface; greyish brown in colour |  |
| 9. | Sirish | *Albizia lebbeck* | Fabaceae | surface rough, deeply fissured, exfoliating in irregular semi brittle scales; black-brown in colour |  |
| 10a. | Arjun | *Terminalia arjuna* | *Combretaceae* | scaly surface; dark grey in colour |  |

| | | | | | |
|---|---|---|---|---|---|
| 10b. | Arjun | *Terminalia arjuna* | *Combretaceae* | peeling surface; dark grey in colour |  |
| 11. | Date Palm | *Phoenix dactylifera* | Arecaceae | fleshy bark with persistence of old leaves; green to brown in colour |  |
| 12. | Rain tree | *Samanea saman* | Mimosaceae | slightly to deeply fissured; grey-brown in colour |  |
| 13. | Drumstick | *Moringa oleifera* | *Moringaceae* | Smooth surface, brown in colour |  |
| 14. | Sausage tree | *Kigelia africana* | *Bignoniaceae* | smooth surface; grey in colour |  |

| | | | | | |
|---|---|---|---|---|---|
| 15. | Kadam | *Neolamarckia cadamba* | Rubiaceae | longitudinally fissured, grey in colour |  |
| 16. | Chhatim | *Alstonia scholaris* | Apocynaceae | surface with lenticels; greyish-brownish in colour |  |
| 17. | Tamarind | *Tamarindus indica* | Fabaceae | rough, fissured surface; dark-grey in colour |  |
| 18. | Casuarina | *Casuarina* sp. | Casuarinaceae | rough surface with lenticular bristles; greyish-brown in colour |  |
| 19. | Rosewood | *Dalbergia* sp. | Fabaceae | ridges and sharp prickles; greyish-brown in colour |  |

| | | | | | |
|---|---|---|---|---|---|
| 20. | Debdaru | *Polyalthia longifolia* | Annonaceae | surface vertically cracked; dark brown in colour |  |
| 21. | Mango | *Mangifera indica* | Anacardiaceae | surface vertically cracked; dark brown in colour |  |
| 22. | Eucalyptus | *Eucalyptus sp.* | Myrtaceae | peeling surface; whitish-brown in colour |  |
| 23. | Banyan | *Ficus bengalensis* | Moraceae | thick and smooth surface; brown in colour |  |
| 24. | Guava | *Psidium guajava* | Myrtaceae | peeling surface; yellowish-brown in colour |  |

| | | | | | |
|---|---|---|---|---|---|
| 25. | Copper pod | *Peltophorum pterocarpum* | | surface with warts, brownish black in colour |  |