

## Updates on some medicinal and ornamental plants- *Ayurvedic* medicines Kiran

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### Abstract

This literature review paper highlights morphology, distribution, medicinal properties of commercially important tree species, *Thespesia populnea*, *Terminalia arjuna*, *Butea monosperma* (Palas), Silver oak (*Grevillea robusta*), *Mangifera indica*, *Madhuca longifolia*, *Melia azadirachta*, *Michelia champaca*, *Moringa oleifera*, *Peltophorum pterocarpum*, and *Aegle marmelos*. These plants have been used for centuries by local communities and traditional healers for their therapeutic and medicinal properties. Medicinal plants play a crucial role in the Western Ghats, both ecologically and culturally. The use of herbal medicines for the treatment of diseases is safe and traditional. Therefore, medicinal plants have been receiving great attention because of their safety. The Western Ghats harbors more than 7,500 flowering plant species, of which nearly 1,500 are recognized for their medicinal values by local communities and traditional healers. The Western Ghats population traditional medical practices frequently center on using plant-based treatments. These medicinal plants are carefully chosen, and preparation techniques have been perfected through many years of practice. Studies indicated that *Mangifera indica* possesses antidiabetic, anti-oxidant, anti-viral, cardiotoxic, hypotensive, and anti-inflammatory properties. Mango contains Mangiferin, a polyphenolic antioxidant and a glucosyl xanthone, has strong antioxidant, anti lipid peroxidation, immunomodulation, cardiotoxic, hypotensive, wound healing, antidegenerative and antidiabetic activities.

**Keywords:** *Ayurveda*; Dharwad; Karnataka; Medicinal plants; Phytochemicals; Traditional healers; Tree species; Western Ghat

### 1. Introduction

India has one of the most expanded plant-origin medical traditions in the world. Researchers have evaluated molecules obtained from plants to treat a variety of ailments [1-148-161]. Karnataka, one of the Southern states of India has 3.83 Million ha of recorded forest area which is around 20 percent of its geographical area [1-14-80, 147]. The State of Karnataka is a part of highly biodiversity rich regions of India. The Western Ghats of Karnataka is one of the mega biodiversities of the world. The Karnataka state is endowed with great diversity of climate, topography and soil [1-14-80, 147]. Karnataka is endowed with most magnificent forests in the country ranging from majestic evergreen forests of the Western Ghats to the scrub jungles of the plains. The Western Ghats of Karnataka are one of the 25 global priority hotspots for conservation and one of the two on the Indian subcontinent. Several economically important species such as Sandalwood, Rosewood, Teak, White cedar grow naturally in these forests [1-14-80, 147]. Forests of Karnataka harbors more than 1493 medicinal plants belonging to 808 genera and 108 families. They occur in different vegetation types across the Western Ghats. Medicinal plants are the most valuable natural resources. Rapid urbanization and habitat loss is resulting in the loss of many important medicinal plants [164-233]. Medicinal plants find application in pharmaceutical, cosmetic, agriculture, animal husbandry and food industries. Some of the medicinal plants are on the

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verge of extinction due to unsustainable harvest and lack of knowledge Medicinal plants are the main ingredients of local medicines and are of vital importance in traditional healthcare [164-233]. People use medicinal plant species for sustenance of their traditional healthcare system both logistically as well as economically. But an inclination towards modern technology and over extraction of many of these plants have resulted in considerable depletion of the population of such species and some have become extinct [1-14-80, 147].

In Karnataka, according to a study of the Botanical Survey of India, there are 3924 species belonging to 1323 genera and 199 families in the forests, of which 1493 species are of medicinal value. These belongs to 808 genera and 108 families. They occur in different vegetation types across the Western Ghats. It is estimated that 90% of the industrial requirement of plant material is coming from the forests. In the direction of conservation, the species recovery programme by conserving the habitat of threatened medicinal plants and steps to enhance production seem to be the only solution to stop further degradation [1-14-80, 147]. The Karnataka Forest Department has initiated various programmes for the conservation of medicinal herbs, shrubs and trees associated with traditional methods of medicine. The traditional knowledge is based on Indian ethnic medicine system which can help in improving general wellness [1-14-80, 147] The rich biodiversity coupled with higher endemism can be attributed to the humid tropical climate, topographical and geographical characters. Western Ghats form an important watershed for the entire peninsular India, and is a source of west flowing rivers and three major east flowing rivers. The Western Ghats belong to one of the oldest mountain ranges of the planet; harbor numerous elements of flora and fauna having lineage to the Gondavana land [1-14-80, 147-161].

The Western Ghats, also known as the Sahyadri range, is a mountain range that runs along the western coast of the Indian subcontinent [1-14-80, 147]. It stretches over a distance of about 1,600 kilometers (990 miles) from the southern part of India in Karnataka, Kerala, Andhra Pradesh, Tamil Nadu, Goa, Maharashtra to the state of Gujarat. The Western Ghats is considered as one of the world's major biodiversity hotspots [1-14]. It is a home to numerous endemic flora and fauna, including many rare and endangered plant species. The Western Ghats harbor an incredible diversity of plant and animal species. It is estimated to have more than 7, 500 species of flowering plants and also known for its vast variety of medicinal plants. These medicinal plants have been used as traditional medicine due to their high medicinal value and plays a major role in the lives of people. Many traditional remedies for ailments and diseases rely on the use of these medicinal plants [1-14-80-161, 164-233]. Many indigenous communities residing in the Western Ghats have a rich traditional knowledge of medicinal plants and their therapeutic properties [1-14-78]. In the bygone period, people relied mainly on the plant kingdom for their medicines to cure various health disorders [1-14-80-161]. As per World Health Organization (WHO) statistics, 80% of the world's population still consumes traditional herbal supplements and medicines [1, 2-70-161-233]. These plants are integral to their healthcare systems, providing solutions for various ailments. Ethnomedicinal plants play a significant role in traditional healthcare practices in the Western Ghats, serving as a primary source of healthcare for the local population [164-233]. The preservation of these plants and their habitats is crucial for the overall conservation of the region. The loss of these plants would not only impact local communities but also limit future possibilities for drug discovery [1-14-80, 147-233].

Conservation of medicinal plants in the Western Ghats is necessary for the preservation of biodiversity and to maintain the traditional knowledge associated with these plants. Medicinal plants are grown for food and for several novel nutraceutical and industrial applications [1-58- 72-163]. Research is extended to the new oil-bearing plants, which provide high amounts of phytochemicals and oils for nutritional and pharmaceutical products. It has been used for centuries by local communities and traditional healers for their therapeutic and medicinal properties. The Western Ghats in India is the site of one of the richest tropical forest regions in the world, which is not only of high conservation value but also a treasure house of valuable plants with medicinal and other uses. These medicinal plants are carefully chosen, and preparation techniques have been perfected through many years of practice[1-14-80-161]. Unlike synthetic drugs, medicinal herbs are easily available, especially in low-income countries, and are also generally considered to be non-toxic with fewer side effects. Thus, they are often the preferred treatment option, especially in underdeveloped or other developing countries [1-14-80, 147]. *Atharvaveda* is the oldest world literature on plant use against diseases. Many diseases are mentioned in *Atharvaveda*. To combat these diseases, many plants were prescribed in the process of treatment. Charaka samhitha and Sushrutha samhitha are the two major post- Vedic codified literature in *Ayurveda* [1-14-80, 147-161]. In *Ayurveda* and other systems of medicine, different parts of the same plant in different seasons and for different therapeutics are used.

These medicinal plants are most valuable natural resources. Rapid urbanization is resulting in the loss of many important medicinal plants [164-233]. Scientific documentation of medicinal plants has proved a helpful resource for *Ayurvedic* healthcare system[1-14-80, 147]. Only a quarter of the world population knows the helpfulness of different Indian medicinal plants. With the help of modern scientific knowledge and research, we can develop a healthcare system without side effects [164-233]. The literature on medicinal plants is written in Sanskrit. This knowledge is used in synthesis of life saving drugs. According to World Health Organization, almost 33% of the world population living in

Asia and Africa is not able to buy essential drugs[1-14-80, 147-161]. This problem can be solved by replacing the high-priced drugs with traditional medicines which is effective, cheaper ones derived from naturally occurring resources[1-14-80, 147-161-233].

With the advent of vertical farming and advancements in biotechnology, there is more scope for these medicinal herb-based systems to get popular in developed countries as well as in the coming years [1-14-80]. These medicinal herbs are currently being utilized in pharmaceuticals, food preparations, nutraceuticals, folk medicines, and many others due to the biological properties of the bioactive molecules in the plants [164-233]. The plants have been purifying the atmosphere by assimilating carbon dioxide by increasing the number of trees in a city and its supply of oxygen can be augmented by photosynthetic activity [1-14-80]. Tissue culture methods to get young plant-lets is one of the few methods available and one of the most effective, to maintain and improve productivity without destroying the environment [1-14-80]. Stem grafting is a simple technique in plant breeding [1-14-80]. A lot of emphasis has indeed been devoted to the investigation for antimicrobial compounds in sustainable materials, and efforts have been taken to find compounds that can adequately replace manufactured antimicrobials [1-14-80-161].

The natural remedy has developed in the Global scenario over the past few decades. Since the beginning of time, people from practically every civilization have sought to heal benefits from various plants by employing their medicinal properties. It is possible to trace the widespread usage of herbal medicines and healthcare preparations made from traditionally used herbs and medicinal plants back to the emergence of natural products with medicinal characteristics [1-14-80]. Plant-based phytochemicals are employed as a paradigm to generate healthier and more efficacious therapeutics for preventing the growth of microorganisms [1-14-80-163]. Different plant extracts have been utilized in various researches to screen for antimicrobial property and discover novel antimicrobial substances[164-222]. Phytopharmaceutical products have a very long history in India, despite the fact that appropriate scientific rationalization is a recent development [1-14-80-160]. There are many issues with plant extracts, one of which could be the loss of the precise active component utilized to improve natural contraceptives [1-14-80-161].

However, a significant amount of basic and applied research is required to validate and use of plants in phytopharmaceutical chemistry. The potential use of higher plants as a source of new medications is still underutilized [1-14-80-160]. Only a small portion of the approximated 250,000–500,000 plant genera have been thoroughly explored in terms of their pharmacological qualities, and only a small portion have been investigated phytochemically [1-14-80-161].

In the following section, the medicinal value, distribution, morphology of the plants have been presented. The present paper enumerates various traditional, medicinal utility of the listed plants and attempt was made to gather information about the chemical composition and pharmacological aspects of the listed plants.

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## 2. The Bhendi - tree

- Botanical Name: *Thespesia populnea* soland,Cav.
- Syn. *Hibiscus populneus* L.
- Family: Malvaceae.
- Eng.: Indian Tuliptree or umbrella tree
- Hindi: Bhendi

### 2.1. Kannada: Adavi bende mara, or Huvarasi mara

*Thespesia populnea*, commonly known as the Portia tree, is a species of flowering plant in the mallow family, *Malvaceae* [1-8]. The scientific name, *Thespesia* in Greek means = divine. Because the tree was first noticed in the neighborhood of the temples in Tahiti by Captain Cook in 1769. “Populnea” meaning “poplar like” and refers to the shape of the leaves that are like that of ‘European poplar[1-8].



**Figure 1** *Thespesia populnea* flower

#### *2.1.1. Distribution*

This is one of the indigenous small tree or arborescent shrub that has a pan tropical distribution, found on coasts around the world. It is wildly found along the sea-coasts from Konkan South wards, on the coast of Chittagong, Andamans and Nicobar Islands, India. It is widespread on the Burma and Islands of Pacific, and Westwards to East Africa [1-8-13].

#### *2.1.2. Description*

This is an evergreen medium sized tree with a straight trunk. It is usually grey in color, its branches are closely set and dense crown which gives appearance of umbrella [1-13]. Hence the tree was named as umbrella tree in English. The leaves are alternate, heart shaped, and are 7-14 cm long. The apex of the leaf tapers into a fine point like that of the leaf of Peepal tree [1-8-13]. The leaves do not fall off at once. In the month of February, many leaves turn yellowish and gradually fall from the tree. The flowers are showy, bright yellow colored ( Figure-1) posses a purple “eye” at the base inside usually 7-9 cm. As flower turn old they become acquires a brick red of pinkish color. The calyx is green colored, cup shaped and the petals are nicely fringed re-crinkled. The stamens are fused together in a long tube, the anthers are golden colored and the style splits into five branches[1-8-13]. The fruit is globular, it is green which later turns to brown and finally black [1-8].

#### *2.1.3. Season of flowering*

The flowers are found throughout the year( Figure-1). Generally found at the beginning of the cold season.

#### *2.1.4. Characteristics of Seed*

The fruits containing several seeds, commonly 6-15 seeds in each fruit. The seeds are oval shaped covered with fine down [1-8-13].

#### *2.1.5. Special Characteristics of The Plant*

The tree is tough and resistant to water.

The tree yields a good quality timber.

This is an erect, and evergreen tree. Very quick growing tree.

#### *2.1.6. Method of Reproduction: Natural method of reproduction*

This tree can be naturally raised using seeds. Seeds showed successful germination. Healthy growth is observed with light porous soil [1-8-13].

#### *2.1.7. Artificial method of Reproduction*

In this method, the plants are successfully raised from cuttings. Preferably small cuttings are advisable because the large cuttings liable to decay since small cuttings gives good results [1-8-13].

### 2.1.8. Medicinal Uses

*Thespesia populnea* is a reputed ever green tree belonging to the family *Malvaceae*; commonly known as Indian tulip tree [1-13]. The plant is distributed in tropical regions and coastal forest in India. It is well known plant and all the parts are used in traditional system of medicine [1-13]. *Thespesia populnea* is a plant that has been used in *Ayurvedic* medicine for a long time and recent research has confirmed its medicinal properties [1-8-13]. The plant's different parts including the bark, fruit, stem, seed oil, leaves and roots contain a variety of therapeutically useful substances [1-13]. Among the significant chemical constituents of this plant are gossypol, gossipetin, lupenol and harbacetin [1-8-13]. These chemicals have a variety of biological effects including anti-inflammatory, antioxidant, hepatoprotective, anti-cancer and anti-fertility qualities [1-13]. *Thespesia populnea* soland ex Correa (family *Malvaceae*) is a large tree found in the tropical regions and coastal forests in India and it is cultivated in the gardens [1-13]. All the parts of the plant used in traditional system of medicine [1-8-13]. The bark, leaves, flower and fruits are useful in cutaneous infection such as scabies, psoriasis, eczema, ringworm, and guinea worm [1-13]. The decoction of the bark is commonly used for the treatment of skin and liver diseases [1-8-13]. The oil of bark and capsules is useful in urethritis and gonorrhoea [1-13]. The bark, root, fruits were used in dysentery, cholera and hemorrhoids. The fruits of the plant are used in *Ayurveda* for the control of diabetes [1-13]. The bark and flowers possess astringent, hepatoprotective, antioxidant and anti-inflammatory activities in rats. Tree has economic value and medicinal properties. The wood is very tough and resistant to water [1-8-13]. So it is used for the manufacture of domestic applications such as boxes, cart-wheels and also boats. The commercial fiber is obtained from the bark of the tree is used to prepare the tough and strong cordage [1-13]. The bark of the tree are very rich with tannins and red coloring matter and these substances are commercially exploited [1-13]. The root paste is used for the various skin diseases and the bark is used in treatment of diarrhea due to its astringent value [1-8-13]. The viscid, yellow juice in which the fruit abounds is also used as an external application in scabies and other cutaneous diseases [1-13]. The root is taken as a tonic.

Recently one of the study concluded that the *Thespesia populnea* L. ethanolic bark extract and its bioactive fractions (petroleum ether and ethyl acetate) effectively stimulate wound contraction in excision wound model [1-13]. This is mainly due to their anti-oxidant activity that promoted the healing and through the stimulation of collagen amino acids production together with the anti-inflammatory effect that helped in exerting strong healing action [1-13]. The presence of major compounds viz  $\beta$ -sitosterol and lupeol acetate in the Pet-B fraction and flavonoids together with anthocyanins especially cyanidin and delphinidin in Etac-B may contribute to the wound healing activity of these bioactive fractions [1-13]. In addition, chitosan encapsulated nanoparticles-hydrogel containing the Etac-B fraction showed highly more activity than that exerted by conventional hydrogel containing Etac-B fraction only, proving the importance of nano-formulations in improvement of wound healing [1-13]. Furthermore, conventional hydrogel formulation was the best designed for Pet-B fraction, where no observed improvement of wound healing due to nanoparticles [1-13].

## 2.2. Botanical Name: *Terminalia arjuna*, Roxb. W and A.

FAMILY: *Combretaceae*

2.2.1. Kannada: *Kula masuthi, hole mathi*

English: Arjuna

HINDI: Arjun



**Figure 2** *Terminalia arjuna* flowering

### Distribution

*Terminalia arjuna* is a potential cardioprotective agent belonging to the *Combretaceae* family [15-26]. It is an *Ayurvedic* remedy that has been mentioned since vedic period in many ancient Indian medicinal texts including Charaka Samhita, Sushruta Samhita, and Astang Hridayam [15-26]. It was Vagabhatta who, for the first time, advocated the use of stem bark powder in heart ailments [15-26]. This plant is found commonly throughout Indian peninsula along rivers, streams, ravines, dry water sources and hot localities. Extensively planted in India far shade or ornament along roadsides in avenues and gives good results on fertile alluvial loam [15-26].

### Morphology of Plant

This is a large evergreen hard tree with smooth bark [15-26]. Bark is grey with a greenish or reddish tinge in the color varying with the size of the tree and season of the year (Figure-2) [15-26]. The tree is a 15 large crown and drooping branch. The bark is smooth spreading in thin irregular scalar. They are green when newly young bark with chlorophyll and showed narrower wings to the fruits. The new foliage appears on hot season and showed white flowers in panicle spikes. The fruit is winged nut [15-26].

### Season of Flowering

The plant starts flowering (Figure-2) during the month of April to July. The flowers are small and usually white colored. The fruits ripens in the month of February to May.

### Special Characteristics of the Plant

The plant shows superficial root system. The tree gives out the root suckers.

### Propagation

Propagation is mainly by seed which should be sown so that half of the fruit is below and half above ground. If buried too deeply requires a deep and moist soil. It can be transplanted from nurseries at one year old [15-26].

### Methods of Reproduction

Natural method of regeneration of the plants are raised by seed. The seeds are sown in the nursery in month of April-May and covered with soil. Further seeds germinated early in the rainy season before the actual start of the monsoon. Further, certain amount of shade is required usually from side it helps for the proper growth of the seedlings but the heavy shade gives bad results [15-26].

### Artificial Method of Regeneration

In this method, the one-year-old seedlings are transplanted preferably on the rainy seasons before the taproot becomes too long. Watered regularly the line sowings and irregular weeding is advisable for better results [15-26].

### Medicinal Uses

Herbal medicines were the main source of therapeutic agents in the ancestral era. *Terminalia arjuna* is one such medicinal plant widely known for its several medicinal properties, especially its cardiovascular properties [15-26]. They have several phytochemicals, such as flavonoids, polyphenols, triterpenoids, tannins, glycosides, several minerals, proteins, and others that are responsible for the above-mentioned medicinal properties [15-26]. *Terminalia arjuna*, commonly known as arjuna, belongs to the family of *Combretaceae* [15-26]. Its bark decoction is being used in the Indian subcontinent for anginal pain, hypertension, congestive heart failure, and dyslipidemia, based on the observations of ancient physicians for centuries. The utility of arjuna in various cardiovascular diseases has been reported [15-26]. Most of the studies, both experimental and clinical, have suggested that the crude drug possesses anti-ischemic, antioxidant, hypolipidemic, and antiatherogenic activities [15-26]. Its useful phytoconstituents are: Triterpenoids,  $\beta$ -sitosterol, flavonoids, and glycosides. Triterpenoids and flavonoids are considered to be responsible for its beneficial antioxidant cardiovascular properties [15-26]. The drug has shown promising effect on ischemic cardiomyopathy. So far, no serious side effects have been reported with arjuna therapy [15-26]. However, its long-term safety still remains to be elucidated [15-26]. Though it has been found quite useful in angina pectoris, mild hypertension, and dyslipidemia. Its exact role in primary/secondary coronary prevention is yet to be explored [15-26]. *Terminalia arjuna* is an excellent shade tree and often noted on roadsides [15-26].

The bark is used in native medicine as a tonic and astringent [15-26]. The wood is very hard so it is used for various constitutive works like in buildings, agricultural implements as carts and boats [15-26]. The bark is chiefly used in tanning [15-26]. Experimental studies have revealed the bark of *Terminalia arjuna* to exert inotropic and hypotensive effect, increasing coronary artery flow and protecting cardiac tissue against ischemic damage [15-26]. *Terminalia arjuna* herb has also been detected to have mild diuretic, blood thinning, prostaglandin E(2) enhancing and blood lipid lowering activity [15-26]. This herb has been studied in patients with angina [15-26]. *Terminalia arjuna* dilates blood vessels, even in cigarette smokers [15-26]. *Terminalia arjuna* bark extract on myocardial fibrosis and oxidative stress induced by chronic beta-adrenoceptor stimulation [15-26]. *Terminalia arjuna* protects against myocardial changes induced by chronic beta-adrenoceptor stimulation [15-26].

### 2.3. Botanical Name: *Butea monosperma*, Taub.

Syn. *Butea*. Frondosa.

Family Leguminosae (*Papilionaceae*)

Popular name Flame of the Forest

Kannada: Muttuga

English: Parrot tree.

Hindi :



**Figure 3** *Butea monosperma* flowering

#### 2.3.1. Distribution and Commercial uses

*Butea monosperma* (Palas), is a medium-sized deciduous tree (Figure-3) belongs to family Leguminosae-Papilionaceae [27-32]. This tree is also called 'Flame of the Forest' and Bastard Teak [27-32]. It grows throughout the Indian subcontinent, especially in Indo-Gangetic plains. It is said that the tree is a form of Agnidev, God of Fire [27-32]. The traditional systems of medicine together with homoeopathy and folklore medicine continue to play a significant role largely in the health care system of the Indian population [27-32]. *Butea monosperma* (Palas) belonging to the family *leguminaceae* grown wildly in many parts of India. The plant is highly used by the rural and tribal people in curing various disorders [27-32]. Historically, Dhak forests covered much of the doab area between the Ganges and Yamuna. However, these were cleared for agriculture in the early 19th century as the East English Indian Company increased tax demands on the peasants [27-32]. This tree gets up to 50 ft high, with stunning flower clusters. It loses its leaves as the flowers develop during January - March (Figure-3) [27-32]. The trunk becomes twisted and gnarled by the wind, making it a conversation piece [27-32]. This tree is used as a specimen, or as a background component of the canopy [27-32]. It is a useful plant in many ways. Its leaves are essential for various religious rituals in Hindu homes [27-32]. These are also used as cheap leaf plates and cups for rural feasts [27-32]. In some parts of the country, these are used for wrapping tobacco to make biddies. These are further used as packing material for parcels [27-32]. The cattle also eat the palas foliage quite eagerly. The bark yields a kind of coarse and brown colored fiber, which is used for rough cordage [27-32]. *Butea* gum is a dried astringent juice obtained from incisions in the stem of the tree. The juice exuded by the bark hardens into brittle ruby colored gum beads [27-32]. This gum is sanctioned to be used as a substitute for the kino gum. It finds use for caulking boats as well. The flowers yield an orange dye [27-32]. A preparation of the same is used as an insecticide. The seeds are used in *Ayurvedic* and Unani medicine for treating a number of human diseases [27-32]. The tree acts as a host for lac insect and is, therefore, useful in producing natural lac [27-32]. It is a sacred tree, referred to as a treasurer of the gods, and used in sacrifice related rituals [27-32]. From its wood, sacred utensils are made. The dry stem pieces are used to make sacred fire. It is an anthropogenic tree of several castes [27-32]. 'Chakradatta' mentions the use of its gum in external astringent application [27-32]. The leaves are believed to have astringent, depurate,

diuretic and aphrodisiac properties. It promotes diuresis and menstrual flow [27-32]. The seed is anthelmintic. When seeds are pounded with lemon juice and applied to the skin act as a rubefacient [27-32].

### 3. Morphology

It is an erect, medium sized tree of 12-15 m high, with a crooked trunk and irregular branches [27-32]. The shoots are clothed with gray or brown silky pubescence. The bark is ash colored. The leaves 3 foliate, large and stipulate (Figure-3) [27-32]. Petiole is 10-15 cm long. Leaflets are obtuse, glabrous above, finely silky and conspicuously reticulately veined beneath with cuneate or deltoid base [27-32]. From January to March the plant is bald. Flowers in rigid racemes of 15 cm long, densely brown velvety on bare branches [27-32]. Calyx is dark, olive green to brown in color and densely velvety outside [27-32]. The corolla is long with silky silvery hairs outside and bright orange red (Figure-3). Stamens are diadelphes, anthers uniform [27-32]. Ovary 2 ovule, style filiform, curved and stigma capitate. Pods argenteoanthescent, narrowed, thickened at the sutures, splitting round the single apical seed, and lowest part indehiscent [27-32]. The seeds are flat, reniform, and curved [27-32]. It is slow growing and attains a height of about 5 to 8 m and diameter of about 20 to 40 cm when mature at the age of about 50 years [27-32]. The bark of palas is fibrous and bluish gray to light brown in color. It exudes a kind of red juice when injured [27-32]. The leaves are compound. Each has three leaflets. The texture of the leaflets is fairly tough [27-32]. These are coriaceous with the surface glabrescent above and hairy silken beneath. The size varies from 15 cm to 20 cm by 10 cm x 15 cm. The shape is obliquely ovate and broadly elliptic [27-32]. The leaves fall off by December and reappear during spring. When the tree is leafless, it bears flaming orange to red-colored flower [27-32]. These flowers start appearing in February and stay on nearly up to the end of April. The size is nearly 2 to 4 cm in diameter. These tend to be densely crowded on leafless branches [27-32]. The calyx i.e. the lower whorl of the flower tends to be darkish gray like the supporting branch itself [27-32]. The upper parts are brick red. These give the plant so handsome a look despite it is leafless during spring season when entire terrain having palas trees wears a kind of exquisite orange and red hue [27-32]. The flowers (Figure-3) form a gorgeous canopy on the upper portion of the tree, giving the appearance of a flame from a distance [27-32]. The fruit of palas is a flat legume; a pod, nearly 15 cm long and 3 to 5 cm wide. Young pods have a lot of hair — a velvety cover [27-32]. The mature pods hang down like peculiar legumes. The seeds are flat, from 25 to 40 mm long, 15 to 25 mm wide, and 1.5 to 2 mm thick. The seed-coat is reddish-brown in color, glossy, wrinkled, and encloses two large, leafy, and yellowish cotyledons [27-32]. The hilum is conspicuous, and situated near the middle of the concave edge of the seed [27-32]. The odor is faint, the taste is slightly acrid and bitter. The wood is greenish white in color. It is porous, soft in texture and has annual rings though not very distinct [27-32].

#### 3.1. Method of Reproduction

Natural method of reproduction is commonly takes plant by root suckers [27-32]. Seeds usually germinate during monsoon rains. The seeds are hard and they can recover themselves by root injury and browsing damage [27-32]. In the beginning of years, the growth is very slow till 3-4 years. They die under unfavorable conditions. The root develops well and the shoot grows fast. The regeneration by root suckers is very successful and grows faster when compared with that of seedlings [27-32].

#### 3.2. Artificial Method of Regeneration

In this method, the one-year-old seedling containers are raised in nursery because transplanted seedlings die in winter and hot weather [27-32]. So the plants should be planted in 45cm cube pits and the seeds are sown on containers that should be the mixture of red soil, sand and manure. The seeds immediately sown after collection from the pods because the viability is not long lasting. During initial 3 year the growth is slow [27-32].

#### 3.3. Medicinal uses

The main constituent of the flower is butrin (1.5%) besides butein (0.37%) and butin (0.04%) [27-32]. Also contains flavonoids and steroids. Other than these in flowers, coreopsin, isocoreopsin, sulphurein (glycoside) and other two with monospermoside and isomonospermoside structures are also identified [27-32]. Roots contain glucose, glycine, glucosides and aromatic compounds. Tetramers of leucocynidin are isolated from gum and stem bark. Seed contains oil. The bright color of the flower is attributed to the presence of chakones and aurones [27-32]. *Butea frondosa* Roxb. and Koen. syn. *Butea monosperma* Lam. (Leguminosae or Fabaceae) is a tree grows up to the height of 8 m at the age 50 years [27-32]. Its flowers are being used in traditional medicine for the treatment of ulcer, inflammation, hepatic disorder, and eye diseases [27-32]. *Butea monosperma* commonly known as flame of the forest or the flame tree belongs to the subfamily "Caesalpinioideae," of family Fabaceae or Leguminosae [27-32]. It grows all over India. Various parts of this plant such as flower, bark, leaf, and seed gum are used in traditional medicine [27-32]. The *Ayurvedic* formulations made from this plant are used to reduce the vāta and kapha among the tridoas [27-32]. Previously, many



biological activities of the flower extracts with its isolated chemical constituents were studied [27-32]. The butein, a constituent was studied and reported to have anticancer activity, prophylactic activity against inflammation and cancer [27-32]. Phytoconstituents from the extract of the flower: Butein, butrin, iso butrin, and isocoreopsin were reported to have inhibitory activity against inflammatory gene expression. Its flower extract with isolated content rutin was reported for antioxidant activity [27-32]. The methanolic extract of the flowers and its isolated phytochemicals isobutrin and butrin were reported as having anti-inflammatory, anticonvulsant activities, antidiabetic, and hepatoprotective effects [27-32]. Indian National Medicinal Plant Board has been encouraging researchers by allotting funds to develop standardization methods of selected medicinal plants of potential therapeutic significance [27-32].

A fraction containing sodium salt of phenolic constituent isolated from the bark has shown potential as an anti-asthmatic agent and estrogenic activity in mice. Aqueous extract of the flowers showed significant anti-implantation activity [27-32]. Hot alcoholic extract of the seeds showed significant anti-implantation and anti-ovulatory activity in rats and rabbits. It also showed abortive effect in mice. Butrin and isobutrin has proven to have antihepatotoxic activity [27-32]. The fresh juice is applied to ulcers and for congested and septic sore throats. The gum is a powerful astringent given internally for diarrhea, dysentery, phthisis, hemorrhage from stomach and the bladder, in leucorrhoea, ringworm and as a substitute for gum Kino [27-32]. The bark is reported to possess astringent, bitter, pungent, alliterative, aphrodisiac and anthelmintic properties. Bark is also useful in tumors, bleeding piles and ulcers [27-32]. The decoction of bark is useful in cold, cough, fever and menstrual disorders. Roots are useful in elephantiasis and in curing night blindness and other eyesight defects. Also cause temporary sterility in women [27-32]. Also applied in sprue, piles, ulcers, tumors and dropsy. Leaves have astringent, tonic, diuretic and aphrodisiac properties. They are also used to cure boils, pimples and tumors hemorrhoids and piles [27-32]. Also used as beedi wrappers. Flowers are reported to possess astringent, diuretic, depurative, aphrodisiac and tonic properties. They are used as emmenagogue and to reduce swellings both in human and veterinary applications [27-32].

*Butea monosperma* as astringent, antidiarrheal, antidysenteric, febrifuge, aphrodisiac, purgative, and anthelmintic properties [27-32]. It is used for timber, resin, fodder, medicine, and dye. The bark, the flowers, the leaves, the gum and even the seeds are used to prepare herbal remedies. The gum from the tree, called kamarkas in Hindi, is used in certain food dishes [27-32]. The gum is also known as Bengal Kino, and is considered valuable by druggists because of its astringent qualities, and by leather workers because of its tannin [27-32].

### 3.4. Botanical Name: *Grevillea robusta*, A.Cunn.

Family: *Protaceae*

Kannada: Silver Oak



**Figure 4** *Grevillea robusta* Flowering

#### 3.4.1. Distribution

This is also one among few exotic species imported from Australia [33-41]. Silver oak (*Grevillea robusta*) (Figure-4) is one of the important tree species in Agroforests of Kodagu, India [33-41]. They are found in the small subtropical region of Queensland and New South Wales. Now it grows in different parts of India. The Australians call it as Silky Oak. But Indians call it as silver Oak [33-41]. It requires maximum temperature of 40° C to a minimum of 0° C. Furthermore, rainfall above 1000 mm, the sandy, alluvial, loam and red soils good for its growth [33-41]. The Grevillea is so named in honor of C.F Greville, at one time vice president of the royal society [33-41]. Robusta in Latin means robust or vigorous. Silk-oak (*Grevillea robusta*), also often called silver-oak, is a medium to large tree commonly planted as an ornamental

in many warm-temperate and semitropical climates [33-41]. It has been established as a forest tree in some countries and showed promise as a fast-growing timber tree [33-41]. Although it is most commonly grown in nurseries and planted, silk-oak regenerates naturally at the edges of plantations, in openings within plantations, and under open stands of other species [33-41]. It does not regenerate directly underneath itself either in closed stands or under open-grown trees [33-41]. Natural regeneration is reported from India, Tanzania, and Queensland, Australia (at the edges of plantations), as well as from Hawaii [33-41].

#### 3.4.2. Morphology

This is a big tree without dense foliage [33-41]. The leaves are simple, silvery underneath, ciliate and usually 12-20 cms long. The orange colored flowers (Figure-4) arranged continuously in bloom. These provide forage for bees. The tree ever falls leaves, in spite the leaf fall is seen in poor dry areas during the month of April-May and the leaf renewal in the month of April and May [33-41]. Silk-oak is native to coastal eastern Australia from the Clarence River, New South Wales, to Maryborough, Queensland, and is now naturalized in Hawaii and southern Florida [33-41]. Silk-oak is tolerant of a wide range of soils if they are well drained [33-41]. It will grow on neutral to strongly acid soils but does best on those that are slightly acid. In Hawaii, good growth is achieved on soils of a wide range of orders [33-41].

#### 3.4.3. Season of flowering

The plant starts flowering during the month of December-January, and May to June [33-41].

#### 3.4.4. Characteristics of Seed

The seeds are soft and possess wings about 1 cm diameter and the capsule derivable still attached to the plant. So such capsules are collected, dried and sown in nursery [33-41]. The viability of seed is short only 3 months. Silk-oak is a prolific seeder [33-41]. Seeds are about 10 mm (0.4 in) long, flattened, and surrounded by a membranous wing [33-41]. There are reported to be 64,000 to 154,000 seeds per kilogram (29,000 to 70,000/lb) [33-41]. Because of their relatively large wing, the lightweight seeds are widely disseminated by wind. Possibly because seedfall coincides with the onset of winter rains in dry leeward rangeland in Hawaii, regeneration is most prolific on these sites [32-40]. The seeds, if kept at 10 percent or less moisture content, can be stored for as long as 2 years at -7° to 3° C (20° to 38° F) with little loss in germinability [33-41]. Germination of fresh, unstratified seeds requires about 20 days. Stratification at 3° C (38° F) for 30 days, or a 48-hour water soak, substantially increases germinative capacity of seeds that have been stored [33-41].

#### Seedling Development

Germination is epigeal [33-41]. Seedlings are grown in flats or containers in nurseries. Methods vary among the countries where silkoak is grown. In some countries 4- to 6-week-old wildlings are lifted, potted and later replanted [33-41]. Elsewhere plants are grown to 45-cm (18-in) heights in large baskets so that they can compete when outplanted. In Hawaii, seedlings in individual containers can be grown to a plantable size of 20 cm (8 in) height and 4 mm (0.16 in) caliper in 12 to 14 weeks [33-41].

#### Vegetative Reproduction

Silk-oak coppices when cut. After being damaged by fire, a 5-year-old stand in Karnataka State, India, was cut [33-41]. One year later, 93 percent of the stumps had coppiced. After 2 years, 72 percent of the stumps still retained the coppice shoots, which by then averaged 4 m (13 ft) in height [33-41]. As far as is known, vegetative propagation has not been practiced with the species [33-41].

#### 3.4.5. Special Characteristics of the plants

This plant requires a good drainage and it requires shade in the seedling stage [33-41]. The plant can be lopped to avoid excessive side branch shading. The growth is fast. This is light demanding and tolerate to fire, possess strong root system so it is a wind firm tree [33-41].

#### 3.4.6. Artificial regeneration

In this method, the seeds are sown in the month of November in the seedbeds without any pre-treatment. The germination varies from 1-6 weeks and the seedlings are grown in the seedbeds till 1 year. They are transplanted into pots/Polythene bags. Again they are grown about 3-4 months in same condition. They are transplanted to their planting site. The 0-45 cm cube sized pits are suitable for planting [33-41].

### 3.4.7. Method of Cultivation

The natural regeneration is very rare. Therefore, plants are cultivated by artificial method. Furthermore, only one year old seedlings in the seed beds are transplanted to pots/polythene bags. After 3-4 years, they are again nursured, and are transplanted to permanent locations [33-41].

### 3.4.8. Maintenance of Plants

In the nursery, the shade is provided to the seedlings. The care should be taken while transplanting the seedlings to pots/polybags. Furthermore, they are carefully maintained 3-4 in the pots/polybags then they are transplanted[33-41].

### 3.4.9. Medicinal Uses

*Grevillea robusta* A. Cunn.ex R.Br. commonly known as silver oak is a medium to large tree, native to Coastal Eastern Australia from the Clarence River, New South Wales, to Mary Borough, Queensland [33-41]. It is commonly planted as an ornamental tree in many warm-temperate and tropical climates. *G. robusta* is extensively planted in India as shade tree in coffee, tea and cinchona plantations [33-41]. It was the earliest shade tree to be introduced in India. The tree grows well in moderate elevation from 1000 m– 2300 m MSL [33-41]. Silver oak in the coffee based agroforestry perform several roles such as shade tree for the coffee plantation, standard for pepper vine, providing timber and fuel wood etc [33-41]. In addition, *G. robusta* is considered as the best support for black pepper (*Piper nigrum*) vines. In the recent years, Silver oak is being cultivated as monoculture with different crop combinations in the region viz., silver oak with coffee alone, with pepper and coffee etc [33-41]. This plant is extensively planted in the coffee and tea plantations for shade. It gives a good timber, used for state frames, Cabinets furniture and heavy constructions. It also grown in bunds of form lands as shade purpose [33-41].

## 3.5. Botanical Name: *Mangifera indica*, Lin.

Family: *Anacardiaceae*

## 3.6. Kannada: Mavu

English: Mango



**Figure 5** *Mangifera indica* fruit

### 3.6.1. Distribution

Mango is one of the most commonly grown fruit crops (Figure-5) in all tropical and subtropical regions of the world, is a nutritionally important fruit crop, and constitutes an important sector of the economy of local people, particularly in rural sectors of developing countries [42-58]. There are currently an estimated 1500 mango varieties in India [42-58]. India is the largest producer of mangoes in the world, many of which are esteemed for their high quality fruit and considered to be superior on the international market [42-58]. Therefore, there is a great demand by the growers for planting materials of superior genotypes. Mango can be propagated by sexual and asexual means [42-58]. However, sexual means does not warrant the production of true-to-the type planting materials except in some polyembryonic genotypes, while common asexual methods such as grafting and budding, are both cumbersome and time consuming [42-58]. Due to its long juvenile period, erratic flowering, alternate bearing habits and high heterozygosity of seeds, only a limited number of genetic studies have been performed in mango [42-58]. This plant is cultivated throughout India except temperate regions. It is also growing wild in forests. It has a capacity to grow on variety of soil inspite it prefers

deep and well drained loamy soil [42-58]. It requires an average rainfall from 500 mm to 2500 mm. The species appears to have been domesticated about 4,000 years ago [42-58]. The species was brought to East Asia around 400-500 BCE from India; next, in the 15th century to the Philippines; and then, in the 16th century to Africa and Brazil by the Portuguese [42-58]. The species was described for science by Linnaeus in 1753. Mango is the national fruits of India, Pakistan and the Philippines [42-58]. It finds mention in the songs of 4th century CE Sanskrit poet, Kalidasa, prior to it is believed to have been tasted by Alexander (3rd century BCE) and Chinese pilgrim, Hieun Tsang (7th century CE). Later in 16th century Mughal Emperor, Akbar planted 100,000 mango trees in Darbhanga, Bihar at a place now known as *Lakhi Bagh* [42-58].

*Mangifera indica*, also known as mango, aam (Figure-5), it has been an important herb in the *Ayurvedic* and indigenous medical systems for over 4000 years [42-58]. Mangoes belong to genus *Mangifera* which consists of about 30 species of tropical fruiting trees in the flowering plant family *Anacardiaceae* [42-58]. According to *Ayurveda*, varied medicinal properties are attributed to different parts of mango tree. Mango is one of the most popular of all tropical fruits. **Mangiferin**, being a polyphenolic antioxidant and a glucosyl xanthone, has strong antioxidant, anti lipid peroxidation, immunomodulation, cardiotoxic, hypotensive, wound healing, antidegenerative and antidiabetic activities [42-58].

### 3.6.2. Morphology

This is a large evergreen tree. But in cultivated conditions, the dwarf grafted varieties are commonly seen. The bark is rough with blackish/thick brown colored [42-58]. The fruit is a drupe it turns yellow after ripening (Figure-5). The seed is enclosed in the fleshy pulp. The new leaves appear almost simultaneously with the fall of old leaves. The flowers are yellow colored. Mango is a large evergreen tree in the *anacardiaceae* family that grows to a height of 10-45 m, dome shaped with dense foliage, typically heavy branched from a stout trunk [42-58]. The leaves are spirally arranged on branches, linear-oblong, lanceolate – elliptical, pointed at both ends, the leaf blades mostly about 25-cm long and 8-cm wide, sometimes much larger, reddish and thinly flaccid when first formed and release an aromatic odor when crushed [42-58]. The inflorescence occurs in panicles consisting of about 3000 tiny whitish-red or yellowish – green flowers [42-58]. The fruit is a well known large drupe, but shows a great variation in shape and size. It contains a thick yellow pulp, single seed and thick yellowish – red skin when ripe. The seed is solitary, ovoid or oblong, encased in a hard, compressed fibrous endocarp [42-58].

### 3.6.3. Season of flowering

The season of flowering differs with different climates. In south India, flowering occurs from February – March and the ripening of the fruits starts from April to July seed [42-58].

### 3.6.4. Characteristics of seed

The seeds have short viability period so the fresh seeds are sown.

### Special Characteristics of tree

It cannot tolerate too damp climate and this condition is undefeatable for fruits production. It grows well under irrigation and needs a moist warm climate [42-58]. This plant is shade bearer and not resistant to a drought.

### Method of Reproduction: Natural

The seeds germinate under favorable conditions. The primary root is long, strong, tapering and numerous lateral roots arises under root. The growth of the seedlings is usually rapid. The stem is green or greenish red, glabrous and crest [42-58].

## 3.7. Artificial regeneration

The trees artificially generated by planting out naked or lollygaged seedlings out naked. Grafting also easily raises lollygaged seedlings of the different varieties. The fresh seeds are used for sowing since the seeds have very short viability period.

## 3.8. Method of Cultivation

They are grafted to get desired good varieties. They are also easily raised by seedlings. Care should be taken that the fresh seeds are sown and the viability lost very soon.

#### 4. *In Vitro* Regeneration

One of the studies highlights the induction of somatic embryogenesis using nucellar tissue of mango (*Mangifera indica* L.) var. Ratnagiri [42-58]. Somatic embryos formed in the presence of thidiazuron (TDZ) in combination with 2,4-dichlorophenoxy acetic acid (2,4-D), but never on explants cultured on control medium lacking plant growth regulators. Embryogenic callus could be induced from nucellar tissue (collected over 3 different years from the same source) after 4-9 weeks of culture on full-strength Murashige and Skoog inorganic salts – which served as the basal medium – supplemented with 4.52  $\mu\text{M}$  2,4-D and 2.27  $\mu\text{M}$  TDZ (induction medium) [42]. The ability to induce embryogenic tissue varied for each year of collection. An average of 35 somatic embryos per gram of fresh wt of tissue could be developed after 12 weeks and germinated, each with a distinct shoot meristem and radicular end [42-58]. The morphology and growth of seedlings derived from somatic embryos was normal. The high embryogenic potential of nucellar explants of var. Ratnagiri in this study creates the possibility for large-scale clonal propagation of mango. The nucellus is also a novel explant source for the tissue culture of mango [42-58].

##### 4.1. Medicinal Uses

The fruit is edible. The bark, leaves, seeds astringents and used as medicine as they contain tannin. The leaves are used as fodder. The wood is used for planking, bones, Cares and also used as fuel to prepare boxes etc [42-58]. *Mangifera indica*, commonly used herb in *Ayurvedic* medicine. Studies indicated that mango possesses antidiabetic, anti-oxidant, anti-viral, cardiotoxic, hypotensive, and anti-inflammatory properties [42-58]. Various effects like antibacterial, anti fungal, anthelmintic, antiparasitic, antitumor, anti-HIV, antibone resorption, antispasmodic, antipyretic, antidiarrhoeal, antiallergic, immunomodulation, hypolipidemic, antimicrobial, hepatoprotective, and gastroprotective have also been studied [42-58]. These studies are very encouraging and indicated that this plant should be studied more extensively to confirm these results and reveal other potential therapeutic effects [42-58]. Clinical trials using mango for a variety of conditions should also be conducted. Various parts of plant are used as a dentrifice, antiseptic, astringent, diaphoretic, stomachic, vermifuge, tonic, laxative and diuretic and to treat diarrhea, dysentery, anaemia, asthma, bronchitis, cough, hypertension, insomnia, rheumatism, toothache, leucorrhoea, haemorrhage and piles [42-58]. All parts are used to treat abscesses, broken horn, rabid dog or jackal bite, tumour, snakebite, stings, datura poisoning, heat stroke, miscarriage, anthrax, blisters, wounds in the mouth, tympanitis, colic, diarrhea, glossitis, indigestion, bacillosis, bloody dysentery, liver disorders, excessive urination, tetanus and asthma [42-58].

Ripe mango fruit is considered to be invigorating and freshening. The juice is restorative tonic and used in heat stroke [42-58]. The seeds are used in asthma and as an astringent [42-58]. Fumes from the burning leaves are inhaled for relief from hiccups and affections of the throat [42-58]. The bark is astringent, and it is used in diphtheria and rheumatism. It is believed to possess a tonic action on mucus membrane [42-58]. The gum is used in dressings for cracked feet and for scabies. It is also considered anti-syphilitic [42-58]. The kernels are converted into flour after soaking in water and eliminating the astringent principles. Most parts of the mango tree are used medicinally and the bark also contains tannins, which are used for the purpose of dyeing [42-58].

The different chemical constituents of the mango plant, especially the polyphenolics, flavonoids, and triterpenoids. Mangiferin a xanthone glycoside major bio-active constituent, isomangiferin, tannins and gallic acid derivatives [42-58]. The bark is reported to contain protocatechic acid, catechin, mangiferin, alanine, glycine,  $\gamma$ -aminobutyric acid, kinic acid, shikimic acid and the tetracyclic triterpenoids cycloart-24-en-3 $\beta$ ,26diol, 3-ketodammar-24 (E)-en-20S,26-diol, C-24 epimers of cycloart-25 en 3 $\beta$ ,24,27-triol and cycloartan-3 $\beta$ ,24,27-triol [42-58].

The extensive survey of literature revealed that mango is an important source of many pharmacologically and medicinally important chemicals such as mangiferin, mangiferonic acid, hydroxymangiferin, polyphenols and carotenes [42-58]. Many different pharmacological activities, antioxidant, radioprotective, immunomodulatory, anti-allergic, anti-inflammatory, antitumor, antidiabetic, lipolytic, antibone resorption, monoamine oxidase-inhibiting, antimicrobial and antiparasitic, have been reported for mangiferin [42-58]. All these studies indicated that a wide part of activities acknowledged to preparation based on mango bark could be attributed to this C-glucosyl-xanthone (mangiferin) [42-58]. Based on the knowledge of the many properties of mangiferin, phytomedicines should be adequately standardized regarding this active compound. Mango has been used successfully in *Ayurvedic* medicine for centuries, more clinical trials should be conducted to support its therapeutic use [42-58].

Various effects like antibacterial, antifungal, anthelmintic, anti-parasitic, anti-tumor, anti HIV, antibone resorption, antispasmodic, antipyretic, antidiarrhoeal, antiallergic, immunomodulation, hypolipidemic, antimicrobial, hepatoprotective, gastroprotective have also been studied [42-58]. Pharmacologically and medicinally important chemical such as mangiferin, being a polyphenolic antioxidant and a glucosyl xanthone [42-58]. It has strong

antioxidant, antilipid peroxidation, immunomodulation, cardiotoxic, hypotensive, wound healing, antidegenerative and antidiabetic activities [42-58].

#### 4.2. Botanical Name: *Madhuca longifolia*, Macbr.

Family: *Sapotaceae*

#### 4.3. Kannada: Hippe

English: Butternut tree

Hindi: Mahua

##### 4.3.1. Distribution and Morphology

*Madhuca longifolia* is a large-sized deciduous tree (Figure-5) distributed in India, Nepal, and Sri Lanka [59-74]. *M. longifolia* is a shady and deciduous tree dotting much of the central Indian landscape. *M. longifolia* tree is 17 m high with a large top [59-74]. Flowers are numerous, near the ends of branches, drooping on pedicels [59-74]. Corolla is yellowish-white and tube fleshy. Stamens are 20–30, and anthers hispid at the back with stiff hairs. Fruits are green berries, ovoid, fleshy and contain 14 seeds (Figure-5) [59-74]. *Madhuca longifolia* (Mahua) Syn, *Madhuca indica* is one such a large size deciduous tree commonly known as Butter nut tree and belongs to family *Sapotaceae* widely distributed in Nepal, India and Ceylon. *M. longifolia* is an ever green tree which attains height up to 70 ft [59-74]. The tree matures and starts bearing at 8-15 years and fruits up to 60 years. Leaves are 10-30 cm long, lanceolate, narrowed at both ends, glabrous distinctly nerved, anthers 16, 2- seriate sub-sessile, lips 3-toothed, thick and leathery. Flowers are small, fleshy and pale white in color [59-74]. Fruits are 2-6 cm long, ovoid fleshy and greenish yellow when ripe (Figure-5)[59-74]. Flowers are the rich source of sugars, vitamin A, ascorbic acid, thiamine, riboflavin, Ca, P, Fe, Mg, Cu, anthocyanins, betains, salts of malic and succinic acid. Bark contains 17% tannins. Bark is used for rheumatism, ulcers, itches, bleeding and spongy gums [59-74]. The bark is a good remedy for inflammations, sprains and pruritus [59-74]. Mahua seeds are of economic importance as they are good source of edible fats [59-74]. *Madhuca longifolia*, commonly known as *mahwa* or *mahua* or Iluppai is an Indian tropical tree found largely in the central, north Indian plains and forests [59-74]. It is a fast-growing tree that grows to approximately 20 meters in height, possesses evergreen or semi-evergreen foliage, and belongs to the family *Sapotaceae* adapted to arid environments. This is a prominent tree in tropical mixed deciduous forests in India in the states of Karnataka, Chhattisgarh, Jharkhand, Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh, Kerala, Gujarat and Orissa [59-74]. This plant is extensively cultivated in the villages due to its economic values. This plant requires a temperature ranges from 40 °C to 45°C and this plant grow on a variety of soils although the sandy soils are well [59-74].



**Figure 5** *Madhuca longifolia* Fruits

This is a large sized tree. The leaves linear, pedicellate, slender lanceolate with a dark colored bark usually crack, fissured, thick and the inner bark is red milky. The fruits are fleshy with a one to four seeded. The tree falls the leaves in the month of February – April and the leaf renewal during the month of April-May [59-74].

##### 4.3.2. Season of flowering

The plant starts flowering in the month of March – April. Mahua flowers are found in definite fascicles near the ends of branches, and drooping on the pedicels[59-74]. They are small (2cm long), fleshy, dull or pale white in color. Corolla is

tubular, freshly, pale yellow, aromatic and caduceus. Calyx is densely clothed with rusty tomentum. Stamens number between 20-30, usually 24-26 anthers are hispid at the back with stiff hair follicles [59- 74]. Flowers are used as a sweetener in many dishes due to its high content of reducing sugar by the tribal and rural people. People residing near the forests in states like Bihar, Madhya Pradesh, Himachal Pradesh, Orissa and Maharashtra mainly depend on this flower when the agricultural production is impracticable [59- 74]. It is used as a flavoring agent and also in the preparation of pickles [59- 74].

#### 4.3.3. Characteristics of Seed

The ripe fruits (Figure-5) containing one to four seeds. The seeds are usually 1-2.5 cm long and have a hard testa [59- 74].

#### 4.3.4. Special Characteristics of plant

This is drought resistant, it get suppresses under shade. But the prolonged drought may kill the mature trees because of its superficial root system[59- 74]. The tree coppices well in the summer, but not well in monsoons. The flower starts flowering about the tenth year [59- 74].

#### Natural regeneration

The plant germinates naturally by seeds. Germination commences after good shower. Hypogenous germination is observed [59- 74].

#### 4.3.5. Artificial Method

This method of germination is carried out by planting the necked seedlings or by polybagged seedlings [59- 74].

#### 4.3.6. Characteristics of Growth

Seedlings growth is slow, but the growth rapids after sapling stage. The tree starts flowering after 10 years [59- 74].

#### 4.3.7. Medicinal uses

The plant is very useful in many ways. The flowers and leaves are used as fodder [59- 74]. The flowers are used in the distillation of alcoholic beverages. The seeds are used for extraction of oil. The wood is extensively used for construction[59- 74]. The extracts and fats obtained from *M. longifolia* seeds have several nutritional and medicinal applications [59- 74]. *M. longifolia* seed butter has an emulsulent trait; it is used for skin disease, laxative, headache, rheumatism, piles and as galactagogu [59- 74]. Orissa University of Agriculture and Technology, Bhubaneswar (India) has developed many value-added products from dry flowers of *Madhuca longifolia* including candy, cake, toffee, squash and laddoo[59- 74]. One of the study reported that flower juice and pulp of *Madhuca longifolia* are utilized to make juice concentrates and Intermediate moisture foods (IMF) such as jam, jelly, and marmalade [59-74]. Flowers of *Madhuca longifolia* and *Rhododendron arboretum* are also utilized to make ready to serve drink (RTS) and squash by researcher. Studies on the ethanol extract of *Madhuca* bark and seeds had proven anti-inflammatory activities [59- 74]. The ethanol extract and saponin mixture of *Madhuca longifolia* seeds were evaluated for anti-inflammatory activities using chronic (cotton pellet granuloma) models, acute (carrageenan-induced inflammation), and subacute (formaldehyde-induced inflammation) models of inflammation in rats [59- 74]. The ethanol extract and saponin mixtures at doses of 1, 5, 3, and 15 mg/kg reduced the edema induced by carrageenan in an acute inflammation model and inhibiting phases of inflammation. The extracts had a higher effective response than the diclofenac sodium (reference drug) in the subacute inflammation model [59- 74]. The ethanol and crude alkaloidal extracts of *M. longifolia* seeds possessed a dose-dependent inhibitory potential on carrageenan-induced edema, inhibiting prostaglandins or mediators involved in prostaglandin synthesis, the second phase of inflammation [59- 74].

The genus *Madhuca* (family *Sapotaceae*) is a multipurpose tree with *Madhuca latifolia*, *Madhuca longifolia*, and *Madhuca butyracea* being the most prevalent species. Mahua or buttercup, *M. longifolia* Koenig (synonyms, *Madhuca indica* Gmelin), both wild and cultivated, is a large, shady, deciduous tree dotting much of the central Indian landscape [59- 74]. The tree is economically important because of widespread uses of its seeds, flowers, fruits, and timber [59- 74]. This plant is cultivated as avenue tree and also other beautification works like near the temples for its flowers [59- 74]. The timber is well and takes good polish so it is used for planking in building Q making furniture and preparation of decorative plywood's inspite of the bark, leaves, fruits, and flowers are used as native medicine[59- 74]. *Madhuca longifolia* is reported to contain steroids, saponins, sapogenins, triterpenoids, flavonoids, and glycosides [59- 74]. It possesses spasmogenic, oxytocic, uterotonic, antibacterial, anti-implantation, antitumor, antiprogestational, anti-estrogenic activity against menorrhagia, and anticancer activities [59- 74]. The expectorant flowers are used to treat

chest problems such as bronchitis and the flower juice is considered as a tonic used to make vinegar [59- 74]. They are also used to increase the production of breast milk. The leaves are applied to relieve eczema as a poultice. In Indian folk medicine, the leaves ash mixed with ghee was used to make a dressing for burns and wounds [59- 74]. Mahua formulations are utilized to remove intestinal worms, in cases of debility and emaciation and in respiratory infections [59- 74]. The astringent bark extract is utilized for dental-related problems, rheumatism, and diabetes [59- 74]. *M. longifolia* flowers are seasonal and produce green fleshy fruits that contain 3–4 seeds [59- 74]. Fruit seeds are ellipsoid-shaped and measured approximately 2.0 cm, approximately 1.6 cm across the length and breadth[59- 74]. The medicinal traits attributed to *M. longifolia* included emollient, demulcent, stimulant, and astringent. Phytochemical studies on *M. longifolia* included the identification and characterization of triterpenoids, sapogenins, carbohydrates, saponins, steroids, flavonoids, and glycosides[59- 74]. In the view of the mentioned medical traits, compounds including madhushazone (an untypical isoflavone), madhucic acid (a pentacyclic triterpenoid), madhusalmone [(a bis(isoflavone)],<sup>8</sup> and four oleanane-type triterpene glycosides (madlongisides A–D)<sup>9</sup> were reported [59- 74]. Madhucosides A and B isolated from *M. longifolia* and exhibited inhibitory impacts on hypochlorous acid generation from neutrophils and superoxide release from polymorphonuclear cells [59- 74].

Few oil-bearing plants produce oils and/or fats in a sufficient commercial yield [59- 74]. Edible oils contribute about 85% of the edible oils or fats available for consumption. *M. longifolia* fruit is valued for its seeds, which contain high amounts of fats (ca. 50–60%), known commercially as Mowrah or Mahua butter, which is used in several edible and pharmaceutical products. Oils and fats market is searching for solutions that can address the agricultural supply chain challenges [59- 74].

The aromatic compound present in mahua flower is **2-acetyl-1-pyrroline** [59- 74]. It is a rich source of polysaccharides' which on hydrolysis produces D- galactose, D- glucose, L-arabinose, L-rhamnose, D- xylose and D-glucuronic acid [59- 74]. In addition to this, plant also contains 4.4-7% protein and essential minerals like calcium, potassium, phosphorus, magnesium, copper and iron in abundance [59- 74]. Amino acid content includes lysine, arginine, aspartate, glutamate, threonine, valine, tryptophan, isoleucine, leucine and proline[59- 74]. It is also a rich source of anthocyanins, betains, salts of malic and succinic acid. One of the research study reported that air dried mahua flower contains invert sugar (52.6%), cane sugar (2.2%), albuminoids (2.2%) and other substance[59- 74].

#### 4.4. Botanical Name: *Melia azadirachta*, Lin.

Family : Meliaceae

#### 4.5. Kannada: Bevu

Eng : Neem.



**Figure 6** *Melia azadirachta* flowering

##### 4.5.1. Distribution and Morphology

A native of tropical Asia, *Melia azadirachta* (Figure-6)(Meliaceae family) is widely distributed in India, Australia, Southeast Asia, Pakistan, and Indonesia [75- 85]. The *Melia azadirachta* is a medium-sized deciduous tree that may grow up to 45 metres tall, with a spreading crown, and moderately branching limbs. Under normal circumstances, this plant reproduces unrestrictedly from seeds throughout the rain. Direct planting, cutting, and root suckers are further methods of artificial propagation [75- 85]. Smooth, greenish-brown barks mature to a fissured, and grey color. The leaves are compound or bipinnate, alternating, and 20–40 cm long. Leaflets are 3–11, serrated, unseasoned, black on



the side, and lighter underneath. When crushed, they release an unpleasant smell [75- 85]. The inflorescence is a 20 cm long, and axillary raceme. Flowers range from white to lavender to purple and are fragrant. Sepals are separated into five lobes, each about 1 cm long. Petal length is 9 cm, it has five lobes and is pubescent [75- 85]. The staminal tube is deep purple, blue, and brown. Fruit or berries are small, nearly spherical, yellow stone fruits that are smooth, heavy as a stone, and contain four to five black seeds. They have a diameter of 15 metric linear units. The seed has a smooth, brown surface and is surrounded by pulp. Its dimensions are 3.5 mm x 1.6 mm. *Melia azadirachta* Linn may be found practically in every country and is very similar to the neem tree in appearance. The inner bark primarily consists of alkaloids, which are the components that are responsible for an antihelmintic activity. This plant also exhibits features such as anti-cancer activity, anti-malarial activity, antibacterial activity and anti-fertility activity [75- 85]. The genus *Melia* is known for its secondary metabolites and recently, this genus is being explored for its timber. There are vast differences among its species. For instance, *Melia azadirachta* is reported to be invasive and while another species, *M. dubia*, has diverse utility with complex germination and regeneration characteristics. Genus *Melia* has a trans-Indian Ocean distribution and its native to South Asia including the Indian sub-continent, northern Australia, and southern parts of tropical Africa. *Melia azadirachta* is one of the plants (*Meliaceae* family) grown in numerous Indian states [75- 85]. The entire plant or its parts (leaves, stem and roots) have medicinal characteristics and have been used by native and tribal people in various parts of India for a very long time. This plant has traditionally been used to cure various conditions, including piles, itching, asthma, leprosy, and cough [75- 85].

*Melia azadirachta* has antiulcer, antipyretic, anti-fertility, anti-cancer, antiviral, wound healing, and hepatoprotective properties that make it useful for treating a variety of illnesses [75- 85]. The plant contains different types of active substances, including terpenoids, flavonoids, steroids, acids, anthraquinones, alkaloids, saponins, and tannins [75- 85]. Therefore, it is possible to draw the conclusion that *M. azadirachta* is a medicinal plant that has been traditionally and clinically demonstrated to be adequate for its application [75- 85]. In light of the numerous health advantages, research is urgently necessary to purify the *M. azadirachta* components inexpensively and characterize them in respect of potential chemical make-up and mode of action at the molecular basis. These ingredients almost surely have a chance of proving to be beneficial while also being relatively less hazardous than the medications that are currently available [75- 85].

It is very fast growing medium sized tree. The leaves are opposite and are bipinnate or tripinnate leaflets are 3-7 in each pinna. The bark is smooth and dark grey in color. The flowers are numerous born on auxiliary cymes bearing panicles with lilac blue color [75- 85].

#### Medicinal uses

In *Ayurvedic* medicine, preparations of *Melia azadirachta* are used to treat various conditions, including the common cold, inflammation, headaches, stomach issues, diabetes, several types of poisoning, and malaria [75- 85]. In spleen enlargement cases, the gum secreted from the *Melia azadirachta* is thought to be useful, and an extract of the timber is used to treat bronchial allergies [75- 85]. Bark decoctions are administered to patients suffering from paroxysmal fever to alleviate symptoms such as thirst, vomiting, lack of appetite, nausea and skin illnesses [75- 85]. The decoction of the plant's leaves is used to treat hysteria, scrofula and leprosy. The juice of the plant's leaves acts as an antihelmintic, emmenagogue, diuretic, expectorant and vermifuge. The juice of the plant's leaves also acts as an emmenagogue. astringent, refrigerant, emmenagogue, anodyne and diuretic properties can be found in flowers [75- 85]. The consumption of fruits is thought to have antihelmintic, emollient, diuretic and purgative effects [75- 85]. The seeds have several medicinal applications, including as an aphrodisiac, antihelmintic, expectorant, and an aid in treating typhoid fever. In treating various skin conditions, seed oil is frequently applied [75- 85]. The roots are used as an expectorant, astringent and febrifuge in treating constipation. In addition, these plants can be utilized in various contexts, including but not limited to treating conditions such as sciatica, lumbago, piles, cough, bronchial allergies, ulcers, wounds, diabetes, and intermittent fever [75- 85]. The leaves of *Azadirachta indica* L. and *Melia azadirachta* L., belonging to *Meliaceae* family, have been shown to have medicinal benefits and are extensively employed in traditional folk medicine [75- 85].

The main active chemical ingredients of neem leaves are **nimbin**, nimbanene, 6-desacetyl-nimbinene, nimbandiol, nimbolide, ascorbic acid, n-hexacosanol aminoa, 7-benzoylazadiradione, 7-diacetyl-7-benzoylgedunin, 17-hydroxyazadiradione and nimbiol [75- 85]. Traditionally, neem leaves extract are utilized in folk medicine to prevent infectious bacterial and parasitic diseases [75- 85]. In addition, researchers reported many other biological and pharmacological activities including antiviral, antifungal, anti-inflammatory, antipyretic, antiseptic, and cytotoxic activities [75- 85]. By assessing the in vitro antiviral activities of both total leaves extracts against Severe Acute Respiratory Syndrome Corona virus 2 (SARS-CoV-2), it was found that *A. indica* L. and *M. azedarach* L. have robust anti-SARS-CoV-2 activities at low half-maximal inhibitory concentrations (IC<sub>50</sub>) of 8.451 and 6.922 µg/ mL, respectively [75-

85]. *A. indica* L. and *M. azadirachta* L. leaves extracts could induce antibacterial activities against both Gram-negative and positive bacterial strains. The minimal inhibitory concentrations of *A. indica* L. and *M. azadirachta* L. leaves extracts varied from 25 to 100 mg/mL within 30 min contact time towards the tested bacteria [75- 85]. *Azadirachta indica* L. (Neem) and *Melia azadirachta* L. (China tree) are popular medicinal herbs that belong to the *Meliaceae* family. *A. indica* L., originated in India, is extensively scattered in all countries.

Various phytoconstituents were identified from neem leaves such as triterpenoids, phenolics, flavonoids, carotenoids and steroids, that proved to be significant in many biological fields especially antibacterial, antifungal, antiviral, antiparasitic, and many chronic diseases [75- 85]. **Limonoids**, a class of triterpene and a major class identified from the *Meliaceae* family including different compounds and their derivatives (e.g. nimbidin, nimbin, and nimbolide) are broadly circulated all over the plant parts [75- 85]. Through changes in several genetic pathways and other effects, they recreate a significant function in regulating human ailments. *A. indica* has great medicinal values and was traditionally utilized to treat stomach ulcers and jaundice besides its significance in controlling a variety of infectious diseases such as malaria. Lately, limonoids are evidenced to have curative role in digestive system complaints and as an insects repellent, in addition to its significant effect as diuretic and anti-diabetic, and healing numerous skin diseases [75- 85]. On the other hand, *M. azadirachta* is native to Africa, Asia and Northern Australia, and is conventionally employed as an antiparasitic and antifungal agent with significant free radical scavenging activity. The bioactivity of such herbal plant is principally accredited to occurrence of high level of limonoids compounds besides other phenolic acids and flavonoid glycosides mainly rutin [75- 85].

*M. azadirachta* L. leaves contain significant quantities of **limonoids** of the nimbolinin type, which have a variety of therapeutic effects, including antimicrobial, antioxidant, and anticancer potential [75- 85]. Both *A. indica* L. and *M. azadirachta* L., belonging to *Meliaceae* family, were documented to have inhibitory effect against bacteria due to their enrichment in antimicrobial bioactive compounds [75- 85]. They have been widely used in traditional Chinese and *Ayurvedic* prescriptions to control various infections. *A. indica* L., aside from the plant's phytochemistry, a lot of development has been made over the past 20 years in terms of antimicrobial activity and prospective medical uses [75- 85].

#### 4.6. Botanical Name: *Michlia champaka*, Linn.

Family: *Magnoliaceae*

English: Golden champaka

Kannada: Sampige



**Figure 7** *Michlia champaka* flower

##### 4.6.1. Distribution and Morphology

*Michelia champaka* (Figure-7) is native to India, where it occurs in humid tropical evergreen forests from 250-1500 m in elevation [86-99]. It is found throughout Indo-China, Malaysia, Sumatra, Java, and southwestern China. Outside of India, the native range of this species is difficult to determine as it has been dispersed extensively by humans throughout Southeast Asia and Indonesia on account of the use of the trees [86-99]. *Magnolia champaka*, commonly called ( Figure-7) jade orchid tree is a large evergreen tree, native to the Indomalaya ecozone (consisting of South Asia, Southeast Asia and some parts of China) [86-99]. The genus *Michelia* and its species with a distribution from India, to Malaysia, Indonesia, in southern Japan and Taiwan [86-99]. *Michelia champaka* Linn is also known as champaka belonging to the family of *Magnoliaceae*. It consists of 12 genera and 220 species of evergreen trees and shrubs, native to tropical and subtropical South and Southeast Asia (Indomalaya), including southern China [86-99]. It is commonly referred as yellow

champaca. There are three species of *Michelia* available in Malaysia. They are *Michelia Alba* (white chempaka), *Michelia champaca* (orange chempaka) and *Michelia figo* (dwarf chempaka), with *Michelia champaca* and *Michelia Alba* being the most popular species within the family [86-99]. It is best known for its strongly fragrant yellow or white flowers (Figure-7) [86-99]. However, primarily cultivated for its timber, and is also used in urban landscaping. In India, the tree is mostly cultivated in various parts especially near the temples due to its fragrant flowers [86-99]. This species is wild in the eastern sub Himalayan tract and lower hills will 1000mts [86-99]. This is also seen in Assam and Western Ghats, rarely found in deep valleys, it shows the characteristics of moist and evergreen forests [86-99]. One of these 80 species, *M. champaca* which is commonly known as Champa in Hindi; Champaka in Bengali; Atigandhaka in Sanskrit. It is highly distributed in the Sub-Himalayan tract, Assam, Western Ghats, South India, Burma-Yunnan, Indo-China, Siam, and Malaya [86-99].

*Michelia champaca* belongs to family *Magnoliaceae* is commonly known as Champak or Goldenchampa [86-99]. Leaves are simple, alternate, petiole 1 to 3 cm long, lanceolate, spiral and reticulate. Flowers are solitary, dull yellow when fresh, orange when old and fragrant [86-99]. In India, this plant is cultivated in garden and near temples for its fragrant flowers [86-99]. This plant possesses the yellow to orange color flowers (Figure-7) with strong fragrance. Leaves and root bark contain parthenolide, and stem bark contain michampanolide, 8-acetoxy parthenolide, Magno grandiose, costunolide, dihydro parthenolide,  $\beta$ -sitosterol, lirioidenine, ushinsunine, magnoflorine and micheliolide from root bark. Its volatiles oil is highly esteemed in perfumery and is useful in cephalalgia, ophalalgia, ophthalmia, gout and rheumatism [86-99]. It is well known and widely used in traditional medicine such as fever, colic, leprosy, post partum protection, eye disorder and many more [86-99]. This plant was claimed to possess various pharmacological properties such as antipyretic, anti-inflammatory, insecticidal and antimicrobial. This plant possesses various pharmacological activities like antidiuretic, anti-diabetic, antimicrobial, and anti-ulcer [86-99]. In recent times there are several reports of medical roles. The activities of *Michelia champaca* and its active principals on the circulatory system, antipyretic, and diuretic has been reported [86-99].

*Michelia*, known by the scientific name *Michelia champaca*, is a very tall tree that grows up to 30m tall [86-99]. The young branches are covered with grey hairs. The leaves are ovate in shape and are up to 30.5cm long and 10.2 cm wide narrowing to a fine point at the apex [86-99]. Small bracts, known as stipules, are present on the leaf stalk of the alternately arranged leaves. The flowers are pale yellow to orange and fairly large growing up to 5.1cm in diameter [86-99]. They are also very fragrant and when a *Michelia* tree is in flower and the fragrance produced is noticeable some distance from the tree [86-99]. The flowers have 15 petals that curve up towards the tips and many stamens (pollen producing structures) [86-99]. The fruit of *Michelia champaca* is made up to 3-20 brown follicles that are dry at maturity and split open at one side. Each follicle contains 2-6 reddish seeds [86-99]. This is tall evergreen tree. It attains a 35mtrs height attains more height under ordinary forest conditions [86-99]. The bark is smooth and light grey colored usually a centimeters thick. The yellow colored scented flowers blooms at various seasons. Fruits ripen in August or later [86-99].

#### Medicinal uses

Conventionally it is widely used in both *Ayurveda* and Siddha medicine. It is being used in fever, colic, leprosy, post-partum protection and in eye disorders. Juice of the leaves of *Michelia champaca* is given with honey in cases of colic [86-99]. The flower oil is useful in cephalalgia, ophthalmia and gout [86-99]. The bark is used as a stimulant, expectorant, astringent and febrifugal properties [86-99]. The dried root, roots bark, mixed with curdled milk, is useful as an application to abscesses, clearing away or maturing the inflammation. In the form of an infusion it is valuable emmenagogue [86-99]. It is also considered purgative. Root and bark are used as purgative and in the treatment of inflammation, constipation and dysmenorrhea [86-99]. The flowers and fruits are considered stimulant, antispasmodic, tonic, stomachic, bitter, cool remedies and are used in dyspepsia, nausea and fever [86-99]. Flower, flower buds, fruits are useful in ulcers, skin disease and wounds [86-99]. The flowers mixed with sesamum oil forms an external application in vertigo and also applied to foetid discharges from the nostrils [86-99]. They are useful as a diuretic in renal diseases and in gonorrhoea [86-99]. The flower buds of *Michelia champaca* are commonly used by many traditional healers in most of herbal preparations for diabetes [86-99]. The flowers and fruits in combination with other drugs are recommended. Indian medicinal plants are often used as ancient style of food providing helps for many ailments [86-99]. Presently, variant peoples are looking on healthful plants for his or her primary health care wishes. *Michelia champaca* Linn, being as a vital healthful plant in Indian medication [86-99]. There are many medical specialty activities like antipyretic, analgesic, anti-inflammatory, antihelminthic, anticancer, antihyperglycemic, antiulcer, antimicrobial, wound healing, antioxidant and antifertility activities has been reported [86-99]. Different active constituents such as alkaloids, saponins, tannins, sterols, flavonoids, triterpenoids, michelia-A, lirioidenine, parthenolide and guaianolides, methyl linoleate, methyl anthranilate, stigmaterol and  $3\beta$ -16 $\alpha$ - dihydroxy- 5-cholestene-21-al have been reported from *Michelia champaca* [86-99].

*M. champaca* L. has traditionally been used to treat diarrhea, cough, bronchitis, hypertension, dyspepsia, fever, rheumatism, abscesses, dysmenorrhea and inflammation. It is also used as purgative, expectorant, cardiotoxic, digestive, carminative, stomachic, stimulant, diuretic, diaphoretic, antipyretic and astringent [86-99]. The plant is traditionally used for the treatment of cough, fever, colic, leprosy, and rheumatism, also helps in curing cephalalgia and ophthalmia [86-99]. The phytochemical analysis of the leaves and flowers of the plant showed the presence of alkaloids, tannins, glycosides, carbohydrates, amino acids, flavonoids and sterol in different solvent system [86-99]. The petroleum ether extract of the dried flower contained n-alkane hydrocarbons, unsaturated aliphatic ketones, beta sosterol and quercetin [86-99]. The quercetin forms the first report of its occurrence in the genus *Michelia* [86-99]. The volatile oils contained six sesquiterpene hydrocarbons, four oxygenated sesquiterpenes and two aliphatic alcohols from water using dichloromethane solvent in leaves of *M. champaca* L. [86-99].

#### 4.7. Botanical Name: *Moringa oleifera*, Lamk.

Family: *Moringaceae*

Kannada: Nugge

Eng: Drumstick



**Figure 8** *Moringa oleifera* Fruits

##### 4.7.1. Distribution and Morphology

*Moringa oleifera*, is also known as the “tree of life” or “miracle tree,” is classified as an important herbal plant due to its immense medicinal and non-medicinal benefits (Figure-8) [100-128]. *M. oleifera* is widely distributed worldwide, but its indigenous origin is in India, Arabia and the East Indies [100-128]. It is common in Asia, Africa, the Caribbean, Latin America, the Pacific Islands, Florida, Madagascar, Central America, Cuba, the Philippines, Ethiopia, and Nigeria [100-128]. The history of the plant explains that *M. oleifera* was introduced from India to Africa, Southeast Africa, and the Philippines in ancient times [100-128]. It requires tropical and subtropical regions and grows at a temperature of about 25–35 °C. *M. oleifera* is a deciduous type of tree typically grown in tropical and subtropical regions across the globe [100-128]. It grows best in indirect sunlight and without waterlogging, and the soil should be slightly acidic to alkaline [100-128]. The tree begins to bear fruit at 6 to 8 months of age. Commercially, it is grown in different countries such as Africa, Mexico, Hawaii, and South America, but due to different soil conditions, the nutrient content varies from country to country [100-128]. Traditionally, the plant is used to cure wounds, pain, ulcers, liver disease, heart disease, cancer, and inflammation [100-128]. The pharmacological studies confirmed the hepatoprotective, cardioprotective, and anti-inflammatory potential of the extracts from the various plant parts [100-128]. It was found that bioactive constituents are present in every part of the plant. So far, more than one hundred compounds from different parts of *Moringa oleifera* have been characterized, including alkaloids, flavonoids, anthraquinones, vitamins, glycosides, and terpenes [100-128]. In addition, novel isolates such as muramoside A&B and niazimin A&B have been identified in the plant which have potent antioxidant, anticancer, antihypertensive, hepatoprotective, and nutritional effects [100-128].

The tree grows rapidly in loamy and well-drained sandy soils, preferring a height of 500 m above sea level [100-128]. Normally, the tree is small to medium in size, the leaves are naturally trifoliolate, the flowers are born on an inflorescence 10–25 cm long, and the fruits are usually trifoliolate and commonly referred to as pods (Figure-8) [100-128]. The trunk usually grows straight but is occasionally poorly formed, the branches are usually disorganized, the canopy is umbrella-shaped; the brown seeds have a semi-permeable hull, and each tree has a capacity of about 15,000–25,000 seeds per year [100-128]. *Moringa oleifera* (*M. oleifera*), the “miracle tree”, thrives globally in almost all tropical and subtropical regions, but it is believed to be native to Afghanistan, Bangladesh, India, and Pakistan [100-128]. The Moringa family comprises 13 species (*M. oleifera*, *M. arborea*, *M. rivae*, *M. ruspoliana*, *M. drouhardii*, *M. hildebrandtii*, *M. concanensis*, *M.*

*borziana*, *M. longituba*, *M. pygmaea*, *M. ovalifolia*, *M. peregrina*, *M. stenopetala*), of which *M. oleifera* has become well known for its use in nutrition, biogas production, and fertilizer, etc., [100-128]. Moringa has the unique property of tolerating drought [100-128]. Studies have shown that *M. oleifera* is among the cheapest and most reliable alternatives for good nutrition [100-128].

#### Medicinal Uses

Nearly all parts of the tree are used for their essential nutrients. *M. oleifera* leaves have a high content of beta-carotene, minerals, calcium, and potassium [100-128]. Dried leaves have an oleic acid content of about 70%, which makes them suitable for making moisturizers [100-128]. The powdered leaves are used to make many beverages, of which “Zija” is the most popular in India [100-128]. The bark of the tree is considered very useful in the treatment of different disorders such as ulcers, toothache, and hypertension [100-128]. Roots, however, are found to have a role in the treatment of toothache, helminthiasis, and paralysis [100-128]. The flowers are used to treat ulcers, enlarged spleen, and to produce aphrodisiac substances [100-128]. The tree is believed to have incredible properties in treating malnutrition in infants and **lactating mothers** [100-128].

People worldwide have included *M. oleifera* in their diet since ancient times because of its vital therapeutic values [100-128]. Various medicines made from the plant are said to have ethnomedicinal properties for curing diseases and have been used for centuries [100-128]. Approximately every part (leaf, pod, bark, gum, flower, seed, seed oil, and root) of this plant has been used to treat one disease or another [100-128]. Uses of *M. oleifera* are observed in pathological alterations such as antihypertensive, anti-anxiety, anti-diarrheal, and as a diuretic [100-128]. Moringa is also used to treat dysentery, and colitis [100-128]. A poultice made from Moringa leaves is a quick remedy for inflammatory conditions such as glandular inflammation, headache, and bronchitis [100-128]. The pods treat hepatitis and relieve joint pain [100-128]. The roots are conventionally used to treat kidney stones, liver diseases, inflammation, ulcers, and pain associated with the ear and tooth [100-128]. The bark of the stem is used to treat wounds and skin infections [100-128]. Indians use the gum extracted from this plant to treat fever, and it is also used to induce abortions [100-128]. The seeds of the plant act as a laxative, are used in the treatment of tumors, prostate, and bladder problems [100-128]. The seeds showed promise for the treatment of arthritis by altering oxidative stress and reducing inflammation [100-128]. Preparations from the plant leaves benefit nursing mothers and malnourished infants and improved the general health of the population. The leaves have been useful for patients suffering from insomnia and treating wounds [100-128]. Moringa is used incredibly extensively in the cosmetic industry nowadays, and in ancient Egyptian history, it was similarly used for preparing dermal ointments [100-128].

Recent pharmacological studies have revealed that different extracts of *M. oleifera* exhibit different pharmacological activities, such as antimicrobial, antifungal, anti-inflammatory, antioxidant, anticancer, fertility, wound healing, and other pharmacological activities [100-128].

The presence of alkaloids, phenolic acid, glycosides, sterols, glucosinolates, flavonoids, terpenes and fatty acids are responsible for the medicinal effects of *M. oleifera* [100-128]. In addition, *M. oleifera* is also rich in compounds such as vitamins, micronutrients, and carotenoids which increase its medicinal value and consumption as a superfood [100-128]. Pharmacological studies showed that the active constituents of the plant have effectively cured various diseases such as neuropathic pain, cancer, hypertension, diabetes, and obesity [100-128]. Nevertheless, several phytochemicals have yet to be explored for their possible therapeutic benefits. In addition to its clinical use, the plant is also used as an effective biostimulant for farmers in their fields and has proven to be a cost-effective alternative [100-128]. A literature survey suggested that much preclinical research has been carried out in the last few years. In the future, more clinical studies are required to investigate the efficacy of the plant in life-threatening diseases such as coronavirus outbreaks, an acquired immunodeficiency syndrome (AIDS), and various cancers [100-128]. Moreover, further mechanism base studies are also proposed to explore the mechanistic approach of the plant to identify and isolate active or synergistic compounds [100-128]. Overall, *M. oleifera* signifies its name, “Miracle tree,” and appears to be a phytopharmaceutical and functional food. If consumed daily, can potentially to treat various chronic diseases in humans and could be used by medical practitioners as a safer alternative to treat various ailments [100-128].

#### 4.8. Botanical Name: *Peltophorum ferrugineum*, Benth.

Family: *Leguminosae*

Kannada: Peltophorum

English : Copper-pod tree.



**Figure 9** *Peltophorum pterocarpum* flowering

#### 4.8.1. Distribution

*Peltophorum pterocarpum* (DC.) Backer ex K. Heyne (*Fabaceae*) (Figure-9) is a deciduous tree originated from the tropical regions, ex. Sri Lanka, the Andamans, the Malay Peninsula and North Australia [129- 146]. This tree is native of Srilanka [129- 146]. This plant is commonly seen in Karnataka, Bihar, West Bengal and also in Western Ghats. Traditionally, its flowers are used for slowing intestinal diseases, **childbirth pain**, treating muscle sprains, bruises, and swelling pain [129- 146]. Roots and barks are also used to cure abdominal colic, joint back pain, and ascites [129- 146]. Reports on *Peltophorum* species have described antibacterial, antifungal, antiviral, antioxidant, antitumor, deworming, hypoglycemic, cardiogenic, hepatoprotective and leucoagglutinating bioactivities [129- 146]. However, there are only a few studies related to the chemical composition of the *Peltophorum* species. A preliminary examination showed that the methanol extract and fractions of leaves of *P. pterocarpum* displayed significant superoxide anion and elastase inhibition at 10 µg/mL [129- 146]. In one of the study, the chemical profiles of leaves of *P. pterocarpum* were comprehensively investigated and a total of fifty-four compounds were identified [129- 146]. Among these, two new sesquiterpenoids **1** and **2** were characterized. The structures were established by spectroscopic and spectrometric analyses [129-146]. In addition, the purified compounds were examined for their superoxide anion and elastase inhibitory effects. *Peltophorum pterocarpum* is a rich source for phenols. The wood, leaves, and flowers of the plant are used as medicinal agents in traditional medicine [129- 146]. **Peptic ulcer** is a major disease of gastrointestinal tract, affecting nearly 40 lakh people each year worldwide and affects 10% of world population with different etiologies [129- 146]. The leaves of the *Peltophorum pterocarpum* have been scientifically proven to be **hepatoprotective**, flowers have antibacterial property and the wood has anticancer potential [129- 146]. *Peltophorum pterocarpum* consists of phenols and flavonoids, tannins which have potential antioxidant and cytoprotective activity [129- 146]. Medicinal plants have antioxidants such as phenols, carotenoids, vitamin C, tocopherols and flavonoids. *Peltophorum pterocarpum* is a rich source for phenols and flavonoids, its parts are used as medicinal agents in traditional medicine [129- 146].

#### Morphology

*Peltophorum pterocarpum* (Copperpod, Golden Flamboyant, Yellow Flamboyant, Yellow Flame Tree, Yellow Poinciana and Radhachura in Bangla; Synonyms: *Peltophorum inermis* and *Peltophorum ferrugineum*) belongs to a family *Fabaceae*. It is a native of tropical Southeastern Asia. Plant is a popularly ornamental tree grown around the world [129- 146]. It is a deciduous tree growing to 15–25 m (rarely up to 50 m) tall, with a trunk diameter of up to 1 m [129- 146]. The leaves are bipinnate, 30–60 cm long, with 16– 20 pinnae. Each pinna with 20–40 oval leaflets 8–25 mm long and 4–10 mm broad. The flowers are yellow (Figure-9), 2.5–4 cm in diameter, produced in large compound racemes up to 20 cm long [129- 146]. The fruit is a pod, 5–10 cm long and 2.5 cm broad, red at first, ripening black, containing one to four seeds. Trees begin to flower after about four years [129- 146]. The plant is native to tropical southeastern Asia and Northern Australasia, Sri Lanka, Thailand, Vietnam, Indonesia, Malaysia, Papua New Guinea, Philippines, the Islands of the coast of Northern Territory, and Australia [129- 146]. The plant is also found in different regions of India including Birbhum District, West Bengal. The wood of the plant has a wide variety of uses, including cabinet-making and the foliage is used as a fodder crop [129- 145].

*Peltophorum pterocarpum* (DC.) Baker ex Heyne is a deciduous tree commonly used for ornamental purpose and as an avenue tree [129- 146]. Different parts of this tree are used to treat many diseases like stomatitis, insomnia, skin troubles, constipation, and ringworm. Its flower extract is known to be a good sleep inducer and used in insomnia treatment [129- 146]. Its bark is used as medicine for dysentery, as eye lotion, embrocation for pains and sores. The traditional healers use the leaves in the form of decoction for treating skin disorders [129- 146]. Stem infusion of *Peltophorum pterocarpum* Baker ex K. Heyne is used in dysentery, for gargles, tooth powder and muscular pain [129-

146]. Flowers are used as an astringent to cure or relieve intestinal disorders after pain at childbirth, sprains, bruises, swelling or as a lotion for eye troubles, muscular pains and sores [129- 146].

#### 4.8.2. Season of Flowering

The bright golden yellow colored flowers (Figure-9) bloom twice in the year, March - May and September-November. The flowers are arranged in a large panicles at the end of the branches. The blossoms last for a very short period and daily carpet the ground. The flowers are mildly fragrant[129- 145].

#### 4.8.3. Characteristics of Seeds

No special characteristics are noticed in seeds.

### 4.9. Special Characteristics of Plant

- The stem is erect and grows straight.
- It is light demanding spars.
- This is partially deciduous tree shows huge spreading crown with big bole[129- 145].

### 4.10. Medicinal uses

*Peltophorum pterocarpum* (belonging to *Fabaceae* family) (Figure-9) regarded as one of the most significant plant species in traditional system of medicine [129- 146]. The plant is used in different parts of the world for the treatment of several ailments like stomatitis, insomnia, skin troubles, constipation, ringworm, insomnia, dysentery, muscular pains, sores, and skin disorders. The plant is the source of a diverse kind of chemical constituents such as aliphatic alcohols, fatty acids, amino acids, terpenoids, phenolics, flavonoids, alkaloids, and steroids [129- 146]. The isolated phytochemicals as well as different extracts exhibited numerous biological activities including antimicrobial, antioxidant, cytotoxic, aldose reductase inhibition and antiglycaemic activities [129- 146]. *Peltophorum pterocarpum* is used for the treatment of numerous ailments like insomnia, stomatitis, constipation, skin disorders, worms and dysentery [129- 146]. Studies have shown that *Peltophorum pterocarpum* is a rich source for various active constituents, including flavonoids, phenolic compounds and tannins, which have medicinal uses because of their antioxidant, anti-inflammatory, curative properties and probable to have the hypothesis for antiulcer potential [129- 146]. *Peltophorum pterocarpum* (Lim Xẹt or Muồng Kim Phụng Vàng in Vietnamese) belongs to the *Fabaceae* family and is native to tropical, southeastern Asian countries such as Thailand, Laos, Vietnam, India, and Sri Lanka, and Australia [129- 146]. This plant is a popular ornamental tree, grown around the world. The leaves of *P. pterocarpum* are bipinnate, the flowers are yellow, and the fruit is initially red, then ripens to black, containing one to four seeds [129- 146]. Traditionally, the bark of this tree was used for the treatment of dysentery, an eye lotion, and as an embrocation for pains and sores [129- 146]. The leaf decoction was used to treat skin disorders; the stem bark was used to treat dysentery, for gargling applications, as a tooth powder, and to treat muscular pain. Its flowers were also used to cure or relieve intestinal disorders [129- 146]. In Chinese traditional medicine, this plant has been used for the treatment of several ailments, including stomatitis, insomnia, skin troubles, constipation, ringworm, insomnia, dysentery, muscular pains, sores, and skin disorders [129- 146]. *P. pterocarpum* is known to be a rich source of aliphatic alcohols, fatty acids, amino acids, terpenoids, phenolics, flavonoids, alkaloids, and steroids [129- 146]. The isolated phytochemicals and various extracts from this plant have exhibited numerous biological activities, including antimicrobial, antioxidant, and cytotoxic activities, aldose reductase inhibition, and antiglycemic activities [129- 146]. A 70% ethanolic extract of *P. pterocarpum* leaves displayed hepatoprotective effects in paracetamol-induced acute liver damage in albino Wister rats. This ethanolic extract (100 mg/kg and 200 mg/kg) significantly decreased tissue lipid peroxidation in rats [129- 146]. These results suggest that the *P. pterocarpum* extract might have value for the treatment of paracetamol-induced hepatic damage and some liver diseases, via its antioxidant effects [129- 146]. *P. pterocarpum* and *Morinda lucida*, combined, were evaluated for their cognitive enhancing potential in scopolamine-induced amnesic animals; the two ingredients resulted in the considerable enhancement of cognition in mice [129- 146]. The aqueous extract of *P. pterocarpum* wood also exhibited inhibitory effects against Epstein-Barr virus (EBV) in Raji cells and melanogenesis in  $\alpha$ -melanocyte-stimulating hormone ( $\alpha$ -MSH)-stimulated B16 melanoma cells, and demonstrated potent free radical-scavenging activity [129- 146]. Additionally, bergenin and gallic acid, isolated from *P. pterocarpum*, exhibited potent inhibitory effects against EBV-early antigen activation and skin tumor promotion in an in vivo, two-stage, mouse skin carcinogenesis test, using 7,12-dimethylbenz[a]anthracene as an initiator and tissue plasminogen activator (TPA) as a promoter [129- 146].

### 4.11. Botanical Name: *Aegle marmelos*, Corr.

Family: *Rutaceae*

Kannada: Bilwapatri



**Figure 10** *Aegle marmelos* fruits

#### 4.11.1. Distribution

*Aegle marmelos* (L.) Correa (*A. marmelos*), (Figure-10) commonly known as Bael belonging to the family *Rutaceae*, has been widely used in indigenous systems of Indian medicine due to its various medicinal properties [148-161]. Bael is one of the most appreciated plants used in *Ayurvedic* medicine by the Indian and other South Asian inhabitants in ancient history [148-161]. According to the historical records, bael is used as a medicinal and food item since 5000 B.C. and known to human beings even when writing the famous Sanskrit epic-poem Ramayana [148-161]. Bael mentioned in the renowned book Charaka Samhita, a comprehensive compilation of all the essential *Ayurvedic* information, which identified bael as a necessary item in *Ayurvedic* medicine [148-161]. The tree is aromatic, and all the parts are medicinally important [148-161]. Fruits, leaves, bark, roots, and seeds are used in *Ayurvedic* and folk medicine systems to treat various ailments [148-161]. *A. marmelos* is native to Northern India, but widely found throughout the Indian Peninsula, Ceylon, Nepal, Burma, Bangladesh, Thailand and Indo-China [148-161]. It is a medium to large sized deciduous glabrous, armed tree with the axillary 2.5 cm long alternate trifoliate leaves, short flower and globular fruits (Figure-10) [148-161]. This plant grows in dry deciduous forests, is seen in regions of the sub-Himalayan tract, also seen in central and southern India [148-161]. This plant is frequently planted all over India [148-161]. Bael is an underutilized fruit species in South Asian countries [148-161]. However, numerous studies report the medically significant properties and industrially vital characteristics of bael in India [148-161]. Bael trees are usually planted near temples dedicated to Lord Shiva and routinely worshiped by the devotees [148-161]. This plant is commonly found in Karnataka and throughout India [148-161]. Bael (*Aegle marmelos* L. Corrêa) is an economically valuable tree species in South Asia [148-161]. The ripen bael fruits are popular among people because of the delicious fruit pulp, which is ideal for making jam, syrup, and pudding. Bael possesses many medicinal values therefore, used as an ingredient in *Ayurvedic* herbal medical preparations [148-161]. The fruits, bark, leaves, seeds, and roots of bael contain bioactive compounds such as coumarin, xanthotoxol, imperatorin, aegeline, and marmeline [148-161]. These compounds can provide antidiabetic, anticancerous, antifertility, antimicrobial, immunogenic, and insecticidal activities [148-161]. Bael is also essential as a species for reforestation, especially in the unfertile marginal lands [148-161]. Bael seeds possess a unique fatty acid (12-hydroxyoctadec-cis-9-enoic acid or ricinoleic acid), a convertible item into biodiesel [148-161].

Medium or small sized deciduous plant. The leaves are trifoliate and aromatic in nature. The trunk of the plant is somewhat fluted [148-161]. Quite often corky on the cut side with a characteristic gray bark [148-161]. The medium-sized, slow-growing *A. marmelos* tree can grow to 12–15 meters [148-161]. It spreads with spiky branches and has a small trunk, thick, soft, and peeling bark [148-161]. Fractured branches, a transparent, viscous liquid that resembles gum arabic, oozes out, hangs down in long strands, and gradually solidifies [148-161]. It starts tasting sweet but soon becomes unpleasant to the throat [148-161]. Bael is a medicinal cum fruit tree with multipurpose utility and propagated mostly through seeds [148-161].

#### 4.12. Morphology of Plant

Bael tree is deciduous, and the crown is compact or dense, with no weeping branches. Sometimes the lower limbs are drooping [148-161]. The tree is tough and widely adaptable to adverse soil and climatic conditions [148-161]. The bael tree can grow up to 10 m or higher with medium or large sizes with numerous branches. The fruits mainly occur in the periphery of the canopy [148-161]. The trunk is short and thick with narrow oval shape ends. The wood is rigid and slow-growing [148-161]. The young wood has a central pith [148-161]. Under natural habitats, the trees are smaller and irregular. The trees possess short, sturdy, nonspiny, or piercing-spiny branches [148-161]. The straight shaped spines are 3 cm in length when fully grown and originate from the leaves' axis. The tree's bark is flaking, bluish-grey, soft, and contains irregular furrows on the younger branches [148-161].



The trees possess dimorphic twigs. The regular twigs have 3–5 cm long internodes with a leaf at each node and one to two spines[148-161]. The other type of twigs, the foliage spurs, are arising on the primary branches[148-161]. The foliage spurs are shorter than usual twigs (1–3 cm) with copious diminutive internodes[148-161]. In foliage spurs, each node has a leaf; however, the spine is absent[148-161]. The twigs produced on the first-year twigs have glabrous surfaces, whereas the new twigs produced in the second- and third-year twigs have striated surfaces[148-161]. The prickles are generally absent on the stem, or if present, they are not persistent[148-161]. The suckers originate from the main bael trees when they grow up to a sufficient height and crown width [148-161]. The young suckers have the stout and sharpest spines to protect the suckers from the herbivores [148-161]. Usually, gum-like sap is secreting out from the wounds. Initially, the sap secretions appear as long thick threads and later become dried up long solid crystals[148-161].

The leaves are alternate, single, or compound, with one or occasionally two pairs of shortly stalked opposite leaflets[148-161]. The leaf petioles are glabrous and long, with no wings [148-161]. The leaves are trifoliate and aromatic, mostly when chopped. The leaves are deciduous, alternate, and borne as single or compound. In compound leaves, the leaflets appear in 2–5 oval-ovate or ovate shaped, pointed, and frivolously toothed leaflets (i.e., shallowly serratocrenate) [148-161]. A leaflet is 4–10 cm long and 2–5 cm wide [148-161]. The leaflets are thin, and their midribs are prominent from the beneath[148-161]. The terminal leaflet has a longer petiole. The new foliage emerging after a dormant or a reproductive phase is glossy in appearance and pink or burgundy in color[148-161].

The flowers are fragrant and form 4–7 clusters along the new branches[148-161]. A flower has four or five recurved and fleshy petals (the exterior color is green, and the inside color is yellow) with 50 or more greenish-yellow stamens[148-161]. The flower is 2 cm wide, sweet-scented, stalked, lax, erect, and occurred axillary or terminal cymes. The calyx is shallow, with five short, broad teeth, and pubescent outside[148-161]. The stigma is capitate, and the ovary is oblong-ovoid and slightly tapering into the thick short style[148-161].

The fruits have a hard, smooth-woody shell (i.e., pericarp), a soft rind at immature stages[148-161]. The crust is gray-green at early stages, turns yellowish or orange at the ripening stage, and becomes very hard and orange-red when dried[148-161]. The bael fruit exists in diverse shapes ranging from round, pyriform, oval, or oblong. The fruits are 5–20 cm in diameter [148-161]. The aromatic tiny oil glands appear as dots on the fruit shell. Inside the fruit, there is a hard central core with 8 to 20 indistinctly apparent triangular segments with thin, dark-orange walls[148-161]. They contain aromatic, pale-orange, pasty, sweet, resinous, astringent pulp with a pleasing aroma. The fruits are slow ripening, and they could take one year for full ripening. The ripen fruit flesh is yellowish-orange in color, mucilage, fibrous, and aromatic [148-161]. The number of seeds varies from 10–50[148-161]. A seed is 1 cm long with a flattened-oblong shape. The seeds also contain woolly hairs. The seeds encase in a sack of sticky transparent mucilage or gummy substance that solidifies after drying [148-161]. The testa is white. The embryo has large cotyledons with a short superior radicle [148-161]. There is no endosperm. Some seeds can get aborted during the development[148-161]. The seeds undergo no dormancy and germinate within 2-3 weeks[148-161]. The seedlings are ready for transplanting within 2-3 months [148-161]. The seedlings used as rootstocks are ready by the next year to produce grafted/budded plants[148-161].

#### 4.13. Medicinal uses

Extensive studies showed that *A. marmelos* has antidiarrhoeal, antimicrobial, antiviral, anticancer, chemopreventive, antipyretic, ulcer healing, antigenotoxic, diuretic, antifertility, and anti-inflammatory properties, which helps to play role in prevention and treatment of many disease [148-161]. The bael tree is sacred to Hindus, the leaves being used in the worship of The Lord Shiva [148-161]. It is planted near temple [148-161]. It is very useful plant and yields a hard wood and the wood is used for agricultural and other implements[148-161]. The fruits are chiefly used as a medicinal purpose to prevent dysentery and diarrhea. *A. marmelos* leaf, seed and fruit is known to **affect male fertility** in reversible manner [148-161]. *A. marmelos* bark extract is a rich source of **marmin** and fagarine known for reducing **male fertility**. Agrawal *et al.* found that methanolic extract of *A. marmelos* causes a dose and duration dependent infertility via reducing reproductive organ weight and serum testosterone levels in animal models[148-161]. They also report reduction in sperm density, motility, viability and sperm acrosomal integrity[148-161]. Different organic extracts of the *A. marmelos* leaves possess highly significant acute and subacute anti-inflammatory activity. *A. marmelos* has been reported to contain several phytoconstituents mainly marmenol, marmin, marmelosin, marmelide, psoralen, alloimperatorin, rutaretin, scopoletin, aegelin, marmelin, fagarine, anhydromarmelin, limonene,  $\alpha$ -phellandrene, betulinic acid, marmesin, imperatorin, marmelosin, luvangentin and auroptene[148-161].

One of the study determined the contents of tannin (0.985%) and riboflavin (0.005%) [148-161]. Various organic acids including oxalic, tartaric, malic and ascorbic acids were separated and quantified using a RP-HPLC [148-161]. Another

study have characterized the various phenolics in the fruit as chlorogenic acid (136.8 µg/g), ellagic acid (248.5 µg/g), ferulic acid (98.3 µg/g), gallic acid (873.6 µg/g), protocatechuic acid (47.9 µg/g) and quercetin (56.9 µg/g) through LC-MS and LC-MS/MS scans and HPLC studies [148-161]. Recent study found hexanal, isoamyl acetate, limonene, β-phellandrene, p-cymene, acetoin, (E)-2-octenal, (E,E)-2,4-heptadienal, dehydro-p-cymene, linalool oxide, 3,5-octadiene-2-one, α-Cubebene, *trans-p*-mentha-2,8-dienol, citronellal, β-cubebene, β-caryophyllene, hexadecane, pulegone, α-Humulene, verbenone, carvone, carvyl acetate, dihydro-β-Ionone, (E)-6,10-dimethyl-5,9-undecadien-2-one, β-Ionone, caryophyllene oxide, humulene oxide and hexadecanoic acid [148-161]. Seed oil is composed of palmitic, stearic, oleic, linoleic and linolenic acid. Apart from these, seed oil has been found to contain 12.5% of an unusual fatty acid, ricinoleic acid along with other normal fatty acids [148-161].

## 5. Conclusion

India's Western Ghats, also known as the Sahyadri mountains, are a stunning and environmentally vital terrain that run over 1,600 kilometers along the country's western coast. Medicinal plants play a crucial role in the Western Ghats, both ecologically and culturally. This vast mountain range is one of the richest tropical forest zones in the world due to its tremendous diversity of flora and fauna in addition to its spectacular beauty. The Western Ghats populations' traditional medical practices frequently center on using plant-based treatments. *Thespesia populnea* is a reputed ever green tree belonging to the family *Malvaceae*, commonly known as Indian tulip tree. The plant is distributed in tropical regions and coastal forest in India. It is well known plant and all the parts are used in traditional system of medicine. *Melia azadirachta* has antiulcer, antipyretic, anti-fertility, anti-cancer, antiviral, wound healing, and hepatoprotective properties that make it useful for treating a variety of illnesses. The plant contains different types of active substances, including terpenoids, flavonoids, steroids, acids, anthraquinones, alkaloids, saponins, and tannins. *Michelia champaca* belongs to family *Magnoliaceae* is commonly known as Champak or Goldenchampa. Leaves are simple, alternate, petiole 1 to 3 cm long, lanceolate, spiral and reticulate. *Michelia champaca* flowers are solitary, dull yellow when fresh and orange when old and fragrant. In India this plant is cultivated in garden and near temples for its fragrant flowers. *Butea monosperma* (Palas) belonging to the family *leguminaceae* grown wildy in many parts of India. The plant is highly used by the rural and tribal people in curing various disorders. Mahua seeds are of economic importance as they are good source of edible fats. *Madhuca longifolia*, commonly known as *mahua* or *mahua* or Iluppai is an Indian tropical tree found largely in the central and north Indian plains and forests. In *Ayurvedic* medicine, preparations of *Melia azadirachta* are used to treat various conditions, including the common cold, inflammation, headaches, stomach issues, diabetes, several types of poisoning, and malaria. *M. champaca* L. has traditionally been used to treat diarrhea, cough, bronchitis, hypertension, dyspepsia, fever, rheumatism, abscesses, dysmenorrhea and inflammation. *Moringa oleifera*, is also known as the "tree of life" or "miracle tree," is classified as an important herbal plant due to its immense medicinal and non-medicinal benefits. In addition, *M. oleifera* is also rich in compounds such as vitamins, micronutrients, and carotenoids which increase its medicinal value and consumption as a superfood. *Peltophorum pterocarpum* (DC.) Baker ex Heyne is a deciduous tree commonly used for ornamental purpose and as an avenue tree. Different parts of this tree are used to treat many diseases like stomatitis, insomnia, skin troubles, and constipation. *Mangifera indica*, commonly used herb in Ayurvedic medicine. Studies indicated that mango possesses antidiabetic, anti-oxidant, anti-viral, cardiotoxic, hypotensive, and anti-inflammatory properties. *Terminalia arjuna* is a potential cardioprotective agent belonging to the *Combretaceae* family. *A. marmelos*, native to Northern India, are also widely dispersed over the Indian Peninsula, Burma, Bangladesh, Ceylon, Thailand and Indo-China. *Aegle marmelos* possesses antidiarrhoeal, antimicrobial, antiviral, radioprotective, anticancer, chemopreventive, antipyretic, ulcer healing, antigenotoxic, diuretic, antifertility and anti-inflammatory properties.

## Compliance with ethical standards

### Disclosure of conflict of interest

No conflict of interest to be disclosed.

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