INTRODUCTION
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There are three basic necessities of human, these are food, clothes and shelter and now the fourth one is good health, all are fulfilled by the plant kingdom. The medicinal plants are a divine gift to us from 'mother nature' who has kept these green remedies in her plant kingdom for mankind to use to fight against death from diseases and cure themselves from ailments. It is up to us to explore, seek, search and reap the benefits of this treasure. Fossil records date human use of plants as medicines atleast to middle Paleolithic age some 60,000 years ago (Solecki, 1975). The development of traditional medicinal systems incorporating plants as a mean of therapy and usage of plants in treating human diseases is probably as ancient as the human civilization.

The folk and tribal medicinal systems which are in practice, involve use of medicinal plants in large quantities. WHO has estimated that about 80% of world population residing in vast rural areas of the developing and under developed countries still rely mainly on medicinal plants, since it is the only affordable and accessible source of primary health care, especially in the absence of access to modern medical facilities (WHO, 2002).

The plant kingdom contributed immensely to human health when no synthetic medicines were available, and when no concept of surgery existed. India is endowed with a rich wealth of medicinal plants. These plants have made a good contribution to the development of ancient Indian Materia Medica. It is estimated that about 2,50,000 to 5,00,000 plant species present on the earth possess medicinal properties, which are used to cure a number of disorders and diseases. In most part of Asia, traditional medicinal plants have been part of their culture (Prajapati et al., 2006; Kaushik and Dhiman, 1999).

In fact it is well known that even in developed countries the use of traditional medicines is quite prevalent. This culture has been passed down
from one generation to another (Nurliani, 2004) hence, promoting the use of medicinal plants for health purpose. In India alone less than 10% of medicinal plants traded in the country are cultivated, about 90% are collected from the wild, very often in a destructive and unsustainable manner (Natesh, 2000).

Medicinal plants are one of the most sensitive commodity areas of research in the world today. Many countries would like to keep their information and knowledge about medicinal plants to themselves, for fear of being marginalized in the race to exploit the commercial values of medicinal plants.

Phytochemistry is closely related to natural products. It deals with a variety of organic substances accumulated in plants. Plants are rich in wide variety of secondary metabolites such as tannins, terpenoids, alkaloids, flavonoids, phenols, essential oils with antibacterial properties etc. The flavonoids are one of the largest classes of phenolics. The various nitrogen containing secondary metabolites are alkaloids, cyanogenic glycosides, glucosinolates and non protein amino acids (Trease and Evans, 1983). The qualitative estimation of phytochemical constituents of a medicinal plant is considered to be an important step in medicinal plant research (Kokate, 1994).

More recently many secondary metabolites have been suggested to have important ecological functions in plants. They protect plants against being eaten by herbivores and against being infected by microbial pathogens. They serve as attraction for pollinators and seed dispersing animals and as agents of plant competition (Torssell, 1983).

The phytochemical studies of medicinal plants are essential to determine the potent components present in the plant, which are responsible for cure a disease singly or in association with others. It was found as a result of such studies that these plants contain various chemicals which have specific
effect on biological system. These biodynamic substances are alkaloids, glycosides, flavonoids, phytosterols, essential oils, resin, tannins, vitamins etc. Out of these alkaloids, flavonoids and phytosterols are most important from medicinal point of view.

India is sitting on a gold mine of well recorded and well practiced knowledge of traditional herbal medicine. Medicinal plants are excellent chemical factories capable of synthesizing unlimited numbers of biochemicals which are used in Indian system of medicine, so that, they may be considered as biosynthetic laboratory (Retnam and Martin, 2006).

Herbs have always been the principal form of medicine in India and presently they are becoming popular throughout the world as people strive to stay healthy in the facing of chronic stress and pollution. There is a wide spread belief that green medicines are healthier and more harmless or safer than synthetic ones. The high cost of modern medicines, their unavailability in remote areas and the most importantly the serious side effects of certain drugs have resulted in a significant return to traditional and indigenous herbal medicine (Bhattacharjee, 2001).

India is well known as emporium of medicinal plants. The scientific studies of medicinal plants are carried out all over India since Vedic times 3000BC to 1000BC. There is evidence since early Vedic period (Atharva Veda) for plants being used for wide range of medicinal purposes. Out of an estimated 17,000 higher plant species occurring in India, about 2,500 species belonging to more than 1,000 genera are used by traditional healers over several centuries in the traditional system of medicine viz. Ayurveda, Siddha, Unani and Homoeopathy. Apart from these classical systems practiced innumerable local folk medicinal traditions also exist (Retnam and Martin, 2006). Over 50% of all modern clinical drugs are of natural origin and natural
products play a vital role in modern drug development in pharmaceutical industry (Baker et al., 1995).

Medicinal plant preparations are chemically complex and may contain one or many structurally related active compounds that produce a combined effect on biological system or causal agents in order to cure a disease. Phytochemical studies help in standardizing the herbal preparation, their active constituents as well as preserving their activities.

It is a well known fact that plant species show different phytochemical characteristics when grown under different geographical and climatic conditions. They also exhibit seasonal variations in their phytochemical contents (Dadun et al., 1992; Yakota et al., 1994). The varieties of a species differ in their morphological, anatomical and phytochemical characteristics (Shannon et al., 2001; Raja et al., 2008; Hossam et al., 2010; Sheth, 2011). Like other plants, medicinal plants also have morphological variants which differ in their little morphological characteristics but they belong to same species. These morphological variants are referred as "Morphotypes". Several morphotypes of medicinal plants exist in nature. The main objective of the present research work is to compare morphological, anatomical, phytochemical and antimicrobial characteristics of these morphotypes. The variations would provide adequate scope for selection of chemically superior morphotypes (chemovars or chemotypes). In present research work morphotypes of two medicinally important plants are selected. These are:-

1. *Cissus quadrangularis* L.
2. *Butea monosperma* (Lam.) Taub.

The medicinal value of these two plant species is known through ages. A bulk of literature is available on the medicinal uses and phytochemical constituents of these selected plants, but very little is known about the variants or morphotypes of these plant species so, it is taken for the present study.
Cissus quadrangularis L.

*C. quadrangularis* L. belonging to family Vitaceae is found throughout hotter parts of India. It is commonly known as “Hadjor” (in Hindi) or “Asthi Sanhara” (in Sanskrit) or “Edible Stemmed Vine” (in English). It is one of the important medicinal plants used in Ayurveda. The plant is a tendril bearing woody vine with stout, fleshy quadrangular stem, leaf opposed inflorescence and bisexual tetramerous flowers.

The stem extract of the plant is found very useful in healing bone fractures (Udupa and Prasad, 1962,1964; Chopra et al., 1975; Shirwaikar et al., 2003; Sanyal et al., 2005; Rao et al., 2007; Potu et al., 2009). In addition plant extract has antimicrobial, antioxidant, antitumor, antiobesity, antianalgesic, antiinflammatory, antihemorrhoidal and gastroprotective properties (Mishra et al., 2010; Raj and Joseph, 2011; Joseph and Raj, 2011).

*Cissus quadrangularis* L. exhibits following three morphotypes in nature:

- **Morphotype I (C1)** - Rectangular stem which is wingless and with bilabial corner (Fig. No. 01)
- **Morphotype II (C2)** - Round stem (Fig. No. 02)
- **Morphotype III (C3)** - Two sided flat stem with sharp edges (Fig. No. 03)
Fig. No. 01. Cissus quadrangularis L.

morphotype I Rectangular stem (C1)
Fig. No. 02. Cissus quadrangularis L.
morphotype II Round stem (C2)
Fig. No. 03. *Cissus quadrangularis* L. morphotype III Flat stem (C3)
**Butea monosperma** (Lam.) Taub.

*Butea monosperma* (Lam.) Taub. belongs to family Fabaceae, a medium sized deciduous tree, widely distributed throughout India. It is popularly known as “Dhak,” “Palash” (in Hindi), “Palasha” (in Sanskrit) and also “Flame of forest” (in English). The plants possess trifoliate leaves and brightly orange red flowers.

*B. monosperma* (Lam.) Taub. is extensively used in Ayurveda, Unani and Homeopathic system of medicines. It is also used widely in modern medicines.

The crude extract of various parts of the plant and pure isolates are reported to possess antibacterial, antifungal, antidiarrhoeal, anticancer, antistress, antiinflammatory, antidiabetic, antifertility, hepatoprotective, wound healing and free radical scavenging properties (Sindhia and Bairwa, 2010; Pal and Bose, 2011).

In nature following three morphotypes of this plant species have been reported:-

Morphotype I (Butea Red) - With Orange Red flowers (Fig. No. 04)
Morphotype II (Butea Yellow) - With Yellow flowers (Fig. No. 05)
Morphotype III (Butea White) - With White flowers (Fig. No. 06)
Fig. No. 04. *Butea monosperma* (Lam.) Taub. Morphotype I (Butea Red)
Fig. No. 05. Butea monosperma (Lam.) Taub.
Morphotype II (Butea Yellow)
Fig. No. 06. *Butea monosperma* (Lam.) Taub. Morphotype III (Butea White)
CONCLUSION
CONCLUSION

*Cissus quadrangularis* L.

**Morphological Characteristics**

The three tested morphotypes of *Cissus quadrangularis* L. have identical habit. They are climbing herb with fleshy, glabrous stem, contracted at nodes. Stem is leafless in older parts. In morphotypes C1 stem is quadrangular, in C2 stem is round but in C3 stem is flat with sharp margins.

All three morphotypes have simple alternate leaves. Shape of leaves is variable, reniform in morphotype C1 and C3 but trilobed and trinerved in C2 morphotype. Leaf margin is denticulate in C1 and C2 but crenate in morphotype C3. Long petioles are found in C1 and C2 but petiole is very short or leaves are subsessile in morphotypes C3.

Tendrils are simple and develop opposite the leaves from nodes in all the three morphotypes. In morphotypes C3 tendrils are sometimes forked.

Flowering was not observed in the tested morphotypes of *Cissus quadrangularis* L.

**Anatomical characters**

All the three morphotypes of *Cissus quadrangularis* L. exhibit similar stem anatomy which is of a typical dicot stem type. They differ in their outline in T.S. C1 is quadrangular, C2 is round while C3 is flat with two corners. Stem of all the three morphotypes have single layered cutinized epidermis provided with sunken stomata. Epidermis is followed subsequently by collenchymatous hypodermis, parenchymatous cortex, a zone of chlorenchyma and a ring of conjoint, collateral and open vascular bundles. In all the three morphotypes vascular bundles are capped with sclerenchymatous patches of pericycle. Pith is parenchymatous. Abundant mucilage ducts are found in pith and cortex. The most important feature of stem is the presence of large collenchymatous
patches at corners outer to pericycle in cortex. Four such patches are found in morphotype C1 and two in morphotypes C3. In morphotypes C2 stem is round but 4 such small patches are evident. This shows its closeness with morphotypes C1

A typical dorsiventral leaf anatomy is found in all the three morphotypes. They have single layered upper and lower epidermis, two or three layers of compactly arranged palisade cells and spongy parenchyma with narrow spaces. Stomata are found on both the epidermis but abundant on lower epidermis. In midrib region 5-6 layers of collenchyma are found below the upper epidermis but 1-2 layers of collenchyma are found inner to lower epidermis forming hypodermis. The vascular tissues in all the three morphotypes are represented by a ring of vascular bundles found in midrib region. The number of vascular bundles is variable among the morphotypes five in C1 and C2 but six to seven in morphotypes C3.

**Stomata and Stomatal Index**

Stomata in the three tested morphotypes are anomocytic type. The guard cells are surrounded by four unmodified subsidiary cells in all cases.

Stomatal Index is low on upper surface as compared to lower surface of leaf in all the three morphotypes. It is more or less equal on upper and lower epidermis in morphotypes C3.

**Preliminary phytochemical screening**

The preliminary phytochemical screening of ethanolic stem extract of the three morphotypes of *Cissus quandrangularis* L. reveals the presence of alkaloids, carbohydrates, phytosterols, flavonoids, phenolic compounds, proteins, amino acids, gums and mucilages. The saponins, fixed oils and fats are absent in all the three morphotypes. Among carbohydrates glucose and
fructose are predominantly present. This can be concluded that the three tested morphotypes show uniform phytochemical constituents.

The TLC observations of three morphotypes of *Cissus quadrangularis* L. show uniform pattern on TLC plates in different mobile phases. Maximum separation is observed in Ethyl acetate : Chloroform mobile phase. It reveals the presence of three spots in all the three morphotypes, which is corresponding to atleast three compounds in the extract.

The UV and IR spectroscopy of ethanolic stem extract of *Cissus quadrangularis* L. indicates the presence of functional groups like diallyl sulfoxide, sulfonamide, carbonyl (ketone and aldehyde) amide and gem dimethyl in all the three tested morphotypes. They show presence of uniform functional groups.

These observations also indicate that the compound present in the extract possesses aromatic nucleus attached with diallyl sulfoxide group. The N-H stretching vibrations in IR shows that the nitrogen is present outside the ring which may be a secondary amine having intramolecular hydrogen bonding.

The preliminary phytochemical screening shows the presence of phytosterols. The UV and IR spectroscopy gives some evidences of probable basic structure of the following adrenal steroids type compounds.
The IR spectroscopy of the three morphotypes also reveals the presence of similar flavonoids. The common flavonoids are flavone, fistein (3, 7, 3' 4' tetrahydroxy flavone) and hespertin (5, 7, 3 trihydroxy 4' methoxy flavone) (Heneczowski et al., 2001).

Seasonal Variations

The UV spectroscopy of ethanolic stem extract of *Cissus quadrangularis* L. reveals no significant seasonal variations in the samples collected during March-April and August-September.

The functional groups or active phytochemical constituents like carbonyl groups (aldehyde and ketone) amide, furans, lactams and aromatic structure of compounds are common in the samples collected in both the seasons in all the three tested morphotypes. Since, these functional groups contribute to the antimicrobial activity of the extract, it can be concluded that seasonal variation does not affect the chemotherapeutic value of the plant. The results are not in agreement with the findings of Dadun et al. (1992) and Yakota et al. (1994) that seasonal variations in phytochemicals are found in plants.
Antimicrobial activities

The results of antimicrobial testing show uniform pattern activity-wise. The ethanolic and aqueous stem extract of all the three morphotypes exhibit very strong antimicrobial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. They are also effective against *Bacillus subtilis*, *Salmonella typhi* and *Escherichia coli*.

The functional groups which are reported in IR spectrum viz dially sulfoxide, sulfonamide, carbonyl (ketone and aldehyde) amine, amide groups and flavonoids are mainly contributed to the antimicrobial activity of the plants (Chatwal, 1996). Flavonoids being polyphenolic compounds, also contribute to the antioxidant activity of this plant (Raj and Joseph, 2011; Taraphdar et al. 2001). Phytosterols show wide spectrum antimicrobial activity (Sharma, 1993). Some phytosterols like β-sitosterol and sitosterol β-D glucopyranoside act as strong antimicrobial agent against *Bacillus subtilis* (Flavio et al. 2002). Phytosterol containing sulfoxide group also enhances the antimicrobial activity.

Phytosterols found in *Cissus quadrangularis* L. may be involved in stimulating Osteoblastogenesis in bone cells (Potu et al. 2009). Phytosterols containing sulfoxide group can also act as phytoestrogens. Estrogen receptor have been detected in bone cells (both in Osteoblast and Osteoclasts) suggesting the direct action of estrogen on these bone cells (Eriksen et al. 1988; Ernest et al. 1991; Migliaccio et al. 1992). Several studies have shown that estrogen can modulate bone cell physiology *in vitro* by direct estrogen receptor mediated mechanism. This evidence implicates a direct effect of estrogen on skeleton and alternatively on bone tissue turnover. This property correlates the application of stem juice in healing fracture in the bone. This activity is primarily due to high content of calcium and phosphorous in plant.
Another property of this plant is its analgesic effect (Vijay and Vijayvargiya 2010). It is due to presence of amines, amides and triterpenoids present in essential oils (Kokate et al. 1990, 2013). This plant when is used in healing of bone fracture may be of great value in relief of pain which is a constant feature in these cases (Mishra et al. 2010).

Essential oils have also been reported in all the three morphotypes of *Cissus quadrangularis* L. These oils contain triterpenoids. Terpenes and triterpenoids are found in all essential oils of plant and animal origin. Therapeutically, they exhibit a wide spectrum activity like antiseptic, analgesic, stimulant, carminative, diuretic, anthelminitic and antirheumatic (Kokate et al. 1990, 2013). This observation enhances the utility of plant in the above mentioned activities. This is needless to say that versatile uses and various therapeutic activities have made the plant a valuable medicinal herb.

From the present research work this can be concluded that the three morphotypes of *Cissus quadrangularis* L. (C1, C2 and C3) exhibit uniform phytochemical characteristics. They exhibit similar antimicrobial activity. Although, they are differ in their morphology and minor anatomical characteristics. The plant *Cissus quadrangularis* L. has largely been used in traditional medicinal systems for curing various disease (Mishra et al. 2010; Raj and Joseph, 2011; Joseph and Raj 2011). The present studies confirm correct use of these plants in traditional medicinal system. The identical phytochemical characteristics and antimicrobial activity of the three tested morphotypes of this plant suggest their uniform role in traditional medicinal system. Any one morphotype can be used as a substitute, for other in curing diseases. The varietal status may be given to these morphotypes on the basis of morphological and anatomical features but it is not justifiable on phytochemical ground. The morphological and anatomical characteristics are not strong enough to create varietal status for these morphotypes.
Butea monosperma (Lam.) Taub.

Morphological characteristics

The three morphotypes of Butea monosperma (Lam.) Taub. i.e. Butea Red (BR), Butea Yellow (BY) and Butea White (BW) are medium sized deciduous tree resemble in broad morphological characteristics except they produce flowers of different colours. They are about 20-40 ft. in height. They have similar ash coloured fissured bark, trifoliate leaves, showing reticulate venation. The size of terminal and lateral leaflets, number of lateral veins in leaflets and length of petiole are similar in Butea Red and Butea Yellow but smaller leaflets, less number of lateral veins, short petiole are found in Butea White. The laminar margin is entire in leaflets of all the three morphotypes, the laminar apex is round in Butea Red but retuse in Butea Yellow and Butea White.

Flowers are borne in large dense rigid recemes in all the three morphotypes but comparatively small sized racemes are present in Butea White. The three tested morphotypes of Butea monosperma (Lam.) Taub. blossom during Feb-March. The calyx tube is dark olive green, velvety outside in Butea Red and Butea Yellow, but in Butea White calyx tube is slightly larger, black and velvety outside. Corolla is papilionaceous in the three morphotypes. It is orange red, yellow and creamy white in Butea Red, Butea Yellow and Butea White respectively. The androecium is diadelphous and gynoecium is monocarpellary in all the three morphotypes of Butea.

Anatomical characteristics

The petiole and leaf anatomy is broadly similar in all the three morphotypes of Butea. The petiole in T.S. is provided with a continuous vascular cylinder with typical adaxial invaginations in all the three studied morphotypes. Two inner accessory vascular bundles are present in all the
three studied morphotypes of Butea, but the number of outer cortical accessory vascular bundles is variable.

The leaves of three studied morphotypes exhibit typical dorsiventral anatomy. Trichomes are distributed on both upper and lower epidermis but abundant on lower epidermis. The tannin cells are uniformly distributed in ground tissues, cortex and pith of both petiole and leaves.

**Stomata types and Stomatal Index**

The three tested morphotypes of *Butea monosperma* (Lam.) Taub. have paracytic type of stomata. They are distributed on lower epidermis only.

Stomatal index is variable in the three morphotypes it is low in Butea White, while high in Butea Red and Butea Yellow.

**Trichomes**

Trichomes in all the three testes morphotypes are long, unicellular with pointed ends. They are distributed on petioles and leaflets. In leaflets they are densely crowded on lower surface. Their length varies from 130-360 µm.

**Preliminary phytochemical screening**

The preliminary phytochemical screening of ethanolic flower, bark and leaf extracts of the three tested morphotypes of *Butea monosperma* (Lam.) Taub. i.e. Butea Red, Butea Yellow and Butea White shows the presence of carbohydrate, phenolic compounds, proteins, amino acids and flavonoids in all the parts of the plant. Among carbohydrates fructose is present in all morphotypes. All the three tested morphotypes lack alkaloids and saponins.

The tested morphotypes differ in some phytochemical characteristics; even they differ in phytochemical constituents of different parts. Tannins are
found only in bark extract of three morphotypes but absent in leaf and flower extract. Glycosides and phytosterols are found in all parts of Butea Red and Butea White but totally absent in Butea Yellow. On the other hand Butea Yellow shows the presence of fixed oils and fats which are found absent in Butea Red and Butea White. Gums and mucilages are found only in flower and bark of the three morphotypes but totally absent in their leaves.

The three tested morphotypes of *Butea monosperma* (Lam.) Taub. exhibit some marked differences in separation pattern on TLC plates for extracts of different parts. The morphotypes resemble in flower extract. They form two or three spots in n-Butanol : Acetic acid : Water (4:1:5) mobile phase. But they form only one spot in rest of the mobile phases. Similar pattern of separation is found in leaf extract of the morphotypes. They form two spots in Ethyl acetate : Benzene (6:4), Ethyl acetate : Benzene (1:1) and n-Butanol : Acetic acid : Water (4:1:5) mobile phases. No separation is found in Petroleum ether : Benzene (6:4) and (8:2) mobile phases. Much diversity is found in bark extract of the three morphotypes. The observations show the presence of more than one compound in the extract.

The UV and IR spectroscopy of ethanolic extracts of three tested morphotypes of *Butea monosperma* (Lam.) Taub. have shown the presence of variable functional groups. But extract of different parts of same morphotypes exhibits some similarities.

The UV spectroscopy reveals the presence of diallyl sulfoxide and carbonyl groups (aldehyde) in Butea Red and Butea White. But sulfonamide and ketonic carbonyl groups are found in Butea Yellow. The Butea Yellow shows presence of phenolic hydroxyl group only in flower extract. Amide and amine groups are also common in all the tested morphotypes.
The IR spectroscopy also reveals the presence of flavonoids in all the tested morphotypes. The flavonoid chalcone is found uniformly in flowers of all the three morphotypes. The flavonoid Butein is a characteristic of *Butea monosperma* (Lam.) Taub. belongs to this group of flavonoids (Sindhia and Bairwa 2010). Flavone is universally found in all parts of three morphotypes except the flower of Butea Yellow. Quercetin is also found in all parts of the three tested morphotypes except flower of Butea White. Anthracene glycoside is found exclusively in flower of Butea Red. Similarly Sodium salt of Quercetin 5' Sulfonic Acid (NAQSA) and Sodium salt of Morin 5' Sulfonic Acid (NaMSA) are found only in flowers of Butea Yellow and Butea White respectively. These three above mentioned phytochemicals can be considered as biochemical markers for the three morphotypes of *Butea monosperma* (Lam.) Taub. as they are found exclusively in flowers of these plants :-

<table>
<thead>
<tr>
<th>Morphotype</th>
<th>Phytochemicals</th>
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<tbody>
<tr>
<td>Butea Red</td>
<td>Anthracene</td>
</tr>
<tr>
<td>Butea Yellow</td>
<td>Sodium salts of Quercetin 5' Sulfonic Acid (NaQSA)</td>
</tr>
<tr>
<td>Butea White</td>
<td>Sodium salts of Morin 5' Sulfonic Acid (NaMSA)</td>
</tr>
</tbody>
</table>

The flavonoid Morin is found only in bark of Butea Red and Butea Yellow but absent in bark of Butea White. Morin is present in leaves of Butea Yellow only. From these studies this can be said that bark and leaf extracts of all the morphotypes contain many different types of flavonoids as compared to flower extract. Similarly all parts of Butea Yellow show the presence of a combination of various different flavonoids as compared to Butea Red and Butea White. The types of flavonoids reported in different parts of Butea Yellow are chalcone, aurones, quercetin, morin, flavone and sodium salts of quercetin 5' sulfonic acid.
Seasonal variations

The UV spectroscopy of the ethanolic bark extracts of *Butea monosperma* (Lam.) Taub. reveal no significant variations in the samples collected during March-April and August-September. The little variations in phytochemical constituents are observed in all the three tested morphotypes.

In all the three tested morphotypes carbonyl, phenols, amide and lactams which contribute to the antimicrobial activity are found in samples of both the seasons. This indicates seasonal variations do not affect the chemotherapeutic value of the plant.

In Butea Red thiophene, enones and ethyl acetate appear in samples of both the two seasons. In Butea Yellow thiopene, pyrrol and cyclopentadiene are found in bark of August-September season but ethyl acetate appears in the bark of March-April season only.

In Butea white benzonitril and ethyl acetate appear in bark of March-April but, azomethane is found only in samples of August-September only.

The seasonal variations in phytochemicals supports the findings of Dudun et al. (1992) and Yakata et al. (1994), that plant species show seasonal variations in phytochemical constituents. But appearance of antimicrobially active groups in extract of both the seasons indicates identical chemotherapeutic value of plant in both the seasons.

Antimicrobial activities

The antimicrobial activity results of different parts of the morphotypes of *Butea monosperma* (Lam.) Taub. exhibit variations activity wise. The flower extracts of the three morphotypes are effective against *Salmonella typhi*, *Bacillus subtilis* and *Staphylococcus aureus*. While this shows no response against *Pseudomonas aeruginosa*. Butea Red and Butea Yellow are found
effective against *Escherichia coli* but Butea White does not show any response. The bark and leaf extracts of Butea Red and Butea Yellow are found effective against all the tested microorganisms but that of Butea White does not show any response against *Escherichia coli* and *Pseudomonas aeruginosa* although it is effective against rest of the tested microorganisms.

Butea Yellow is found strongly active against all the tested microorganisms as compared to Butea Red and Butea White. Butea White appears less antimicrobially active among the three morphotypes. The bark extract of Butea Yellow is found most active against all the tested microorganisms.

The antimicrobial activity of this plant species is due to presence of various functional groups viz diallyl sulfoxide, sulfonamide, carbonyl, amine, amide and phenolic groups. The flavonoids are also responsible for the antimicrobial activities of the plant.

The strong antimicrobial activity of Butea Yellow is attributed to the presence of unique combination of functional groups and flavanoids present in different parts.

Flavonoids are natural biologically active compounds. They are hydroxyl, methoxyl and glycoside derivatives of flavone. They play an important role in contributing to the beauty and splendour of flowers and fruits in nature (Torssell 1983). Inspite of these they also play a role as antimicrobial, antiproliferative activities (Kuntz et al. 1999).

Flavonoids vary significantly in their antimicrobial and antiproliferative potency depending on the structural features. Their antimicrobial activity is due to their polyphenolic nature. Dietary flavonoids are known to be antiproliferative and play an important role in cancer chemo prevention especially cancer of gastrointestinal tract because of its direct contact with the
food. Two most potent dietary flavonoids quercetin and genistein are known to induce apoptosis in colon cancer cells (Taraphdar et al. 2001). Flavonoids also contribute to the antioxidant activity of plant due to their polyphenolic nature (Raj and Joseph, 2011).

Aldehydes and ketones have strong antiseptic property. Aldehydes are more reactive than ketones. In case of aromatic compounds introduction of -OH group (phenolic) increases physiological activity of compounds including biological and antimicrobial activity (Chatwal, 1996, 2010).

Amines and amides play important roles in our day to day life. In many drugs viz amphetamines, barbiturate, analgesics, anesthetics, decongestants and antibiotics are such medicinal compounds which are amines and amine derivatives (Carnet et al. 1993; Satoskar and Bhandarkar 1999; Drug Today 1999). Many of medicinal amines are also used as analgesic and anesthetics in medicines. For example Novocain and related compounds are used as local anesthetic while Demerol is a very strong pain reliever (Tyagi and Yadav 1998).

Sulfa drugs the important classes of antibiotics are also synthesized from amine and amine related compounds (Lemke et al. 2013). Sulfonamides are synthetic chemotherapeutic agents which contain SO₂, NH₂ group in their structure. These were the first effective chemotherapeutic agents, widely used in case of bacterial infections in humans. At present they have been largely replaced by antibiotics, but they are still used either alone or in combination with antibiotics for cure of bacterial infections.

Morphotypes of Butea monosperma (Lam.) Taub. differ in their phytochemical constituents and antimicrobial activity significantly. Among the three tested morphotypes Butea Yellow appears as a better chemotype as compared to Butea Red and Butea White. It possesses a unique combination of functional groups and flavonoids, this can be reflected in the term of strong
antimicrobial activity shown by this morphotypes. These observations make this morphotype a plant of better therapeutic value.

Butea Yellow was recognized as a separate variety namely, *Butea monosperma* (Lam.) Taub. var. *lutea* (Witt.) long back in sixtees (Maheshwari, 1961). The phytochemical analysis in the present research work also supports the varietal status of Butea Yellow. In Flora of Madhya Pradesh and Flora of Maharashtra a separate varietal status was given to this plant variant (Verma et al. 1993; Singh and Karthikeyan 2000).

The present study also gives a direction for further research work i.e. comparison of morphotypes using Mass Spectroscopy, NMR Spectroscopy, HPTLC and Nucleic Acid Analysis.