DISCUSSION

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A knowledge system encompassing a wide variety of areas, held by ethnic communities that can be a non-formal practices of certain region (Mukherjee, 2006).This knowledge is non-quantitative, non static and out of date, so that it has to be preserved and codified for the economic development of a country.

Ethnobotanical research can provide a wealth of information regarding both past and present relationships between plants and the traditional societies. In addition to the traditional roles in economic botany and exploration of human cognition, ethnobotanical research has been applied in current areas of study like biodiversity, prospecting and vegetation management. It is hoped that, in future, ethnobotany may play an increasingly important role in further development and biodiversity conservation.

However, traditional knowledge base and practices have been marginalised due to political and socioeconomic reasons. Recently in traditional medicine has been increasing and ethnobotanical studies have been initiated to explore the knowledge base from various tribal groups across the country. Several studies have revealed that tribal population in remote area, not only depend on plant based resources for medicines, food, forage and fuel, but also play a vital role in the management natural resources (Ignacimuthu *et al*., 2006; Ragupathy *et al*., 2008; Ragupathy and Newmaster, 2009). Tribal communities in Gujarat and Tamil Nadu meet their healthcare needs by using non-timber minor forest produces and preparations based on traditional knowledge. Further, it has been established that herbal drugs obtained from plants are safe with few side effects in treating various ailments (Ayyanar and Ignacimuthu, 2005).

The information about herbal medicine is passed on from one generation to the other verbally. Most of the people know the usage of the plant but they do not know even the name of the plant. Only common plants are used even in tribal areas. The knowledge of rare plants is found to be decreasing. Therefore, the significant role of ethnobotanist is to act as a bridge between traditional and modern medical practitioners. Apart from documentation process, conservation of medicinal plants is also an important process.

The conservation of medicinal plants not only saves the society but also improves the socioeconomic status of the tribal people. Hence the present study is focused on identifying their culture and traditional medical practices of two different tribal such as Kuknas and Soligas of Western Ghats. The selected tribes of two different geographical areas of Western Ghats are inevitable, using the forest resources to meet their necessity for food, fuel, shelter, medicine etc (Nair 1983). Since they had continuous medical practices, they are confident about their herbal knowledge and age-old ethnicity. The herbal knowledge of tribals which still lies within them is very useful and transferred to the society through various documentation processes. (Jadhav *et al.,* 2013).

I. ETHNOBOTANICAL STUDIES ON KUKNAS AND SOLIGAS

In the present documentation, it was observed that, 45 medicinal plants belonging to 26 families were found to be used by Kukna tribals in traditional medicinal system for the treatment of 13 different types of ailments. Most of the plants belong to Poaceae (Table-4). 49 plants belonging 23 families were found to be used by Soligas to 12 different types of ailments and Euphorbiaceae are dominant (Table-6). However the tribals named as 'Kani' of Tirunelveli hills use 28 plants belonging to 21 families for the treatment of only two ailment such as skin disease & poisonous bites. Some workers have also reported 24 important plants which are commonly used by the tribals in the Sub-Himalayan Tarai region of Uttar Pradesh for the treatment of skin diseases alone (Sharma *et al.,* 2003; Ali & Singh 2002).

Among the Kuknas the elderly herbalist of the village have sound knowledge about various medicinal herbs. A good number of the collected plants are used for the treatment of multiple diseases. *Butea superba* is used to cure poisonous bites such as insect bite, snake bite and scorpion sting; *Aconitum heterophyllum* for ulcer and diabetes, *Aloe vera* is used for burns and wound, *Artemisia annua* for fever and vomiting, *Euphorbia caducifolia* for cuts and wounds (Table –11).

As far as Soligas are concerned *Aegle marmelos, Curcuma longa* are used to cure three disorders (auorexia, indigestion and diarrhoea), *Citrus medica, Coleus aromaticus,*

Murraya koenigii, Ruta graveolens are used for common cold and cough; *Emblica officinalis, Tridax procumbens* are used for problems such as jaundice, wound healing, diabetes and indigestion and other species are used for curing one disease (Table- 12). *Achyranthes aspera* is used for the treatment of poisonous bites by the Soligas whereas, the villagers of Gingee hills of Villupuram district of Tamil Nadu used this plant for piles complaint (Muralidharan, 2012) and the Tharu tribes of Bihar use this plant for contraceptive. (Maheswari *et al.*, 1980).

Mangifera indica is used by Kuknas for the treatment of wound healing. In contrast, the bark of this tree is used for liver disorders by the tribes of Uttar Pradesh (Singh and Maheswari 1983). *Abutilon indicum* is used for diabetes by Kuknas and for dysentery by Soligas but it is used for Leprosy by tribes of Rajasthan (Singh and Pandy 1980).

Several workers have reported the uses of plants to cure various ailments in tribals and non-tribal people inhabiting various regions of Tamil Nadu (Eluvakkal 1991; Alagesaboopathi *et al.,* 1999; Sankarasivaraman 2000; Ganesan *et al*., 2003; Muthukumarasamy *et al.,* 2003a; 2003b; Ignacimuthu *et al*.,2006; Ayyanar *et al.,* 2008; Kottaimuthu 2008; Shanmugam *et al*.,2011).

In the present study, jaundice, diabetes and poisonous bites were found to be common. *Phyllanthus amarus* is used to cure jaundice (Poongodi *et al.*, 2011), (Jenisha and Jeeva 2014; Alagesapoopathi 2014 and present investigation). *Andrographis* species used for poisionous bites, (Ayyanar and Ignacimuthu 2005; present investigation) and *Gymnema sylvestre* is used for diabetes by Soligas. Similarly the tribal people of Sirumalai Hills (Alagesapoopathy 2012) and Kolli hills, (Elavarasi and Saravanan 2012) Tamil Nadu used this plant species for diabetes. These plants are accepted to cure the above mentioned diseases by both the tribal and nontribal people living all over India. Therefore, it is well understood that an identical use of same plant by different tribal groups as well as nontribals indicating the curative properties of specific plant species. (Jain and Saklani 1984). *Eclipta prostrata* is used for circulatory system disorder by the Soligas of Talamalai, Tamil Nadu. In contrast with this result the rural people in Sivagangai district of Tamil Nadu use this plant for wound healing (Shanmugam 2012).

Calotropis gigantea and *Thespesia populnea* is used by Kuknas for the treatment of skin problems. Similar results as found among tribes living in Uttar Pradesh, Bihar, Orissa, Madhya Pradesh and Nadiyas of North Kerala and Rajasthan **(**Shah and Joshi 1971; Jain *et al*.,1973; Chaudhuri *et al*.,1975; Bhalla *et al*.,1982; Nagendra Prasad and Abraham 1984; Singh and Pandy 1980).

In the present investigation it was observed that leaf is the mostly used plant part to treat a particular disease than the other parts of the medicinal plant such as root, seed, entire plant, stem, fruit and tuber, whereas the bulb, fruit skin, rhizome, pseudostem, shoot and nut are the least used plant parts, for the treatment (Karupusamy 2007). Information gathered regarding the usage of plant parts during this study are in agreement with the previous reports (Pushpangadan and Atal, 1984, Kala, 2005; Jain,2001; Ayyanar and Ignacimuthu, 2005; Sandhya *et al*., 2006; and Ignacimuthu *et al*.,2006).

The tribal communities of Kuknas and Soligas have found to be affected by different kinds of illness such as fever, skin disease, cut / wound, dermatological infections, ear, nose and throat problems, poisonous bites, reproductive system ailments, respiratory system disorders, skeletomuscular system and urinary system disorders. The consumption of medicinal plants by the sufferer varies and it should be prepared and used as whole plant or its parts in the form of ash, decoction, extract, gel, gum, infusion, juice, latex, oil, paste, and powder.

There are 13 different medicinal preparations followed by Kuknas of Gujarat and 11 are followed by Soligas of Talamalai forest. Soligas inhabiting in Talamalai forest of Tamil Nadu used the medicinal preparation mostly in the form of paste or extract, followed by juice, decoction, raw and powder. Tribal communities living in different regions of Gujarat of Saputara and Purna forests in Dang district (Nirmal Kumar *et al*., 2007), Jhalod Taluka of Dhahod district, (Maru and Patel, 2012) and Poshina Forest Range of Sabarkantha district (Patel and Patel, 2013) are also practicing the same.

In another selected study site of Western Ghats of Tamil Nadu, the researchers recorded the same kind of results regarding medicinal preparation, viz., Thalaiyanai hills

of Tirunelveli Forest Division (Shanmugam *et al*., 2007), Theni district (Ignacimuthu *et al*., 2008), Southern districts (Rajendran *et al*., 2008), Pachalur of Dindigul district (Shanmugam, 2008), Dharapuram taluk (Balakrishnan *et al*., 2009), Grizzled Squirrel Sanctuary of Virudhunagar district (Balamurugan, 2014), Sakkimangalam region of Madurai district (Muthupandi, 2015), etc. In contrast with this result, paste is the main method of preparation surveyed (Revathi and Parimelazhagan 2010), among ethnic groups of Irulas in Hasanur Hills of Southern Western Ghats.

Indigenous people were found to use medicinal plants either separately or in combination with other ingredients to improve the power of palatability. For example, in some of the treatments, asafoetida, milk, butter milk, coconut oil, salt, sugar, ginger, honey can also used with the medicinal plants.

Medicinal preparations are made from whole plant or a part of it is used to treat diseases by external application or by oral administration. Based on the nature of the complaint, the mode of medicinal preparations would be categorised. The internal forms of administrations are in cooked form, decoction, extract, infusion, juice, powder and soup. The external form of application are ash, paste, gel, gum, oil, latex, smoke and vapour (Shinwair *et al*., 2003; Subramanyam *et al* 2008; Poongodi *et al*.,2011; Muralidharan and Narasimhan 2012; Kensa mary 2011).

Informant Consensus Factor for Kuknas and Soligas

Consensus analysis is a useful tool in establishing a comparitive estimation of the level of informant consensus on the use of medicinal plant remedies.

In the present investigation it was stated that the Kuknas used 7 plants and Soligas used 12 plants to treat gastrointestinal disorders. Kuknas use *Aconitum heterophyllum, Artemisia annua, Bambusa arundinacae, Ficus racemosa, Psidium guajuva, Punica granatum and Sorghum vulgare* whereas the Soligas use *Abutilon indicum,Aegle marmelos, Adathoda zeylanica, Allium sativum, Carica papaya, Chlorophytum borovillianum, Citrus medica, Clitoria ternate, Emblica officinalis, Melothria maderaspatana,Mentha arvensis and Jasminum angusitifolium* for gastro intestinal problems.

The gastrointestinal ailments has the high ICF (0.84) in Kuknas of Waghai. The maximum ICF value for gastrointestinal ailments (0.80) was found in Soligas living in Talamalai area. Similarly the highest ICF value (0.81) (i.e, >0.8) for gastrointestinal problems was recorded in the study which has conducted among the people living in Shivalik Hills by Usha *et al*., (2014). It is contradictory (0.50) to the result of Muthuvans and Irulas settled in Western Ghats of Tamil Nadu (Ragupathy *et al*.,(2008). Among the Kuknas and Soligas, the consumption of lot of underground tubers and rhizomes in their regular food. Secondly, the unclean habits of those who are living below poverty line can be the main reason for their gastrointestinal ailments.

In this present study out of 94 plant species, four species viz., *Cissus quadrangularis, Eluesine coracana, Phyllanthus amarus, and Terminalia catappa* were found to be common and are used by both the tribes to treat the conditios like bone fracture, headache, jaundice and to increase body stamina. *C.quadrangularis* shows tremendous medicinal properties. It is used to cure bone fracture (Kirtikar and Basu 1999; Mia *et al*., 2009; Lachure 2012; Bagul 2013), dysentery, (Shanmugam *et al*., 2011), rheumatism (Palaniappan *et al*., 2012), stomach pain and indigestion (Mayilsamy and Rajendran 2013; Karuppusamy 2007); stimulant (Natarajan and Udhayakuar 2013) and treatment of insect bite etc., (Muthupandi 2015).

Usually tribals live in remote areas where there are no basic facilities and many of the tribals do not know the welfare schemes and the latest improvements in the medicinal field. They fully depend on natural resources only. However, there are certain tribes where the impact of urbanisation, industrialisation and education has changed their mode of education.

Urbanisation has changed the life of Kuknas and they lead a well civilised life. This has led to the depletion of herbal knowledge and hence in the present investigation, medicinal properties of common plants were recorded. In contrast, Soligas, even though their lifestyle has not improved, the herbal healers do not reveal the secrets of their traditional knowledge. This is a drawback in the present investigation and the list of medicinal plants includes common plants only. It is recommended that necessary steps should be undertaken to preserve the herbal knowledge and its importance through education.

II. PHYTOCHEMICAL ANALYSIS AND BIOLOICAL ACTIVITIES OF ROOT OF *CISSUS QUADRANGULARIS*

The chemical constituents of the stem of *C.quadrangularis* include potasium, calcium, zinc, sodium, iron, lead, cadmium, copper, calcium oxalate and magnesium. There is also the presence of resveratrol, piceatannol, pallidol, parthenocissin and other compounds like teraxeryl acetate, taraxerol, isopentadecanoic acid, phenol, tannin, α-amyrin and β-sitosterol. *C.quadrangularis* is rich in vitamin C and beta-carotene. (Oben *et al*., 2006; Kumar *et al.,* 2012). The hydroalcoholic extract of rhizome of *C.quadrangularis* showed the presence of alkaloids, flavonoids, tannins, proteins, carbohydrates, reducing sugars, gums and mucilage (Vijayakumari *et al.,* 2012).

In the present investigation, the phytochemical screening of the root of various chemical constituents of *C.quadrangularis* showed the presence of alkaloids, flavonoids, steroids, triterpenoids, proteins and tannins. They were known to show medicinal activity as well as physiological activity (Sofowara, 1993).

Steroids were found to be present in the root extract of *C.quadrangularis* in all extracts. It should be noted that steroidal compounds are of importance in pharmacy due to their relationship with compounds such as sex hormones (Okwu, 2001). The young stem of *C.quadrangularis* is used as vegetable by expectant mothers or during breast feeding, to ensure their hormonal balance, as steroidal structure could serve as a potent precursor in the synthesis of these hormones (Okwu, 2001).

The present research work also revealed the presence of alkaloids synthesised by plants, as an important feature of secondary metabolites in the roots of *C.quadrangularis* (Table – 19). Thus, these alkaloids have been found to be in vitro effective antibacterial agents against a wide range of microbial infections, due to infective organisms.(Jamine et al., 2007). Tannins were also found in root of *C.quadrangularis* (Table-19). Tannins are also effective antimicrobial agents. They are water-soluble polyphenols and which precipitate proteins present in many plant foods. Tannins have been reported to prevent the development of microorganisms by precipitating microbial proteins. The growth of many fungi, yeasts, bacteria, and viruses were inhibited by these compounds. They have

been reported to have various physiological effects like anti-irritant, antisecretolytic, antiphlogistic, antimicrobial and antiparasitic effects. Phytotherapeutically, tannin-containing plants are used to treat nonspecific diarrhoea, inflammations of the mouth, throat and abrasions of the skin (Naveen Prasad *et al*., 2008). The presence of biologically important phytochemicals in the *C. quadrangularis* root, as tested in present study, contribute to their medicinal value and serve as potential sources for useful drugs.

The methanol extract of the root of *C.quadrangularis* contain maximum amount of total phenols (356.43 mg/g GAE), tannins (151.67 mg/g GAE) and flavonoids (493.00 mg/g RE). (Table-21).On the other hand, the methanolic leaf extract of *Bauhinia vahlii* showed the presence of phenols (487mg/g GAE), tannins (217 mg/g GAE) and flavonoids (103 mg/g RE) (Sowndharrajan and Kang 2013). Similar results were obtained by Singh *et al.,* (2012) in *Thuja orientalis,* where the methanolic extract of the whole plant contain high flavonoids 11mg/g Qu/g and phenols 106mg/g.

GC-MS studies of the roots of *C.quadrangularis,* showed the presence of 24 compounds. Further investigation on these compounds may reveal more information on their medicinal properties. Kumar *et al*., (2012) carried out a GC-MS study to screen the phytochemicals of *C.quadrangularis* stem revealed the presence of taraxeryl acetate, taraxerol, isopentadecanoic acid, phenol, tannin, α-amyrin and β- sitosterol. They also found that *C.quadrangularis* also contains 31 methyl tritiacontanoic acid and 7 -Oxo onocer-8-ene-3, 21- diol and *C.quadrangularis* is a very good source of vitamin C and beta- carotene. Manikandan and Muhammad Ilyas (2013) analysed some of the phytocomponents by GC-MS analysis of stem of *C.quadrangularis* and they have reported that Eugenol, n-Hexadecanoic acid, 1, 2- Benzenedicarboxylic acid, diisooctyl ester, Phenol, 2, 4-bis (1-phenylethyl)- are present in the stem extract of *C.quadrangularis.*

DPPH (2,2-diphenyl-1-picryl hydrazyl) reagent has been used extensively for investigating the free radical scavenging activities of root extracts of *C.quadrangularis* extracted with different solvents like petroleum ether, chloroform and methanol.

DPPH results are often interpreted as the "ideal concentration" or IC_{50} value, which is defined as the concentration of substrate that causes 50% loss of the DPPH activity (Molyneux, 2004). The assay is based on the reduction of alcoholic DPPH solution in the presence of a hydrogen-donating antioxidant due to the formation of the non-radical form DPPH-H by the reaction (Shon *et al*., 2003). Some researchers also confirmed that the methanol extract of the stem of *C.quadrangularis* exhibits strong antioxidant and free radical scavenging activity *in vitro* and *in vivo* systems mainly due to the presence of β-carotene (Murthy *et al*., 2003; Mallika and Shyamala Devi, 2005). *C.quadrangularis* contains tannin like structures, which, when tested *in vitro*, are potent COX inhibitors, which showed that it also had anti-inflammatory effects (Bhujade, 2012). Manikandan and Muhammad Ilyas (2013) reported that the antioxidant activity of *C.quadrangularis* was high (30.60) in DPPH method whereas in FRAP method it shows the lowest (1.96) activity.

The antioxidant capacity of phenolic compounds is mainly due to their redox properties which can play an important role in absorbing and neutralising free radicals, quenching singlet and triplet oxygen, or decomposing peroxides (Osawa, 1994). The DPPH activity obtained indicates that the methanolic extract of the root of *C. quadrangularis* have most potent IC_{50} value (15.78 µg/ml) to reach 50% inhibition of DPPH radical activity, when compared with petroleum ether (IC_{50} value-61.46 µg/ml) and chloroform (IC_{50} value – 146.35 µg/ml) extracts. This suggested that methanol extract of the root of *C. quadrangularis* is a better antioxidant source. Similar DPPH scavenging activiy were reported in methanolic extracts of leaves of *Axonapus compressus* and *Yucca aloifolia* (Ibeh *et al*., 2013; Sobia *et al*., 2013). This concurs with previous studies as reported by Trease and Evans (1996) that secondary metabolites such as alkaloids, tannins, flavonoids and cardiac glycosides present in the plant, are the basis for the curative and/or management of many ailments such as wounds, digestive disorders, coughs, ulcers, skin disorders and different kinds of inflammations claimed in its ethnomedicinal property.

In the present study, the methanolic extracts of root of *C. quadrangularis* sample showed a higher (1968.29 µM/g) $ABTS^{+}$ radical scavenging activity. Likewise, the

methanolic leaf extract of *Hypochaeris radicata* has highest antioxidant activity (2706.73 µM/g) (Jamuna *et al.,* 2012). Mundla and Sitaram (2013) studied the antioxidant activities of the seed extract of *Blepharis* genus. The results of this study revealed that the ability of *Blepharis* seed extract as a DPPH scavenger and also reflects its ability to inhibit the formation of $ABTS^{+}$. The free radical scavenging activity of $ABTS^{+}$ radical by the seed extract was found to be appreciable and this implies that the seed extract may be useful for treating radical-related pathological damage, especially at higher concentration (Shaikh *et al*., 2011).

Metal chelating capacity is significant since it reduces the concentration of the transition metal that catalyses lipid per oxidation. In the present study, the methanol extract of root of *C. quadranglaris* showed the highest level of ability of chelating ability (117.58 mg/EDTA/g). In contrast with this result, the acetone extracts of *B. vahlii* leaves were found to have the highest level (6.2 mg EDTA/g extract) of chelating ability. In methnol extract it shows the lowest level i.e 5.7 mg EDTA/g

Some other studies (Yogamoorthi and Sathya Priya, 2004; Wetson, 2012; Zeng, 2006) also have stated that plants with antioxidant activities have been reported to possess free radical scavenging activity and these free radicals are known as major contributors for therapy of several clinical disorders such as diabetes mellitus, cancer, liver diseases, renal failure and degenerative diseases, as a result of deficient natural antioxidant defence mechanism.

Quantitative analysis showed that the root of *C. quadrangularis* has a high content of flavonoids and phenolics with moderate level of tannin. This high content of flavonoid may play a role in the therapeutic effectiveness of plants. It is generally known that these compounds (flavonoids and alkaloids) can inhibit alpha-glucosidase activity to depress the glucose level in blood (Geng *et al*., 2007). It has been demonstrated that flavonoids could inhibit alpha-glucosidase activity co-operatively which, would successfully depress blood glucose levels in antidiabetic therapy. Some researchers have evaluated the chemical structures of flavonoids responsible for its inhibitory activity especially in Yeast. Also , anthocyanidin, isoflavone, and flavonol groups with IC_{50}

values less than 15μM has been shown to inhibit Yeast and rat α-glucosidase (Tadera *et al*., 2006). Vijayakumari *et al*. (2012) noted that hydroalcoholic extracts of the rhizome of *C.quadrangularis* showed enhanced antidiabetic activity.

Further, tannin has been shown to have antidiabetic effect in human T_2D patients and also to induce glucose transport through activation of the insulin-mediated signaling pathway in adipocytes (Liu *et al*., 2005). The data derived by the present investigation work (Table-25) recorded the presence of saponin component in *C.quadrangularis* which may contribute to the plant's mechanism of action in reducing diabetes (hypoglycemic activity).

According to the World Health Organization (2004), about three-quarters of the world population rely on plants for the treatment of many illnesses and useful drugs have been developed from plants used in traditional medicine and the toxicity and efficacy may be known from the long history of usage.

Inflammation is a defence mechanism of the body and inflammation is a healthy process resulting from some disturbance or disease (Medzhitov, 2010). But in some conditions, negative effects of the inflammatory process is produced which include inflammatory disorders like rheumatoid arthritis, osteoarthritis, inflammatory bowel diseases, retinitis, multiple sclerosis, psoriasis and atherosclerosis. To overcome this problem, anti-inflammatory agents are required. For this purpose variety of safe and effective anti-inflammatory agents are available, including aspirin and other non-steroidal anti-inflammatory, and many more drugs under development. So these agents are very helpful to reduce the inflammatory response but they produce side effects. Plants with phyto-constituents are helpful in reducing inflammation without side effects.

Protein denaturing activity of the methaolic extract of root of *C.quadrangularis* showed increased activity with increase in concentration (Table-26). However high IC_{50} (285.84±7.43/ug/ml) indicates its weak activity. Similarly proteinase inhibitory activity also showed concentration dependent activity. Higher IC_{50} value than Aspirin indicates the weak activity of the plant extract (Table-27). Denaturation of proteins is one of the

causes of inflammation. Proteinase play an important role in tissue damage during inflammation and its inhibition protects tissues.

It was reported by Srisook *et al.,* (2011) that the ethyl acetate extract of *C.quadrangularis* had antioxidants which activated HO^{-1} which in turn had anti-inflammatory action. Also, *C.quadrangularis* contains tannin like structures which had *invitro* properties of being potent COX inhibitors having anti-inflammatory. Panthong *et al*., (2007) noted that methanol extract of *C.quadrangularis* possess analgesic, anti-inflammatory and venotonic effects associated with hemorrhoids and anti-inflammatory activity is due to flavonoids especially luteolin and by β-sitosterol. β-sitosterol present in methanol extract has ability to reduce the enzymes MPO indicating a reduction of neutrophils influx in the inflamed tissue (Delapureta *et al*. (2000). Jaiswal *et al.,* (2004) stated that calcium oxalate carotene, tetraterpenoids, β-sitosterol, amyrin and anabolic ketosteroids, which are responsible for acceleration of healing and possess anti-inflammatory and analgesic activity.

All the available literature on anti-inflammatory activity strongly suggests that the different flavonoids, polyphenols of the plants are speculated to account for the observed anti-inflammatory of the plant. Similarly *C.quadrangularis* also had significant anti-inflammatory activity due to the presence of various phytoconstituents in its various parts including root.

In the present investigation, it was also noted that the antibacterial activity is concentration dependent, as an increase in inhibitory activity was observed with increase in the concentration of extract (Table – 28). In the present investigation methanolic root extract of *C.quadrangularis* was screened for antifungal activity. The different concentrations of extract showed moderate activity against *Malassezia furfur* (MTCC 1374) while the extract did not show any activity against *Candida albicans* (MTCC 227) (Table – 29). The most effective concentration of methanolic extract against fungal strain was found to be 2000 µg/well for *M. furfur* which clearly indicates its strong inhibition potential.

The ethanol and chloroform stem extract of *C.quadrangularis* against two pathogenic bacteria viz., *Pseudomonas aeroginosa* and *Xanthomonas citri* are ineffective to inhibit the growth of the tested bacteria and the diameter of inhibition zones for each solvent extracts were compared with the standard antibiotic chloramphenicol (30µg/disc). The ethanol and chloroform stem extract showed nil inhibition on both the tested fungi *Aspergillus flavus* and *Aspergillus niger*. (Manikandan and Muhammad Ilyas 2013).

The antimicrobial activity of medicinal plant material would probably be due to the presence of alkaloids, tannins and flavonoids. (Cowan, 1999; Dranughon, 2004 and Moghadam *et al*., 2010) The phytochemical studies of the root of *C.quadrangularis* confirmed the presence of these compounds which supports the antimicrobial activity of this plant. The variation in the antimicrobial activity of *C.quadrangularis* used in this study might be attributed to the different level of concentration of root extract (present investigation).

Chloroform extract was observed to recover the bioactive principles from the aerial parts of *C.quadrangularis* Variant I, whose extract was screened for its bactericidal activity against *Helicobacter pylori*. The MIC at 30µg/ml was observed from the samples collected in vegetative and flowering season.(Anoop Austin *et al*., 2012).

Polyphenols have been reported to exhibit antimicrobial activities with proteins related polyamides polymers (Haslam, 1996). The inhibition of microorganisms by phenolic compounds may be due to iron deprivation or hydrogen bounding with vital proteins such as microbial enzymes (Scalbert, 1991). Phenolic compounds notably proanthocyanidins (often called condensed tannins) are vulnerable to polymerisation in air through oxidisation reactions. Therefore, an important factor governing their toxicity is their polymerisation size. Oxidized condensation of phenols may result in the toxification of microorganisms. On the other hand, polymerisation can result in the detoxification of phenols (Scalbert, 1991; Fiel and Lettinga, 1992). These support the fact that polyphenols may be responsible for the antimicrobial activities of the root extract of *C. quadrangularis*.

The present study results indicate that the major compounds present in roots of *C.quadrangularis* possess the following biological activities viz., antioxidant, antiinflammatory, antidiabetic, antibacterial, antifungal and antihaemolytic. The comprehensive database of the natural medicines showed that the major compounds present in different parts of *C.quadrangularis* have biological activities such as antioxidants, antiulcer, antiasthmatic, antimalarial, analgesic, anti-inflammatory, antiosteoporotic, antihemorrhoids, antiobesity and antidiabetic.

The highest percentage of antihaemolytic effect (5.39 ± 0.33%) was obtained by *C.quadranglaris* root extract at 500µg concentration with an IC_{50} value of 1037.04 ± 64.15.

During the present ethnomedicinal investigation, it was also noted that sickle cell disease is very common in both the study area and most of the tribal people were affected by this disorder. Unfortunately, they did not elaborate about the plants which are used to treat SCD.

Mpiana *et al*. (2013) described that antihemolytic activity is an important feature for an antisickling agent since it has been known so far that chronic anemia is the most frequent SCD symptom. The ability of phytochemicals to reduce the lysis of sickle erythrocytes may be due to their capacity to act as an antioxidant. Indeed, it is postulated that the sickling leads to the modification of the membrane flexibility, which makes it more sensitive and fragile towards free radicals or oxidants. Therefore, antioxidant or free radical scavenger compounds prevent hemoglobin from oxidizing the methemoglobin and inhibit the generation of free radicals. It is thus probable that the phytochemical extracts exert these protective capacities to prevent oxidative damage to the lipid membrane, hemoglobin and the enzymatic components.

The various secondary metabolites, which are significantly present in medicinal plants, are well known for their large spectrum of pharmacological properties, including antimicrobial, antioxidant, antifungal, antiprotozoal, antiviral activities, etc.

(Mpiana *et al*., 2008). There is, therefore, more evidence that these extracts contain some metabolites which inhibit the sickling process of erythrocytes. More promising candidates responsible of this biological activity are polyphenols; besides their remarkable well-known antioxidant properties they have shown *in vitro* antisickling activity (Mpiana *et al*., 2009). Thus, it was suggested that the root extract of *C.quadrangularis* may be used as an effective drug for the treatment of sickle cell disease.