CHAPTER 1

GENERAL INTRODUCTION
Plants have fed and caused the world since life began. Medicinal plants play an important role in the lives of rural people, particularly in remote parts of developing countries with a few health facilities. Approximately 80% of the world’s population depend on herbal medicine as a primary health care (WHO, 1999). This causes considerable pressure on many species, since the majority of the material is collected from wild plants. Globally, approximately two third of the total of 50,000–70,000 plant species used for medicinal purposes are collected from the wild (Schippmann et al., 2006), and even in Europe only 10% of the medicinal species used commercially are cultivated (Vines, 2004). Unfortunately, the limited quantity of active metabolites in the plant, slow growth rates and destruction of natural supplies are problems encountered when exploiting plants for medical needs. Thus, alternative sustainable and renewable production systems are urgently needed to protect and preserve plant diversity.

During the 25-year period 1981–2006, a total of 1184 NCEs (new chemical entities) were approved as drugs. Of these, 52% have a natural product connection and 30% are purely synthetic. It is interesting to note that 52% of all anti-inflammatory drugs and 51% of all anticancer drugs hitherto approved are directly or indirectly derived from natural sources (Newman & Cragg, 2007). A total of 24 unique natural products discovered in the last 35 years were launched on the market, consisting of molecules isolated from soil microorganisms (79%) and plants (21%) (Ganesan, 2008).

Plants have been utilized as medicines for thousands of years. Morphine, produced by the opium poppy, was the first active component isolated from plants in the early 19th century (Samuelsson, 2004). Since then many important drugs, such as artemisinin, atropine, camptothecin, cocaine, codeine, digoxin, papaverine, pilocarpine and podophyllotoxin, have been discovered from plants. Drug discovery from medicinal plants has played an important role especially in fighting against cancer, with most clinical applications of plant secondary metabolites being targeted to cancer treatment (Butler, 2004). Information provided by traditional medicine has been of great value for the discovery of many new drugs and hundreds of pharmacologically active leads for synthetic modifications. Currently, a large number of natural products are produced solely from massive quantities of whole plant parts. The production of pharmaceutically important plant metabolites has been a target for
practical application of plant cell cultures for several decades. However, only a few compounds have reached the commercial production scale, including shikonin and paclitaxel.

The consumption of herbal medicines is increasing worldwide, primarily due to the benefits it offers. Systematic cultivation of medicinal plants has been proposed and adopted as a substitute to germplasm collection from nature, with the following advantages: (i) optimization of yield and high quality product; (ii) to overcome identification; (iii) to overcome genetic and phenotypic variability; (iv) the issue of contaminants is taken care; (v) the problem of variability in extracts and their instability is reduced; and (vi) availability in large quantities without disturbing the natural destruction. However, sometimes the spectrum of compounds produced by medicinal and aromatic plants (MAPs) under cultivation are quite different from those of natural habitat.

The herbal industry has paid scant attention so far to the efficient utilization and conservation of natural resource in the environment. It is, therefore, imperative to conserve this precious bioresource. Both *in situ* and *ex situ* methods of conservation have been utilized in recent years and are essential. However, it has been unanimously felt that biotechnological interventions are essential for selection, maintenance and multiplication of the elite genotypes of MAPs. Tissue culture has been widely employed for conservation of MAPs. However, tissue culture-based approaches aimed at *in vitro* conservation of MAPs should be able to efficiently and rapidly multiply and preserve genetic stability of the plant material. Conservation of germplasm using tissue culture techniques can be envisaged either as short- and medium-term conservation or as long-term conservation/cryopreservation. Molecular techniques are increasingly being employed for germplasm characterization. However, a lot needs to be done in this area. The coming years are likely to witness more efforts in the direction of conservation of medicinal and aromatic plants since climate change is taking a heavy toll and several useful plant species are on the verge of extinction.

Plant tissue culture techniques offer a viable solution for the production of standardized quality phytopharmaceuticals through mass-production of consistent plant material for physiological characterization and analysis of active ingredients.
Micropropagation protocols for cloning a variety of MAPs have been developed over the years (Rout et al., 2000; Nalawade & Tsay, 2004; Rathore et al., 2010). Integrated approaches of micropropagation are needed to provide a basis for the development of novel, safe, effective and high-quality commercial products. Micropropagation can be utilized for rapid multiplication of elite clones. The advantages offered by micropropagation of medicinal plants are many. In vitro propagation (micropropagation) offers a number of clear advances, as recently summarized by Denabth (2006). Basically, these include: (i) the production of large number of plantlets in a comparably short time, due to usually high multiplication rates; (ii) micropropagation is feasible independently of the season; and (iii) plants produced in vitro are usually free from microorganism borne diseases. Although micropropagation is a multi-billion dollar industry, the share of MAPs as of now is miniscule, though efficient protocols for several MAPs are available. It is anticipated that with the realization of the importance of quality medicinal plants for the pharmaceutical industry and rapid depletion of natural populations, more attention will be paid to this area.

Plant propagation using artificial or synthetic seeds developed from somatic and non zygotic embryos opens up new vistas in agriculture. Artificial seeds make a promising technique for propagation of transgenic plants, non seed producing plants, polyploids with elite traits and plant lines with problems in seed propagation. Being clonal in nature the technique cuts short laborious selection procedure of the conventional recombination breeding and can bring the advancements of biotechnology to the doorsteps of the farmer in a cost-effective manner. Development of micropropagation techniques will ensure abundant supply of the desired plant species. In some crop species seed propagation has not been successful. This is mainly due to heterozygosity of seed, minute seed size, presence of reduced endosperm and the requirement of seed with mycorrhizal fungi association for germination (eg. Orchids), and also in some seedless varieties of crop plants like grapes, watermelon, etc. some of these species can be propagated by vegetative means. However, in vivo vegetative propagation techniques are time consuming and expensive. Development of artificial seed production technology is currently considered as an effective and efficient alternate method of propagation in several commercially important agronomic and horticultural crops. It has been suggested as a
powerful tool for mass propagation of elite plant species with high commercial value. Artificial seed technology involves the production of tissue culture derived somatic embryos encased in a protective coating. Artificial seeds have also been often referred to as synthetic seeds. However, the term ‘synthetic seed’ should not be confused with commercial seeds of a synthetic cultivar which is defined as an advanced generation of an open pollinated population composed of a group of selected inbred clones or hybrids. The artificial or synthetic seed is consisted of 3 parts: artificial seed coat, somatic embryo and artificial endosperm. These synthetic seeds would also be a channel for new plant lines produced through biotechnological advances to be delivered directly to the greenhouse or field. Advantages of artificial/synthetic seeds over somatic embryos for the propagation are: 1) ease of handling while in storage 2) easy to transport 3) has potential for long term storage without losing viability 4) maintains the clonal nature of the resulting plants 5) serves as a channel for new plant lines produced through biotechnological advances to be delivered 6) directly to the greenhouse or field 7) allows economical mass propagation of elite plant varieties. This synthetic seed production technology is a high volume, low-cost production technology. High volume propagation potential of somatic embryos combined with the formation of synthetic seeds for low-cost delivery would open new vistas for clonal propagation in several commercially important crop species (Saiprasad, 2001).

Somatic embryos are bipolar structures with both apical and basal meristematic regions, which are capable of forming shoot and root, respectively. A plant derived from a somatic embryo is sometimes referred to as an ‘embling’. Somatic embryos are structurally similar to zygotic embryos found in seeds and possess many of their useful features, including the ability to grow into complete plants. However, somatic embryos differ in that they develop from somatic cells, instead of zygotes and thus, potentially can be used to produce duplicates of a single genotype. Since the natural seed develops as a result of a sexual process in cross-pollinating species, it is not genetically identical to one single parent. In contrast, somatic embryo develops from somatic cells and does not involve sexual recombination. This characteristic of somatic embryos allows not only clonal propagation but also specific and directed changes to be introduced into desirable elite individuals by inserting isolated gene sequences into somatic cells. This bypasses genetic recombination and selection inherent in conventional breeding technology. If
the production efficiency and convenience comparable to that of a true seed are achieved, somatic embryos can be potentially used as a clonal propagation system.

Recently, production of synthetic seeds by encapsulating somatic embryos has been reported in few species. One prerequisite for the application of synthetic seed technology in micropropagation is the production of high-quality, vigorous somatic embryos that can produce plants with frequencies comparable to natural seeds. Inability to recover such embryos is often a major limitation in the development of synthetic seeds. Synthetic seed technology requires the inexpensive production of large numbers of high quality somatic embryos with synchronous maturation. The overall quality of the somatic embryos is critical for achieving high conversion frequencies. Encapsulation and coating systems, though important for the delivery of somatic embryos, are not the limiting factors for the development of synthetic seeds. At present, the characteristic lack of developmental synchrony in embryogenic systems stymies multi-step procedures for guiding somatic embryos through maturation. The lack of synchrony of somatic embryos is, arguably, the single most important hurdle to be overcome before advances leading to widespread commercialization of synthetic seeds can occur. Synchronized embryoid development is required for the efficient production of synthetic seeds (Saiprasad, 2001).

Phytochemicals are the bioactive, non-nutrient, naturally occurring plant compounds found in fruits, vegetables, and whole grains (Liu, 2004). They can be categorized into various groups, i.e., polyphenols, organosulfur compounds, carotenoids, alkaloids and nitrogen-containing compounds. The polyphenols are some of the most studied compounds and can be further divided into flavonoids (including flavonols, flavones, catechins, flavanones, anthocyanidins, and isoflavones), phenolic acids, coumarins, and tannins (Liu, 2004). Many phytochemicals are potent effectors of biologic processes and have the capacity to influence disease risk via several complementary and overlapping mechanisms (Liu, 2004; Fresco et al., 2006; Kar et al., 2006; Nichenametla et al., 2006; Rao & Rao, 2007).

Screening of medicinal plants for biologically active compounds has become a vital source of cancer-related drugs. Most of the anticancer drugs currently used in chemotherapy are cytotoxic to normal cells, leading to unwanted side effects. Therapeutically effective doses of many anticancer drugs such as anthracyclines
induce oxidative stress in normal tissues like heart and brain (Chen et al., 2007). Therefore, a search for compounds that can reduce the harmful side effects of anticancer drugs in normal tissues is necessary (Sun & Peng, 2008). Complementary and alternative medicine is one of the emerging fields in health care today, especially as supportive medicine in treating diseases like cancer (Bhattacharjee et al., 2009; Dawn DeSylvia et al., 2011). Some modern drugs have been deduced from folklore and traditional medicines (Mothana et al., 2010; Al-Zubairi et al., 2011). Therefore, the safe traditional medicinal plants are investigated to obtain potential chemotherapeutic drugs (Bouhlel et al., 2007). Plant-derived natural products such as flavonoids, terpenes, alkaloids, alpha-tocopherol and carotenoids have received considerable attention in recent years due to their diverse pharmacological properties, including cytotoxic and chemo preventive effects (Jayaprakasha & Patil, 2007; Kviecinski et al., 2008).

Secondary metabolites are often produced in miniscule quantities in the plant and the ever increasing demands of the industry can hardly be met through this approach. Therefore, attention has been paid to development of biotechnological methods. Plant cell and tissue cultures represent a viable renewable resource of industrially important plant natural products, required for food, drug, fragrance, flavour and dye industries (Phillipson, 2003; Mulabagal & Tsay, 2004; Oksman-Caldentey & Inze, 2004). Some of the exclusive advantages that cell and tissue culture-based production technology provide include the following: (i) control of product supply independent of the geographical availability of plant; (ii) no constraint of seasonal fluctuations; (iii) uniform growth under defined environment; (iv) shorter life cycle free of seasonal or batch-to-batch variation; (v) biotransformation through feeding and elicitation is possible.

The commercial successes have not been proportionate to the level of expectations that were generated initially. However, a few notable exceptions are the production of ginsenosides by Nitto Denko Corporation; berberine from Coptis japonica and Thalictrum minus by Mitsui Petrochemical Industries and paclitaxel from Taxus by ESCA Genetics and PhytonBiotech GmbH, Germany (Dornerburg, 2008). Besides these, shikonin from Lithospermum erythrorhizon (Fujita, 1988) and rosmarinic acid from Coleus blumei. Ulbrich et al., (1985) have also been reported to be produced at large scale in cell cultures. There can be several reasons for this slow
pace of advancement such as poor understanding of the biogenetic pathway of the target molecule(s), low expression of key pathway genes/enzymes in undifferentiated cultures, genetic instability of cells in vitro, tissue or organ specific synthesis and/or accumulation of desired product, and too much emphasis on employing a wild type cell or tissue for the hyperexpression of a native pathway under a set of defined culture conditions rather than designing or tailoring a cell or tissue to perform a definite biochemical task (Alfermann & Petersen, 1995; Yeoman & Yeoman, 1996; Wu & Zhong, 1999; Bourgaud et al., 2001; K Julsing et al., 2007). Bioreactors have been utilized for the production of secondary metabolites (Wang et al., 2010a).

MAPs have been utilized for the prevention and treatment of diseases for a long time. In recent years, a plethora of drugs have been derived from medicinal plants e.g., reserpine, an antihypertensive alkaloid from Rauvolfia serpentina, vinblastine, an antitumour alkaloid from Catharanthus roseus, podophyllotoxin from Podophyllum hexandrum and P. peltatum, morphine, a narcotic derived from Papaver somniferum, cocaine, a local anaesthetic and a potent central nervous system stimulant from Erythroxylon coca, strychnine, a nerve stimulant from Strychnos nux vomica, caffeine from tea, coffee beans and cocoa, quinine from Cinchona ledgeriana and C. succirubra, artemisinin, an antimalarial drug from Artemisia annua, atropine, a parasympatholytic agent from Atropa belladonna, camptothecin, the chemotherapy drug from Camptotheca acuminata, taxol, the anticancer drug from Taxus brevifolia and Taxus baccata, papaverine from Papaver somniferum, silybin from Silybum marianum, hyperoside from Crateaegus laevigata, anticancer genistein and diadzein from Glycine max, hypericin from Hypericum perforatum etc (Sharma & Arora, 2006; Arora, 2010).

A number of medicinal compounds have been produced in bioreactors, e.g. rosmarinic acid from Coleus blumei, berberine from Coptis japonica, ginsenosides from Panax ginseng, podophyllotoxin from Podophyllum hexandrum and Linum album, sanguinarine from Papaver somniferum and antitumour drug taxol from Taxus baccata. In future, more such compounds may be produced in macro-, micro- or nano-bioreactors.

It is now clear that, the medicinal values of these plants lies in the bioactive phytochemical constituents that produce definite physiological effects on human
body. Though the traditional Indian system of medicine has a long history of use, they lack adequate scientific documentation, particularly in light modern scientific knowledge (Shrivastava Surabhi & Leelavathi, 2010). These natural compounds formed the base of modern drugs as we use today (Edeoga et al., 2005a; Rout et al., 2009; Akinmoladun et al., 2011). Several medicinal plants have been evaluated for possible antimicrobial activity and potential cure from a variety of ailments especially of microbial origin (Chandrasekaran & Venkatesalu, 2004). Plants are important source of potentially useful structures for the development of new chemotherapeutic agents. The first step towards this goal is the in vitro antibacterial activity assay (Tona et al., 1998). The use of plant extracts and phytochemicals both with known antimicrobial properties is of great significance, in the past few years a number of investigations have been conducted worldwide to prove antimicrobial activities from medicinal plants (Alonso Paz et al., 1995; Nascimento et al., 2000). Plants secrete bioactive compounds from specialized tissues and cells. These bioactive compounds can be used for therapeutic purposes or as precursors for the synthesis of useful drugs (Sofowora, 1982).

The scientific basis for the statement that plants and their active constituents play an important role in the prevention diseases is continuously advancing. It is an interesting source of potential bioactive molecules, as iridoids compounds, flavonoids, diterpenoids derivatives, phytosteroids, with antioxidant, anti-inflammatory, antimicrobial, hepatoprotective activity, analgesic and antihistamine, anti-implantation, antiasthmatic activities and anticancer activity (Meena et al., 2011).

Plants have been a prime source of highly effective conventional drugs for the treatment of many forms of cancer, and while the actual compounds isolated from the plant frequently may not serve as the drugs, they provide leads for the development of potential novel agents (Cragg & Newman, 2005b). During the past decade research activities in many disciplines, such as phytochemistry, food sciences, biotechnology, medicine, etc., broadened the hitherto narrow view on betalains. The challenge to bringing together knowledge from all these different areas is considered to be most fruitful (Stintzing & Carle 2007).

The coloring properties and desirable biological activities of betalains have aroused strong scientific interest in the in vitro production of these important food
colorants. Although no large-scale processes have been developed yet, several highly productive plant in vitro systems, including cell suspensions and hairy root cultures, have been reported. Moreover, applying non-conventional methods, such as elicitation, cell permeabilization, product recovery and exposure to radiation of selected wavelengths (either singly or in combination) could significantly increase betalain yields. These considerations clearly indicate that large-scale production of betalains is technically and commercially feasible (Georgiev et al., 2008).

Over the last few years, there has been great interest in the anti-tumor properties of the triterpenoids, oleanolic, ursolic and glycyrrhetinic acid in presence of many plants such as Olea europeae L., Actostaphylos uva-ursi and Glycyrrhiza uralensis. The three acids and their derivatives show potential anti-tumor promoting and cytotoxic activities, inhibiting proliferation, inducing apoptosis and preventing invasion, which suggested that they could be developed as anti-cancer and cancer chemopreventive agents (Feng et al., 2009).

Ursolic acid (UA), a pentacyclic triterpenoid derived from berries, leaves, flowers, and fruits of medicinal plants, such as Rosemarinus officinalis, Eriobotrya japonica, Calluna vulgaris, Ocimum sanctum, and Eugenia jambolana is one such agent that has been extensively studied for its anti-inflammatory and anticancer activities in the past decade (Liu, 1995). UA has been reported to suppress the proliferation of a variety of tumor cells, to induce apoptosis, and to inhibit tumor promotion, metastasis, and angiogenesis (Aggarwal & Shishodia, 2006; Pathak et al., 2007; Kassi et al., 2009; Zhang et al., 2010).

Several biochemical and pharmacological effects of UA such as anti-inflammatory, antioxidant, anti-proliferative, anti-cancer, anti-mutagenic, anti-atherosclerotic, anti-hypertensive, anti-leukemic and antiviral properties are reported in a number of experimental systems (Ikeda et al., 2008; Tsai & Yin, 2008). UA exhibited anti-inflammatory effects in RAW264.7 cells (Mouse monocyte macrophage cell line) by attenuating inducible nitric oxide synthase and cyclooxygenase-2 expression (Suh et al., 1998; Ryu et al., 2000). The anti-proliferative, anti-tumor and anti-leukemic properties have been shown to be mediated via suppression of NF-κB activation and inhibiting the expression of NF-κB
regulated genes like lipoxygenase, COX-2, MMP-9, and iNOS (Najid et al., 1992a; Cha et al., 1996; Ringbom et al., 1998; Shishodia et al., 2003).

**Scope of the present investigation**

Crop improvement facilitated by modern biotechnology is one of the most significant developments in plant biotechnology research and development (R&D). Within Asia, plant biotechnology has largely been acknowledged as a key strategy for achieving food security and sustainable agriculture; many governments give high priority to agricultural biotechnology R&D. Many of Asian countries focus their biotechnology research on food crops and crops of high commercial value in the hope of meeting increasing food requirements and reducing poverty, particularly among resource-poor farming household. Hamessing biotechnology applications for the benefit of the poor, however, requires considerable attention in many areas, including appropriateness and access to agri-biotechnology by resource-poor farmers, capability of the public sector in biotechnology R&D, regulatory framework that enhances the use of biotechnology applications, and public-private sector partnerships (Hautea & Escaler, 2004).

Plant cell and tissue culture play important role in the manipulation of plants for improved crop varieties. *In vitro* propagation of medicinal plants with enriched bioactive principles and cell culture methodologies for selective metabolite production is found to be highly useful for commercial production of medicinally important compounds. To improve yields metabolic engineering offers promising perspectives, but requires the understanding of the regulation of the secondary metabolite pathways involved on the levels of products, enzymes and genes, including aspects as transport and compartmentation (Siahsar et al., 2011).

Out of the 3,50,000 plant species known so far, about 35,000 (some estimate up to 70,000) are used worldwide for medicinal purposes and less than about 0.5% of these have been investigated for their phytochemical and pharmacological potential (Hostettmann & Marston, 2002). This green inheritance thus represents an enormous reservoir of putative lead compounds to be discovered for various diseases (Farnsworth, 1984). Medicinal plants would be the best source to obtain a variety of drugs and therefore such plants should be investigated to understand better about their properties, safety and efficacy (Nascimento et al., 2000). Medicinal plants are major
sources of obtaining antimicrobial drugs (Sofowora, 1986). In addition to the alarming increase in the incidence of new and re-emerging infectious diseases, one major health concern is the resistance to existing antibiotics (Khanahmadi et al., 2010; Agbafor et al., 2011).

Review of literature shows that only few studies have been conducted on the *Trianthema decandra* which some of them are:

1) Comparative Pharmacogonostic Studies of Genuine and Commercial Samples of *Trianthema Decandra* Linn (Gopalakrishnan & Venkataraman, 2000).

2) Antibacterial activity of root extract of *Trianthema decandra* (Jaswanth et al., 2002).

3) Hepatoprotective activity of methanol extracts of *Glinus oppositifolius* and *Trianthema decandra* against paracetamol-induced liver damage (Gupta et al., 2007).

4) Hepatoprotective activity of *Trianthema decandra* on carbon tetrachloride-induced hepatotoxicity in rats (Sengottuvelu et al., 2008).

5) Observation of the hepatoprotective and antioxidant activities of *Trianthema decandra* Linn. (Vallai sharunna) roots on carbon tetrachloride-treated rats (Balamurugan & Muthusamy, 2008).

6) Antibacterial activities of flavonoids obtained from the root extract of *Trianthema decandra* lin (Prabhu et al., 2008).

7) Antibacterial activity of ethanolic extract of *Zaleya decandra* in alloxan-induced diabetic rats (Meenakshi et al., 2010).

8) Evaluation of Antimicrobial and Antioxidant Potentials of *Trianthema decandra* L (Geethalakshmi et al., 2010a).

9) α-Amylase Inhibitory Activity of *Trianthema decandra* L (Geethalakshmi et al., 2010b).

10) *Trianthema decandra* L: A review on its phytochemical and pharmacological profile (Geethalakshmi et al., 2010c).

11) Antioxidant and antibacterial activities of *Trianthema decandra* linn (Sukantha et al., 2012).
So, there is no plant tissue culture work on \textit{T. decandra} and only a few researches have been done as mentioned above. Thus, there is need to study on plant tissue culture of the \textit{T. decandra} in order to know the medicinal properties of the selected plant. From the foregone introduction it is obvious that there is an urgent need to catalogue biodiversity, to identify and to analyze the chemistry of medicinal plants, as they are storehouses of “futuristic medicines”. To continue such efforts which have been made by earlier researchers in obtaining significant results in the \textit{in vitro} establishment and studies of a number of medicinal plants, we in the present investigation attempted to work with \textit{T. decandra}, which has been extensively used by the traditional practitioners for curing several human disorders in India. The present thesis deals with micropropagation studies of \textit{T. decandra}.

\textbf{\textit{Trianthema} decandra L.}

\textit{Trianthema decandra} L. is a synonym of \textit{Zaleya decandra} (L.) Burm. f. \textit{T. decandra} (Aizoaceae) as a medicinal plant has been selected for the present study among some other medicinal plants. \textit{Trianthema decandra} is a prostrate, glabrous, succulent and annual found almost throughout India as a weed in cultivated and waste land. The genus \textit{Trianthema} consists of 20 species but only a few species have been phytochemically reported. \textit{Trianthema} is a genus of annual or perennial plant characterized by usual fleshy, opposite, unequal, smooth-margined leaves ; prostrate growth form; flowers with five perianth segments; flowers subtended by a pair of bracts; superior fruit a circumscissile capsule with a winged lid and stamens 5 or 10. It is commonly known as gadabani (Hindi) and vellai sharuni (Tamil) (Kiritikar & Basu, 1983). \textit{Trianthema decandra} has been used in various parts of Asia, Africa, Australia, and South America for curing various diseases. In some African countries the plant has been popular use for skin diseases, wound healing, fever and tooth aches. In India it is used in the treatment of ophthalmic (Upadhay \textit{et al}., 1998). The root applied to the eye cures corneal ulcers, itching, dimness of sight and night blindness. The juice of leaves is used to treat the black quarter. The bitter roots are used for curing bacterial infections and it’s also given in combination with ginger as a cathartic. The leaves contains huge amount of vitamin C which is used to treat edema. The decoction of the herb is used as a vermifuge and is useful in rheumatitis. It is also an antidote to alcoholic poison (Geethalakshmi \textit{et al}., 2010a).
Keeping in view of medicinal importance of *T. decandra*, the current study was undertaken to provide scientific bases to use this plant in traditional system of medicine have been evaluated for their bio-potentiality with the following objectives:

**The objectives of present investigation**

1. To develop protocol for regeneration from different explants of *Trianthema decandra*

2. Suspension culture, somatic embryogenesis, preparation and germination of synthetic seeds

3. Antimicrobial studies on root and root callus extracts of *Trianthema decandra*.

4. Phytochemical analysis and characterization of bioactive compounds from callus