Summary and Conclusion
The present study titled “Phytochemical and Pharmacological Investigation of *Trianthema decandra* Linn Roots and *Pithecellobium dulce* Benth Fruit Peel” focused on chemical investigation of two medicinal plants for their phytoconstituents and carry out systematic biological and pharmacological activity studies to establish the pharmacological potential bestowed with these plant materials. Owing to the increasing significance of the use of medicinal plants in the field of medicine, two medicinal plants were chosen for the phytochemical and pharmacological investigation.

Plant I: *Trianthema decandra* Linn of plant family *Aizoaceae*

Plant II: *Pithecellobium dulce* Benth of plant family *Mimosaceae*

Both the plants have been extensively documented in ethno medicinal literature.

The first chapter is a brief introduction highlighting the significance of phytochemical studies in isolating active principles from plants and the significance of pharmacological studies. The objectives of the proposed study are listed in this chapter.

The second chapter presents the review of literature pertaining to the study. Review of literature was done on the following:

- Natural products isolated from genus *Trianthema*
- Biological properties of various species of the genus *Trianthema*
- Natural products isolated from genus *Pithecellobium*
- Biological properties of various species of the genus *Pithecellobium*
- Nano Particle synthesis and Cyclic Voltammetric Studies on Plant Extracts

The genus *Trianthema* belongs to *Aizoaceae*. Literature reports on this genus have been reviewed from 1947 onwards. Major constituents of plants of this genus are ecdysteroids. There are few reports of isolation of flavonoids and phytosterols. The plant *Trianthema decandra* has been in ethnomedicinal use since long time and not much scientific investigation was earlier done.
The genus *Pithecellobium* belongs to *Leguminosae*, which is one of the largest flowering families comprising of 12000 species classified into 600 genera. Review of literature shows that only very few species in this genus *Pithecellobium* have been investigated for their chemical constituents. Earlier work on the isolation of chemical constituents from some common species native to India has been reviewed for the period from 1976 till date. *Pithecellobium dulce* is one of the familiar species among them, and has got several therapeutic properties. Chemical investigation on the different parts of the plant has resulted in the isolation of a number of secondary metabolites. Terpenoidal derivatives α-amyrin, luteolin, ursolic acid, oleanolic acid, glycoside derivatives of β-sitosterol, α-spinasterol, stigmasterol and campesterol, the derivatives of flavonoids - catechin, myricitin, quercitin, apigenin, genistein and kaempferol have been mainly reported from the various species of *Pithecellobium*. Notable is the number of Pithecelloside derivatives isolated from *P. dulce*. These are oleanane type of triterpenoid saponin glycosides. This *P. dulce* species also elaborates a number of flavans and simple gallate derivatives. The only sugar alcohol reported from the leaves of *P. dulce* is dulcitol.

Literature review revealed that the roots of *T. decandra* and fruit peel of *P. dulce* have not been explored for their phytoconstituents and pharmacological potential.

The third chapter deals with the methodology adopted.

The stages of methodology comprises of:

- Systematic collection of roots of *Trianthema decandra* Linn. and fruit peel of *Pithecellobium dulce* Benth
- Sequential extraction of the plant materials using petroleum ether, ethyl acetate and methanol
- Phytochemical colour tests for the various solvent extracts
- Column chromatographic isolation of the phytoconstituents in the ethyl acetate and methanol extracts of roots of *Trianthema decandra* Linn.
- Column chromatographic isolation of the phytoconstituents in the methanol extract of fruit peel of *Pithecellobium dulce* Benth
Characterization of the isolated compounds by colour tests and physical properties

TLC and HPTLC analysis of isolated compounds

Spectral characterization of isolated compounds using UV, FTIR, $^1$H NMR, $^{13}$C NMR, $^1$H $^1$H COSY, $^1$H $^{13}$C COSY, DEPT 45, DEPT 90, DEPT 135, HSQC, HMBC and GC-MS.

GC-MS analysis of the petroleum ether, ethyl acetate and methanol extracts of both plant materials

Antibacterial activity of the petroleum ether, ethyl acetate and methanol extracts of both plant materials by disc diffusion method

Antioxidant activity of the petroleum ether, ethyl acetate and methanol extracts of both plant materials by determination of phenolic content, DPPH assay, *in vitro* Lipid peroxidation in Liver Homogenate, hydroxyl radical scavenging activity, hydrogen peroxide scavenging activity and reducing power assay

*Invitro* anti cancer activity of the ethyl acetate and methanol extract of *Trianthema decandra* Linn. and ethyl acetae, methanol and aqueous extracts of fruit peel of *Pithecellobium dulce* Benth by MTT assay

*In vivo* anti diabetic activity of methanolic and aqueous extracts of both plant material

Hepato protective activity of methanolic and aqueous extracts of both plant material

Synthesis of silver nano particles using aqueous extract of *Pithecellobium dulce* Benth

Anti bacterial assessment of the synthesized silver nano particles

Cyclic voltammetric evaluation of the presence of bioactive cyclitols in plant extracts

The results are presented in the fourth chapter and discussed in the light of the objectives set forth. The ethyl acetate and methanol concentrates of roots of *T.decandra*
and the methanol concentrate of *P. dulce* were analyzed by systematic column chromatography which resulted in the isolation of **eight** compounds from the roots of *T. decandra* and **six** compounds from the fruit peel of *P. dulce*. The characterization of the isolated compounds was done. The roots of *T. decandra* yielded phytosterols as major constituents and a triterpenoidal compound α-amyrin apart from disaccharides maltose and sucrose. An echdysteroid derivative was identified in the methanol extract by GC-MS analysis.

The fruit peel of *P. dulce* yielded six compounds from its methanol extract. The major constituents characterized are the flavonoids quercetin and its 7-O- rhamnoside and two cyclitols along with two phytosterols.

The cyclitols are sugar alcohol type of molecules and they have significant bioactivity. The cyclitols isolated have been characterized as the bioactive molecule Pinitol and its isomer.

The isolation of Pinitol from the methanol extract of fruit peel of the common plant *Pithecellobium dulce* bestows immense significance to the study owing to the enormous pharmacological potential of pinitol. This is the first report of isolation of Pinitol from this plant. Its identity was confirmed by HPTLC profiling in comparison with standard pinitol.

D-pinitol (3-O-methyl-chiro-inositol) is a naturally occurring compound found in soya bean seeds, pine wood, alfalfa and legumes. It has immense pharmacological potential and is pronounced as a **new hope for management of type II diabetes**. Its isolation from the fruit peel validates the ethnomedicinal use of aqueous extracts of the fruit peel in control of blood sugar by diabetics in the local areas.

Owing to the presence of pinitol in the extracts of *Pithecellobium dulce* fruit peel, extracts of this plant were analysed by cyclic voltammetry to affirm the use of this technique as a tool for identifying pinitol and its isomers in plant extracts. The results were promising and also helped in confirming the identity of the isolated cyclitols as pinitol and its isomer.

GC-MS analysis of the petroleum ether, ethyl acetate and methanol extracts of both plant materials was carried out and the study revealed the presence of a number of
constituents in the extracts. Certainly the extracts can be further explored for newer constituents.

Biological and pharmacological activity studies have been exhaustively systematically done on the various extracts of both plants. Both the plants were found to exhibit moderate antimicrobial activity. The anti oxidant activity was assessed elaborately by various assays which indicated that the polar extracts of both plant materials possessed a very high anti oxidant potential. The methanolic and aqueous extracts of both plant materials showed anti diabetic activity comparable to standard glibenclamide. The same extracts also showed hepato protective activity comparable to standard silymarin. The ethy acetate extract of both chosen plant materials showed very good cytotoxicity against Hela-S cell line. These results support the fact that the efficacy of these plants in various medicinal uses.

The methanolic extract as well as aqueous extract of both the plants showed significant hepato protective activity. The results clearly indicate that, the methanolic and aqueous extracts of roots of *T.decandra* and *P.dulce* fruit peel have significant hepatoprotective (p>0.05) activity compared to that of the standard drug silymarin. These results suggest that both the plants can be further studied for developing herbal formulation for liver disorders.

Results of antidiabetic activity studies revealed that the methanol and aqueous extracts of *T.decandra* root and *P.dulce* fruit peel possess significant (p>0.05) antidiabetic activity compared to the standard drug glibenclamide. *P.dulce* extracts can be further explored in-depth for their efficacy in treatment of diabetes since they are now proved to contain pinitol as an active principle.

Further, extracts of both plants were preliminarily analysed for their ability to generate silver nano particles. Extracts of *P.dulce* showed promising results. The study will form the basis of future in-depth studies on strategic nano particle production.

The present study has exposed medicinally valuable molecules from a fruit peel which is usually an agro waste. *T.decandra* is a weed but it is proven to possess immense potential by this study. Future studies will be focused on developing herbal formulation using extracts of the chosen plant materials after thorough standardization studies based on the isolated molecules as biomarkers.