SUMMARY

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The current thesis is entitled as "Isolation of Phytochemical Constituents from Bhallataka and Synthesis of Bhallataka Biodiesel, Biolubricants, Novel Applications and their Biological activities" and it consists of Five Chapters.

CHAPTER -1: INTRODUCTION

It consists of three parts: Importance, Investigation and Pharmacological activities of Sa Anacardiaceae family Bhallataka [*Semecarpus anacardium* L.f (Sa)].

A. Importance of Natural Products from Herbal plants

Herbal drugs are contributing much to the human health especially in 21stcentury. Natural medicine improves the inner immune system of the human body and no adverse effects could be observed. Hence, the herbal drug acts more effectively than the modern medicine. Now there is a great demand and stress from the people and various Governments including Pharmaceutical Industries for the isolation of active Chemical ingredients from the natural herbal plant species and also for the development of novel chemical synthetic strategies to make their availability in large quantities to satisfy the immediate needs of the suffering people. Out of these, 121 plant derived drugs are produced commercially from less than 90 species of higher plants. It is estimated that 80% of anti-tumor and anti-infectious drugs already in the market or under clinical trial are of natural origin obtained directly or indirectly. Prior to World War II, a series of natural products isolated from higher plants became clinical agents and a number are still in use today.

Quinine from Cinchona bark, morphine (*Papavera somniferum),* codeine from the latex of the opium poppy, digoxin from Digitalis leaves; Atropine (Atropa belladonna) and Hyoscine from species of the Solanaceae continue to be in clinical use. The antibiotic era dawned during and after World War 2 due to the antibacterial

effects of a whole series of natural products isolated from species of Penicillium, Cephalosporium, and Streptomyces. In the post-war years there were relatively few discoveries of new drugs from higher plants with the notable exception of reserpine from the *Rauwolfia serprntina* heralding the age of the tranquillisers and also vinblastine and vincristine from *Catharanthus roseus* which were effective in cancer chemotherapy. During recent years, the attention of the pharmaceutical industry has switched once more to the natural world and this may be illustrated by reference to three clinical drugs, Taxol, Etoposide and Artemisinin. Taxol is obtained from the bark of the Western Pacific Yew, *Taxus brevifolia*.

B. Preliminary investigation of Anacardiaceae Family and their Biological Activities

In our survey, we found that, the Anacardiaceae family has 83 genera and 860 species existing as trees, shrubs and vines. Out of these, the commonly known Cashew family or Sumac family has tremendous commercial importance. Due to the presence of several anticancer drugs isolated from Anacardiaceae family, we have selected *Semecarpus anacardium* L.f, for its high medicinal value in ayurveda and siddha systems and isolated several active constituents which is very well known as "Bhallataka". The most important of these are *Toxicodendron radicans* (poison ivr) and sap of the plants was toxic, mostly in the genus Toxicodendron that takes its name from the Greek "toxicos" meaning poisonous and "Dendron" meaning tree. This genus was formerly included in the genus Rhus (Sumac). Others include *Toxicodendron vernicifluum* (varnish tree) and *Toxicodendron vernix* (poison sumac). Brushing a leaf or any other part of the plant releases 3-n-pentadecycatechol, an irritating oil causing a red itch vesicular rash that appears 12-24 hours after exposure and lasts 4-5 days. Other toxic components of this family contain *Cotinus coggygria* (smoke tree), *Semecarpus anacardium* (marking nut tree) and *Smodinginum argutum* (African poison oak), *Schinus molle* (pepper tree), Cashew (Anacardium occidentale), *Mangifera indica* (Mango).

C. Chemical constituents and their Pharmacological activities of *Semecarpus anacardium* L.f – A Review

Semecarpus anacardium L.f. Belongs to the family (Anacardiaceae) is a deciduous tree distributed in the forests of the Western Ghats of India. In the Indian system of medicine, the plant is well known as Bhallataka (Sanskrit) and commonly known as 'marking nut' (English) and Kaadugeru (Kannada). *Semecarpus anacardium* L.f (Anacardiaceae) is reported to possess many medicinal properties.

Trees: up to 25 m tall; young branches: terete, tomentose, watery latex present, which on drying it turns black. The black corrosive juice of the pericarp contains 90% of oxy acid, 'anacardic acid' and 10% of higher nonvolatile alcohol called 'cardol', also contains catechol and a mono-hydroxy phenol called as anacardol. The most significant components of the *Semecarpus anacardium* L.f. oil are phenolic compounds. On exposure to air, phenolic compounds get oxidized to quinones. The oxidation process can be prevented by keeping the oil under nitrogen.

Many of the well-known properties of marking nut oils are easily explainable by the catechol half and lipoid-soluble C_{15} chain. During exposure to air, the catechol ring might be oxidized to an orthoquinone which might impart the dark color and also implies polymerization. The vesicant nature and the indelible pigmentation due to the rapid formation of the orthoquinonoid intermediate. The absorption of the oil by the skin is obviously due to the lipid-soluble C_{15} chain. In addition to this, Chemical and phytochemical analysis of *Semecarpus anacardium* nuts revealed the presence of bhilawanol, Anacardic acid, I-4^{I},II-3^{I},4^{1},I-5, II5,I7hexahydroxy [I-3,II-8] biflavonone, I-4^{I}, II-4^{I}, I-5, II-5, I-7, II-7-hexahydroxy [I-3, II-8] biflavonone (3^{1}, 8-binaringenin), I-4^{I}, II-4^{I}, I-7, II-7-tetrahexahydroxy [I-3, II-8] biflavonone (3^{1},8-billiquiritigenin), Tetrahydrorobusta flavonone, Tetrahydroamentoflavonone, Amentoflavone, Semecarpuflavonone, Galluflavonone, Jeediflavonone, Semecarpetine, Anacarduflavonone, Nallaflavonone, Anacardoside, Bhilwanol analogs, Flavonoids and its Pharmacological activities such as Hypocholesterolemic activity, Anti-inflammatory , Immunomodulatory activity, Antioxidant, Adjuvant, Antimicrobial activity, Hypoglycemic and anti hyperglycemic , Breast cancer , Acetyl

cholinesterase inhibitory activity , Acute and sub chronic toxicity study, Anti mutagenic effect , Bioactivity , Renal cortical necrosis and Hair growth .

Chapter-II: This Chapter deals with Isolation and Structural Determination of New Triacylglycerides from *Semecarpus anacardium* L.f

Due to the presence of several anticancer drugs isolated from Anacardiaceae family, we have selected *Semecarpus anacardium* L.f, for its high medicinal value in ayurveda and siddha systems and isolated several active constituents. All plant parts of ***Semecarpus anacardium*** L.f. were collected from field area very nearer to the village Nandgaon, Kolhapur City, Maharashtra, India. All plant material specimens were identified by Dr. Vatsavaya S. Raju, Plant Systematic Laboratory, Department of Botany, Kakatiya University, Warangal (A. P. State) and conformed as Semecarpus anacardium L.f. (syn: Anacardium latifolium Lam., A. orientale Steud.) of Anacardiaceae family and plant specimen deposited at Kakatiya University Herbarium, Warangal (KUW) with accession number1874. It is locally known as 'Nallajeedi' and popularly known as 'marking nut/dhobi nut.'

The crushed nuts (3.5 kg) were extracted with cold petroleum ether. Solvent from this extract was removed under reduced pressure. 129gms of blackish gummy substance was obtained and this is designated as Semecarpus anacardium cold hexane extract (SaCHE).The residue left after cold extraction was Soxhlated with hot petroleum ether ($60\text{-}80^0$) and this was concentrated under reduced pressure which resulted blackish gummy mass of 680gms and is designated as Semecarpus anacardium hot hexane Extract (SaHHE). The residue was extracted with cold acetone; the solvent from this extract was removed under reduced pressure which resulted dark blackish substance of 420gms which is designated as Semecarpus anacardium cold acetone extract (SACAE). Finally the left residue was soxhlated with hot acetone, the solvent from this extract was removed under reduced pressure, resulted the yield of dark reddish brown substance of 959gms which is designated as Semecarpus anacardium hot acetone extract(SaHAE).

All the four filtrates (SaCHE, SaHHE, SaCAE, and SaHAE) were subjected for column chromatography on silica gel and column was eluted with increasing polarity of solvents individually.

Six New Non-volatile Triacylglycerides oils were obtained from Hot hexane extract (1), Cold acetone extract (3), Hot acetone extract(1) of *Semecarpus anacardium* L.f Nuts and Methanolic extract of Root bark(1). These were found to be as **new** Triacylglycerides as Bhallataka oils-(1 to 6):

(1) Nonvolatile Triacylglyceride (Bhallataka Oil-1) appears as golden yellow oil obtained from Sa hot hexane extract of (20-23rd) fractions were mixed and designated as HH_{20} with boiling Point 78- 80^{0}C and characterized by spectral analysis and named as **'Ganesh triglyceride'**.

(2) Nonvolatile triacylglyceride (Bhallataka Oil-2) was obtained from Sa nuts cold acetone extract of (29-30) fractions by elution with hexane obtained as yellowish oil with 78-80^{0}C, characterized and named as '**Tulja triacylglyceride'**.

(3) Nonvolatile triacylglyceride (Bhallataka Oil-3) was obtained from (31-32) fractions of Sa nuts of cold acetone extract by the elution with hexane obtained as brownish yellow oil with 74-78.5^{0}C which was characterized and named as **'Kabala triacylglyceride'.**

(4) Nonvolatile triacylglyceride (Bhallataka Oil-4) was obtained from (33-39) fractions of cold acetone extract by elution with (hexane: ethyl acetate (1:1)) obtained as Brownish yellow oil with 79-80^{0}C which was characterized and named as '**Sola triacylglyceride'**.

(5) Nonvolatile triacylglyceride (Bhallataka Oil-5) was obtained from hot acetone extract of (5-12) fractions by elution with benzene as golden yellow oil obtained with 78.5^{0}C which was characterized and named as '**Shiva triacylglyceride'**.

(6) Nonvolatile triacylglyceride (Bhallataka Oil -6) was obtained from methanol Root bark extract of Sa (10-15) fractions eluted with hexane as 78.5^{0}C which with was characterized named as '**Ramadas triacylglyceride'.**

Fatty acid composition: Fatty acid composition of the Bhallataka oils (1-6) were determined by converting the Oil in to its fatty acid methyl esters, and then analyzed by gas chromatographic method. The fatty acid profile of fats and oils as well as their derivatives such as alkyl esters in the major factor influencing their chemical and physical properties and subsequently their various applications. And GC is usually the method of choice for determining the fatty acid profile.

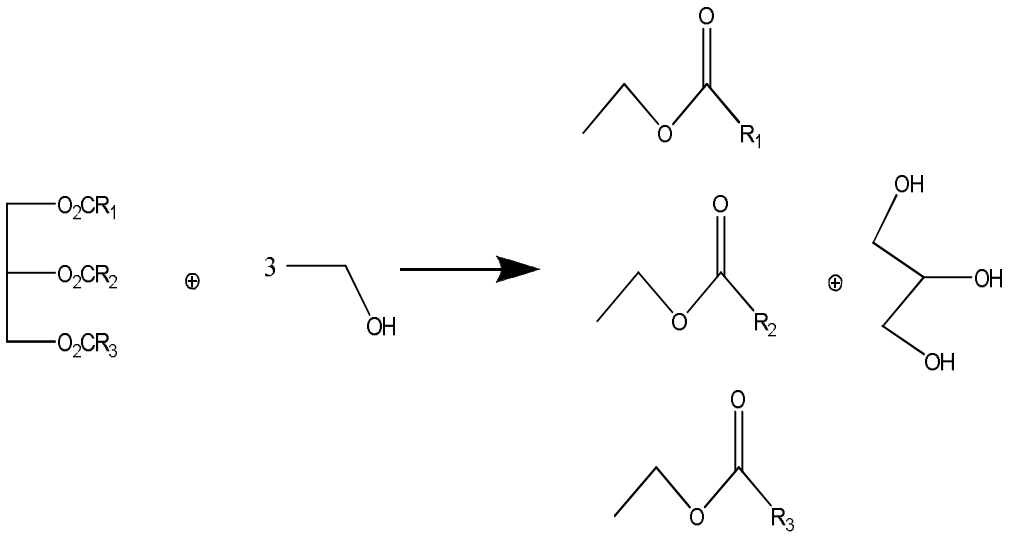


Fig.1: Mechanisim of Trans- esterification process.

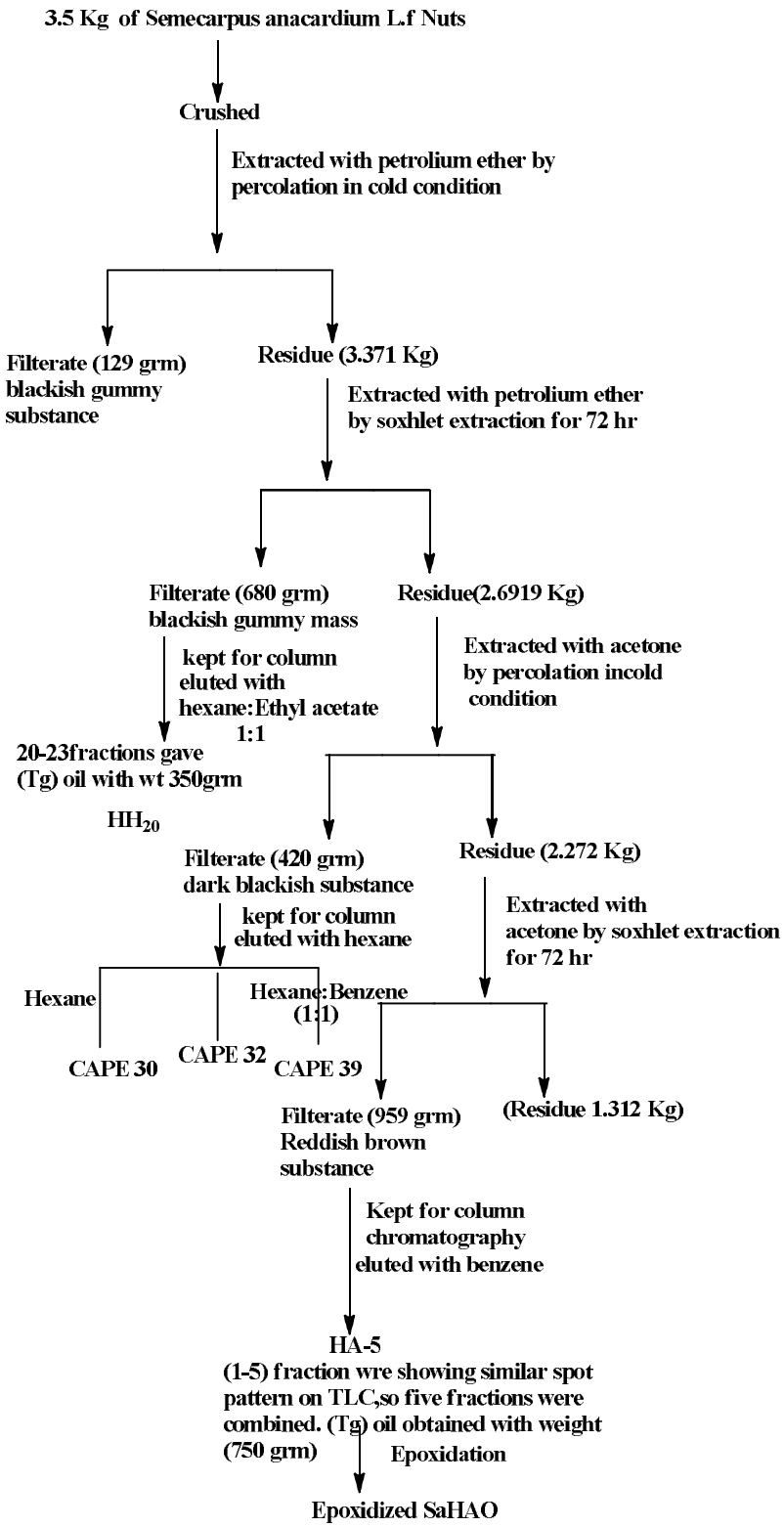


Fig.2: Process of Flow Diagram of Semecarpus anacardium L.f Nuts

Chapter 3: Biodiesel Conversion and Epoxidation

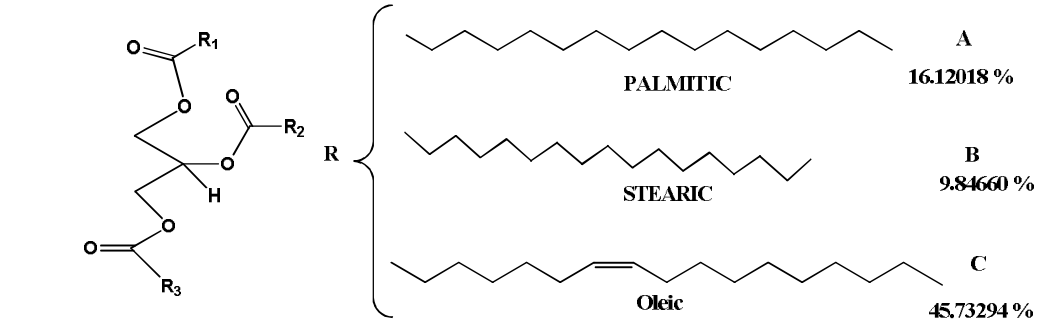
3A.Recent Advances in the Synthesis of Biodiesel from Bhallataka Oil-2(Tulja triacylglyceride)

This Chapter deals with the Recent Advances in Synthesis of Biodiesel from New Bhallataka Oil-2 (**Tulja triacylglyceride**) which is obtained from *Semecarpus anacardium* (Bhallataka) Cold acetone extract of nuts 29-30 fractions Fraction.

As petrol is a fast depleting natural resource, it became a tremendous need for the scientists to search because another alternative renewable resource to petrol is a deemed necessity. Now serious efforts are being made on the production and utilization of biodiesel in India and other parts of the world. As an alternative, invention of biodiesel from naturally growing herbal plants gained much interest. In this study, *Semecarpus anacardium* L.f., which grows naturally without any cost and timely care, is analyzed and investigated as a proper feedstock in producing biodiesel for the first time. In order to prove its suitability, its seed and oil were experimented first.

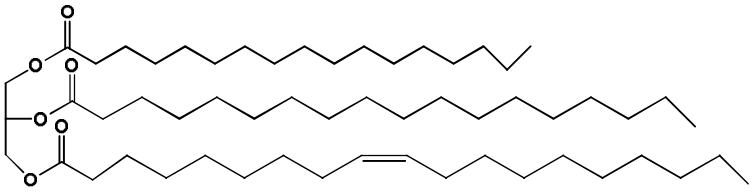
The tree is widely distributed throughout the hotter parts of India. It is frequently found in dry deciduous forests of Central India, Common in dry deciduous forests of Maharashtra spreading over Khandesi, Marathwada and East Maharashtra, in India. In the present study, biodiesel has been synthesized from *Semecarpus anacardium L.f.* oil. The acid value of this oil was found to be 0.5 during these investigations, which leads us to convert it to biodiesel by the esterification followed by trans-esterification process. The methyl esters produced by these methods were analyzed and found that, some of them are suitable as biodiesel fuel to ascertain their suitability as diesel fuels. Oils, however, are not suitable for direct use in diesel engines because of high viscosity, poor cold flow properties and low cetane number. It can however, be utilized by either blending with diesel fuel or trans-esterification with alcohol producing methyl ester is called biodiesel.

As a substitute for petroleum based diesel due to environmental considerations and depletion of vital resources like petroleum and coal, the possible use of renewable resources as fuels and as a major feedstock for the chemical industry is currently gaining acceptance. Further, as petroleum is a fast depleting natural resource, an alternative renewable route to petroleum is a deemed necessity. Now, serious efforts are being made on the production and utilization of biodiesel in India. Methyl esters are clean burning fuel with no sulfur emission. Although its heat of combustion is slightly lower than that of the petro-diesel, there is no necessity of engine adjustment and there is no loss in efficiency. Methyl esters are non-corrosive and are produced at low pressure and low temperature conditions. Concentrated (about 80 %) glycerin is obtained as a byproduct in the Trans-esterification process.



General structure of Triacylglyceride

Major fatty acids of Bhallataka Oil-3



Structure of Bhallataka Oil-2 of major fatty acids

Fig.4: Structure of 3-(heptadecanoyloxy)-2-(stearoyloxy) propyl oleate [Bhallataka Oil-2(Tulja triacylglyceride)] of major fatty acids

In our investigation, Nonvolatile New Triacylglyceride (**Tulja triacylglyceride**) had found to have a free fatty acid (0.52) hence; alkaline Trans-esterification was done by using anhydrous methanol at a molar ratio of 6:1 and 3g/Liter of sodium hydroxide as catalyst. The processor was stirred at 600 rpm and at a temperature of 60^0C for 2 hours, after which the mixture was poured into a decanter and allowed to settle for 3 hours, so that the reaction can be driven to end. By following mechanism as in Figure 2, it was found that the mixture has been separated into its corresponding methyl ester.

The glycerol at the bottom was drained off by gravity. The excess methanol in the ester was removed by using a flash rotatory evaporator. The impurities were removed from the methyl ester by washing with distilled water of volume in the ratio of 3:1. Finally, the washed methyl ester was dried by passing it through anhydrous sodium sulphate (Na_2SO_4) during trans-esterification process.

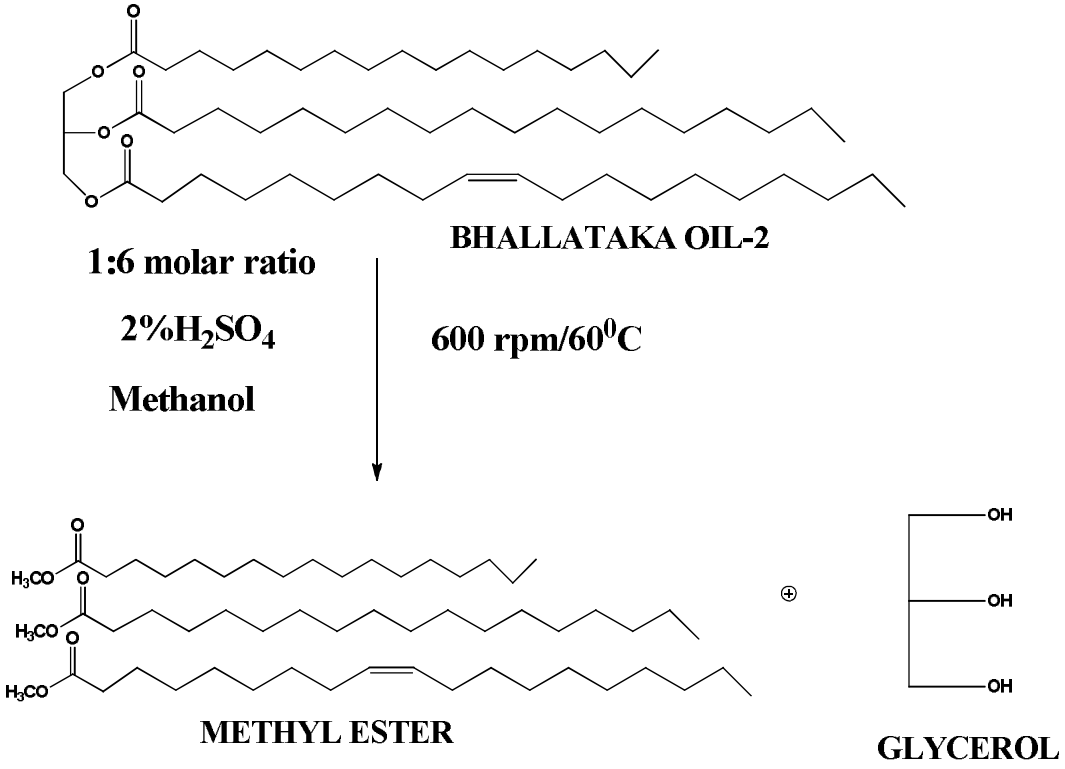


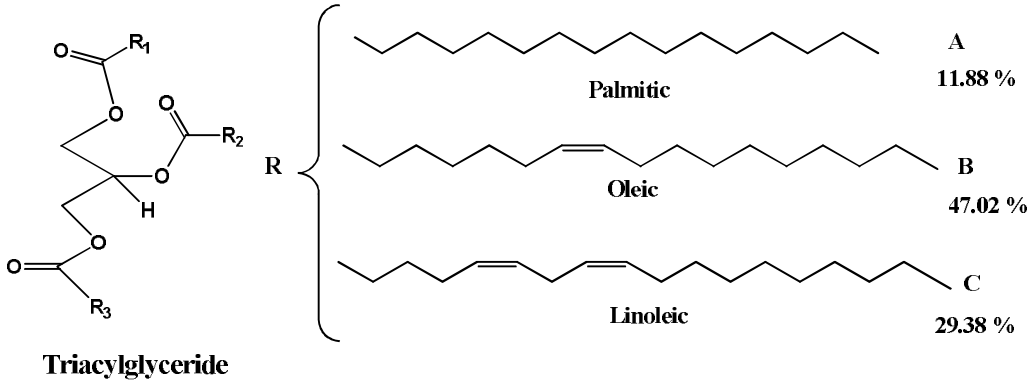
Fig.5: Trans- esterification of Bhallataka Oil-2(Tulja triacylglyceride)

As the production of biodiesel from edible oils is currently much more expensive than diesel fuels. Due to relatively high cost, Renewable energy such as biodiesel has the potential to replace petroleum derived transportation fuel in the future. The production of *Semecarpus anacardium L.f* nuts were discussed in the topic of tran-sesterification of triacylglycerides of Bhallataka Oil-2 **(Tulja triacylglyceride)** to yield Fatty Acid Methyl ester, and glycerine as a by-product and the Spectral Data of Bhallataka Oil Which was presented in Table 1and Fig.4 Their derivative (FAME) determined by Trans esterification process compared with the Various Oil Spectral data & Various properties of Bhallataka Oil-2 was determined by using standard methods. Properties of nut oil methyl esters of Bhallataka Oil-2 were determined experimentally to ascertain their suitability as diesel fuel.

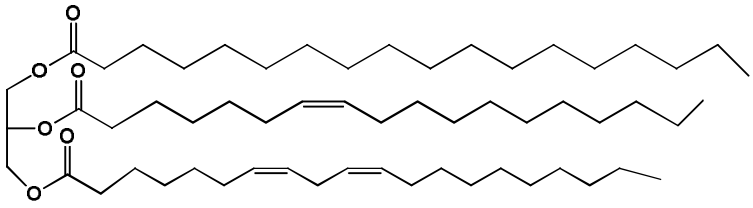
The properties of nut oil methyl esters of Bhallataka Oil L.f. have been compared with the properties of biodiesel and petro diesel. The fuel properties of nut oil methyl esters of Bhallataka oil-2 were with in specifications. The properties of its oil, such as its saponification value, iodine value, and the amount of its free fatty acid content were 165, 80.5 and 0.52, respectively. Eventually, the methyl ester of its crude oil, which was produced through alkali trans-esterification reaction with methanol in the presence of NaOH as catalyst was experimented and its physicochemical properties were determined. All the determined characteristics, namely, density (0.8720 g/mL), kinematic viscosity (5.96 mm 2/s at 40 ºC), flash point (140ºC), cloud point (-7ºC), pour point (-5ºC), cetane index (48.99) meet the two accepted biodiesel standards (*i.e.* ASTM D6751 and EN 142140). Therefore, according to our recent results *Bhallataka Oil-2* ***(Tulja triacylglyceride)*** can be considered as a very good biodiesel feed stock. Which was not reported earlier, is a feed stock in producing biodiesel for the first time. Among the few recent investigations done on this field, ours is the first report on the FAME *Semecarpus anacardium* L.f. nut oil (Bhallataka biodiesel).

B: The present study reports the preparation of Epoxy Bhallataka Oil- 5 (Shiva triacylglyceride) as potential Lubricant for Chemical Industry.

Strong environmental concerns and growing regulations over contamination and pollution in the environment have increased the need for a renewable and biodegradable lubricant as an alternative to replace fossil-based lubricant. In this paper, bio-lubricant was synthesized from *Semecarpus anacardium* L.f oil through Epoxidation and Hydrolysis reactions, SaHA-5 L.f Oil (Bhallataka Oil-5) which is obtained from hot acetone Extract of Sa, and is identified as a potential raw material for biodiesel was explored for its use as a feed stock for bio lubricants. Epoxidized SaHA-5 oil was prepared by peroxyformic acid generated in situ by reacting formic acid and hydrogen peroxide in the presence of employing sulphuric acid as catalyst. Almost complete conversion of unsaturated bonds in the oil into oxirane was achieved with oxirane value 3.77 and iodine value of oil reduced from 90.7 to 12.01.



Triacylglyceride **Major fatty acid chains**



New Bhallataka Oil -5 of major fatty acids(Shiva triacylglyceride)

Structure of New Bhallataka Oil-5(Shiva triacylglyceride) (7Z, 10Z)-2-((Z)-octadec-7- enoyloxy)-3-(stearoyloxy)propyl icosa-7,10-dienoate of major fatty acids

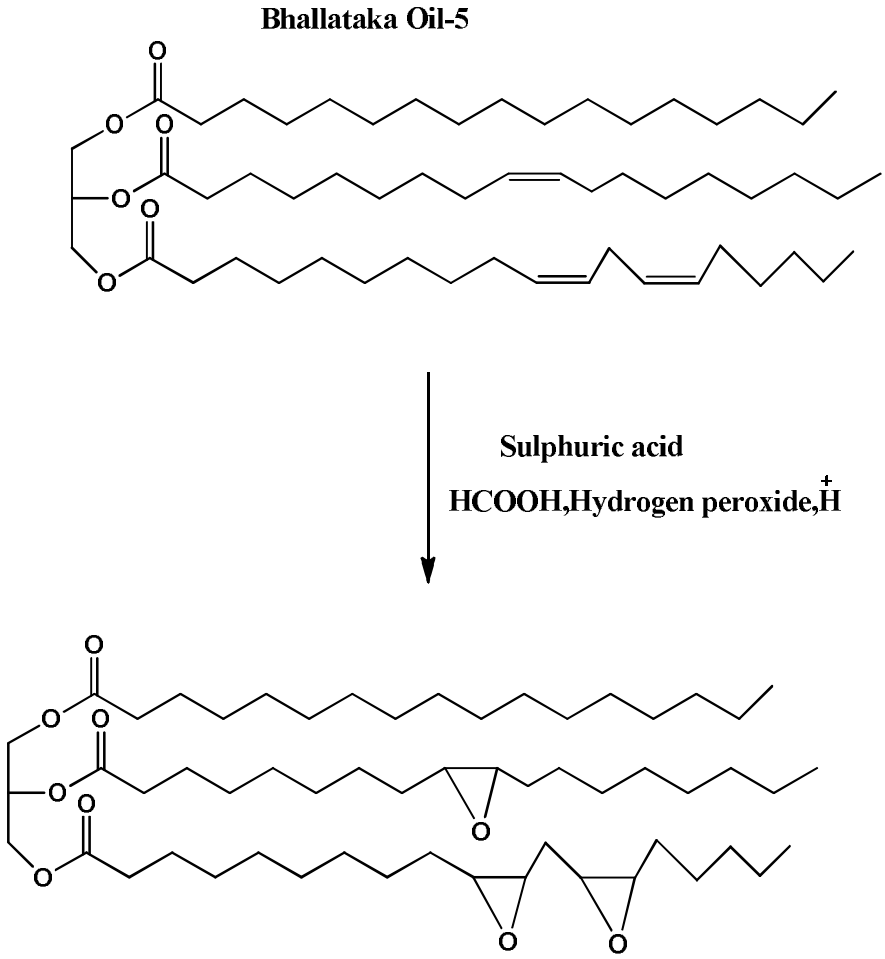


Fig.3: Epoxy Bhallataka Oil-5

$ESaHA_5O$(Epoxy Bhallataka Oil) exhibited superior oxidative stability compared to $SaHA_5O$ (Bhallataka Oil-5).The lubricating properties of $ESaHA_5$ O and epoxy Jatropha oil EJO and ESABO Epoxy soyabean oil were compared with SaHA-5O(Bhallataka Oil-5 ,The lubricating properties of $ESaHA_5O$, Epoxy jatropha oil EJO and epoxy soybean oil (ESBO) are comparable. Hence, $ESaHA_5O$ (Epoxy Bhallataka Oil) can be projected as a potential lubricant base stock for high temperature applications.

CHAPTER –IV: Molecular Modeling of fatty acids and Metal analysis

1V-A. This chapter mainly deals with the Isolation of Fatty Acids From Flowers, Leaves, Stem bark, Root bark and Nuts of S*emecarpus anacardium* L. f. (Anacardiaceae), their molecular Modeling and Comparative studies

We have isolated 20 fatty acids from *Semicarpus anacardium* L.f whole plant and compared with the known compounds with their authentic samples and also with corresponding spectral data. The total number of fatty acids isolated from *Semecarpus anacardium* L.f.in our laboratory is as follows: Root bark: 8; leaves: 3; stem bark: 4 and flowers were compared with the total (20) fatty acids present in nuts.

The total number of 20 fatty acids isolated from nuts, root bark, leaves, stem bark and flowers of *Semecarpus anacardium* L.f. and each structural elucidation was confirmed individually in our laboratory. To render support to our experimental results we have conducted molecular modeling studies. To explore the binding mode and understanding of key active site residues of the extracted natural fatty acids in the active site docking studies were carried out by taking the crystal structure of human FAAH (PDB ID: 3K84).

The docking results obtained were complementary with the known reference cognate natural ligand ADA. In all isolated fatty acids, the carboxylic two oxygen atoms showed hydrogen bond interactions with Thr236, Ser217 residues. The long aliphatic chain of the ligand showed hydrophobic interactions with Met191, Phe192, Met495, Leu380, Val491, Leu372, Tyr335, Trp531 and Phe432. The identified probable binding mode of isolated natural compounds and their key active site interactions could provide design clues for the optimization of new analogues by adding various substitution groups on the desired places on the core moiety for the development of novel, potent inhibitors for FAAH target.

IV B. Multimetal analysis of Plant Extracts and Ash content of Root bark, Stembark, Leaves, Flowers and Nuts of *Semecarpus anacardium* L.f and their Biological activities.

Essential elements that could enhance and synergize the curative process of ill health. The results obtained in the ICP-AES analysis showed that Semecarpus anacardium L.f Ash contents contains Calcium (SaRA-3071; SaLA-376.5; SaNA-724), Potassium (SaFA-653.7; SaRA-1075; SaLA-1166.5; SaNA-1959.5), Magnesium (SaRA-734.2; SaNA-317.5) in rich concentrations. The potentially toxic elements like Ni, Al, Pb of low concentrations detected in the present plant extract and Ash. It has been concluded from this study that estimation of heavy metals and trace elements in crude drugs is highly essential to use them as the medicine that would help in maintaining quality assurance and practicing the safe use of herbal drugs. Potassium is an element of high concentration and mobility in plants and it does not bind to organic compounds. Cu is an element with great affinity to organic matter, binding to humic and fulvic acids. Nearly 98%of Cu is chelated to organic compounds. Phenolic compounds show high stability in their complexes with metal and they even show the antioxidant properties that cause changes in plant growth.

CHAPTER –V: Isolation of Bhavanol and Biflavonoids

VA. Novel Applications of "Bhavanol" isolated from Roots and Nuts of Bhallataka for Chemical Industries

In this study, **New 'Bhavanol'** is obtained from Nuts and Root Bark Extracts which is an abundant agricultural by product, holds considerable promise as a source of unsaturated phenol, an excellent Bio based thermosetting resin as well as monomer for polymer and industrial chemical products.

VB. Biflavonoids isolated from *Semecarpus anacardium* L.f Nuts, Rots, their Docking studies and their Biological Innovations

This chapter mainly deals with the Isolation of Biflavonoids from *Semecarpus anacardium L.f* Nuts, Root bark and Leaves ,Docking studies and their Biological Aspects Biflavonoids were isolated by acetone extract of the nut, Methanolic extracts of Root bark and Leaves of *Semecarpus anacardium L*.f ,these were purified by usual chromatographic techniques such as column chromatography and thin layer chromatography (TLC) Compounds were isolated, purified and highly analyzed basing on FT-IR, ^{1}H NMR, ^{13}C NMR, MASS ,NP-HPLC,GC & GC-MS Analysis, obtained result were correlated with the reference compound literature.

Furt/her, these were subjected for Docking. The docking parameters and physicochemical properties of flavonoids in PTPIB target Compounds THAF&AF as well as Methanolic Crude Extracts of whole plant of *Semecarpus anacardium* L.f were the most active against both gram positive and gram negative bacteria, and also showing Antioxidant activity. Which are found to be the first time reports from this plant.

Highlights of the Ph.D. Thesis on *Semecarpus anacardium* L.f Extraction and purification:

All the plant materials related to *Semecarpus anacardium* L. f Nuts, Flowers, Leaves, Root bark, Stem bark, were collected and shade dried. 3 kg Nuts, 7kg Leaves, 3Kg flowers, 3kg stem bark and 10kg root bark were collected individually and dried under shade. After shade drying, each one of them was powdered and finally obtained 2 kg of leaves powder, 1.5kg of flowers powder, 2Kg of stem bark powder and 3kg of root bark powder. These powders were extracted each with 3 Liters of hexane/methanol by Soxhlet extraction method for 72 hours. The excess of solvent from crude extracts was distilled off and the crude was weighed. The individual weight of the extracts was subjected to Column chromatography. The individual fractions were purified by crystallization, the following compounds were Isolated from *Semecarpus anacardium* L.f.

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From Roots: Eleven (11) Compounds are found in roots of Sa and these are Oleic acid, Stearic acid, Linoleic acid, Palmitic acid, Hexacosanoic acid, Campesterol, β-Sitosterol, Stigmasterol, Stigmest-4-en-3-one, Triglyceride(Tg), **'New Bhavanol'**.

From Stem Bark: Seven (7) Compounds are found, in Stembark of Sa and these are Palmitic acid, Oleic acid, Linolenic acid, Stearic acid, γ-Sitosterol, Campesterol, Stigmast- 4-Ene-3- one.

From Leaves: Twelve (12) Chemical constituents are found in the Leaves of Sa and these are Oleic acid, Stearic acid, Vitamine –E, γ-tocopherol, Vitamine-E, Campesterol, Stigmasterol, β-Sitosterol, β-Amyrine, Stigmast-4-ene-3-one, Urs-12-ene, Ergost-5en-3-ol.

From Flowers: Thirteen (13) Chemical constituents are found in flowers and these are Palmitic acid, Oleic acid, Stearic acid, Bhenic acid, tetracosanoic acid, γ-tocopherol,Stigmest-4-ene-3-one, Vitamine-E, Campesterol, Stigmasterol, β-amyrine, α-amyrine,4, 4, 6a, 6b, 8a, 11, 12, 14b-octamethyl .

From Nuts: Thirty (30) Compounds are found in Nuts and these are Lauric acid, Myristic acid Pentadecanoic acid ,Palmitic acid, Palmitoleic acid, Heptadecanoic acid, Stearic acid Ricinoleic acid, Linoleic acid , α - Linoleic acid, γ-Linolenic acid , Dihydro gamma linolenic acid, Archidic acid, Archidonic acid, Gadoleic acid, Behenic acid , Erucic acid , Tetracosanoic acid ,Oleic acid, Nervonic acid, β-Sitosterol, β-tocopherol, Campesterol, Lup20 (29)- en-3- one, Bhavanol, Bhallataka Oil (1-6). In addition to this 9 Multi metals were found to be present in *Semecarpus anacardium* L.f Plant parts.

From our Laboratory "84" Chemical constituents were isolated from *Semecarpus anacardium* L.f of Various Extracts by increasing polarity of the Solvents. Out of which Bhallataka Oils (1-6), Bhallataka Biodiesel (7), Bhallataka biolubricant (8), Fatty acids and their Docking studies, Bhavanol (8) and Bhavanol reactions with Thiols (10-12), isolation of Biflavonoids and Docking studies, Antimicrobial activity and antioxidant activities were discussed first time in this Thesis. Out of the 84 Compounds present in Sa, 12 compounds are found to be Novel and New, In addition to this Nine (9) multi metals were found to be present in *Semecarpus anacardium* L.f from various extracts and Ash contents by ICP-AES Method, Docking studies and antioxidant, antimicrobial activities are the first time inventions from this *Semecarpus anacardium* L.f.

Flow diagram of Isolation of chemical constituents from *Semecarpus anacardium* L.f Nuts

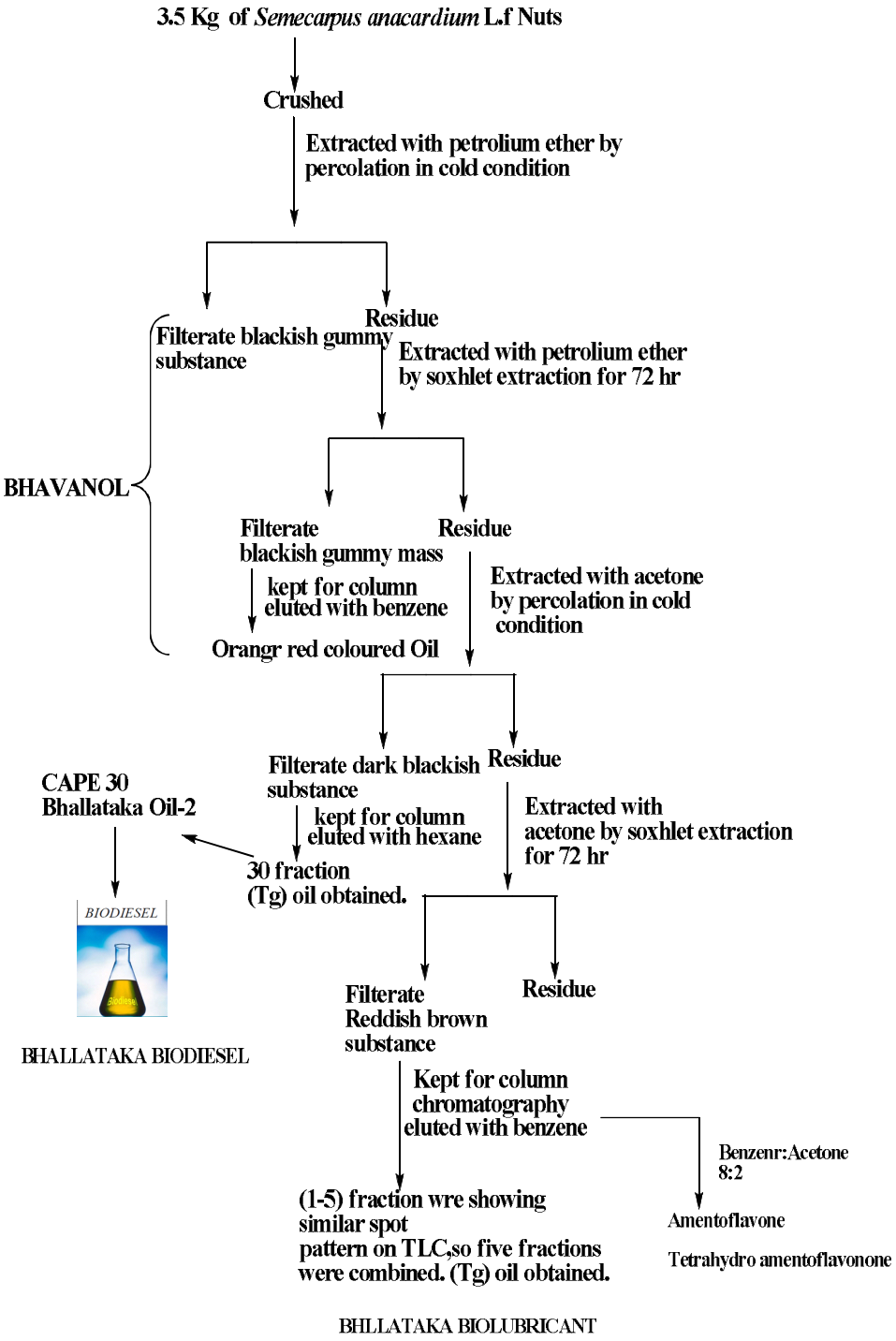

Fig. 3: Flow diagram of Isolation of chemical constituents from *Semecarpus anacardium* L.f Nuts

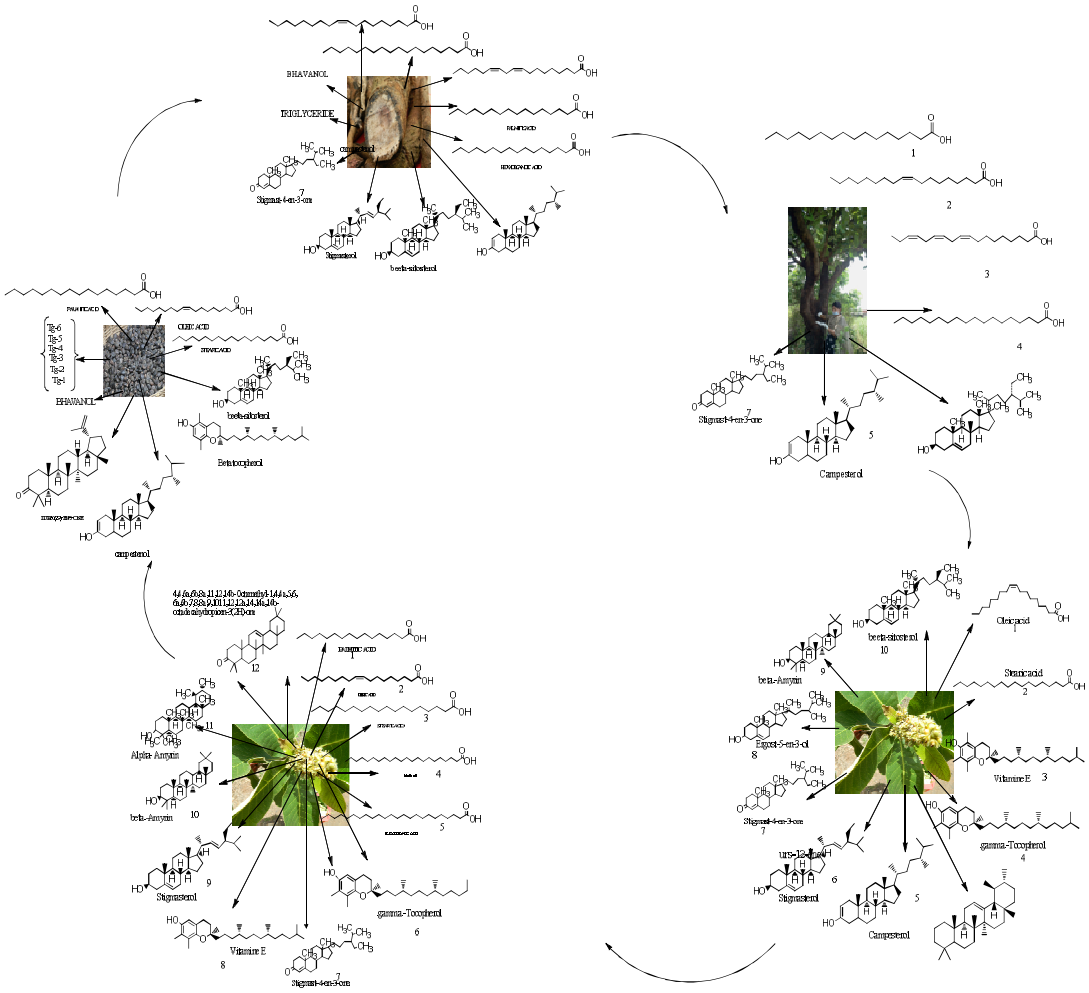

Fig.4: An over view of ***Semecarpus anacardium*** L.f (Bhallataka)