Preface

Increasing cost of fossil fuels and environmental concern have gained imperative consideration to search for alternate fuels. Among various alternative fuels, biodiesel has gained more attention in recent years due to its eco-friendly nature. As considering environmental pollution, many countries have ignored this issue liable for climate change such as transportation sector contributes significant amount of greenhouse gases (GHG) emission, particularly in developed as well as developing countries. To improve performance and emission, research has been focused on biodiesel which offers better solution to these problems. Biodiesel comprises of fatty acid alkyl esters obtained from transesterification of triglycerides existing in animal fats or vegetable oils.

Developing countries depend on other nations for fuel supply and hence their economy is affected largely by change in fuel cost and resources. India imports crude oil from Middle East countries and depends on them. Thus, for economy of India, energy security is a preeminent challenge. To overcome on these challenges, biodiesel offers a hope for self-dependence and has been accentuated during past decades for viable alternative in diesel engines. Biodiesel produced was studied as neat and in blended form in diesel engine with respect to engine performance and exhaust emission with fuel properties. Properties and composition of biodiesel vary from diesel fuel and lead to difference in performance, emission and combustion from engine. It has been proved that biodiesel helps to reduce GHG emissions due to nonappearance of aromatic compound as well as sulphur. It is renewable,

nontoxic with high oxygen content which decreases emissions associated to poor combustion.

Heterogeneous catalyst usage for biodiesel production is environment friendly route since it does not necessitate water in separation and eventually reduces the cost by regeneration as well as by reusability. This reduction in cost is adequate for biodiesel to compete with fossil diesel. The main characteristics of these catalysts are that in case of basic transesterification reaction, they share basic sites on their surface. beta-potassium dizirconate, barium zirconate, calcium aluminate and beta-tricalcium phosphate, all heterogeneous solid base catalysts were synthesized and characterized by several techniques. Waste vegetable oil (WVO) and *Pongamia pinnata* (Karanja) oil were used as feedstocks in transesterification reaction. Direct transesterification was performed for waste vegetable oil, whereas, esterification followed by transesterification was performed for the synthesis of biodiesel from *Pongamia pinnata* oil by using the above heterogeneous catalysts. Investigations were carried out on influence of reaction variables such as catalyst concentration, oil: methanol molar ratio, reaction temperature, reaction time, stirring speed and catalyst reusability on biodiesel conversion to achieve optimum reaction conditions at each stage. Physicochemical properties of biodiesel were deliberated as per ASTM standards.

This thesis includes synthesis of non-conventional heterogeneous catalysts and their characterization; properties of waste vegetable oil and karanja oil; transesterification reactions for biodiesel production and impact of reaction variables on FAME conversion; physical and chemical properties of biodiesel produced via transesterification reaction was studied.