CHAPTER 1
INTRODUCTION

The world is developing not only industrially but also technologically. Along with these developments the concern has also grown for an economy and environment particularly with the issues like global warming and depleting oil reserves. These issues are driving worldwide interest in exploring for renewably sourced materials that can be used as feedstock for biofuel production. When a fuel is obtained from organic materials such as energy crops, residues of crop or waste biomass it is termed as biofuel.

Ethanol can be a best option to mitigate the problems associated with the rising energy demands across the world. An advantage of biomass-based biofuels with respect to fossil fuels is that it significantly reduces the green house gas emission to an extent of 85% (Perlack et al. 2005). Of all biofuels, ethanol has been trusted as an alternate fuel for the future and is already produced on a huge scale (about 14-26 million tons) worldwide. Ethanol is not only an oxygenated fuel with high octane value but also provides superior performance because it is known to run combustion engines at higher compression ratios (Wheals et al. 1999). Ethanol can be blended with petrol in various proportions, such as E10, E85, E95, containing 10%, 85% and 95% of ethanol respectively or can be used as biofuel in its pure state (E100). When 10% ethanol is blended with petrol it does not require any alterations in engine (Balat 2009). The blending of ethanol into petroleum-based automobile fuels can significantly decrease petroleum consumption. Methyl tertiary butyl ether (MTBE) is a known toxic contaminant in ground water. Ethanol can be a safer substitute to this common additive in gasoline (Wang and Sheu 2000). Evaporative emission of ethanol is lower than gasoline due to its lower vapor pressure than that of latter’s (ethanol’s Reid vapor pressure is 16 KPa versus 71 for typical gasoline). Use of ethanol reduces the number and severity of vehicle fires because ethanol has lower flammability in air (1.3 to 7.6% v/v) than compared to gasoline (3.5 to 19% v/v) (Goldemberg et al. 1993). Ethanol has a lower energy density than gasoline [ethanol has lower and
higher heating values of 21.2 and 23.4 MJ/L, respectively; for gasoline the values are 30.1 and 34.9 MJ/L] when used as a neat fuel (McMillan 1997).

Government of India introduced Ethanol Blended Petrol Programme (EBPP) in January 2003 with a vision of blending ethanol with petrol. National Policy on Biofuels formulated by the Ministry of New and Renewable Energy (MNRE) in 2009 recommended the blending of at least 20% biofuels with diesel and petrol by 2017. This would increase the bioethanol requirement of 3.4 billion litre by 2020 (Basavaraj et al. 2013). As the present requirement of ethanol for potable and chemical sector is fulfilled solely by molasses, to suffice the above need of blending we need to cultivate 20-23% sugarcane (to generate molasses) in excess of what is the present requirement of sugar industry. To cultivate 736.5 million tons of sugarcane, to meet the molasses demand, an area of 10.5 million hectare will be required which seems to be rather impossible as it will deprive the production of food crops (Shinoj et al. 2011, Ray 2012). Subramanian et al. (2005) stated that to produce ethanol from various feed stocks or organic matter we should not rely solely on molasses.

First generation process of bioethanol production from sugarcane and starch rich feed stocks will require increase amount of cultivable land and this will lead to hike in food prices (Uppal 2007, Mitchell 2008).

Use of lignocellulosic material for bioethanol production is a second generation process and is one of the best approaches because of its widespread abundance, easy procurement and affordable cost. Agro-industrial wastes such as husk, shell, peel, straw, stem, stalk, bagasse are generated from sugarcane or sweet sorghum milling, during their industrial processing. Wastes are generated in abundance and its availability is throughout the year. About 154-185 x 10^6 tons wheat straw and 317-380 x 10^6 tons of bagasse is produced per year globally (Carmen 2009). India produces 179 metric tons/ year sugarcane bagasse on an average, second after Brazil (Kapoor et al. 2006). Taking estimated production of fruits in India at 75 x 10^6 tons (in 6383x10^3 ha of land), the total waste generated comes to 25 million tons per annum (India Agricultural Research Data Book 2013). Due to tropical climate of India, the pineapple (Ananas cosmosus) is one of
the leading produce in the India, but pineapple peelings have no commercial value, and thus discarded leading to waste management problems. In the pineapple canning manufactures, the waste usually reaches 60% of the processed pineapple (Itelima et al. 2013). India and China together shares 91% of the world litchi (*Litchi chinensis*) production (Jiang et al. 2003). According to a report of National Horticulture Board, New Delhi (2005), 429,600 metric tons of litchi from 60,200 ha of land is annually produced in India. Easy availability, high cellulose content and no competition with the food chain makes peels of sweet orange (*Citrus sinensis var mosambi*) and *A. cosmos* an ideal substrate for bioethanol production. Peels of *C. sinensis var mosambi* constitute an important non-edible lignocellulosic biomass, which are generated widely throughout India.

Various biomolecules like carbohydrates and proteins; fibers and minerals are found in these agro-wastes. These are compounds of industrial engrossment. Due to this richness in composition, one can find a large scope both from economic and environmental aspects if these wastes are reutilized. The economical aspect is based on the fact that such wastes may be used as low-cost raw materials for the production of bioethanol, finally reduces the production costs. Because most of the agro-industrial wastes also contain phenolic compounds of toxic prospective; which may cause downturn of the environment if discharged to the nature, it is but natural that an environmental concern is also associated with it.

Taking all the above aspects into consideration, the aim of the study is;

To develop an economical and environment friendly bioprocesses to produce bioethanol from lignocellulosic waste materials like wheat straw, bagasse, peels of *Litchi chinensis, Citrus sinensis var mosambi* and *Ananas cosmos*us. To achieve the above aim, experiments were scientifically designed using Response Surface Methodology (RSM) for developing, improving, and optimizing the ethanol yield.
Objectives

- Screening of most suitable physical and chemical parameter at the stage of pretreatment by various strategies.
- Thin layer chromatography of the substrates after pretreatment to evaluate chromatographic separation studies thus analyzing comparative separation of sugars.
- High Performance Liquid Chromatography (HPLC) to obtain the sugar profile of the hydrolysate samples of standardized pretreatment method.
- Determination in chemical change of the surface of pretreated substrate by FTIR analysis thereby providing mapping profile.
- Selection and optimization of the parameters like, inoculum concentration, temperature and nutrient factors for bioethanol production from various microbial cultures.

This study holds significance as it is ecofriendly and economical, and will not be in any way detrimental to the environment. This will consequently lessen the pollution worldwide. This research will also answer the crisis of looking for a clean, alternative and environment-friendly energy source.