1. INTRODUCTION

Energy consumption has increased steadily during the last century as the world population has grown and more countries have become industrialized. Crude oil has been the major resource to meet the increased energy demand. Campbell and Laherrere (1998) used several different techniques to estimate the current known crude oil reserves and the reserves as yet undiscovered and concluded that the decline in worldwide crude oil production will begin before 2010. The increasing dependency on oil imports and the growing emissions of greenhouse gases are the two main concerns which justify the introduction of public policy incentives in Europe for developing lignocellulosic ethanol. According to International Energy Agency (2008) the total world demand for oil is projected to rise by 1% every year mostly due to increasing demand in emerging markets, especially India (3.9%/year) and China (3.5%/year). In view of continuously rising petroleum costs and dependence upon fossil fuel resources, considerable attention has been focused on alternative energy resources. Production of ethanol or ethyl alcohol (CH₃CH₂OH) from biomass is one way to reduce both the consumption of crude oil and environmental pollution (Lang et al., 2001). Bioethanol represents one of the most prominent technical options due to the possibility of blending it with fossil fuels and using in the existing automobiles without significant adaptations. Unlike fossil fuels, ethanol is a renewable source produced through fermentation of sugars. Ethanol is widely used as a partial gasoline replacement in the USA. Fuel ethanol that is produced from corn has been used in gasohol or oxygenated fuels since the 1980s. These gasoline fuels contain up to 10% ethanol by volume. Ethanol has a higher octane (ability to resist compression) rating than gasoline, enabling combustion engines to run at a higher compression ratio and thus giving a superior net performance (Wyman, 1996). Additionally, the vapor pressure of alcohol is greater and the heat
of vaporization is higher than that of gasoline, which is primarily responsible for the increased power outputs by alcohol. Production of ethanol from sugars or starch impacts negatively on the economics of the process, thus making ethanol more expensive than fossil fuels. Hence the technology development focus for the production of ethanol has shifted towards the utilization of residual lignocellulosic materials to lower production costs.

Bioethanol may serve both as an additive or complete replacement for petroleum-derived transportation fuels, particularly gasoline in spark ignition (SI) engines. The volumetric energy fraction of ethanol is approximately 66% that of gasoline, suggesting a one-third reduction in the total kilometers per volume of ethanol consumed. However, review of the comparative physical chemistry data provides insight into why ethanol combustion results in 15% higher efficiency. Ethanol (C$_2$H$_5$OH, 34.7wt% oxygen) is a partially oxidized fuel compared to gasoline (C$_4$-C$_{12}$, 0wt% oxygen), resulting in a lower stoichiometric air-to-fuel ratio. Therefore, a larger mass or volume of ethanol compared to gasoline is required to yield the same caloric output from combustion. A higher compression ratio results in higher power output, efficiency, and consequently favorable fuel economy. Compared to gasoline, there is only a 20–25% reduction in kilometer efficiency. Furthermore, as a result of the significantly higher latent heat of vaporization for ethanol (1177kJ/kg compared to 348kJ/kg at 60° C) there is an effective engine cooling. This leads to significant reductions in CO gas and NOx gas emissions, with 85% ethanol blends of gasoline (referred to as E-85) yielding NOx gas emission reductions of 20% compared to pure gasoline. However, the emission of reactive aldehydes, including acetaldehyde and formaldehyde, is increased. Several studies on the effect of ethanol–gasoline blends (up to 60% ethanol) on engine performance and exhaust emissions have suggested that proper fine tuning of engine parameters can lead to excellent performance with significantly reduced hydrocarbon and
CO gas emissions. Second generation bioethanol production uses relatively cheap, abundant and renewable agricultural by-products, such as corn stover, wheat straw or forestry residues. Compared to first generation bioethanol production, the use of lignocellulosic byproducts results in less competition between food and fuel application.

Bioethanol is seen as a good fuel alternative because the source crops can be grown renewably and in most climates around the world. In addition, the use of bioethanol is generally CO$_2$ neutral. This is achieved because in the growing phase of the source crop, CO$_2$ is absorbed by the plant and oxygen is released in the same volume that CO$_2$ is produced in the combustion of the fuel. This creates an obvious advantage over fossil fuels which only emit CO$_2$ and other poisonous emissions. In the 1970s, Brazil and the USA started mass production of bioethanol - from sugarcane and corn respectively. Smaller scale production started more recently from lignocellulosic feedstock derived from agricultural residue. However, lignocellulosic biomass requires a more complicated hydrolysis stage. The reason for this is that cellulose in the wood contains carbohydrate polymers called cellulose. Cellulose is made up of long chains of glucose and a more complex set of enzymes are required to break the long chains. Therefore, lignocellulosic bioethanol is technically more demanding and thus more expensive. Work at the moment is ongoing to enhance the pre-treatment methods such as steam explosion, ammonia steam explosion, acid processing and use of efficient enzymes. Another area for development is fractionation technology so one can use more variable biomass, such as agriculture and forest crop residues and urban waste. The chemical structure of the crop and forest residues are highly variable which creates added complexity compared to the homogeneity of starch or sugar crops. Spain, France and Sweden mostly derive starch from wheat and sugar beet. (Yi Zheng et al., 2009)
Bioethanol has mostly been used as a biofuel for transport, especially in Brazil. Indeed it was in Brazil that the first bioethanol fuelled cars emerged on a large-scale. A large volume of bioethanol is also used in Europe as a blend with petrol at 5%. It is used as a substitute for lead as an oxygenating additive and has a high octane rating, which improves performance. Although the eventual target is the private consumer, few are aware of bioethanol’s potential to, at least, partly replace petrol as a transport fuel in Europe. Stakeholders in the Bioethanol Fuel Market - bioethanol producers, fuel suppliers, car manufacturers, the government - support is also extremely important as was the case in Brazil in the late 1970s and in the USA today. Bioethanol has been endorsed by the President and helped by subsidies and tax breaks. In addition, supermarkets who provide petrol stations to customers are seeing the opportunity to provide petrol/ethanol blends from 5-85% (E5 –E85). Even though most experts agree that up to a 10% mix will not damage modern car engines. The manufacturer warranty for standard cars is set at 5%. Above this level to maintain the warranty, the car engines need to be modified or one has to buy a fuel flexible vehicle (FFV).

The opportunity to reduce dependence on fossil fuels, while reducing CO₂ is of strategic importance today. Since there is increased consensus among experts on the reality of human induced global warming and the repercussions which are associated with it, the potential to use carbon neutral fuels like bioethanol can help us stop (or slow down) this negative impact on the environment. As long as the plantation of the bioethanol feed stocks are done in a sustainable way without compromising native species habitats and endangering the local biodiversity, there is no reason why bioethanol cannot be one of the energy solutions for today. The potential for bioethanol to create jobs is immense in farming, biorefineries, the chemical industry, the fuel supply sector as well as fuel-flexible vehicle engineering.
economic climate is ripe for investing in bioethanol production. The bioethanol by-products can provide useful side revenue through use as animal feed and power generation.

In this respect, the sustainable production of bioethanol from lignocellulosic biomass is expected to become one of the most credible alternatives to fossil fuels. Significant efforts in research, development and demonstration (RD and D) are being undertaken in this direction.

Using ethanol-blended fuel for automobiles can significantly reduce petroleum use and exhaust greenhouse gas emission (Wang et al. 1999). Ethanol is also a safer alternative to methyl tertiary butyl ether (MTBE), the most common additive to gasoline used to provide cleaner combustion (McCarthy and Tiemann, 1998). A dramatic increase in ethanol production from cornstarch-based technology may not be practical because corn is used as food and feed. The other source for low-cost ethanol production is lignocellulose from crop residues, grasses, sawdust, wood chips, and solid animal waste. Cellulosic resources such as paper, cardboard, wood, agricultural residues, waste papers and fibrous plant materials from forests which comprise about 80% of the world’s biomass (Seungdo Kim et al., 2004).

The world ocean with a coastline of 312,000 km (193,000 miles) and a volume of $137 \times 10^6$ km$^3$, is the largest ecosystem on earth, and has been used for a variety of purposes by man for millennia. Because of its large volume and vast area, influence of the ocean on world climate is profound. Microorganisms occur abundantly in ocean and play important role in human life. Marine microbes represent a potential source for commercially important bioactive compounds and their bioremediation capabilities are also remarkable. They also play a crucial role in decomposition of organic matter and cycling of nutrients. Microbes also serve as food for some organisms living in ocean bed. Our knowledge of marine microbial diversity has, however, been
severely limited because of our dependence on laboratory culture methods for their isolation. In recent years marine microorganisms have become important in the study of novel microbial products exhibiting antimicrobial, antiviral, antitumor as well as anticoagulant and cardio active properties. (Surajit das et al., 2006)

Seventy per cent of our planet is covered by water and our seas are home to over 8,500 plants and animals. This variety of life plays a key role in supporting a wide range of goods and services. The marine environment can be described or characterized at a number of different scales, ranging from ocean-level processes through to those that occur at species and genetic level (Connor et al., 2002). The scales of relevance here are marine landscapes, habitats and species; their inter-relationship can be expressed as follows:

Species provide the globally accepted original classification of biological diversity, with well-established rules of taxonomy to distinguish between different types. Their classification is arranged in a hierarchy of genera, families, orders, classes and phyla.

Habitats comprise suites of species (communities or assemblages) that consistently occur together, but which are derived from different parts of the taxonomic hierarchy (e.g. kelps, molluscs and fish in a kelp forest habitat). Their classification can also be structured in a hierarchy (biotopes, biotope complexes, broad habitats), reflecting degrees of similarity.

The approach to classification or characterization at each scale differs, each adopting differing factors to suit the requirements at that scale. Whilst the classification (taxonomy) of species, and to a lesser degree habitats, is now well established the seascapes concept and their characterization is a more recent approach to characterization of the marine environment.
The marine landscape concept was applied to the seabed and water column of the Irish Sea as part of the Irish Sea Pilot.

Each species tends to live within a certain environment; that is, it has a preference for a combination of environmental factors (a niche), such as the substratum, temperature, salinity and hydrodynamic conditions that it is able to live within. The tolerance to different environmental conditions varies between species; it can be rather broad for some very common species but much more tightly defined for others. The niche occupied by a species may vary both temporally and spatially and is influenced not only by its physiological requirements and tolerance to change but also by the interactions between species, i.e. competition and predator-prey relationships.

In any particular place on the shore or seabed, a suite of species will occur, each adapted to the particular environmental conditions of that place, such as the conditions of an intertidal mudflat. Where such a suite of species occurs in other locations under similar environmental conditions, it can be defined as a community (or association or assemblage) of species which is occurring within a particular habitat type. The collective term biotope is now in common usage to encompass both of these biotic and abiotic elements.

Marine microbes rule the world. Earth has the largest ecosystem in the form of Oceans and 90% of its biomass is microbial. There are more than a billion micro-organisms living in each litre of sea water, and it is now known that microbes dominate the abundance, diversity and biological activity of the ocean. They comprise 98 percent of the biomass of the world's oceans, supply more than half the world's oxygen, are the major processors of the world's greenhouse gases and have the potential to mitigate the effects of climate change. The diversity of microbial life in the oceans is extremely high and spans all known groups of Bacteria, Archaea and microbial
eukaryotes. Marine bacteria transform carbon, nitrogen, sulphur and iron compounds, thus playing crucial roles in the global material cycle. These bacteria display widely varying adaptations, e.g., to food gradients in sediments, to low and high temperatures and to high pressure in the deep sea. They include cellular life forms: bacteria, fungi, algae and plankton along with the viruses that multiply on the cellular life forms.

Solid state fermentation, the culturing of microorganisms on moist solid substrates for harvesting bioactive compounds has generated great deal of interest because of its advantages over submerged fermentation even though marine microorganisms are used to aquatic environment.

Lignocellulose is the major structural component of woody plants and non-woody plants such as grass and represents a major source of renewable organic matter. Lignocellulose consists of lignin, hemicellulose and cellulose. The chemical properties of the components of lignocellulosics make them a substrate of enormous biotechnological value (Malherbe and Cloete, 2003). Large amounts of lignocellulosic “waste” are generated through forestry and agricultural practices, paper-pulp industries, timber industries and many agro industries and they pose an environmental pollution problem. Sadly, much of the lignocellulose waste is often disposed off by burning (Levine, 1996). However, the huge amounts of residual plant biomass considered as “waste” can potentially be converted into various different value added products including biofuels, chemicals, improved animal feeds and human nutrients.

Lignocellulolytic enzymes have significant potential applications in various industries including chemicals, fuel, food, brewery and wine, animal feed, textile and laundry, pulp and paper industry, and agriculture.
The raw materials are classified into three categories of agricultural raw materials: (1) simple sugars from sugar cane, sugar beet, molasses, and fruits; (2) starch from grains, potatoes, and root crops; and (3) cellulose from wood, agricultural residue, municipal solid wastes, waste papers, and crop residues.

Lignocellulose is the major structural component of woody plants and non-woody plants such as grass and represents a major source of renewable organic matter. Lignocellulose consists of lignin, hemicellulose and cellulose, (Fengel and Wegener, 1989; Eaton and Hale, 1993). Cellulases and hemicellulases have numerous applications and biotechnological potential for various industries including chemicals, fuel, food, brewery and wine, animal feed, textile and laundry, pulp and paper and agriculture (Wong and Saddler, 1992a,b; Bhat, 2000; Sun and Cheng, 2002; Beaucheminent al., 2001, 2003). The saccharification process of cellulose waste relies on participation of cellulosic organisms and their cellulase enzymes (Beguin and Aubert, 1994; Singh and Hayashi, 1994; Lynd et al., 2002).

The hydrolysis of the lignocelluloses to fermentable sugars seems to be the main reason for the high producing cost of cellulosic enzymes from lignocellulosic wastes. The presence of lignin in cellulosic substrates and the crystalline nature of cellulose make it inaccessible to cellulase. Successful utilization of cellulosic materials as renewable carbon sources is dependent on the development of economically feasible process technologies for cellulase production, and for the enzymatic hydrolysis of cellulosic materials to low molecular weight products such as mono saccharides. Plate assays are efficient methods used in screening fungi for lignocellulose degrading enzyme production. Such tests give a positive or negative indication of enzyme production. They are particularly useful in screening large numbers of fungal isolates for several classes of enzyme, where definitive quantitative data are not required. The reagents required are
all commonly available and relatively inexpensive. Cellulases have been essentially utilized for
the improvement of nutritional values of animal feed and hence the hyper producing species
screened for cellulases can be utilized for enhanced livestock production. The conversion of
cellulosic mass to fermentable sugars through biocatalyst cellulase derived from cellulolytic
organisms has been suggested as a feasible process that has the potential to reduce dependence
on fossil fuels.

Lignocellulosic biomass has great potentials for the production of affordable fuel ethanol
because it is less expensive than starch (e.g., corn, potatoes) and sucrose (e.g. sugarcane)
producing crops and available in large quantities. Lignocellulosic biomass typically contains
50%-80% (dry basis) carbohydrates that are polymers of 5C and 6C sugar units. Most
carbohydrates can be processed either chemically or biologically to yield ethanol. The
prerequisite in the utilization of lignocellulose is to efficiently yield a fermentable hydrolysate
rich in glucose from the cellulose content present in it. Employment of enzymes for the
hydrolysis is considered the most viable strategy, with advantages over chemical conversion
routes because of minimal byproduct formation, low energy requirements, mild operating
conditions, and environment friendly processing. (Galbeet al., 2002).

Lignocellulosic materials require tremendous efforts in achieving a high ethanol yield;
establishing infrastructure for the collection system, increasing the thermal efficiency of
generating electricity and steam, and the difference in process steps between starch and
lignocellulosic feedstocks is that lignocellulosic biomass requires a more complicated hydrolysis
stage.
Pretreatment of lignocellulose through acid hydrolysis or other means prior to enzyme treatment has greatly improved saccharification as well as production of free sugars. Extensive research has been carried out on conversion of lignocellulosic materials to ethanol in the last two decades (Dale et al., 1984; Wright, 1998; Azzam, 1989; Cadoche and Lopez; 1989; Reshamwala et al., 1995; Bjerre et al., 1996; Duff and Murray, 1996). The conversion includes two processes: enzymatic hydrolysis of cellulose in the lignocellulosic materials to fermentable reducing sugars, and fermentation of the sugars to ethanol. The hydrolysis is usually catalyzed by cellulase enzymes, and the fermentation is carried out by yeasts or bacteria.

The most studied process involves some form of chemical or physical pretreatment that disrupts the hemicellulose-lignin-cellulose combination in plant cell walls and modifies the cellulose fibers to make the cellulose more accessible to enzymes, followed by enzymatic hydrolysis to produce sugars, and fermenting the sugars to ethanol. Most processes are designed to produce ethanol, but the technology for fermenting sugars to ethanol is very well established and high concentrations of ethanol can be achieved (15%).

According to the degree of crystallinity, cellulose is classified into crystalline and para-crystalline (amorphous) cellulose. Cellulose can be hydrolytically broken down into glucose either enzymatically by cellulolytic enzymes or chemically by sulfuric or other acids. Hemicellulose, a branched polymer composed of pentose (5-carbon) and hexose (6-carbon) sugars, can be hydrolyzed by hemicellulases or acids to release its component sugars, including xylose, arabinose, galactose, glucose and/or mannose. Hexoses such as glucose, galactose, and mannose are readily fermented to ethanol by many naturally occurring organisms, but the pentoses including xylose and arabinose are fermented to ethanol by only a few microorganisms and with relatively low yields. Since xylose and arabinose generally comprise a significant
fraction of lignocellulosic biomass, especially hardwoods, agricultural residues and grasses, it must be utilized to make economics of biomass ethanol processing feasible.

Four biologically mediated events, could occur in the course of ethanol production from cellulosic biomass i.e., i) cellulase production, ii) cellulose hydrolysis, iii) hexose and pentose production and fermentation. (Lynd et al., 2002).

Process configurations, including Separate Hydrolysis and Fermentation (SHF), Simultaneous Saccharification and Fermentation (SSF), Simultaneous Saccharification and Co-Fermentation (SSCF), and Consolidated Bioprocessing (CBP), proposed for the biological steps differ in the degree to which these events are varied depends on the substrate sources e.g., hardwoods, agricultural residues and grasses. All these must be utilized to make economics of biomass ethanol processing feasible. The development of recombinant ethanogenic strains resulted in bacteria and yeasts capable of co-fermenting pentoses and hexoses into ethanol and other value-added products at high yields. (Sues et al., 2005).

Cellulases are currently the third largest among industrial enzymes worldwide, because of their use in cotton processing, paper recycling, detergent industry, juice extraction, and animal feed additives. However, cellulases will become the largest volume industrial enzyme, if they are used for production of bioethanol for transport industry. Currently, industrial cellulases are almost all produced from aerobic cellulolytic fungi, such as Hypocreajecorina (Trichodermareesei) or Humicolainsolens (Schulein, 1998). This is due to the ability of engineered strains of these organisms to produce extremely large amounts of cellulase (over 100g per liter), the relatively high specific activity of their crude cellulase on crystalline cellulose.
A diverse spectrum of lignocellulolytic microorganisms, mainly fungi (Falcón et al., 1995, Baldrian and Gabriel, 2003) and bacteria (McCarthy, 1987; Vicuña, 1988, Zimmermann, 1990) have been isolated and identified over the years and this list continues to grow rapidly. By 1976 itself, an impressive collection of more than 14 000 fungi active against cellulose and other insoluble fibres were collected (Mandels and Sternberg, 1976). Despite the impressive collection of lignocellulolytic microorganisms only a few have been studied extensively and mostly *Trichoderma reesei* and its mutants are widely employed for the commercial production of hemicellulases and cellulases (Esterbauer et al., 1991; Nieves et al., 1998; Jorgensen et al., 2003). This is so, partly because *T. reesei* was one of the first cellulolytic organisms isolated in the 1950s and because extensive strain improvement and screening programs, and cellulase industrial production processes, which are extremely costly, have been developed over the years in several countries. *T. reesei* might be a good producer of hemi-and cellulolytic enzymes but is unable to degrade lignin. The white-rot fungi belonging to the basidiomycetes are the most efficient and extensive lignin degraders (Akin et al., 1995; Gold and Alic, 1993), with *Phanerochaete chrysosporium* being the best-studied lignin-degrading fungus producing copious amounts of several lignocellulolytic enzymes. *P. chrysosporium* has drawn considerable attention as an appropriate host for the production of lignin-degrading enzymes or direct application in lignocellulose bioconversion processes (Bosco et al., 1999; Ruggeri and Sassi, 2003). Less known, white-rot fungi such as *Daedalea flavida*, *Phlebia fascicularia*, *P. floridensis* and *P. radiate* have been found to selectively degrade lignin in wheat straw and hold out prospects for bioconversion biotechnology where the aim is just to remove the lignin leaving the other components almost intact (Arora et al., 2002). Less prolific lignin degraders among bacteria such as those belonging to the genera *Cellulomonas*, *Pseudomonas* and the actinomycetes
Thermomonospora and Microbispora and bacteria with surface-bound cellulase-complexes such as Clostridium thermocellum and Ruminococcus sp. are beginning to receive attention as representing a gene pool with possible unique lignocellulolytic genes that could be used in lignocellulase engineering (McCarthy, 1987; Eveleigh, 1987; Vicuña, 1988; Shen et al., 1995; Miller (Jr) et al., 1996). It is conventional to consider lignocellulose-degrading enzymes according to the three components of lignocellulose (lignin, cellulose and hemicellulose) which they attack but bearing in mind such divisions are convenient classifications since some cross activity for these enzymes have been reported (Kumar and Deobagkar, 1996). The exact mechanism by which lignocellulose is degraded enzymatically is still not fully understood but significant advances have been made to gain insight into the microorganisms, their lignocellulolytic genes and various enzymes involved in the process.

Cellulose it has become a polymer of considerable interest from the point of view of bioethanol production. Identification and study of marine microorganisms with unique physiological traits can be a very powerful tool for discovering novel cellulolytic enzymes of possible biotechnological interest. There exists enormous amount of data concerning gene diversity in marine environments.

Lignin fills the spaces in the cell wall between cellulose, hemicellulose, and pectin components for covalently linking to hemicellulose and polysaccharides, forming the lignocellulosic substrates (Chabannes et al., 2001). These substrates are degraded by lignolytic and cellulolytic enzymes which are secreted by certain fungi and bacteria. The lignin degrading enzymes present in these fungi and bacteria are manganese peroxidase, Most marine environments contain only dilute substances that can be used for metabolism and growth. In contrast, natural surfaces tend to collect and concentrate nutrients by hydrophobic interactions (Beveridge et al., 1997).
Lignin is a complex chemical compound, most commonly derived from wood and cross-linked racemic macromolecule with molecular masses in excess of 10,000 units. It is relatively hydrophobic and aromatic in nature and present in plants and some algae, and is one of the most abundant organic polymers on Earth, exceeded only by cellulose lignin peroxidase and laccase (Harazono et al., 2003) whereas the cellulose degrading enzymes are endo-1,4-beta-D-glucanase (endoglucanase), exo-1,4-beta-D-glucanase (exoglucanase) and beta-glucosidase (Bhat and Bhat, 1997).

Diversion of corn from food and feed production can be significantly reduced if other agriculture and forestry products such as crop residues, herbaceous crops, saw dust and wood chips are used instead of corn. The bioconversion of lignocellulosic materials to ethanol contains two steps: hydrolysis of cellulose to reducing sugars and the following fermentation by yeast or bacteria to convert fermentable sugars to ethanol. The hydrolysis process currently used is either concentrated acid hydrolysis or enzymatic hydrolysis. Compared to acid hydrolysis, enzymatic hydrolysis is milder and more specific, but it requires pretreatment to improve the enzymatic digestibility. The pretreatment process can remove hemicellulose, reduce cellulose crystallinity, and increase the porosity of the materials. Combination of steam explosion, ammonia fiber explosion, and acid or alkaline pretreatment processes have been extensively investigated (Morjanoff and Gray, 1987; Cadoche and Lo´pez, 1989; Holtzapple et al., 1991; Torget et al., 1991; Bjerre et al., 1996). Among all the pretreatment methods, dilute acid pretreatment has been effectively solubilize hemicellulose into monomeric sugars (arabinose, galactose, glucose, mannose, and xylose) and soluble oligomers, thus improving cellulose conversion. Compared to other pretreatment methods, it is especially useful for the conversion of xylan in hemicellulose to
xylose that can be further fermented to ethanol by many microorganisms (McMillan, 1996). Grohmann et al., (1985) reported the sulfuric acid pretreatment of wheat straw and aspen wood.

A wide variety of diseases and medical problems represent a challenging threat to humans, who since ancient times have searched for natural compounds from plants, animals, and other sources to treat them. Although the process of finding effective treatments against fatal diseases is difficult, extensive searches for natural bioactive compounds have previously yielded some successful results. The isolation and identification of specific natural compounds led to the development of folk medicine, and humans learned to separate the isolates into medicinal drugs, enzymes and many other novel compounds. Most of the products today are derived from natural products, most of which are obtained from terrestrial organisms. However, due to continuous and exhaustive research, land-based natural bioactive compounds have become increasingly difficult to find. Instead, water-based natural compounds have become a more promising source, not only from a pharmacological view, but also for industrial and commercial applications. Theoretically, life is considered to have originated in the sea and, as a result of evolutionary changes, developed into a wide variety of diverse biological systems. The Earth’s surface consists of 70% water, which is inhabited by 80% of all life forms, and consequently aquatic organisms have a greater diversity than their terrestrial counterparts. As research into the marine environment is still in its early phases, many mysteries associated with aquatic fauna and flora have yet to be discovered. Therefore, the marine environment has recently become an attractive research subject for many investigations, because of its rich biodiversity. It should be noted that the number of microbial organisms isolated from the vast ocean territories continues to increase each year. Laatsch et al. (2002) isolated and described nearly 250 marine bacterial metabolites versus 150 isolated from terrestrial bacteria between 2000 and 2005. Research into marine microorganisms and their
metabolites has therefore become a major task in the search for novel pharmaceuticals. Currently, 13 natural products isolated from marine microorganisms are being tested in different phases of clinical trials, and a large number of others are in preclinical investigations, thus highlighting the potential of marine natural compounds. Despite thousands of marine bioactive compounds having been isolated and identified, Marine Microorganisms and Their Bioactive Isolates Marine and terrestrial microflora differ from each other due to the influence of their respective environmental conditions. Microorganisms living in the sea must be able to survive and grow in the water environment with low nutrition, high salinity, and high pressure. Marine microorganisms can be divided on the basis of habitat into psychrophiles (living at low temperatures), halophiles (living at high salinity), and barophiles (living under high pressure). Although these characteristics highlight the differences between marine and terrestrial microorganisms, it remains difficult to separate bacterial genera on the basis of habitat due to the ubiquitous presence of similar species in both environments. As such, most bioactive compounds have been isolated from bacteria in both environments. Marine bacteria, however, are attractive to researchers because they can potentially produce compounds with unique biological properties. Until now, marine Streptomyces, Pseudomonas, Pseudoalteromonas, Bacillus, Vibrio, and Cytophaga isolated from seawater, sediments, algae, and marine invertebrates are known to produce bioactive agents. They are able to produce indole derivatives (quinones and violacein), alkaloids (prodiginines and tambjamines), polyenes, macrolides, peptides, and terpenoids. The biodiversity of marine microbes and the versatility of their bioactive metabolites have not been fully explored. Microbes can sense, adapt and respond to their environment quickly and can compete for defense and survival by the generation of unique secondary metabolites. The ecology of marine natural products actually reveals that many of these compounds are chemical
weapons and have evolved into highly potent inhibitors of physiological processes in the prey, predators or competitors of the marine organisms that utilize them for survival. Venter et al. (2004) harnessed the power of high-throughput DNA sequencing and computational genomics to produce a massive dataset of large DNA fragments from the total microbial genomes extracted from the subtropical North Atlantic Ocean off the Bermuda coast. They studied the DNA extracted from surface seawater and within this identified more than 1.2 million new genes. The discovery of such an enormous number of new genes from such a small sample obtained in one of the world’s most nutrient impoverished bodies of water poses significant challenges to the emerging field of marine molecular microbial ecology and evolutionary biology. Marine microbes live in a biologically competitive environment with unique conditions of pH, temperature, pressure, oxygen, light, nutrients and salinity, which is especially rich in chlorine and bromine elements. There is no wonder that marine microbial metabolites exhibit special biological activities compared with ‘terrestrial’ bacteria. The emphasis of this review is on marine microbial producers and on how to maximize their potential to generate novel biologically active compounds.

Fungal biotechnology or ‘mycotechnology’, has advanced considerably in the last two decades. Terrestrial fungi are used in the production of various extracellular enzymes, organic acids, antibiotics and anti-cholesterolemic statins. They have been used as expression hosts as well as a source of new genes. With modern molecular genetic tools, fungi have been used as “cell factories” for heterologous proteins. Marine fungi form an ecological, and not a taxonomic group. Among these, the obligate marine fungi grow and sporulate exclusively in sea water, and their spores are capable of germinating only in sea water. On the other hand, facultative marine fungi are those from fresh water or a terrestrial milieu that have undergone physiological
adaptations that allow them to grow and possibly also sporulate in the marine environment. About 800 species of obligate marine fungi have been reported so far (Hyde et al., 2000).

Although the enzymatic route to pretreatment of lignocellulose has the highest cost at present, it has long-term potential for cost reductions compared to other more established routes such as concentrated acid and two-stage dilute acid hydrolysis. Native lignocellulose is recalcitrant to direct enzymatic hydrolysis. Therefore, pretreatment step is required to render the cellulose amenable to enzymatic attack before enzymatic hydrolysis. The overall purpose of pretreatment is to break down the shield formed by lignin and hemicellulose, disrupt the crystalline structure and reduce the degree of polymerization of cellulose. Pretreatment has been viewed as one of the most expensive processing steps within the conversion of biomass to fermentable sugar. With the advancement of technologies, pretreatment is believed to have scope for cost reduction. Pretreatment techniques have been developed for various end uses of biomass feed stocks. The present work deals with biomass pretreatment in preparation for enzymatic hydrolysis, and microbial fermentation of the products of hydrolysis for cellulosic ethanol production.

The research work is aimed at isolating industrially important microorganisms from marine sources capable of hydrolyzing cellulose and lignocelluloses producing simple sugars from different agricultural and domestic wastes which in turn can be fermented into ethanol by other organisms. The different raw materials have been screened and selected for bioconversion into alcohol through selected organisms. In addition, bioprocess optimization for the production of bioethanol has been carried out.
The objectives of the current research work were

- Isolation and culturing of microorganisms from marine environment. Preservation of stock cultures.
- Screening the organisms for production of cellulase, hemicellulase and ligninases under culture conditions.
- Identification of the microorganisms with relevant literature.
- Optimization of physical and chemical parameters for lignocellulose biodegradation by various enzymes.
- Estimation of bioethanol produced from sugars that are products of biodegradation of lignocellulose.

The results obtained through the experiments are presented here and interpreted in the light of current developments.