CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Lignocellulosic biomass (e.g. sawdust obtained from wood) provides a unique and sustainable resource for environmentally safe organic fuels and chemicals. Furthermore, due to the abundance of lignocellulosic materials, its conversion to ethanol (a biofuel) is considered one of the most important uses of biomass as an energy source in the modern world especially in the United States, Europe and Asia (Kheshgi, 2000).

Sawdust is produced as a small discontinuous chips or small fragments of wood during sawing of logs of timber into marketable sizes. The chips flow from the cutting edges of the saw blade to the floor during sawing operation, hence its name sawdust has hitherto been classified as a waste and a nuisance to man and its environment, but in recent years, researches have shown that sawdusts can be used in the production of biogas, packaging fillers, and lagging materials etc. The ethanol produced from the food crops were called first generation bio ethanol, whereas the ethanol produced from lignocellulosic biomass were called second generation biomass (Naik et al., 2009). But there were some concerns related to the first generation bio ethanol. Some of them were food security in which there was an issue that the use of food crops will increase the food prices. Greenhouse gases balance also seems to shift as the production of bio ethanol involves more and more food crops. Some environmental concern shows that bio ethanol production from crops might affect the biodiversity and water preservation. The quest for alternative energies has provided many ways to produce electricity, such as wind farms, hydropower, or solar cells. However, about 40% of the total energy consumption is dedicated to transports and in practice requires liquid fuels such as gasoline, diesel fuel, or kerosene. These fuels are all obtained by refining petroleum. This dependency on oil has two major drawbacks, burning fossil fuels such as oil contributes to global warming and importing oil creates a dependency on oil producing countries(Sadler, 2004).

Again, ethanol produced from biomass would be of great benefit to the transportation sector where it is assumed that two-third of Nigeria’s gasoline is consumed. Globally, fossil fuels are being threatened out of dominance over other fuels by the negative effects of fossil fuels products on the environment e.g. the release of greenhouse gases like carbon dioxide that contribute to global warming.

The pollution of air, water, and soil by fossil fuels products (carbon dioxide from fossil fuel combustion accounted for nearly 80% of global warming in the 1990s) (Hileman, 1999). The greatest proportion of the world’s energy requirements comes from petroleum exports especially in the Middle East, a region of high political tension, the reasons that necessitate efforts at finding alternatives to fossil fuels. Lignocellulose wastes refer to plant biomass wastes that are composed of cellulose, hemicellulose, and lignin as well as other minor components. Both the cellulose and hemicellulose fractions are polymers of sugars, and are thereby potential sources of fermentable sugars, which can be converted into other products (Ndukwe et al., 2013). Hemicellulose can be readily hydrolyzed under mild acid or alkaline conditions. The cellulose fraction is more resistant and therefore requires more rigorous treatment than the hemicellulose fraction. Currently, the second generation bio-products from lignocellulosic biomass such as bioethanol, biodiesel, and methane are increasingly being produced from wastes (residues) rather than from energy crops (jatropha, Swtich grass, and willow) because the latter competes for land and water with food crops that are already in high

demand. The use of food crops such as corn and sugarcane to produce biofuels is increasingly being discouraged due to the current worldwide rise in food prices. In order to minimize food-feed-fuel conflicts, it is necessary to integrate all kinds of bio-waste into a biomass economy (Mahro and Timm, 2007). Furthermore, the use of lignocellulosic waste offers a possibility of geographically distributed and greenhouse-gas-Favourable sources of products (Rubin, 2008). The Energy Commission of Nigeria reported that the fuel-wood resource constitutes 2.8% of the total renewable energy resources in Nigeria. Biomass reserve in Nigeria is put at 80 %, which equals to an equivalence of 1.645 billion tonnes of energy which is predicted to be potentially available for the next 100 years (Umar et al., 2000). Nigeria started the importation of ethanol from Brazil, and thereafter there was a call to mass produce cassava as a raw material for cellulosic ethanol production. The argument was that Nigeria has not properly produced enough cassava for its populace, it seems as if the push has died down .thus, the focus at establishing the fact that sawdust (hardwood) can be used as a veritable resource for bio-ethanol production (Nwakaire, 2013). Most importantly the greatest reason for research and development of alternative energy is the environmental consequences emanating from exploitation of fossil fuel the goal is to achieve zero net carbon (iv) oxide balance and improvement in urban air quality.

1.2 Statement of the Problem

In order to provide an alternative source of energy, fuels and chemicals from traditional fossil fuel, the project aims at considering how to generate energy in a systematic approach of utilizing wood wastes or residues (sawdust) generated from Nigerian forest reserves. Ethanol produced from sawdust can provide a cleaner environment, environmentally friendly fuel and stimulate community based jobs for our teeming youths and economic growth. Lignocellulosic biomass such as sawdust, poplar wood, sugar cane bagasse, herbaceous grasses, and municipal wastes provide a unique and sustainable resource for environmentally safe organic fuels and chemicals.

1.3 Aim and Objectives

Aim: To produce ethanol through the fermentation of reducing sugars resulting from the hydrolysis of pretreated sawdust (Hardwood). The objectives are as follows:

1. To characterize the sawdust
2. To assess the yield of bioethanol produced
3. To characterize the bioethanol produced
4. To evaluate the effects of process parameters on the yield of bioethanol.

1.4 Scope of the Study

This research work is restricted to the use of hardwood sawdust (Danta) as the substrate for the production of bioethanol. The extraction will be done by hydrolysis of sawdust to breakdown the cellulose and hemicelluloses to simple sugar.

1.5 Significance of the Study

Most African countries manage a large area of forest lands (reserves) from which timber is harvested. The sub-Saharan African population depends mainly on wood (Ceceski et al., 1979). However, due to lack of technical know-how needed for using wood and wood wastes (residues) for renewable energy and the huge finances involved (Walker, 2006). There has been general motivation towards the exploitation of wood and wood wastes as important sources for renewable energy (bio-energy). Biofuel sources are geographically more evenly distributed than fossil fuels. Lignocellulosic raw materials (biomass materials that have

cellulose, hemicellulose binded together with an insoluble substance known as lignin) minimize the potential conflict between land use for food (and feed) production and energy feedstock production. Presently, ethanol is produced from food reserve crops like cassava, beet or carrots (Momoh, 1997). These are meant for human consumption. The raw material is less expensive and can be produced with lower input of fertilizers, pesticides and energy.

The production of bioethanol from sawdust (lignocllulosic) is attracting interest due to the relative availability and less expensive nature of the raw material. Biofuels might also produce employment in rural areas. Wood and wood wastes as energy sources on an industrial scale in African countries have not been sufficiently looked into. Industries are more interested in the more convenient and high energy content fossil fuels (Momoh, 1997). In the field of research it is well known that there has been very little input of experimental data from African countries into the global development of wood and wood residues for the production of solid, liquid or gaseous fuels. For environmental reasons, ethanol, a clean burning fuel, constitutes the most important approach for using lignocellulosic residues. Ethanol is a better fuel than gasoline because of its excellent physiochemical characteristics (Bailey, 1996). Adding 10 percent ethanol (v/v) to gasoline increases the octane number, improves engine efficiencies through excellent anti-knocking properties and gasoline oxygenation.

PRODUCTION OF ETHANOL THROUGH THE FERMENTATION OF REDUCING SUGARS RESULTING FROM THE HYDROLYSIS OF PRETREATED SAWDUST (HARDWOOD)