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Production of Bioplastic from Banana

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ABSTRACT
Every developed country depends on the industry as the main factor of its economy. Lack of export, depression in both the general economy and the value of the currency are consequences of neglecting the industry all countries work on increasing the efficiency of their industry by whether working on the input, the output, the cost or the time of the process. Plastic industry is considered one of the most important industries because plastic is an important factor in the making of many useful products such as sheets, tubes, rods, slabs, building blocks and domestic products.
Making bioplastic from banana peels instead of the traditional petroleum-based plastic is believed to be a successful solution to increase the efficiency of plastic industry. The solution produce the same amount of plastic with higher efficiency and durability and with a little cost in less time than normal plastic, so it meets the design requirement of any successful solution which are production, efficiency, and cost. The prototype of this project represents the process of manufacturing bio-plastic from banana peels and tests the durability and the efficiency of the plastic produced. The result showed that the plastic produced could bear the weight one and a half time more than petroleum-based plastic so it is suitable for being used in the making of traditional plastic products. In conclusion, test results showed that this project is the perfect solution to develop the plastic industry process.

Keywords: banana peels; NaOH, sodium Metabisulfite, Glycerol.

1. Introduction

The dawn of industry is rising more than ever it had raised since civilization began as shown. Its continues improvement has been saving effort and time to humankind and further needs are being met to more population.
Moreover, the economic income from industry saved it the leading position amongst all national and business plans. Increasing the efficiency of the production was the chief concern to mankind to increase income and suffice the needed goods. Pollution, industry supplies, energy and the efficient use of them were the highest obstacle grand challenges came in the way of industry.
If Industrial efficiency was attempted to be risen, production must increase with constant inputs, inputs decrease with constant production, time of production decreases with constant inputs and outputs or a combination of them all. Plastic industry is very important because it's important products. Plastic represents only a small percentage of recycled materials .
A prior solution to develop plastic industry process is using paper instead of petroleum-based plastic to make traditional plastic products such as sheets, slabs and domestic products. There are some advantages of this solution as it's cheap and environmental. Also, there are disadvantages as paper can't be used to make all plastic products such as rods, tubes and building flocks. Banana peels based bioplastic is a lower cost, more productive and boosted efficient project.

The production of bio-plastic from banana peels which are rich in starch and cellulose, important raw materials used in the bio-plastic industry, was the suitable piece of the puzzle. It uses waste material that is cheap, Massive amount of plastic can be generated due to the huge amount of unused peels which represent about 30%-40% of the fruit mass. The prototype of this solution took several steps and many local and cheap materials were used which will be addressed in the materials section. Through the data collection from tests that have been done on the prototype, it was concluded that the project achieved the design requirements.

Plastics are an essential part of modern life. Plastic is a broad name given to different polymers with high molecular weight, the term plastic is commonly used to refer the synthetically or semi synthetically created materials that we constantly use in our daily lives.

Plastics continue to play a defining role in finding innovative and forward looking solutions to the way we live. Plastics are everywhere, in our housing, clothing, automobiles, packaging, electronics, aircrafts, cars, autos decorative items and medical implants to name but a few of their many applications like in housing and construction, in wind turbines and solar panels etc Bioplastics can be defined as plastics made of biomass such as corn, banana peels and sugarcane.

Biodegradability of bioplastics has been widely publicized in society and the demand for packaging is rapidly increasing among retailers and the food industry at large scale.

Population growth has led to the accumulation of massive volume of non degradable waste materials across our planet. The accumulation of plastic waste has become a major concern in terms of the environment. Conventional plastics not only take many decades during decomposition, but also produce toxins while degradation. Hence, there is need to produce plastics from materials that can be readily eliminated from our biosphere in an "ecofriendly" fashion. Bioplastics are natural biopolymers synthesized and catabolized by various organisms.

1.1 What are bioplastic

Bio-plastics from renewable origin are a new generation of plastics which are able to significantly reduce the environmental impact in terms of energy consumption and green house effect in specific applications. Bioplastics comprise a range of materials with differing properties. Bioplastics encompasses a family of materials which differ from conventional plastics insofar as that they are biobased, biodegradable, or both. Initially, bioplastics were mostly made of carbon hydrogen rich plplant such as corn or sugar cane, so called food crops or 1st generation feedstock. Consistently, 1st generation feedstock were the most efficient feedstock for the production of bioplastic as it required the least amount of land to grow and produces the highest yields.[1] But due some justified reasons, thebioplastics industry is of course also researching the use of non-food crops (2nd and 3rd generation feedstock), such as cellulose, and some waste material sugarcane bagasse or banana peels or potato peels, with a view to its further use. Today bio-plastics and starch based plastics are used in special industrial applications where bio degradability is required. Bio-plastics are 100% biodegradable,compostable or recyclable free from hazardous chemical and toxic substances. Biodegradable plastic materials take less energy to recycle; it reduces the dependency on limited fossil resources mainly imported from other countries and reduces greenhouse gas emissions. Bioplastics has the potential to reduce the, petroleum consumption for plastic by 15 to 20 percent by 2025.

1.2 Materials

Materials used in this project are yellow banana, green banana, corn flour (1.375) g, glycerol (3.55)g,lemon juice. Materials used in this project are yellow banana, green banana, corn flour (1.375) g, glycerol (3.55)g,lemon juice.

Methodology

Materials needed to produce bioplastic from banana peels generally are similar, but there will be slightly different materials added such as chemical substances that can change the chemical structure of the bioplastic either for it to be stronger or more durable. The materials used are important as it will influence the bioplastic produce. The main apparatus used to produce bioplastics are beaker, weight balance, pH meter, measuring cylinder, stove, oven, pipette, stirrer rod, blender, and petri dish .

Next the raw material use is banana peels. Banana peels is the main substance used to produce this bioplastic. Other than that, there are also a few chemical uses in this experiment such as hydrochloric acid, glycerol natrium hydroxide and sodium metabisulphite . The first significant steps of making bioplastic from banana peels is to prepare the banana skins . The banana skins will first be removed by using a stainless steel knife . Approximately 300 g of banana peel were dipped in sodium metabisulphite solution and the peels were then placed into a beaker containing 800 ml water and then the peels were kept for boiling for 30 minutes. After boiling for 30 minutes, the water was then decanted off and the peels were left out on filter paper for drying for 30 minutes at room temperature.

Banana peel has been found to be a suitable raw material for the production of biodegradable plastic. It can be used to create plastic products with high biodegradable capacity. Banana becomes a best raw material for plastic production due to its fast production, high starch content, its fsat growth cycle and universal availability. The raw or green banana has higher starch content as compared to yellow fruit (Rossell, 2002).Bioplastic made from banana peel has various desirable properties such as low cost of production,.easy availability and degradability. According to the Packaging Bulletin magazine's report, it has been proved that banana starch is the suitable and important raw material for synthesis of biodegradable plastic. Banana peel contain starch which can be used to produce propane-1,2,3triol which is as an additive used to improve plasticity and elastic behavior of material (Manimaran, 2016). Growth cycle of banana is fast and it is the basic reason for the industries to use banana most as a raw material. Plastic made from banana peel exhibit same properties as the plastic made by petroleum manifest. However, the biggest difference between plastic manufactured from banana peel and one produced by petroleum is that, the latter of Bioplastic is completely non- toxic, once it is degraded it can be used in various fields such as fertilizer (Mooney, 2009).

Figure 1 Fresh Bananas were taken

Figure 2 Banana Peels were taken

Figure 3 Sodium metabisulphite

Figure 4 Banana peels were soaked

Figure 5 Peels were boiled with water

Figure 6 3ml of (0.5M) HCL and 3 ml NaOH

Tensile strength

The tensile strength was measured by using standard machine ASTM. In the absence of starch the tensile strength is negligible and in the presence of starch its tensile strength increases. The mechanical properties of the developed bio-plastic films are the most important properties and they were characterized in terms of tensile strength (TS) and elongation at break (EB).

Accordingly, The TS and EB values of the as prepared bio plastic films were investigated in the Ethiopian Conformity Assessment Enterprise by calibrated Universal Tensile Testing Machine (UTM, made in Thailand). The lab room condition was 45% relative humidity (RH) and 24.5oC temperature. The test parameters i.e. (thickness, width and length of the test samples) were feed to the tensile strength tester with the gauge length and the crosshead of 20 mm and 100 mm/min, respectively.

And the pre-prepared sample Films were cut into strips with 2 cm length and 2 cm width in dumbbell shape. Finally, the test results were generated, that is, the mean of tensile strength at break in Mpa, elongation at break in %.

Advantages of bio plastic :-

1. Improved „printability‟, the ability to print a highly legible text or image on the plastic
2. A less „oily‟ feel. Bioplastics can be engineered to offer a much more acceptable surface feel than conventional plastics.
3. Less likelihood of imparting a different taste to the product contained in a plastic container. Milk, for example, will acquire a new taste in a styrene cup but the bioplastic alternative has no such effect.
4. A bioplastic may have much greater water vapor permeability than a standard plastic. In some circumstances, such as sandwich packaging, this can be a disadvantage, but in the case of newly baked bread a bioplastic container will offer a significant advantage in letting out excess vapor or steam.

5. A bioplastic can feel softer and more tactile. For applications such as cosmetics packaging, this can be a major perceived consumer benefit.
6. Bioplastics can be made clearer and more transparent (although they are usually more opaque).

Disadvantage of bio plastic:-

a. They are generally two or three times more expensive than the major conventional plastics such as polyethylene or PET. This disadvantage will tend to diminish as bioplastics manufacturing plants become larger and benefit from economies of scale. When the local biological feedstock is particularly cheap, as it is in Brazil, large bio polyethylene plants may already be close to being costcompetitive with oil-based alternatives. But more generally, the crude oil for a kilo of plastic costs around €0.20 but the corn, a key source of feedstocks for bioplastics currently (August 2011) costs about twice this amount.

2. 2) Their physical characteristics are not always a perfect substitute for the equivalent polymer. Sometimes the differences are trivial, such as the biological version having a slightly different texture, but in some cases the bioplastic cannot substitute for the conventional plastic. But for the most important plastic – polythene – the product based on biological sources is identical to the plastic made from oil.

3. 3) There are a huge number of different market segments in which bioplastics can compete. In some cases, bioplastics are likely to make substantial inroads into share of traditional plastics while in others they will struggle. Novamont, the leading Italian bioplastics company, has estimated that biodegradable plastics can replace about 45% of the total sales of oil-based plastics in horticulture and 25% of those used in catering. Others regard these estimates as too low.

4. Bioplastics versus food in many types of applications bioplastics offer substantial advantages over conventional products. Despite of their relatively minor current role, one serious issue does need to be addressed, both now and in the future. At the moment many bioplastics are made from sugars and starches harvested from crops that otherwise might be grown for food. As with liquid biofuels, the bioplastics industry has to deal with the vitally important question of whether the growth of bioplastics will tend to decrease the land available for food production, or increase the incentive to cut down forested areas to create more arable land.

5. Perhaps 300,000 hectares are used to grow the crops which the industry processes into plastics. If today‟s entire plastics production was made from biological sources it would consume between 0.1% and 0.2% of the globe‟s total annual production of organic matter („net primary production‟). This is not a trivial amount but concerns about the competition for land need to be balanced by consideration of the enormous potential value of making bioplastics compared to the equivalent oilbased plastics.

6. Finally, we need to consider the impact of improved recycling. We are stressing the importance of the recycling of non-biodegradable plastics, because whether from oil or from plant matter? Because the world needs to be more economical in its use of its scarce resources. Whether this is the oil used for most plastics or the starches, sugars and cellulose for biological plastics, we cannot afford to continue to throw a

Discussion

The tensile strength for sample keeps increasing when the residence times are increased from 5 minutes to 15 minutes and reaches a maximum at 15 minutes and then starts decreasing when the time is increased

to 20 minutes. This suggests that the optimum hydrolysis time is 15 minutes for this sample set.
During the initial stages of hydrolysis, the amylose content increased, this was attributed to the fact that due the hydrolysis of branched chains of amylopectin, linear chained amylose were formed. However, if the hydrolysis time was increased further, the amylose content decreased albeit slightly. If this hydrolysis time was continued uninterrupted for long durations, the analysis revealed significant drop in the amylopectin and amylose content of starch. This was because once the amylopectin is hydrolyzed to amylase, further hydrolysis leads to formation of glucose monomers which do not aid in polymer formation.
The color of the plastic we got is black. It can be change by adding some additives in it. We can use other plasticizer also such as sorbitol for the production of bioplastic. Bananas are annual plants and their peels are available at all times of the year . Raw green banana peels have been identified as potent producers of bioplastics owing to their higher starch content, better transparency, and several other features that meet standard requirements for commercial bioplastic production .
The fermentation of banana peel wastes yields polylactic acid (PLA); a renewable polyester material in nature that is also studied for its applications in bioabsorbable fixation devices, drug delivery systems, and several other biomedical applications. Various additives have been used to enhance the properties of the banana peel bioplastic; which includes the usage of citric acid, a co-plasticizer in increasing the tensile strength of the final product. usage of starch to polythene help improve biological degradation . Studies regarding the methods to improve the standard requirements of bioplastic production can be pursued shortly, as it would be of great benefit to the environment and the species occupying it.
In this project, the experiment conducted in order to form biodegradable plastic from banana peel. The plastic was formed after several experiment was made. The plastic sample produced may not achieving the ideal characteristic of a plastic but it is good in biodegradability as it can be composted in just 6 days.

Result

25 ml is the optimum amount of banana paste used.
Trial 1: While adding ½ $C_6H_8O_7$ and 3.55gm $C_3H_8O_3$, corn flour 1.375gm, plastic has formed but it was fragile and thin. The plastic started to decay after 1day. While adding $C_6H_8O_7$and $C_3H_8O_3$, no plastic was formed. The mixture formed started to decay after 1day.
Trial2: plastic has formed, and it was much thicker than trial 1 but it started to decay after 3 days. It has acquired a darker color and a sharp scent a lost its strength and has become much more fragile.
Trial3: plastic has also been fragile.
Ttial4: plastic has formed and was much thicker than trial 1 and 3. It has not shown any signs of decay for 30 days and counting. No change in strength has been recorded as well of course no experiment is perfect and there is always room for improvement for example, the experiments were not all done at the same time and the bananas used were not purchased on the same day. This is a limitation which could be improved by conducting all the experiments at the same time, on the same batch of banana.

Conclusion

After specifying the grand challenge and the consequences of neglecting it such as lack of exports and depression in the general economy, a lot of researches have been done in order to find a suitable solution to improve plastic industry by producing plastic which has lower cost and higher efficiency to achieve the main grand challenge. A solution has been chosen and a prototype has been constructed, to make sure that this solution meets the design requirements. After performing the test plan on the prototype and analyzing the results, it appeared that the solution succeeded in achieving the design requirements by producing bio plastic from banana peels that has half the cost of petroleum-based plastic, and has higher efficiency as it could bear the weight one and a half time more than traditional plastic. The results showed that the banana peels-based bio plastic is able to achieve the main grand challenge of increasing the industry's efficiency, also it supports the general economy in many other products that plastic plays a factor in the process of their manufacturing.

The bioplastic produced through this method could be substantial and the biodegradable too and one of the main challanges in developing bio-plastic material. The new developments of bioplastics in future can cause the efficiency of production will be increase ,built up the new applications and new opportunities of bio-plastics.Furthermore,the future market for bio-plastics will be increasing owing to its sustainability. Besides the biotechnology of microorganism gives an opportunity to bioplastic manufacture because it could significantly apply and commercialize for various industries such as agriculture, medicine, pharmaceutical, veterinary etc,.

Banana peel bioplastic is a biodegradable and an environment friendly alternative to conventional plastics. The main advantage of bioplastics over conventional plastic is that they degrade in environment without creating any pollution. These type of bioplastics would reduce the dependency on petroleum based plastics this versatility of bioplastic plays key role in green applications. Bioplastic film can sustain the weight near about 2 kg and which have enough tensile strength. The bioplastic prepared from banana peels that can be used as packaging material or as a carrying bag. Glycerol is added as plasticizer that increases its flexibility. To prevent growth of bacteria and fungi sodium metabisulphite is used. The degradation of bioplastic starts after 3 to 4 months from the date of manufacture. The atmospheric condition also effects on degradation period of bioplastic. Conventional petroleum based plastics creates many environmental problems, so we have to focus more on bioplastic which completely degrade after specific time interval in environment by microbial action.

The main advantage of bioplastics over conventional plastic is that they degrade into environment without creating any pollution. Bioplastics is one the best replacement over conventional plastic. By using banana peels as a raw material we can produce good quality bioplastics which has good life.

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