Operational Excellence and Feasibility Analysis of raw material

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Abstract

Plastic is a material that has a high impact on the environment due to the long amount of time it takes to decompose, contaminating residues involved in this material, and the damage caused to human health that this implies. Currently tons of plastic are discarded day after day, for this reason our research is oriented to the production of a bioplastic capable of supplying the conventional plastic but with the advantage that our bioplastic has a considerable environmental impact since this comes from conventional organic waste which are of daily consumption. In the development of our project, we present the data that validate that self-extinction was improved unlike a commercial plastic, in the present project is also taken into account the productivity part of improvement since through operational excellence, costs are reached in several areas of the project such as savings in the amount of raw material when working with a waste material.
Keywords: reusable material, bioplastic, temperature.

1. Introduction

There are many companies and industrial plants where the operations do not have cyclic or repetitive patterns. Such is the case of the greenhouse industry (Espinosa, G et al., 2017). The greenhouses are an important type of agriculture covered in the whole world and have as main objective to achieve a greater production of crops through the modification of the natural environment; especially prolong the growing season in relation to open field crops. Greenhouse cultivation benefits people by providing off-season or high-quality fruits to improve health while generating employment opportunities and high incomes in relation to conventional vegetable cultivation (Jessen, M, and Malter, A 1995). The main goal of building a greenhouse is to provide an optimal level of microclimate conditions for plant growth, development and productivity on a year-round basis or to extend the growing season (Ali, S 2012). Although modern agriculture plays an important role in the provision of goods and services for human well-being (Tilman, D et al., 2002), it also causes the degradation of some ecosystem services (MA 2005). During the last two decades, the productivity and efficiency of greenhouses has been improved, however, farmers must use their resources such as land and water more effectively. Therefore, achieving maximum performance per unit area has become a high research priority. A greenhouse allows to increase the productivity of the crops maintaining a favorable environment for the plants; and thus, production using greenhouses has become more popular than in the past (Cemek, B et al., 2006). During the eighties and nineties, greenhouse cover materials and their effects on the environment received special attention due to the high production costs involved (Cemek, B et al., 2006). The greenhouse cover materials have a substantial impact on weather conditions. The development of alternative materials that can regulate radiation and heat penetration in the greenhouse can significantly improve the growing conditions, as well as minimizing the energy requirements for heating (Kavga, A et al., 2018). Bioplastics are defined as a new generation of plastics that significantly reduce the environmental impact in terms of greenhouse effect and energy consumption. They have the potential to replace petrochemical plastics in homes and private offices, as well as in technical devices. Due to its biodegradability, it can be used for packaging materials or unidirectional applications as an opportunity to decrease the amount of plastic pollution in the world (Schulze, C et al., 2017).

2. Theorical Framework

A greenhouse is a structural building with various types of roofing materials, such as a glass or plastic roof and often glass or plastic walls; It´s heated because the visible solar radiation coming from the sun is absorbed by the plants, the soil, and other things within it. However, the cost of glasshouse (greenhouse) systems is much higher (Sangpradit, K 2014). The plastics used are made of polyethylene film of polycarbonate material, or acrylic glass of PMMA (Geoola, F et al., 1998). Plastics block or selectively enhance certain wavelengths, improve growth rates, inhibit certain diseases

in the crop, allow the correspondingly reduced use of chemicals, maintain heat and humidity in the greenhouse (Jaffrin, A., and Morisot, A 1994).
The management of greenhouse energy is one of the most significant challenges for greenhouse agriculture. The cost of heating has increased to 49% of the total cost of production due to the ever-increasing prices of fossil fuels (Yang, S 2012). A material that covers the greenhouse must have good thermal insulation properties by allowing short wave radiation in the greenhouse to be opaque to infrared radiation (Rasheed, A et al., 2017). The most important features of greenhouse cover films is the ability to provide cooling, high mechanical strength, and durability against photo-degradation (Abdel-Ghany, A et al., 2012). The most common greenhouse cover material is low density polyethylene (LDPE) films. Due to environmental conditions, high temperature, solar radiation, oxygen, chemical pollution, rain, wind, sand wind, ozone, dust, etc., these films are susceptible to be degraded and to undergo structural changes. Because of these structural changes, the films become more rigid, but also less ductile (Dehbi, A et al., 2011). On the other hand, plastic greenhouses (PGS) with transparent materials can protect food crops against unfavorable growing conditions, significantly increasing harvest yield (Takakura, T., 199). Plastic materials used primarily as PG covers have unique properties in aspects of optical transparency, gas tightness, and high reflectivity (Elsner, B et al., 2000). There are two types of common bioplastics, one uses fruit peels and the other is made with vinegar and milk. The purpose of using a bioplastic is because it could present the same advantages as a normal plastic, but with the social responsibility to make an impact on the environment. It has been tried to prove with different citrus peels since they are those that present better mechanical properties for bioplastics. This proposal must comply with the characteristics for effective operation of the greenhouse to allow the entry of light without increasing its temperature, allowing the passage of photosynthetically active radiations (PAR) and reducing the amount of heat accumulated in the greenhouse, therefore, the variables that will govern our system are: the PAR, the resistance, the allowed wind flow, the temperature and the humidity generated by the material. For the validation of the new material, mechanical tests will be carried out to show us the behavior of the material, such as effort, tension and elasticity.
Finally, we must remember that in our changing world, the production plants continue to be an important part of the productive sector of our country and generate a boost in economic development such as these to create the greenhouse industry to offer its services and in the same way, give progress and comfort to our society (Espinosa et al. 2013).

3. Method

The main objective of our project is to develop a polymer based on biodegradable materials. "According to ISO 17088: 2008, the relative degree of biodegradation of a truly biodegradable material should not be less than 90%." In order to achieve this goal, the possibilities of using bioplastics based on protein and high zinc content have been studied. Another alternative to the solution of the bioplastic based on protein is the polymer called polylactide which is compostable and biodegradable. This product is made from tapioca roots and cornstarch. In Mexico, there are several types of bioplastics. The diverse range of products of natural origin range from agave to banana peel, from shrimp shells to tomato. One advantage of working with these products is that you can basically add almost any type of organic product to the mix that the bioplastic will make. There is a recent implementation standard that deals with bio-based test methods. Said standard called NMX-E-267-CNCP-2016, "establishes that two test methods to determine the bio content based on resins and plastic products, applicable to all resins and bio based plastic products that can be incinerated in the presence of oxygen to produce gaseous CO2 and that are manufactured, marketed and distributed in national territory. "This standard was created with the relevant Standardization Body to be able to control these products. Furthermore, we will talk about results or tests made with different fruit waste. The materials used for testing and carried out will be the following ones: potato peel, lemon peel, orange peel, grapefruit peel and banana peel. In addition to the fruit shells that will be the most important factor that will define the mechanical properties of the plastic will be tested with other materials, such as the amount of glycerin, distilled water, cornstarch and white vinegar. The amount of material that we will use for the tests varies, since it is generally recommended to use 60% distilled water (ml), 10% cornstarch (g), 5% glycerin (ml), 5% vinegar (ml) and 20% fruit peel (g). These percentages will be modified for the first tests to achieve changes in the mechanical properties. By increasing glycerin, the elasticity of the material is improved, the fiber of the fruit peel will influence as an important factor to give resistance to the tension, as the composite materials work and the cornstarch is important for the starch, which acts as polymer matrix. These will be the three most important factors to vary to achieve the results. What this tells us, is that different parameters of the materials can affect the mechanical properties positively but risking other properties. Increasing the amount of microcrystalline cellulose causes a stronger tensile strength but once that point is exceeded, the material behaves in a less plastic way and could be a problem for certain applications. When looking for a plastic with high elasticity you should add more glycerin and less fiber and vice versa, so if you are looking to make pellets, you should have a plastic with high strength and low elasticity. Fiber, in the same way, is important for mechanical properties in tests with different fruit shells that can be made to see which one best suit the anticipated needs. The prototype to be made will

be a sheet that meets the same mechanical characteristics as current meshes and withstands the weather for as long as necessary. The proposal to be developed is the polymerization of a bioplastic for large scale production that matches the properties of the current greenhouses. Plastics have a competitive advantage in cost, good mechanical strength with little thickness, resistance to weathering, and in this case, it is important to highlight the weight, because an excess of this would need a more resistant structure. One of the main issues, is that these plastics need to change very often, on average from 5 to 8 years, so there are many debris contemplating that they are complete hectares of greenhouses. For this reason, we need to use a plastic but not harm the environment as they do today's plastics.
The procedure for the development of the project was to take the fruits and gather the entire husk including the white part, removing the fruit and seeds. With 180g of the peel, we proceeded to cut it into smaller portions. Then we introduced the little pieces inside a Ninja blender to make these pieces even smaller. In a measuring cup, add 800ml of distilled water. Formerly we added the distilled water to the blender with the peel, until it had the consistency of puree. Then we empty the puree in a pot or pan. Separated two samples, 300g of the substance that looked like puree and, in another pot, 300g of the filtered liquid. Then, the process was divided into two cases. The first using the bagasse and the second liquid pot, we explain in table 1 and 2 the procedure of each.

Table 1. Case 1

CASE 1	
1	Added 50g of cornstarch to the bagasse mixture.
2	Added 25ml of glycerin and 25ml of white vinegar to the mixture.
3	Make a homogeneous mixture before heating.
4	Ignite the stove and heat until it is a paste, and that it behaves more like a plastic.
5	Spread the paste in a plastic for later drying.

Table 2. Case 2

CASE 2	
1	Added 50g of cornstarch to the liquid mixture.
2	Added 25ml of glycerin and 25ml of white vinegar to the mixture.
3	Make a homogeneous mixture before heating.
4	Ignite the stove and heat until it is a paste, and that it behaves more like a plastic.
5	Spread the paste in a plastic for later drying.

In figure 1 you can see both plastics:

Figure 1.

Finally, a test was made with a piece of each sample, putting it into a dehydrator, from 12:30 am to 6:00 am, and we observed that the drying process of the plastic accelerated. In terms of quality, we prefer the plastic in Case 2 for its strength and appearance. Using the same procedure, a test with red fruits was also made. Upon seeing the results of this test, we decided to opt for the fact with lemon thanks to the price, because there is more waste of shells and the consistency obtained is way better.

4. Results
The bioplastic that has been produced, were subjected to stress tests to compare them with the current bioplastic to review the improvements that will be necessary to provide the solution to the market. These tests are presented below.
Stress Testing

1. Current plastic greenhouse tension test: SUNCOVER CLEAR SRCA 200 MIC. Figure 2 shows the characterization of composites. ASTM. As well as their respective data shown in table 3 and 4.

Table 3: Data Characterization Composites

	Test Tube	Deformation by traction (Extension) at break (Standard) [mm / mm]	Tensile strength at break (Standard) [MPa]	Load at break (Standard) [N]
1	Suncoverclear	5.85685	-0.13412	-0.24142
2	Suncoverclear-H	5.62575	0.15268	0.27483
Deviation Standard		0.16341	0.20280	0.36504
Media		5.74130	0.00928	0.01671

Table 4: Data Characterization Composites

	Extension to break (Standard) [mm]
1	292.84253
2	281.28760
Deviation Standard	8.17057
Media	287.06506

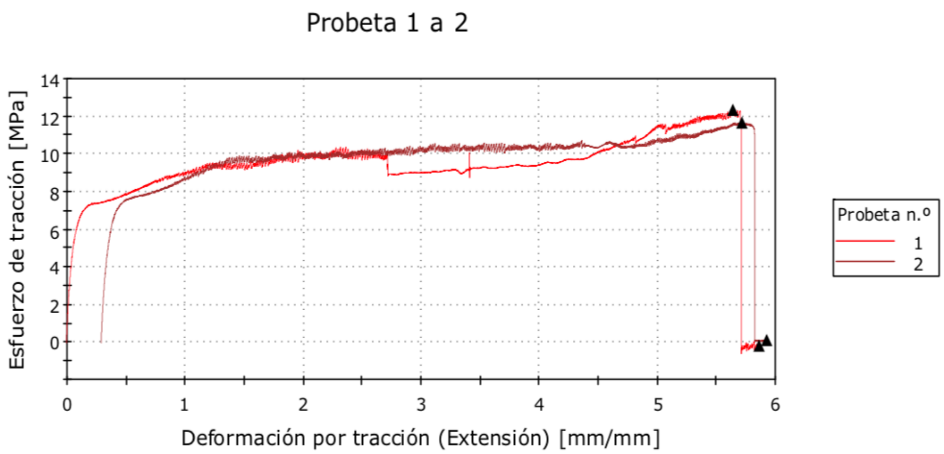

Figure 2. Composites Characterization

2. Bioplastic tension test.
Next, the data corresponding to the stress test carried out on the bioplastic is shown, see table 5 and 6, and in figure 3 we can observe the graphic representation of the ASTM composition characterization.

Table 5. Data Characterization Composites

	Test Tube	Deformation by traction (Extension) at break (Standard) [mm / mm]	Tensile strength at break (Standard) [MPa]	Load at break (Standard) [N]
1	Bioplastic-H	0.33001	-1.19731	-2.26292
2	Bioplastic-H	0.31114	-0.68206	-1.28909
Deviation Standard		0.01334	0.36434	0.68860
Media		0.32058	-0.93968	-1.77600

Table 6. Data Characterization Composites

	Extension to break (Standard) [mm]
1	16.50062
2	15.55712
Deviation Standard	0.66715
Media	16.02887

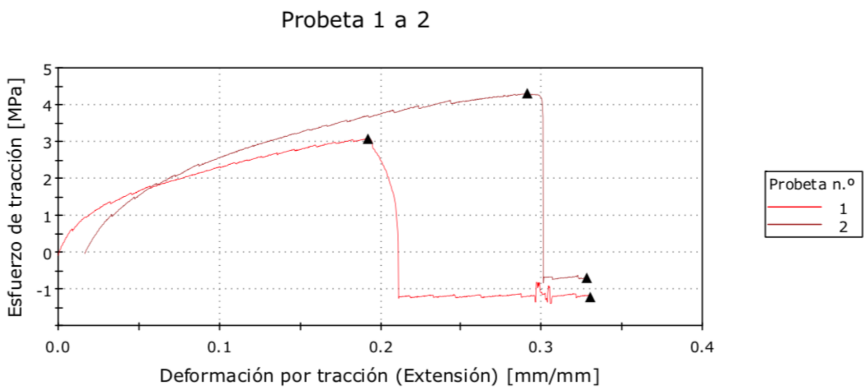

Figure 3. Characterization of ASTM composites

The results of the tests indicated which modifications will be necessary to achieve for the bioplastic to reach a level of production for greenhouses. We had a disadvantage in the bioplastic because the specimen had many fluctuations that interfered with the results. For a bioplastic to be ready for production, it is necessary to follow the next methodology: Synthesis, Rheology tests, Mechanical tests, T, R.P.M., technical tests, Tm, TG and T degradation.
The flame ignition tests are done on the plastic in a test tube and measures how it burns after being exposed to a flame of low calorific value. The aim of this point is to characterize the reaction of fire to small sources of ignition. They are categorized into four types of classifications. These are given as a function of self-extinguishment and the dripping of the burned material. In Table 7 we can see the information of the Self-extinction flame test.

Table 7. Self-extinction flame test

Material	Self-extinguishing time	Total time of self-extinction (10 exposures to specimens	Possibility of dripping (inflaming the cotton)
Plastic greenhouse	11 sec	54	Si
Bioplastic	9 sec	48	No

As you can see, the bioplastic gets to be classified in V0, while the greenhouse plastics are in the V1 classification.

4. Conclusion

To implement bioplastics as a roofing material in the greenhouses, it is necessary to carry out mechanical tests, rheology tests and technical tests. In order to obtain an accurate temperature and extrusion speed data to make bioplastic films, so it can comply correctly with the previously established specifications. Alternatively, one of the main characteristics to consider in the project is the application of bioplastic in different industrial areas as part of evaluating its different uses. One of its uses, is the use of this bioplastic as a replacement for packaging material in products such as: food, cookies, bags used for fruits in supermarkets, which has a very high degradation life and a very low consumption life. This project seeks to be a basis for future research that promotes the introduction of bioplastics to industry, sustainability and ecological impact.

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